

ORA User's Guide 2010

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Abstract

ORA is a network analysis tool that detects risks or vulnerabilities of an organization's design structure. The design structure of an organization is the relationship among its personnel, knowledge, resources, and tasks entities. These entities and relationships are represented by the Meta-Matrix. Measures that take as input a Meta-Matrix are used to analyze the structural properties of an organization for potential risk. ORA contains over 100 measures which are categorized by which type of risk they detect. Measures are also organized by input requirements and by output. ORA generates formatted reports viewable on screen or in log files, and reads and writes networks in multiple data formats to be interoperable with existing network analysis packages. In addition, it has tools for graphically visualizing Meta-Matrix data and for optimizing a network's design structure. ORA uses a Java interface for ease of use, and a C++ computational backend. The current version ORA1.2 software is available on the CASOS website: <http://www.casos.ece.cmu.edu/projects/ORA/index.html>.

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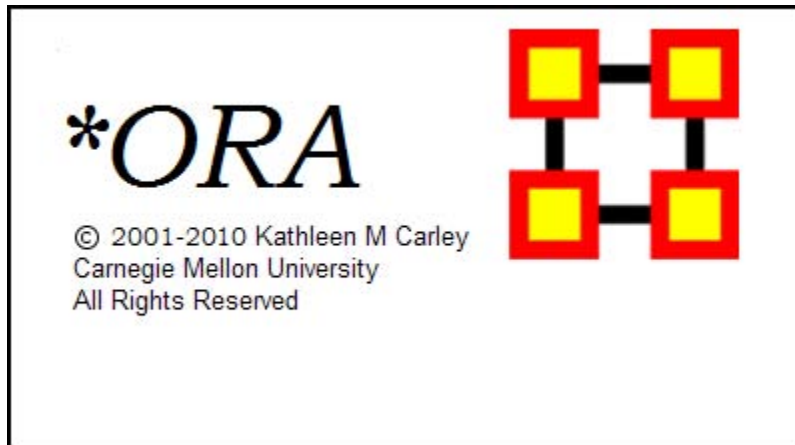
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ORA | Organizational Risk Analyzer

Latest Version

ORA 2.0 (January 2010)

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Release Notes

Latest Version

ORA 2.0 (January 2010)

Notes

The ORA help pages are in a constant state of revision. As the program evolves, grows and improves, the help files and examples attempt to follow suit as soon as possible. However, due to the rapid development of ORA, not every change reflected in the most recent version of ORA, will be listed here, only the major revisions.

More recent screen shots will include the ORA software version. This should be a clear indication of the lag time between a particular section of help and the supporting documentation that accompanies it. Keep in mind: core functionality such as running reports, visualizing a model, building a model, and the math behind the algorithms may change in nuance or material presentation but should remain relatively stable from version to version.

If you should encounter a feature that appears to be entirely without supporting documentation and instruction is needed immediately, please contact the CASOS Center immediately.



Running ORA in Batch Mode

January, 2010
ORA Batch Mode XML
Version 2.0.0

I. Command Line Arguments

The program ora.exe (henceforth called ORA) takes one or more of the following command line arguments as input: (1) Measures File to be used, (2) the Script File to use, and (3) the Log File to use.

If you installed the front-end of ORA, then the executable can be found as:
[ORA installation directory] \include\OraFiles\bin\ora.exe

Likewise, the Measures file can be found as:
[ORA installation directory] \include\OraFiles\xml\ora_xml_measures.xml

Measures File

The Measures File is distributed with ORA and contains an XML encoded description of all the measures available to ORA. This is distributed with ORA and is usually called ora_xml_measures.xml. The following command line parameter specifies the filename:

-measures <filename>

Script File

The Script File is an XML file created by the user and tells ORA where to load the input network data and which reports to generate. Section II - ORA Script XML Specification - describes in detail the format of this XML script. The following command line argument specifies the filename:

-script <filename>

Log File

The Log File is generated by ORA to record the progress and problems of ORA in processing the Script File. The log file is a text file, and the following command line argument specifies its filename:

-log <filename>

Help

A listing of the above parameters is available by using the following command line parameter:

-help

Version

The ORA version can be obtained by the following command line parameter:

-version

II. XML Script

The batch mode script is a user supplied XML document that is input to ORA (see the -script command line parameter above). It tells ORA what network data to load and what reports to generate.

Please note the following general guidelines for the script:

1. camel case capitalization is used for element names: therefore element names begin lower case and the first letter of each word is capitalized. For example, Meta-Matrix is MetaMatrix.
2. default values are used: therefore a short, simple script can initially be used to run ORA. Advanced users can change the default values.

The root node is <ora>, which has two child elements <input> and <output>. The input element describes the network data to load, and the output section describes the reports to generate.

Example: an empty script

```
<ora>
<input/>
<output/>
</ora>
```

A. Input Section

The main unit of input to ORA is the Meta-Matrix, and therefore the input section of the XML script tells ORA how to load one or more Meta-Matrices. A Meta-Matrix is simply an organization modeled as a collection of matrices. The entire Meta-Matrix can be loaded from a single data file, or each matrix can be loaded from separate data files with possibly different data formats.

1. Meta-Matrix Specification

A Meta-Matrix is specified by the <MetaMatrix> element. It accepts a single attribute called id which must be unique across all the Meta-Matrix elements.

The child elements describe the location and format of its matrix data. There are two cases: (1) all data for the Meta-Matrix is stored in a single file, (2) the data for matrices of the Meta-Matrix are located in separate files.

1.1 Meta-Matrix data in a single file

The first case is only possible for a data file in the DyNetML format. In this case, the <filename> and <format> children are required, and the <properties> child is optional. The child elements are described below:

filename : location of the data

format : must be DyNetML

properties : [optional] Describes how ORA should interpret the data read from the file, but does not cause ORA to modify the input data in any way. Each graph in the Meta-Matrix is given the property.

Properties are specified with the attributes below, each of which takes values: yes or no

1. sparse: indicates whether the data is sparse
2. binary: indicates whether the data should be treated as binary (i.e. ignore edge weights)
3. symmetric: indicates whether the unimodal graphs should be considered symmetric
4. diagonal: indicates whether the diagonal values of unimodal graphs should be used

Example:

```
<MetaMatrix id="Organization">  
<filename>data/organization.xml</filename>  
<format>DyNetML</format>  
<properties binary="yes"/>  
</MetaMatrix>
```

1.2 Meta-Matrix data in multiple matrix files

The second case has the Meta-Matrix data located in multiple files. In this case, the script must describe how to assemble the Meta-Matrix from different data files.

Matrix data describes a relationship between two sets of nodes, called the source and target node sets. Therefore, in specifying a matrix, these nodesets must be specified. A unique id for the matrix is also specified. This id must be unique across all matrices in the meta-matrix.

The <matrix> element defines a matrix and has the following case-insensitive attributes:

sourceType : type of the source node set
source : [optional] unique identifier of the source node set
targetType : type of the target node set
target : [optional] unique identifier of the target node set
id : [optional] id of the matrix

The above attributes can be any string.

The sourceType and targetType attributes specify the class or general category of the node sets. By convention, these are taken from Agent, Knowledge, Resource, Task, Location, or Organization, but any string can be used.

The source and target attributes uniquely identify the source and target node sets, and if they are not specified the sourceType and targetType are used. To have more than one node set of a given type (e.g. "blue" agents and "red" agents), the source attribute must be used.

The id uniquely identifies the matrix within the collection of matrices that is the meta-matrix. By default, the id is constructed from the source and target types.

Examples:

```
<matrix sourceType="agent" targetType="agent" id="reports to"/>  
<matrix sourceType="agent" source="employee" targetType="agent"  
target="employee" id="works with"/>
```

As in the first case, the <matrix> element must have the child elements <filename> and <format> that describe the location and format of the matrix data. The <properties> element is optional, and pertains only to the matrix.

The <format> element takes one of the following values:

DyNetML : DyNetML specified data
ucinet : UCINET binary format (refer to UCINET documentation)

dl : UCINET text format (refer to UCINET DL documentation)
csv : CSV (Comma Separated Values) allows row and/or column labels
raw : space, comma, or semi-colon separated data (no labels allowed)

Example:

```
<MetaMatrix id="SampleOrganization">  
<matrix sourceType="agent" targetType="agent" id="communication">  
<filename>data/organization_agent_agent.dl</filename>  
<format>dl</format>  
</matrix>  
</MetaMatrix>
```

Multiple <matrix> elements are used to define the constituent matrices of the Meta-Matrix. Note that <MetaMatrix> has no immediate <filename> and <format> children since the data is described under the <matrix> child elements.

Example:

```
<ora>  
<input>  
<MetaMatrix id="SampleOrganization">  
<matrix sourceType="agent" targetType="agent" id="social">  
<filename>data/organization_agent_agent.dl</filename>  
<format>dl</format>  
</matrix>  
<matrix sourceType="agent" targetType="knowledge">  
<filename>data/organization_agent_knowledge.dl</filename>  
<format>dl</format>  
</matrix>  
</MetaMatrix>  
</input>  
</ora>
```

In the example, the Meta-Matrix contains two matrices: the first of type Agent x Agent and named social, and it is populated with data from the specified file of the specified format. The second has type Agent x Knowledge, and no name is specified.

1.3 Multiple Meta-Matrices

Multiple Meta-Matrices can be specified in the <input> section using unique id attributes.

Example: multiple meta-matrices differentiated by id attribute

```
<ora>
<input>
<MetaMatrix id="SampleOrganization1">
<matrix sourceType="agent" targetType="agent" id="social">
<filename>data/organization_agent_agent.dl</filename>
<format>dl</format>
</matrix>
<matrix sourceType="agent" targetType="agent" id="friendship">
<filename>data/organization_agent_agent_friend.csv</filename>
<format>csv</format>
</matrix>
<matrix sourceType="agent" targetType="knowledge">
<filename>data/organization_agent_knowledge</filename>
<format>ucinet</format>
</matrix>
</MetaMatrix>
<MetaMatrix id="SampleOrganization2">
<filename>data/organization2.xml</filename>
<format>DyNetML</format>
</MetaMatrix>
</input>
</ora>
```

1.3 Meta-Matrix Directories

If there are multiple DyNetML files in a single directory, then one can specify the directory and ORA will create a meta-matrix from each file. The `<metaMatrixDirectory>` element is used, whose only attribute is name that specifies the path of the directory. Each file must have .xml extension. A `<transform>` element can be used within the element to apply to each meta-matrix. The id for each meta-matrix is its filename.

Example: load all meta-matrices from a directory

```
<ora>
<input>
<metaMatrixDirectory name="data/sample/">
<transform>
<conform method="union"/>
</transform>
</metaMatrixDirectory>
</input>
</ora>
```

B. Output Section

The second section of the script file is the <output> element, and it describes which reports to generate. The reports available in ORA and how to specify them in the ora-script is documented in the file ORA-batch-mode-parameters.xml, which is an XML specification in Relax-NG.

ORA-Script Report Generation

To tell ORA to create a report, the <reports> child element is used in the ora-script. The <reports> child element contains a collection of <report> elements. Each report element specifies any input parameters, the output filename, and the output file type/format. Each <report> is uniquely identified by its id attribute.

The <filename> child specifies the name of the output file to create. The filename should NOT have an extension. The <formats> child contains one or more <format> children which specify the format of the report output.

For each report, the possible formats are: text, html, csv, DyNetML

Example: generating a report in multiple output formats

```
<report id="intelligence">
  <filename>reports/intelligence</filename>
  <formats>
    <format>text</format>
    <format>csv</format>
  </formats>
</report>
```

Any report specific parameters are designated within the <parameters> child. The parameters for each report are documented in the file: ora_xml_measures.xml

Example: specifying report parameters

```
<report id="intelligence">
  <parameters>
    <numberOfKeyEntities>10</numberOfKeyEntities >
  </parameters>
  <filename>reports/intelligence</filename>
  <formats>
    <format>html</format>
    <format>csv</format>
  </formats>
</report>
```

Example: shorter script if only one output format is specified

```
<report id="intelligence" filename="reports/intelligence" format="text">
<parameters>
<numberOfKeyEntities>10</numberOfKeyEntities >
</parameters>
</report>
```

3. Saving Meta-Matrices

The input Meta-Matrices can themselves be saved to files. This allows for converting between matrix formats and for saving transformed or conformed input data.

Example: saving a specific meta-matrix

```
<ora>
<output>
<metaMatrices>
<MetaMatrix id="sample">
<filename>data/output/sample.xml</filename>
<format>DyNetML</format>
</MetaMatrix>
</metaMatrices>
</output>
</ora>
```

Only the specified Meta-Matrices will be saved. Individual matrices can be saved using the syntax identical to that of the `<matrix>` element in the input section. The following, for example, saves the agent x agent matrix:

Example: saving a specific matrix from a meta-matrix

```
<ora>
<output>
<metaMatrices>
<MetaMatrix id="sample">
<matrix sourceType="agent" targetType="agent">
<filename>data/output/sample_agent_agent.dl</filename>
<format>dl</format>
</matrix>
</MetaMatrix>
</metaMatrices>
</output>
</ora>
```

In addition, network set operations (union, intersection, difference) can be performed on the input networks and then saved. The sample below assumes that there were two meta-matrices specified in the <input> section, namely, A and B, and the set operations all pertain to them. Union and Intersect operate on one or more input meta-matrices, and the parameter method indicates how to handle common edges. The method attribute takes on one of the following values: binary, sum, maximum, or minimum. The difference between two meta-matrices is taken with respect to edges only, and thus no nodes are removed.

Example: saving union of multiple input meta-matrices

```
<output>
<metaMatrices>
<!--Union-->
<MetaMatrix id="A Union B">
<filename>data/output/A-union-B.xml</filename>
<format>DyNetML</format>
<union method="sum">
<MetaMatrix id="A"/>
<MetaMatrix id="B"/>
</union>
</MetaMatrix>
<!--Intersect-->
<MetaMatrix id="A Intersect B">
<filename>data/output/A-intersect-B.xml</filename>
<format>DyNetML</format>
<intersect method="minimum">
<MetaMatrix id="A"/>
<MetaMatrix id="B"/>
</intersect>
</MetaMatrix>
<!--Difference (edges only)-->
<MetaMatrix id="A Minus B">
<filename>data/output/A-minus-B.xml</filename>
<format>DyNetML</format>
<difference>
<MetaMatrix id="A"/>
<MetaMatrix id="B"/>
</difference>
</MetaMatrix>
</metaMatrices>
</output>
</ora>
```

4. Transform Element

The transform element is used to pre-process a Meta-Matrix or an individual matrix of a Meta-Matrix before generating reports. It transforms its parent element. For example, if the <transform> element is a child of a <matrix> then it applies to that matrix. If it is a child of <MetaMatrix>, then it transforms the entire Meta-Matrix: for node set modifications (removeNodes, subsetNodes, conform), these apply to the Meta-Matrix as a whole, but transformations of edges (symmetrizing, dichotomizing) are applied to each matrix independently.

The <transform> element has the following child elements that define the transformation:

<transpose> : transpose the graph

<removeIsolates> : remove isolate nodes

<removePendants> : remove pendant nodes

<symmetrize method=""> : symmetrize using one of two methods

“union” : symmetrize using the union/maximum method

“intersect” : symmetrize using the intersect/minimum method

Default is “union”.

<subsetNodes> : defines a subset of nodes to create a subgraph

contains one or more of the following child elements:

<nodeSet type=""/> : adds all nodes in the specified node set to the subset.

The type attribute can have values: agent, knowledge, resource, task, organization

<node type="" id="" radius=""/> : adds the specified node to the subset

The type attribute is identical to that of the <nodeSet> element.

The id attribute is the node's unique id within the node set.

The radius attribute is optional (by default it is zero), and includes all nodes within a distance $\leq$ radius of the node. This is useful for defining ego node sets.

<removeNodes> : defines a subset of nodes to remove

contains the same <nodeSet> and <node> child elements as subsetNodes

`<conform method=""/>` : creates an identical set of nodes across meta-matrices. This is useful for time-series data to give each Meta-Matrix the same node sets. The union method adds isolates to achieve identical sets, and the intersect method removes nodes.

The method attribute can have one of two values:

union: create union of node sets

intersect: create intersection of node sets

Default is "union".

By default the agent, knowledge, resource, task, and organization node sets are conformed. This can be customized by adding `<nodeSet>` child elements to specify specific node sets, as in `subsetNodes` above.

`<dichotomize criteria="" cutoff=""/>` : creates a binary graph according to the criteria and cutoff. Any edges whose value does not satisfy the criteria and cutoff are given a value of 0, otherwise a value of 1.

The criteria attribute takes one of the following values:

lessThan, lessThanEquals, equals, greaterThanEquals, greaterThan

The cutoff attribute can be any numerical value.

Precedence

The order (i.e. precedence) in which the transformations occur is as follows: (1) individual matrices, (2) meta-matrices, (3) across meta-matrices. Each of these usages is in the examples below.

The precedence of operations within a transform (for example, is the graph symmetrized before dichotomizing, etc.) is defined to be the same as they are specified in the `<transform>` element. Thus, if the `<symmetrize>` child is before the `<dichotomize>` child, then the transformation first symmetrizes and then dichotomizes.

Example: remove all agent nodes and the specified knowledge nodes from the meta-matrix

```
<MetaMatrix id="test">
  <transform>
    <removeNodes>
      <nodeset id="agent"/>
      <node nodesetId="knowledge" id="physics"/>
      <node nodesetId="knowledge" id="mathematics"/>
    </removeNodes>
  </transform>
```

```

<filename>data/sample.xml</filename>
<format>DyNetML</format>
</MetaMatrix>

```

Example: symmetrize a single matrix of the meta-matrix

```

<MetaMatrix id="test">
  <matrix sourceType="agent" targetType="agent">
    <filename>data/aa.csv</filename>
    <format>csv</format>
    <transform>
      <symmetrize method="union"/>
    </transform>
  </matrix>
  <matrix sourceType="agent" targetType="knowledge">
    <filename>data/ak.csv</filename>
    <format>csv</format>
  </matrix>
</MetaMatrix>

```

This example creates a sub-Meta-Matrix as follows: a set of nodes is defined, and then the Meta-Matrix induced by the nodes (that is, all the edges incident upon those nodes). The set of nodes consists of all nodes within distance 2 of agent Andy and within distance one of Sam. Because the transform is part of the Meta-Matrix, knowledge, task, or organization nodes can be connected to these agents, and would therefore be part of the set.

Example: define a subset of nodes

```

<MetaMatrix id="test">
  <transform>
    <subsetNodes>
      <node nodesetId="agent" id="Andy" radius="2"/>
      <node nodesetId="agent" id="Sam" radius="1"/>
    </subsetNodes>
  </transform>
  <filename>/data/myorg.xml</filename>
  <format>DyNetML</format>
</MetaMatrix>

```

This example makes the agent nodes in the meta-matrices conformable by creating the union of all the agent node sets across the meta-matrices. Currently, only agent nodes can be made conformable.

Example: conform nodesets across meta-matrices

```
<input>
<transform>
<conform method="union"/>
</transform>
<MetaMatrix id="org1">
<filename>data/org1.xml</filename>
<format>DyNetML</format>
</MetaMatrix>
<MetaMatrix id="org2">
<filename>data/org2.xml</filename>
<format>DyNetML</format>
</MetaMatrix>
<MetaMatrix id="org3">
<filename>data/org3.xml</filename>
<format>DyNetML</format>
</MetaMatrix>
</input>
```



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Adjacency Matrix – A Matrix that is a square **actor-by-actor (i=j)** matrix where the presence of pair wise edges are recorded as elements. The main diagonal, or **self-tie** of an adjacency matrix is often ignored in network analysis.

Aggregation – Combining statistics from different entities to higher entities.

Algorithm – A finite list of well-defined instructions for accomplishing some task that, given an initial state, will terminate in a defined end-state.

Attribute – Indicates the presence, absence, or strength of **a particular connection** between entities in a Matrix.

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Betweenness – Degree an individual lies between other individuals in the network; the extent to which an entity is directly connected only to those other entities that are not directly connected to each other; an intermediary; liaisons; bridges. Therefore, it's the number of entities who an entity is connected to indirectly through their direct links.

Betweenness Centrality – High in betweenness but not degree centrality. This entity connects disconnected groups, like a Go-between.

Bimodal Network – A network most commonly arising as a mixture of two different [unimodal networks*](#).

Binarize – Divides your data into two sets; **zero or one**.

Bipartite Graph – Also called a bigraph. It's a set of entities decomposed into two disjoint sets such that no two entities within the same set are adjacent.

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Caesar III – An application for the design of information processing and decision making organizations. An application for the design of decision making organizations at the operational and tactical levels; it takes into consideration cultural differences in coalitions and of adversaries. This tool is under development by George Mason University.

Categorical – An Attribute Type used primarily used for grouping nodes.

Centrality – The nearness of an entity to all other entities in a network. It displays the ability to access information through edges connecting other entities. The closeness is the inverse of the sum of the shortest distances between each entity and every other entity in the network.

Centralization – Indicates the distribution of connections in the employee communication network as the degree to which communication and/or information flow is centralized around a single agent or small group.

Characteristic Path Length – The median of the average shortest distances (number of links) connecting each employee to all other employees.

Interpretation

Characteristic path length gives a insight into how information spreads. It reflects the communication performance of the entire network and is important for diffusing information and routing information to the right people. A small average path length results in fewer "hops" where individuals or groups don't get information.

Classic SNA density – The number of edges divided by the number of possible edges not including self-reference. For a square matrix, this [algorithm*](#) first converts the diagonal to 0, thereby ignoring self-reference (**an entity connecting to itself**) and then calculates the density. **When there are N entities, the denominator is $(N * (N - 1))$** . To consider the self-referential information use general density.

Clique – A sub-structure that is defined as a set of entities where every entity is connected to every other entity.

Clique Count – The number of distinct cliques to which each entity belongs.

Closeness – Entity that is closest to all other Entities and has rapid access to all information.

Clustering coefficient – Used to determine whether or not a graph is a small-world network.

Cognitive Demand – Measures the total amount of effort expended by each agent to do its tasks.

Column Degree – see [Out Degree*](#).

Complexity – Complexity reflects cohesiveness in the organization by comparing existing links to all possible links in all four networks (**employee, task, knowledge and resource**).

Complementarily – The idea that people seek others with characteristics that are different from and complement their own, aka the idea that opposites attract.

Concor Grouping – Concor recursively splits partitions and the user selects n splits. (**n splits -> 2^n groups**). At each split it divides the entities based on maximum correlation in outgoing connections. Helps find groups with similar roles in networks, even if dispersed.

Congruence – The match between a particular organizational design and the organization's ability to carry out a task.

Construct – A reduced form of Construct is found in ORA in the **Near Term Impact Report**.

Continuous – A Attribute Type primarily used for values that are numerical so that statistical analysis can be performed (Average, Minimum, Maximum, and Standard Deviation).

Count – The total of any part of a MetaMatrix **row, column, entity, edge, isolate, etc.**

CSV – File structure meaning **Comma Separated Value**. Common output structure used in database programs for formatting data.

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Degree – The total number of edges to other entities in the network.

Degree Centrality – Entity with the most connections. **(i.e. In the know)**. Identifying the sources for intel helps in reducing information flow.

Density –

- **Binary Network:** The proportion of all possible edges actually present in the Matrix.
- **Value Network:** The sum of the edges divided by the number of possible edges. **(i.e. the ratio of the total edge strength that is actually present to the total number of possible edges)**.

Dyad – Two entities and the connection between them.

Dyadic Analysis – Statistical analysis where the data is in the form of ordered pairs or dyads. The dyads in such an analysis may or may not be for a network.

Dynamic Network Analysis – Dynamic Network Analysis (DNA) is an emergent scientific field that brings together traditional [Social Network Analysis*](#) (SNA), [Link Analysis*](#) (LA) and multi-agent systems (MAS).

DyNetML – DyNetML is an xml based interchange language for relational data including nodes, ties, and the attributes of nodes and ties. DyNetML is a universal data interchange format to enable exchange of rich social network data and improve compatibility of analysis and visualization tools.

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Edge – See **Link**.

Entity – A *who, what, where, how, why, or thing* that is being studied such as people, agents, organizations, beliefs, expertise, resources, tasks, events, or locations. Node the representation of a single entity (a who, what, where, how why item).

Entity Class – A set of entities of one type.

Entity Level Metric – is one that is defined for, and gives a value for, each entity in a network. If there are x entities in a network, then the metric is calculated x times, once each for each entity. Examples are [Degree Centrality*](#), [Betweenness*](#), and [Cognitive Demand*](#).

Entity Set – See Meta-Node.

Eigenvector Centrality – Entity most connected to other highly connected entities. Assists in identifying those who can mobilize others

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FOG – (F)uzzy (O)verlapping (G)roups. Gives a better understanding of individuals spanning groups. Fuzzy groups are a more natural and compelling way of thinking of human social groups.

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General density – The number of edges divided by the number of possible edges including self-reference. For a square matrix, this [algorithm*](#) includes self-reference (**an entity connecting to itself**) when it calculates the density. When there are N entities, the denominator is $(N*N)$. To ignore self-referential information use classic [SNA*](#) density.

Geodesic Distance – A generalization of the notion of a **straight line** to **curved spaces**. In presence of a metric, geodesics are defined to be (locally) the shortest path between points on the space.

Gini coefficient – The measure of inequality of a distribution of income. Uses a ratio with values between 0 and 1: the numerator is the area between the Lorenz curve of the distribution and the uniform (perfect) distribution line; the denominator is the area under the uniform distribution line.

Graph Level Metric – A metric defined for, and gives a value for, the network as a whole. The metric is calculated once for the network.

Examples are Centralization, Graph Hierarchy, and the maximum or average Betweenness.

GraphML – GraphML is a comprehensive and easy-to-use file format for graphs. It consists of a language core to describe the structural properties of a graph and a flexible extension mechanism to add application-specific data.

Group – a collection of things (entities, nodes, ties, networks). A group might at times be represented as a meta-node. Nodes may be classified in to groups on the basis of a shared attribute, type, id-range, label, user selection, etc. For example, if you have a set of people and know their gender, then their might be two groups - men and women. In addition the nodes representing those people could be displayed as a meta-node for men and a meta-node for women. Nodes may be classified in to groups on the basis of a grouping algorithm. For example, if you have a network showing connections among members of an organization and you run a grouping algorithm it will return clusters of nodes that fit together on some mathematical criteria. This cluster is a group and can be represented as a meta-node.

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Hamming Distance – Number minimum number of substitutions required to change one string into another string of equal length. (i.e. "**toned**" and "**roses**" is 3.)

Heuristics – Problem-solving by trial and error: a method of solving a problem for which no formula exists, based on informal methods or experience, and employing a form of trial and error iteration.

Homophily – (i.e., love of the same) is the tendency of individuals to associate and bond with similar others.

- **Status homophily** means that individuals with similar social status characteristics are more likely to associate with each other than by chance.
- **Value homophily** refers to a tendency to associate with others who think in similar ways, regardless of differences in status.

HTML – **H**yper**T**ext **M**arkup **L**anguage.

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In-Degree – The sum of the connections **leading to** an entity **from** other entities. Sometimes referred to **row degree**.

Influence network – A network of hypotheses regarding task performance, event happening and related efforts.

Interstitial – An interstitial (something "in between") is a node situated within but not restricted to or characteristic of a particular group. It provides extra information to the analysis.

Isolate – any entity which has no connections to any other entity

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Latent Semantic Analysis – Latent semantic analysis (LSA) is a technique in natural language processing, in particular in vectorial semantics, of analyzing relationships between a set of documents and the terms they contain by producing a set of concepts related to the documents and terms.

Lattice Network – A graph in which the edges are placed at the integer coordinate points of the n-dimensional Euclidean space and each entity connects to entities which are exactly one unit away from it.

Link – The representation of the tie, connection, relation, edge between two nodes.

Link Analysis – A scientific area focused on the study of patterns emerging from dyadic observations. The relationships are typically a form of co-presence between two entities. Also multiple dyads that may or may not form a network.

Link Class – A set of Links of one type. A set of links of one type can be represented as a meta-link.

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Main Diagonal – in a square matrix this is the conjunction of the rows and cells for the same entity.

Math Terms

These mathematical terms and symbols are used: Let S be any set:

- $\text{card}(S) = |S|$ = the cardinality of S (the cardinality of the entity-sets is represented as $|A|$, $|K|$, $|R|$, $|T|$)
- $\mathbb{R}$ denotes a real number
- $\mathbb{Z}$ denotes an integer

Matrix Algebra – The part of algebra that deals with the theory of matrices.

Measure – A measure is a function that maps one or more networks to $\mathbb{R}^n$. Measures are often scalar ($n=1$) or vector valued with $n=|V|$ or $n=|U|$.

Meta-Link – The representation of a Group of Links.

MetaMatrix – See Meta-Network

Meta-Network – The representation of a Group of Networks.

Meta-Node – A representation of a Group of nodes.

Monte Carlo – A random optimization of your organization

MRQAP - This describes a report in ORA. See [Reports](#) for more information. For multivariate cases, if your dependent variable is continuous or count data (like in a negative binomial case), you should use MRQAP. If your dependent variable is binary, you should use ERGM (P^*) which is forthcoming in ORA. One can perform MRQAP on data that have a dichotomous dependent variable (basically, this is equivalent to using a linear probability model). You do need to interpret your results accordingly.

Multi-Agent System – A loosely coupled network of problem-solver entities that work together to find answers to problems that are beyond the individual capabilities or knowledge of each entity

Multi-entity – More than one type of entity (**people, events, locations, etc.**).

Multi-plex – Network where the links are from two or more relation classes.

Multimode Network – Where the entities are in two or more entity classes.

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Neighbors – Entities that share an immediate edge to the entity selected.

Network – The representation of a set of nodes (including meta-nodes) of one type and the links (including meta-links) of one type between them.

A network N is a triple consisting of two sets of entities, called U and V , and a set of edges $E \subset U \times V$. Thus, we write $N = (U, V, E)$. An element $e = (i, j)$ in E indicates a relationship or tie between entities $i \in U$ and $j \in V$. A network where $U = V$ and therefore $E \subset V \times V$ is called [unimodal*](#); otherwise the network is [bimodal*](#). We write $G = (V, E)$ for [unimodal*](#) networks. For our purposes, unimodal networks will not contain self loops, which means that $(i, i) \notin E$ for $i \in V$.

Network Class – A set of Networks on one type. This can also be represented as a Meta-Network.

Network data format – usually comes in the form of NodeSet 1 listed vertically in column A starting in row 2 and NodeSet 2 listed horizontally in row 1 starting with column B. All the intersecting cells are the links between each of the nodes.

Newman Grouping – Finds unusually dense clusters, even in large networks.

Node – A representation of a real-world entity (a who, what, where, how, why item).

Node Class – A set of nodes of one type. Note a set of nodes of one type can be represented as a meta-node.

Normalized Sum – Otherwise known as the Average.

Notation:

The following matrix notation is used throughout the document for an arbitrary matrix X :

- $X(i, j)$ = the entry in the i^{th} row and j^{th} column of X
- $X(i, :)$ = i^{th} row vector of X
- $X(:, j)$ = j^{th} column vector of X
- $\text{sum}(X)$ = sum of the elements in X (also, X can be a row or column vector of a matrix)

- $\text{dich}(X)$ = dichotomize (make binary) X , so that $\text{dich}(X)(i,j) = 1$ iff $X(i,j) > 0$
- X' = the transpose of X
- $\sim X$ = for binary X , $\sim X(i,j) = 1$ iff $X(i,j) = 0$
- $X@Y$ = element-wise multiplication of two matrices (e.g. $Z=X@Y \Rightarrow Z(i,j) = X(i,j)*Y(i,j)$)

[O](#) | [Top](#)

ODBC – (O)pen (D)ata (B)ase (C)onnectivity is an access method developed by the SQL Access group in 1992 whose goal was to make it possible to access any data from any application, regardless of which database management system (**DBMS**) is handling the data.

Ontology – "**The Specifics of a Concept**". The group of entities, resources, knowledge, and tasks that exist in the same domain and are connected to one another. It's a simplified way of viewing the information.

Organization – A collection of networks.

Out-Degree – The sum of the connections **leading out from** an entity **to** other entities. This is a measure of how influential the entity may be. Sometimes referred to as **column degree**.

[P](#) | [Top](#)

Pajek – A visual tool for analyzing large networks (networks having thousands of vertices).

Path – A set of nodes and links that form a single unbroken chain, such that no node or link is repeated. **i.e. $A \Rightarrow B \Rightarrow C \Rightarrow D \Rightarrow E$**

Pendant – Any entity which is only connected by one edge. They appear to **dangle** off the main group.

Percolation Theory – The behavior of connected clusters in a random network.

Pythia – Program used to create Influence Nets. Pythia is a timed influence net application. This tool can be downloaded at the following URL:
<http://sysarch.gmu.edu/main/software/>.

Q | [Top](#)

QAP Correlation – Calculates measures of nominal, ordinal, and interval association between the relations in two matrices, and uses quadratic assignment procedures to develop standard errors to test for the significance of association.

QAP is designed as a bivariate test (only two variables). Generally, QAP is perfectly fine for almost any bivariate network problem.

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Random Graph – One tries to prove the existence of graphs with certain properties by assigning random edges to various entities. The existence of a property on a random graph can be translated to the existence of the property on almost all graphs using the famous [Szemerédi regularity lemma*](#).

Reciprocity – The percentage of entities in a graph that are bi-directional.

Redundancy – Number of entities that access to the same resources, are assigned the same task, or know the same knowledge. Redundancy occurs **only** when more than one agent fits the condition.

Relation – The way in which entities in one class relate to entities in another class.

Robustness – Two different definitions:

- **Networks** – Concerned with the reliability (Kim & Madard, 2004) and continued functioning of a network following an intervention. The robustness of a network is particularly relevant in communication-type and flow-oriented networks. The purpose for understanding robustness of a network has more of a management of the network connotation.
- **Measures** – This meaning has more of a statistical connotation. Studying the robustness of a measure of a network can also be referred to as conducting a sensitivity analysis on the measure. In keeping with the terminology of the most-recently published research in this area, in lieu of using the term sensitivity, we too will use the robustness term, although the terms can be used interchangeably.
A measure is robust if a slight perturbation in its input produces a slight change in its output.

Row Degree – see [In Degree*](#).

Scale-Free Network – Some entities act as **highly connected hubs (high degree)**, although most entities are of low degree. Scale-free networks' structure and dynamics are independent of the system's size N , the number of entities the system has. A network that is scale-free will have the same properties no matter what the number of its entities is.

Self-Loop – An entity with a connection to itself.

Shapefile - The GIS Visualizer can view overlay a Meta-Network over a map. The map is a shapefile: a digital vector storage format for storing geometric location and associated attribute information. A "shapefile" commonly refers to a collection of files with ".shp", ".shx", ".dbf", and other extensions on a common prefix name (e.g., "lakes.*"). For example, Shapefiles could represent water wells, rivers, and lakes, respectively. Each item may also have attributes that describe the items, such as the name or temperature.

Simmelian Ties – Two entities are **Simmelian Tied** to one another if they are reciprocally and strongly tied to each other and strongly tied to at least one third party in common.

Simulated Annealing – A method of finding optimal values numerically. It's a search method as opposed to a gradient based algorithm. It chooses a new point, and (for optimization) all uphill points are accepted while some downhill points are accepted depending on a probabilistic criteria.

The term **Simulated Annealing** draws its inspiration from metallurgy, where atoms within a metal are heated thereby dislodging them from a metal's internal structure transforming the metal into another atomic state. In this way, your organization is **heated** changing its components in the attempt to arrive at an optimized state.

Slow Measures – As the name implies these measures generally take longer to run.

Small-World Network – Small-World Networks will have sub-networks that are characterized by the presence of connections between almost any two entities within them.

Social Network Analysis – The term Social Network Analysis (or SNA) is used to refer to the analysis of any network such that all the entities are of

one type (**e.g., all people, or all roles, or all organizations**), or at most two types (**e.g., people and the groups they belong to**).

Sphere of Influence – One entity's direct relationship with one of it's neighbors as a function of specified path length.

Standard Deviation – The square root of the variance where variance is the average of the squared differences between data points.

.stl file format – This file format is native to the stereolithography CAD software created by 3D Systems. STL files describe only the surface geometry of a three dimensional object without any representation of color, texture or other common CAD model attributes and can us both ASCII and binary representations

Szemerédi's Regularity Lemma – A fundamental structural result in external graph theory due to Szemerédi (1978). The regularity lemma essentially says that every graph can be well-approximated by the union of a constant number of random-like bipartite graphs, called regular pairs.

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Table data format – Table data usually contains a column with referencing IDs and headers denoting column names.

Tie – see **Link**

Topology – The study of the arrangement or mapping of the elements (links, nodes, etc.) of a network, especially the physical (real) and logical (virtual) interconnections between nodes.

Total Degree Centrality – The normalized sum of an entity's row and column degrees.

Trail – A set of nodes and links that form a single unbroken chain that can revisit nodes but not links. **i.e. $A \Rightarrow B \Rightarrow C \Rightarrow A \Rightarrow D$**

Transpose – In linear algebra, the transpose of a matrix A is another matrix A^T (also written A^{tr} , ${}^tA$, or A') created by any one of the following equivalent actions:

- write the rows of A as the columns of A^T
- write the columns of A as the rows of A^T

- reflect A by its main diagonal (which starts from the top left) to obtain A^T

See [The Transpose Wikipedia Entry](#) for formulas, examples and more information.

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Unimodal networks – These are also called square networks because their [adjacency matrix*](#) is square; the diagonal is zero diagonal because there are no [self-loops*](#).

W | [Top](#)

Walk – A set of nodes and links that form a single unbroken chain that can revisit both nodes and links. **i.e. $A \Rightarrow B \Rightarrow C \Rightarrow B \Rightarrow D$.**

	Getting Started

Welcome to ORA's Help File system! The ORA Help and examples contained herein are written with a specific data set in mind: **Stargate-SG1**. More information on this dataset can be found further down in this section

It is suggested, though not necessary, that the end user work through the examples with this data set. This data set is included with the ORA download and also from the CASOS home page at the following URL:

http://www.casos.cs.cmu.edu/computational_tools/datasets/internal/stargate/index2.html

As an added data set to use, a network model of **The Tragedy of Julius Caesar** will be employed to demonstrate additional examples. In some cases, both data sets may be used to demonstrate the same technique used on two different data sets for added clarity as well to show ORA's unparalleled versatility in the field of **Dynamic Network Analysis**.

In this data set, we set out to build a network model of the people, resources, tasks, events and knowledge that comprised the world of Julius Caesar as portrayed by The Great Bard, also known as William Shakespeare.

How to use ORA help

If you are not familiar with **Social Network Analysis** we encourage you to read through the beginning sections of the help set. The ORA help set is broken up into six primary parts, which are designed for varying levels of user expertise.

Getting Started : provides an overview of Social Networks and how they pertain to ORA.

The Main Interface : details working with the data within the Networks. This includes loading, saving, merging, performing various math functions on the Networks, generating a variety of networks, and running reports.

The Visualizer : takes these Meta-Networks and turns them into graphical representations. There are tools for creating / deleting nodes and links, displaying information in different formats, and helping to analyze the data.

ORA Measures : explains the various measures used in ORA. They contain a short explanation. It also describes the **type, input, and output**.

ORA Reports : contains a description of what each report is and what it will tell you about your data.

Lessons : are designed to teach specific functions and how to carry out many types of useful network analytical tasks that can be accomplished by using ORA.



An Overview

The **Organizational Risk Analyzer** (ORA) is a statistical analysis package for analyzing complex systems as [Dynamic Social Networks](#).

Many complex systems such as organizations, intra-state alliances, food webs, etc. can be represented as an ecology of interlinked networks. Within ORA any complex system is represented as a Network. What follows is a general description of ORA's primary capabilities. Specific instruction is provided under the correlating folders in this help system.

See [Basic Terms](#) for additional definitions relating to Social Networks.

The ORA Visualizer

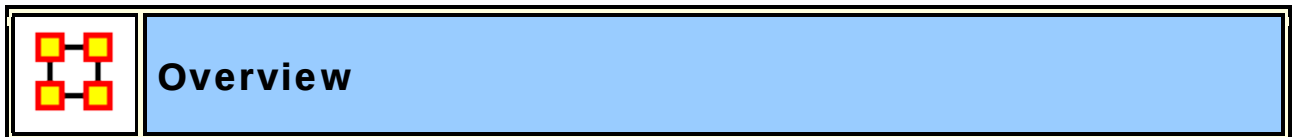
The ORA Visualizer renders conceptual images of social networks. **Nodes such as Agents, Task, Knowledge and Organizations** represent real-world **Entities** like the president of a company, driving to the airport, or how to wash your clothes. Nodes which share the same attributes can be further grouped together creating Meta-Node. **Links** connect nodes that share a direct relationship. Such relationships are derived from the **Network**. ORA's single unit of data input, and are referred to as graphs. The ORA Visualizer is interactive. You can **zoom, rotate, isolate, add and remove Meta-Nodes**, and much more.

Reports

ORA can run many reports: **Risk, Intelligence, and Sphere of Influence** to name a few. Multiple organizations can be compared against each other, network structure can be optimized, subgroups within a network can be identified, and scenarios involving the removal of nodes or links can be examined. Reporting capabilities are constantly being refined and updated.

Charts

Four chart types are available: **Bar Chart, Scatter Plot, Histogram, and Heat Map**. Each one in turn presents a different statistical profile of a selected nodeset. Examples of these reports and how to access them can be found under Basic Usages.



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ORA

ORA is an analysis tool designed to help the user evaluate one or more networks. It can be used to assess the nature of, features of, change in, and determinants of complex networks. A large variety of networks can be assessed including, but not limited to, social networks, activity networks, task networks, knowledge networks, supply chains, and communication networks. Using ORA questions such as the following can be addressed: what is critical, are there groups of interest, are there patterns of interest, how might interventions impact the network, who is critical, are there emerging groups, how is the network changing.

What is a network? In any data there are relations among things such as two people are cousins, or a set of people are all members of the same club. These networks might be psychological or cultural as when two people share the same belief. They might be physical as in two resources being in the same location or two computers being connected by a line, or they might be social as in people being related. There are many reasons why networks exist. Networks are ubiquitous. Everyone and everything is constrained and enabled by the networks in which they are embedded. Everyone and everything is embedded in multiple networks; e.g. you are connected to some people due to work, others due to school, others due to your kids, and so on. ORA lets you visualize, assess, and reason about these networks.

What kinds of networks?

ORA can assess any type of network. Anything that can be represented as a set of nodes and relations can be assessed. Typical networks are: social networks (who interacts with whom), financial networks (who lends money to whom); gant charts (what task needs to be done before what), supply chains (what resources are needed to build what other resources)., semantic networks (what ideas are linked to what ideas), proximity networks (what states border on what states), and so on. ORA can assess any data that can be represented as nodes and relations regardless of what the nodes are or what the relations are.

What if there are many networks?

ORA can be used to assess the interlocks among networks. For examples, imagine that the following networks exist: who works with whom; who has what skills, what skills are needed for what tasks, who is doing what tasks then ORA can assess whether in fact the right people have been assigned to those tasks or where there are problems because there is insufficient skills available for the task. ORA can assess "multi-mode multi-link" data.

What if the networks change?

ORA can be used to assess change in networks over time. Over time, the shape or topology of a network might change; e.g., start up companies move from a collaborative to a hierarchical structure, terrorists change what weapons they use to attack sites, scholars cite different papers, and so on. Consequently, over time, who or what is critical in a network might change. ORA can assess change in networks, and forecast possible ways in which the network might change in the future.

What if information is incomplete?

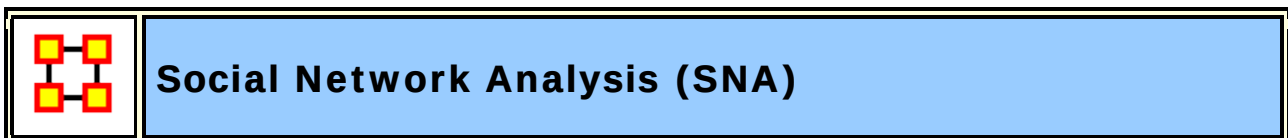
ORA can assess networks even when information is incomplete. ORA has been built to gracefully degrade so that it calculates all and only those metrics for which there is information.

Illustrative applications

ORA has been applied in numerous settings. Examples include the following. Assessment of team-x leadership structure at NASA. Comparison of terror networks. Identification of vulnerabilities in insurgency and terror networks. Assessing change in political elite structures in Korea and early identification of emergent leaders. Designing teams for war games. Assessing the impact of turnover and retirement on public health organizations in Dutchess County, NY. Identifying reports with AIS data. Organizations where ORA has been used include: AFIT, SOCOM, USMA, CIA, many universities.

Tool Evolution

There are still many challenges in the area of dynamic network analysis. Key challenges include handling streaming data, locating confidence intervals for metrics, uncertainty assessment, and so on. As these challenges are met, new algorithms are implemented, tested and added to ORA thus further meeting the user's needs.



[Social Network Analysis*](#) is a scientific area focused on the study of relations, often defined as social networks.

In its basic form, a social network is a network where the people **entities** and the relations **links** are a form of connection such as friendship. Social Network Analysis takes graph theoretic ideas and applies them to the social world.

The term **social network** was first coined in 1954 by J. A. Barnes (**see: Class and Committees in a Norwegian Island Parish**). Social network analysis is also called network analysis, structural analysis, and the study of human relations. SNA is often referred to as the science of **connecting the dots**.

Today, the term Social Network Analysis (**or SNA**) is used to refer to the analysis of any network such that all the entities are of one type (**e.g., all people, or all roles, or all organizations**), or at most two types (**e.g., people and the groups they belong to**). The metrics and tools in this area, since they are based on the mathematics of graph theory, are applicable regardless of the type of nodes in the network or the reason for the connections.

For most researchers, the entities are actors. As such, a network can be a cell of terrorists, employees of global company or simply a group of friends. However, entities are not limited to actors. A series of computers that interact with each other or a group of interconnected libraries can comprise a network also.

Where to find out more on SNA

- Scott, John, 2000, Social Networks, Sage (2nd edition)
- Wasserman, S. & K. Faust, 1994, Social Network Analysis: Methods and Applications



[Dynamic Network Analysis \(DNA\)*](#) is an emergent scientific field that brings together traditional [social network analysis \(SNA\)](#), [link analysis \(LA\)](#) and [multi-agent systems \(MAS\)*](#). There are two aspects of this field. The first is the statistical analysis of DNA data. The second is the utilization of simulation to address issues of network dynamics. DNA networks vary from traditional social networks in that are larger dynamic multi-mode, multi-plex networks, and may contain varying levels of uncertainty.

DNA statistical tools are generally optimized for large-scale networks and admit the analysis of multiple networks simultaneously in which, there are multiple types of nodes ([multi-nodes](#))* and multiple types of links ([multi-plex](#))*. In contrast, SNA statistical tools focus on single or at most two mode data and facilitate the analysis of only one type of link at a time.

DNA statistical tools tend to provide more measures to the user, because they have measures that use data drawn from multiple networks simultaneously. From a computer simulation perspective, nodes in DNA are like atoms in quantum theory, nodes can be, though need not be, treated as probabilistic.

Whereas nodes in a traditional SNA model are static, nodes in a DNA model have the ability to learn. Properties change over time; entities can adapt: A company's employees can learn new skills and increase their value to the network; Or, kill one terrorist and three more are forced to improvise. Change propagates from one entity to the next and so on. DNA adds the critical element of a network's evolution and considers the circumstances under which change is likely to occur.

Where to learn to more:

- *Kathleen M. Carley*, 2003, Dynamic Network Analysis” in Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers, Ronald Breiger, Kathleen Carley, and Philippa Pattison, (Eds.) Committee on Human Factors, National Research Council, National Research Council. Pp. 133-145, Washington, DC.
- *Kathleen M. Carley*, 2002, Smart Agents and Organizations of the Future” The Handbook of New Media. Edited by Leah Lievrouw and Sonia Livingstone, Ch. 12, pp. 206-220, Thousand Oaks, CA, Sage.
- *Kathleen M. Carley, Jana Diesner, Jeffrey Reminga, Maksim Tsvetovat*, 2005-forthcoming, Toward an Interoperable Dynamic Network Analysis Toolkit, DSS Special Issue on Cyberinfrastructure for Homeland Security: Advances in Information Sharing, Data Mining, and Collaboration Systems.



In general, you may want to use ORA in conjunction with other computational tools to advance DNA theory. The **CMU CASOS tools** that

work with ORA to form tool chains are **AutoMap** (extracts networks from texts) and various DNA simulators including both **Construct and DyNet**. These tools are often used in a number of real world applications, including the following areas:

- Designing adaptive teams for Command and Control Networks
- Estimating the impact of organizational downsizing
- Estimating the effectiveness of new structures
- Evaluating risk in organizational designs
- Examine impact of IT effectiveness
- Impact analysis of actions in asymmetric warfare simulation
- Impact analysis of weaponized biological attacks on cities

ORA is interoperable with a number of other SNA and link-analysis tools: **UCINET, KeyPlayer, and Analyst Notebook**. Additional information is listed under data import and export.

Where to learn more about CASOS tools and this tool chain:

Kathleen M. Carley, Jana Diesner, Jeffrey Reminga, Maksim Tsvetovat, 2004, An Integrated Approach to the Collection and Analysis of Network Data, In Proceedings of the NAACSOS 2004 Conference, Pittsburgh, PA

Kathleen M. Carley, 2004, Estimating Vulnerabilities in Large Covert Networks Using Multi-Level Data, In Proceedings of the NAACSOS 2004 Conference, Pittsburgh, PA

Kathleen M. Carley, 2003, Dynamic Network Analysis in Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers, Ronald Breiger, Kathleen Carley, and Philippa Pattison, (Eds.) Committee on Human Factors, National Research Council, National Research Council. Pp. 133-145, Washington, DC.

Kathleen M. Carley, Jana Diesner, Jeffrey Reminga, Maksim Tsvetovat, 2005-forthcoming, Toward an Interoperable Dynamic Network Analysis Toolkit, DSS Special Issue on Cyberinfrastructure for Homeland Security: Advances in Information Sharing, Data Mining, and Collaboration Systems.



System Requirements

ORA performs best on machines that meet or exceed the following specifications:

Spec	Windows	Mac (running XP)
System	XP	OSX 10.4.x
RAM	256 MB	1GB
Processor	Pentium 4	Intel Core 2 Duo
Speed	1.0 GHz	2.0 GHz
Java	6.0	6.0
Extra		Parallels for Dual Booting

NOTE: When working with extremely large data sets, increasing processing speed and RAM is highly recommended.



Files Formats

ORA can read in a multitude of file formats. Below is a list, with examples of the code, of those formats.

[DyNetML](#) – [.dl](#) – [UCINET](#) – [comma delimited \(.csv\)](#) – [text files \(.txt\)](#) – [Pajek \(.net\)](#) – [GraphML](#) – [GMU model \(.stl\)](#) – [Pathfinder \(.lo\)](#).

DyNetML (the native ORA xml format): DyNetML is an xml based interchange language for relational data including nodes, ties, and the attributes of nodes and ties. DyNetML is a universal data interchange format to enable exchange of rich social network data and improve compatibility of analysis and visualization tools.

```
<node id="col_jack_o'neill">
```

```

<properties>

  <property name="ally" type="string" value="yes"/>

  <property name="gender" type="string" value="male"/>

</properties>

</node>

<graph sourceType="Agent" source="Agent" targetType="Agent"
target="Agent" id="agent x agent" isDirected="true">

  <edge source="A01" target="A11" type="double" value="1"/>

  <edge source="A02" target="A01" type="double" value="1"/>

</graph>

```

.dl: DL (for "data language") is a very powerful and (fairly) simple language that allows the creation of quite complex and large UCINET data sets with minimal data entry. DL language files are plain ASCII text files that can be created with any editor (be sure to store the results as plain text).

dl n=9, format=edgelist1

labels:

A,B,C,D,E,F,G,H,I

data:

1 1 1

1 2 1

1 6 1

.

.

.

8 7 1

9 9 1

.##h and ##d (UCINet): UCINET datasets are stored in a special (Pascal) format, but can be created and manipulated using both UCINET's and other software tools (text editors and spreadsheets). Each UCINET dataset consists of two separate files that contain header information (e.g. myfile.##h) and the data lines (e.g. myfile.##d). Because of this somewhat unusual way of storing data, it is best to create data sets with the internal spreadsheet editor or DL language tools, or to import text or spreadsheet files and save the results as UCINET files.

.CSV (comma separated values): The CSV ("Comma Separated Value") file format is often used to exchange data between disparate applications. The file format, as it is used in Microsoft Excel, has become a pseudo standard throughout the industry, even among non-Microsoft platforms. File most commonly created from an Excel spreadsheet using the **Save As...** option

- Each record is one line... but — A record separator may consist of a line feed (ASCII/LF=0x0A), or a carriage return and line feed pair (ASCII/CRLF=0x0D 0x0A)... but — fields may contain embedded line-breaks (see below) so a record may span more than one line.
- Fields are separated with commas.
- Leading and trailing space-characters adjacent to comma field separators are ignored.
- Fields with embedded commas must be delimited with double-quote characters.
- Fields that contain double quote characters must be surrounded by double-quotes, and the embedded double-quotes must each be represented by a pair of consecutive double quotes.
- A field that contains embedded line-breaks must be surrounded by double-quotes

- Fields with leading or trailing spaces must be delimited with double-quote characters.
- Fields may always be delimited with double quotes.
- The first record in a CSV file may be a header record containing column (field) names

```
,A01,A02,A03,A04
```

```
A01,0,0,0,0
```

```
A02,1,0,0,0
```

```
A03,1,0,0,0
```

```
A04,1,0,0,0
```

.txt (text files): Otherwise referred to **ASCII files** which contain no extemporaneous formatting.

.raw:

.net (Pajek): The file format accepted by Pajek provides information on the vertices, arcs (directed edges), and undirected edges. A short example showing the file format is given below:

*Vertices 3

```
1 "Doc1" 0.0 0.0 0.0 ic Green bc Brown
```

```
2 "Doc2" 0.0 0.0 0.0 ic Green bc Brown
```

```
3 "Doc3" 0.0 0.0 0.0 ic Green bc Brown
```

*Arcs

```
1 2 3 c Green
```

2 3 5 c Black

*Edges

1 3 4 c Green

.graphml: GraphML is a comprehensive and easy-to-use file format for graphs. It consists of a language core to describe the structural properties of a graph and a flexible extension mechanism to add application-specific data. Unlike many other file formats for graphs, GraphML does not use a custom syntax. Instead, it is based on XML and hence ideally suited as a common denominator for all kinds of services generating, archiving, or processing graphs.

```
<xs:annotation>
```

```
  <xs:documentation
```

```
    source="http://graphml.graphdrawing.org/"
```

```
    xml:lang="en">
```

```
    Simple type definitions for the new graph attributes.
```

```
  </xs:documentation>
```

```
</xs:annotation>
```

.stl (GMU model): This file format is native to the stereolithography CAD software created by 3D Systems. STL files describe only the surface geometry of a three dimensional object without any representation of color, texture or other common CAD model attributes and can use both ASCII and binary representations

An ASCII STL file begins with the line:

```
solid {name}
```

where *name* is an optional string. The file continues with any number of triangles, each represented as follows:

facet normal n1 n2 n3

outer loop

vertex v11 v12 v13

vertex v21 v22 v23

vertex v31 v32 v33

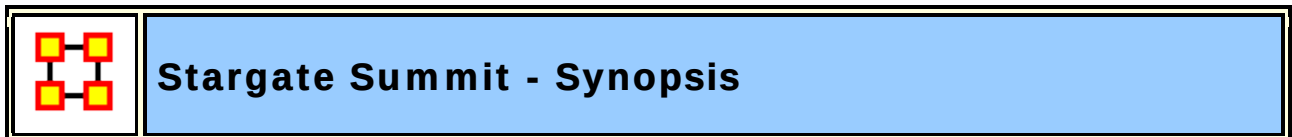
endloop

endfacet

where n1-n3 and v11-v33 are floating point numbers in sign-mantissa'e'-sign-exponent format and concludes with:

endsolid {*name*}

.lo (pathfinder):



Story Background

The data for this scenario is based on the Sci-Fi tv show, Stargate SG-1 and specifically the episodes **Summit / Last Stand**. Following is a synopsis of the episodes if you have any questions regarding the dataset.

The DataSets

The Agents – Colonel Jack O'Neill, Major Samantha Carter, Doctor Daniel Jackson, Teal'c, Jacob Carter/Selmak, Lt Elliot, Ren'al, Aldwin, Janet Frazier, Major Mansfield, General Hammond, Lantash, Narim, Travell, Osiris, Yu

The Short of it

The **Tok'ra** are planning an attack which would kill all of the head **Gou'ald** in one fell swoop by infiltrating a summit and poisoning them all

simultaneously. With the help of Stargate Command and the U.S. Military they are able to infiltrate the summit. The plan is going fine until new information is disclosed which changes everything.

The Story

The Tok'ra have information regarding a secret Goa'uld summit of all the System Lords. They devise a plan to destroy the organization once and for all by poisoning their symbiotes, but they have need of one thing. A human (tauri) who speaks fluent Goa'uld.

Ren'al (the head of the Tok'ra council) travels to Earth to meet with Stargate Command in order to recruit Dr. Daniel Jackson. Dr. Jackson is a human who is fluent in Goa'uld. The System Lords have declared a truce for the summit and each System Lord can bring one human servant.

SG-1 journeys to the Tok'ra homeworld, Revanna. Jacob Carter, previously of the U.S. military but now a Tok'ra, presents the plan to Colonel O'Neill and SG-1. He's established himself as a minor Goa'uld in the service of Yu. He can help get Daniel inside Yu's home base by using the Reole memory-altering chemical to convince Yu that he is his closest human slave, Jarren.

Elsewhere, the Goa'uld Zipacna, a servant of the new and very powerful Goa'uld, welcomes a guest, Osiris. Zipacna offers her a position in service of the Goa'uld, Anubis.

Osiris prepares to depart Zipacna's ship for the summit, as Anubis' official representative. Zipacna, meanwhile, has learned the location of the new Tok'ra homeworld, Revanna, from a captured spy and plans to launch a full-scale invasion.

Jacob and Daniel successfully dispose of Jarren, and, using the Reole drug, trick Yu into believing Daniel is his faithful servant. Yu and Daniel depart to the summit.

Six of the galaxy's most powerful System Lords are waiting: Ba'al, Olokun, Morrigan, Bastet, Kali the Destroyer, and Svarog. They are waiting, though, for another guest, the powerful Goa'uld who has been dealing them all heavy defeats in battle, but who refuses to make his identity known.

As the attack begins on Revanna SG-1 and SG-17 try to help the Tok'ra, but little can be done. The Goa'uld have dialed into Revanna's Stargate, thusly preventing their escape. Zipacna continues bombing the surface of Revanna,

in an attempt to flush out the resistance. As the tunnels collapse many Tok'ra are killed along with Major Mansfield.

Ren'al encrypts the symbiote poison formula onto a data crystal but is killed by falling debris shortly after. Major Samantha Carter takes the data crystal for safe keeping. A large holding tank, where the symbiote Lantash is being kept alive, is destroyed and Lantash takes refuge in the dying Lieutenant Elliot as a host.

Colonel O'Neill, Teal'c and the Aldwin do a scouting run on the surface of the planet only to find Zipacna has amassed an army of Jaffa troops on the surface. Aldwin is killed on their way back to the tunnels. SG-1 regroups but more tunnel collapses prevent their escape to the ring room. Their path to the surface is blocked.

Back at the summit Osiris, the final guest, arrives. Daniel is caught by surprise. Osiris had taken possession of his friend Sarah Gardner a year ago. Osiris recognizes Daniel, but does not reveal this to the System Lords.

In private Daniel communicates her arrival to Jacob. Her arrival presents a large problem. Osiris confronts Daniel Jackson and demands to know what he's planning. Daniel manages to prick her with his ring containing the Reole memory drug and convinces her that he is but Yu's human servant. The drug takes affect and she leaves, somewhat confused. Col. O'Neill and Teal'c find a set of Tok'ra tunneling crystals which they use to grow new tunnels. Major Carter tries to help Lt. Elliot stay alive.

Osiris tells the System Lords she represents the Anubis, who had been believed to be dead for 1,000 years. Anubis has dealt blows to each and every System Lord. Anubis wants entrance back into the System Lords. The Goa'uld vote to allow Anubis to rejoin them, and for Osiris to represent him.

Daniel reports this to Jacob Carter. They both agree that the plan to poison the System Lords must be aborted. If they wipe out the seven most powerful System Lords now, Anubis will be free to conquer the galaxy.

SG-1 and Lt. Elliot make it to the surface but must still must avoid the Jaffa army. They begin the 25-mile walk to the Tok'ra beacon to send a signal to Daniel and Jacob. At the beacon Maj. Carter sends a signal to Jacob and Daniel.

Jacob tells Daniel to get off the space station. But Daniel decides to attempt to kidnap Osiris (still hoping to free her from the Gou'ald). When she arrives, he locks her in the hold and readies to steal the ship. But Yu intervenes

saying that his servant Jarren has betrayed him. He releases Osiris. But believing that Yu plotted to kidnap her she stabs Yu. As she prepares to kill Daniel he reveals who he really is. This cause her to hesitate. That, and the attack by Yu gives him the opportunity to escape.

On their return to Revanna Jacob and Daniel are shot down by the Jaffa army and crash. SG-1 finds them shaken but unhurt. Lt Elliot/Lantash, knowing he's dying anyway, volunteers to sacrifice himself by taking the symbiote poison and wait to be captured. He'll then release the poison clearing the way for SG-1 to escape through the Stargate.

Colonel O'Neill hates to leave his man behind, but sees that there is no other choice. The team goes into hiding. Elliot places the poison in his pocket, and listens as the footfalls of the approaching Jaffa army loom ever closer.

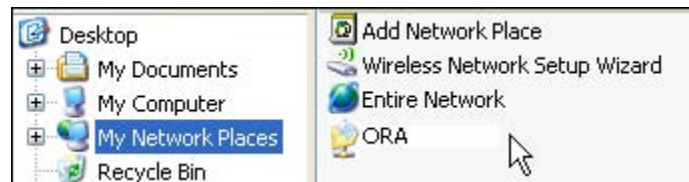


If you are running on a network drive then the help system needs a drive letter in order to work correctly. There are 2 possible solutions to this:

1. Copy the ORA folder to each local machine.
2. If at all possible Map a Network Drive. Right click on the shared folder and select Map Network drive.

Mapping a Network Drive

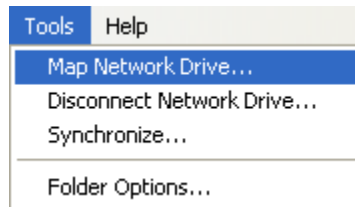
In an Explorer window select **My Network Places**. Find the name of the network which contains ORA.



Go back to **My Document**.



From the menu select **Tools** ⇒ **Map Network Drive**. This brings up the dialog box below.



Select the **[Browse]** button in order to select the network drive.



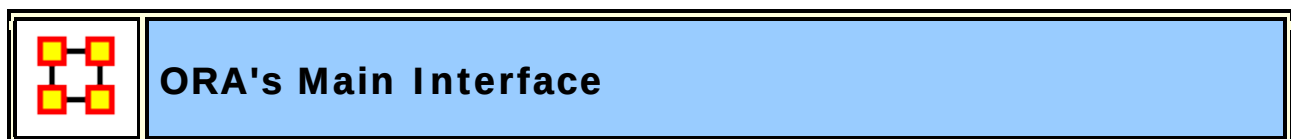
Select the correct network drive and press **[OK]**.



Select **[Finish]**.

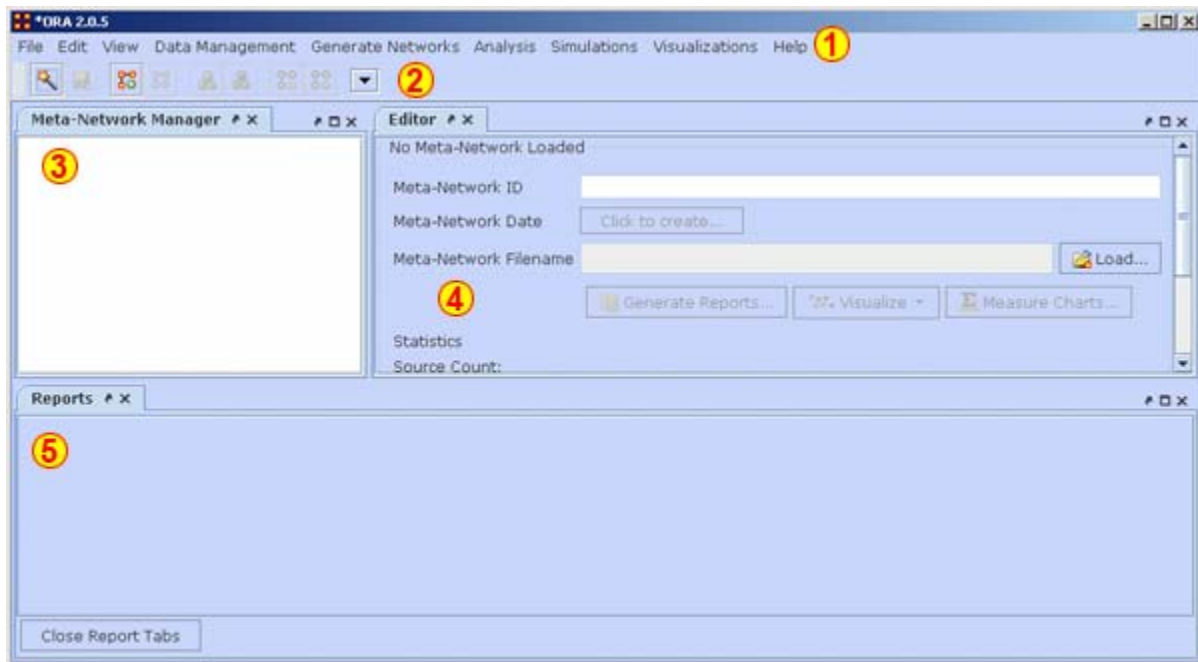


Your computer now has the Network drive with ORA mapped on the desktop.



The ORA interface is organized into **five sections**. The menu, the main icons, and three re-sizable panes which are dockable. On each tab are two buttons: **undock and close**. In the upper right corner of each pane are

three buttons: **undock**, **maximize**, and **close**. This will allow you to arrange the interface to suit your needs.



1 - The Menu

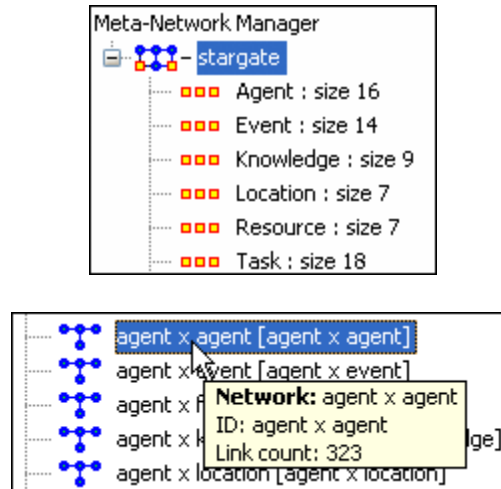
The main source for accomplishing your tasks within the editor. It contains all the functions for managing the Meta-Networks, generating reports and doing analysis.

2 - The Icons

Contains the main functions for adding or deleting Meta-Networks, NodeClasses, and Networks and importing existing Meta-Networks. Clicking the down-facing triangle brings up a window which allows you to add buttons to the GUI for the functions you use the most.

3 - Meta-Network Manager Pane

This pane contains a tree directory of the current Meta-Network(s) loaded into ORA. This contains the Meta-Networks currently active plus all their Meta-Nodes and Networks. Clicking on the **plus** icon will expand the Meta-Network showing all the Meta-Nodes and Networks and clicking on the **minus** icon condenses the Meta-Network. Hovering the pointer over a graph it will display information about that Network.



4 - Editor Pane

Contains the basic information about the highlighted Meta-Network such as how many nodes are represented. This panel also allows quick access to ORA's Visualizer, Reports and Chart tools. By selecting the Visualize button, the currently loaded Network will render in the ORA Visualizer, which will load in a separate window.

With the Meta-Network selected panel 2 displays the information regarding the Meta-Network itself. The Meta-Network name and pathway at the top. In the bottom, under statistics, are information regarding the actual Meta-Network including source, node, link, and network counts.

When a Meta-Network is expanded it reveals nodeclasses and networks. Highlighting any of these will reveal information these items.

The Info Tab : Display relevant information whether a nodeclass or network is highlighted.

The Editor Tab : Displays the information in a matrix which can be edited in multiple ways. The data can be directly manipulated in the grid, nodes and attributes can be

With the **Nodes** and **Attributes** buttons you create, delete, or merge nodes and attributes. The **Find** box assists you in locating particular nodes and attributes.

5 - Reports Pane

This pane is initially empty when ORA is first started up. As reports are run they will be contained within this panel.

NOTE : *All three panes can be resized to your preference.*



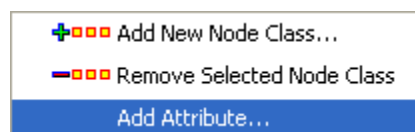
There are a number of tasks that are performed from within the Main Interface to assist in controlling your Meta-Networks, NodeSets, and Networks. These are mostly functions not associated with any of the Menu Items.

For example, renaming Meta-Network, tool tips displayed while hovering, and creating and deleting Nodes & Attributes.



An [attribute*](#) is an extra **container** that can be attached to an Meta-Node. You can add a **value** to this container. To add an attribute to an Meta-Node **right-click** on the Meta-Node name. This will bring up the contextual menu below.

Add Attribute



Type in the name for your new attribute and select **[OK]**. Let's say we want to add other languages spoken by the nodes.



The attribute you added will be inserted **alphabetically** in the editor.

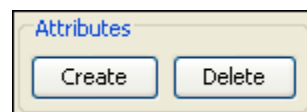
gender	language	race
<set filt... ▾	<set filt... ▾	<set filt... ▾

You can now assign any text to this attribute for any of the rows in the Network which can be used later to help define your Network.

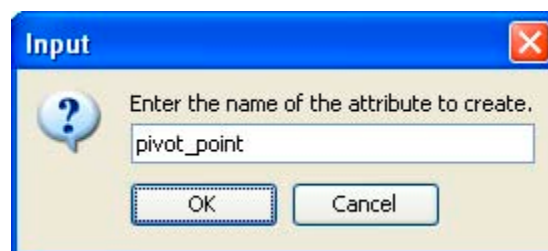
language
<set filt... ▾
English
Gou'ald
Jaffa

Add attribute (second option)

There is a second way to add attributes in the **Editor tab**. Below the matrix is a section called **Attributes** which contains two buttons, **[Create]** and **[Delete]**.



Selecting **[Create]** brings up a dialog box and asks you to input the name for the new attribute.



The new attribute is then inserted within the matrix.

Entity ID	pivot_point	order	where
<set filter> ▾	<set filt... ▾	<set filt... ▾	<set filt... ▾

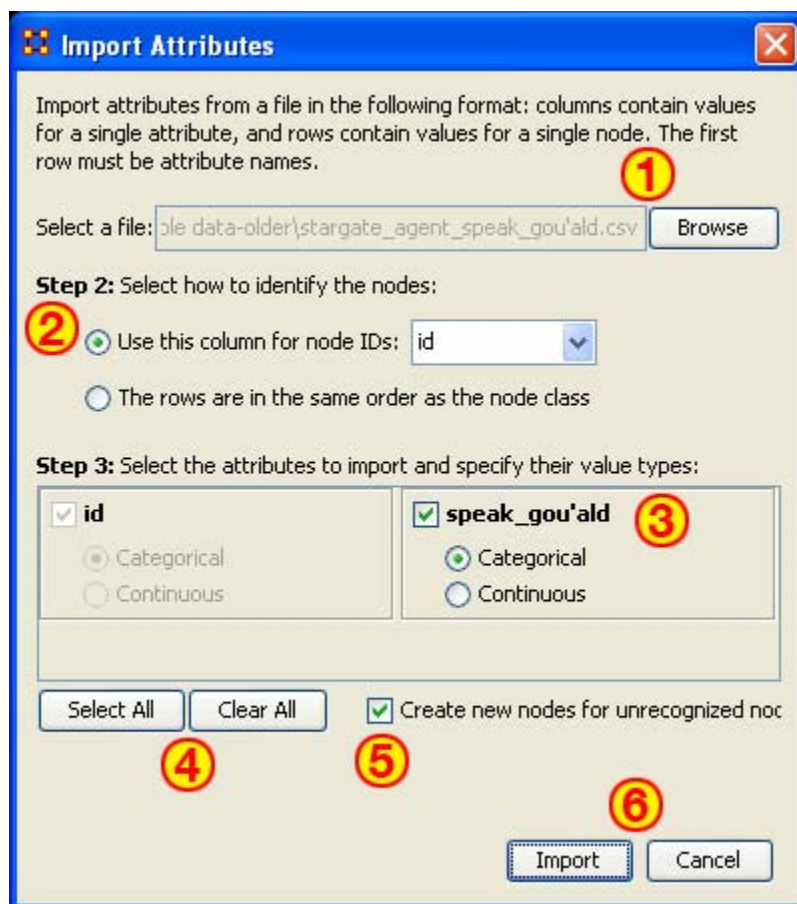
Delete Attribute

And attributes can be removed just as easily by pressing the **Delete** button. The dialog box will present you with a dropdown menu where you can choose which attribute to delete.



Import Attribute

The **[Import]** button allows for the quick importing of an attribute(s) through the Editor panel. Use a **.csv** file with rows as nodes and columns as attributes. This can be done with, or without, an ID column.



1. Use the Textbox and Browse button to navigate to the csv file with the new attribute(s).

2. Select the radio button to use either **1)** an ID column, or **2)** a file in the same order as NodeSet.
3. This section contains all the attributes in the file. If one was chosen to identify the NodeSet then it will be grayed out. For attributes NOT grayed out you can chose to make then [Categorical*](#) or [Continuous*](#).
4. **Select All / Clear All** buttons places a checkmark in all columns or removes same.
5. Placing a checkmark in the **Create new nodes for unrecognized nodes** creates new nodes into the select NodeSet if no node for an attribute currently exists.
6. **Import / Cancel** tells ORA to begin the import or cancel the operation.

Note: Whenever you set a Node Display Attribute for a Nodeset, the info is also set as an attribute of the nodeset. In other words, Node Display Attributes are now encoded in the data, allowing it to be retained from session to session.



The following instruction demonstrates how to add a **document attribute** or a **URI** to a Node.

Adding a document links in the Editor

Load a Meta-Network into ORA. Then expand the Meta-Network using the [+] icon to display all the NodeClasses and Networks in the Meta-Network. Then right-click on a NodeClass and this will access the contextual menu. From here, select **Add Attribute**. Give the new attribute a name.

In Pane 2 click the Editor tab to display the matrix and find the new attribute just created. All cells will be empty. A new pathway can be inserted in the cell at this time.

Once the node title has been changed, you can now enter a URI directly inside the corresponding blank field. This can either be an absolute pathway to a document on the user's hard drive or a web URL.

NOTE : When using a absolute path to a document the link will not work if the Meta-Network is opened on another computer. It's much safer to use URIs from the internet to connect documents.

Adding a URI in the Visualizer

Visualize a Meta-Network, select a node, and right-click to access it's contextual menu. From the contextual menu select, choose **URI submenu > Attach URI**. This brings up the **Add URI** box where the new URI can be entered.

When viewing the Meta-Network in the Editor a new column appears with the title you inserted in the field **Name:**.

The same document pathway can be used for multiple nodes.

When the Meta-Network is displayed in the Visualizer the document URI will appear in the Node Status tooltip. You can go to this URI by right-clicking a node and use the URI submenu to **Go To URI**. A new explorer window will be launched showing the location of the document file. It can then be opened with the appropriate program.

Multiple URIs/URLs

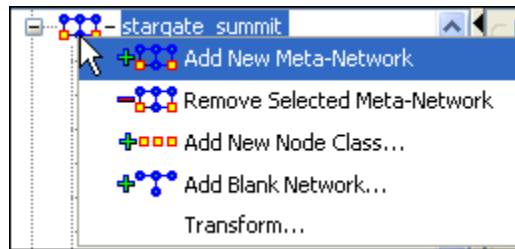
A node can have multiple URIs and you can still launch from the URI SubMenu. The preferred method for launching URIs is through the **Node Status** dialog where you can choose an individual URI to launch.

There's a new URI tab that allows you to view URI's, launch them, and add new ones. When adding new ones, the current convention is to create a new Attribute with name "URI-X", where X is the earliest number that doesn't already exist. So, adding a URI to nodes will create results such as "URI-1", "URI-2", etc. Currently, when finding URI's to launch, only those that follow the above convention are included, but it will be expanded to include any attribute with URI or URL in it anywhere.

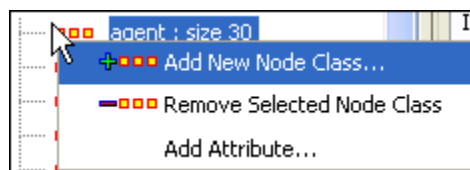


Right-clicking on any Meta-Network, NodeSet, or Network brings up a contextual menu with the functions available such as add or delete. And

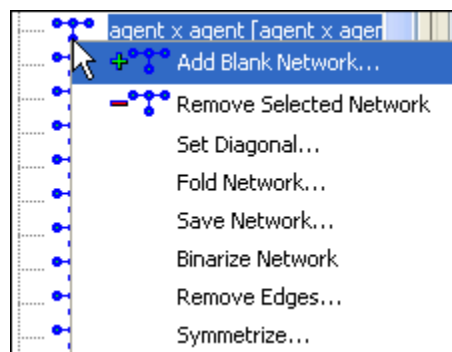
within each contextual menu are specialty functions for Meta-Networks, NodeSets, and Networks.



The first four are self-explanatory. Transform... opens up the [Meta-Network Transform...](#) dialog box.



The first two are self-explanatory. Add Attribute ... opens up the [attribute function](#) in order to add attributes to a nodeset.

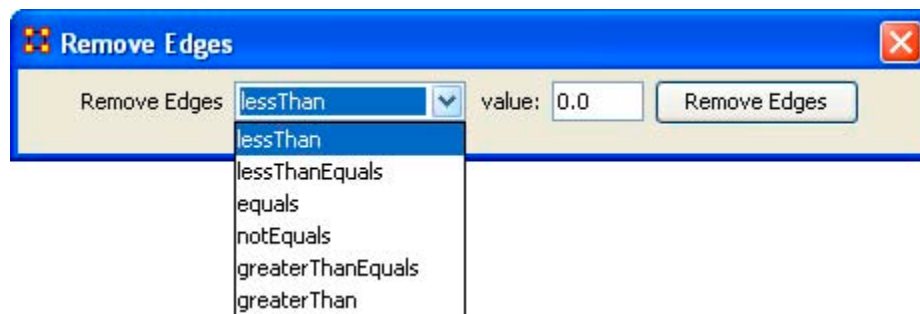


The first two are self-explanatory.

- **Set Diagonal...** : Used on a square network to set cells 1,1 through x,x to the same value. In binary view the choice are **1: True (+1) 2: True (-1) 3: False (0)**. In Numeric view you can put any value into the diagonal.
- **Fold Network...** : This function creates a new network using matrix algebra. Below are four variations of a **four x four** network and the results when each is folded.

	T1	T2			Knowledge_1	Knowledge_2
Knowledge_1	1.0	0.0	→	Knowledge_1	1.0	0.0
Knowledge_2	0.0	0.0		Knowledge_2	0.0	0.0
	T1	T2			T1	T2
Knowledge_1	1.0	0.0	→	Knowledge_1	1.0	0.0
Knowledge_2	0.0	1.0		Knowledge_2	0.0	1.0
	T1	T2			Knowledge_1	Knowledge_2
Knowledge_1	1.0	0.0	→	Knowledge_1	1.0	1.0
Knowledge_2	1.0	0.0		Knowledge_2	1.0	1.0
	T1	T2			Knowledge_1	Knowledge_2
Knowledge_1	1.0	1.0	→	Knowledge_1	2.0	0.0
Knowledge_2	0.0	0.0		Knowledge_2	0.0	0.0

- **Save Network...** : (also called **Exporting a Network**) Any Network can be saved individually to a file in one of the following formats: [CSV*](#), DL, [DyNetML*](#), or UNCINET (.##h). Also check [File Formats](#) for more information
- **Binarize Network** : Turns all **non-zero numbers** to **[1]** and leaving all **[0]** untouched.
- **Remove Links...** : Removes links in accordance to the selection in the dropdown menu (as seen in the images below).



- **Symmetrize...** :



Contextual Menus - Multi Files

Includes: *Union Meta-Networks, Intersect Meta-Networks, Conform Meta-Networks*

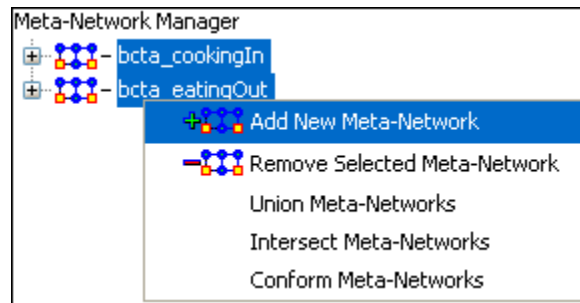
Cooking In and

Eating Out

Meta-Network Manager

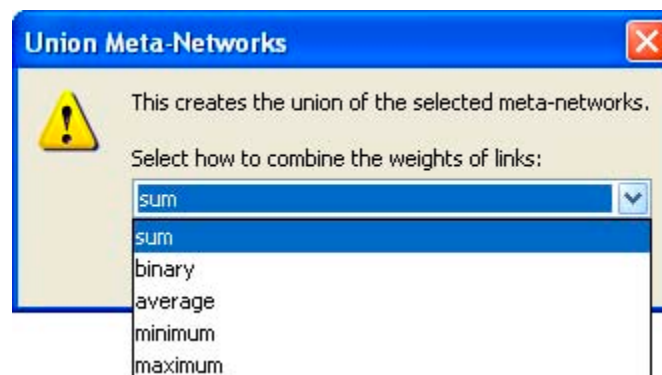
- +  - bcta_cookingIn
- +  - bcta_eatingOut

Highlight both of them by holding down the **[Control]** while clicking on each file. Then **Right-click** on one of the files. This brings up the contextual menu.



The **Add New Meta-Network** & **Remove Selected Meta-Network** are self-explanatory.

The **Union Meta-Network** will create a **new** Meta-Network using one of five actions: **sum, binary, average, minimum, or maximum**.



- **Sum** : In any identical network **all** values from **all** networks are added together. (i.e. bob's score of 4.0 in both meta-networks are added together for a total of 8.0).

	bob	carol	ted	alice
bob	0.0	8.0	0.0	0.0
carol	8.0	0.0	4.0	0.0
ted	2.0	3.0	0.0	4.0
alice	0.0	0.0	8.0	0.0

- **Binary** : Then in the binary option it doesn't matter what numbers appeared in either meta-network as it uses **only 1 or 0** as a result. If any cell has a **non-zero** it will contain a 1 as a result.

	bob	carol	ted	alice
bob	0.0	1.0	0.0	0.0
carol	1.0	0.0	1.0	0.0
ted	1.0	1.0	0.0	1.0
alice	0.0	0.0	1.0	0.0

- **Average** : This option takes the **sum of all identical cell values and divides them by the number of cells used**. In **cookingIn ted x alice** contained a 2 while in **eatingOut** the value for **ted x alice** was a 1. This was averaged out to 1.5.

	bob	carol	ted	alice
bob	0.0	4.0	0.0	0.0
carol	4.0	0.0	2.0	0.0
ted	1.0	1.5	0.0	2.0
alice	0.0	0.0	4.0	0.0

- **minimum** : This function finds the smallest value in any identical cells and uses that in the final result. (i.e. for **ted x carol** and **ted x alice** both cells use the smaller value of "1" even though they are from different meta-networks.

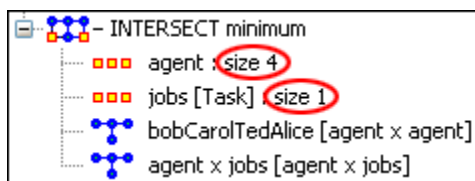
	bob	carol	ted	alice
bob	0.0	4.0	0.0	0.0
carol	4.0	0.0	2.0	0.0
ted	1.0	1.0	0.0	1.0
alice	0.0	0.0	4.0	0.0

- **Maximum** : This function finds the largest value in any identical cells and uses that in the final result. (i.e. for **ted x carol** and **ted x alice** both cells use the larger value of "2" and "3" respectively, each taken from a different meta-network.

	bob	carol	ted	alice
bob	0.0	4.0	0.0	0.0
carol	4.0	0.0	2.0	0.0
ted	1.0	2.0	0.0	3.0
alice	0.0	0.0	4.0	0.0

Intersect Meta-Network works similar to the Union function and has the same five options. But in creating the new Meta-Network only nodes that appear in all Meta-Networks are carried over to the new Meta-Network.

For example: All four agents appear in both Meta-Networks and are brought over into the new Meta-Network. But though there were **six tasks** in the cookingIn and **three tasks** in eatingOut there is only **one task (driver)** in the new Meta-Network created from the intersect function. Only nodes found in all Meta-Networks are brought over.



And even though **bob** has a value for driver in **cookingIn** only carol has a value for driver in both Meta-Networks.

	bob	carol	ted	alice		driver
bob	0.0	4.0	0.0	0.0	bob	0.0
carol	4.0	0.0	2.0	0.0	carol	1.0
ted	1.0	2.0	0.0	1.0	ted	0.0
alice	0.0	0.0	4.0	0.0	alice	0.0

Conform Meta-Network alters the selected Meta-Networks and makes them equal. **union** adds nodes that are found in one Meta-Network but not the other. **intersect** removes nodes that are not common to both.

Create a New Meta-Network

What follows are procedures for creating a new Meta-Network.

There are times you need to run measures on or visualize only part of an existing Meta-Network. This section will show you the easy way to create sub-sets of an existing Meta-Network.

First [duplicate the Meta-Network](#). Highlight the Meta-Network then from the main menu select **Edit ⇒ Copy Meta-Network**. Then from the main menu select **Edit ⇒ Paste Meta-Networks**. It would be a good idea to rename this new Meta-Network immediately so as to not get it confused with the original. You can do this in the Editor tab, see [Renaming](#).

Next, expand the Meta-Network you want by clicking the **[+]** if it isn't expanded already. Highlight the nodeset with the nodes you want to remove.



In panel 2 select the **Editor tab** which brings up the matrix with nodes on the vertical and attributes on the horizontal. Below each attribute is a **<set filter>**. Below left is the **stargate_summit** meta-network along with the **ally** attribute. I wish to make a new meta-network of the **good guys** only. In the dropdown menu under ally I select **no**. These are the nodes I want to remove.

	Entity ID	Entity Title	ally
	<set filt..	<set filt...	<set filt..
☐	A01	col_jack_...	yes
☐	A02	maj_sam...	yes
☐	A03	daniel_jac...	yes
☐	A04	teal'c	yes
☐	A05	jacob_cart...	yes
☐	A06	lt_elliott	yes
☐	A07	ren'al	yes
☐	A08	aldwin	yes
☐	A09	janet_frazier	yes
☐	A10	maj_man...	yes
☐	A11	gen_ham...	yes
☐	A12	lantash	yes
☐	A13	narim	yes
☐	A14	travell	yes
☐	A15	osiris	no
☐	A16	yu	no

Place a checkmark in the box of each node. Below the matrix in the section called **Nodes** are three buttons. Click the **[Delete]** button. The nodeset now contains only the nodes that had **yes** in the attribute **ally**.



With this same procedure I created a Meta-Network of only the **allies**.

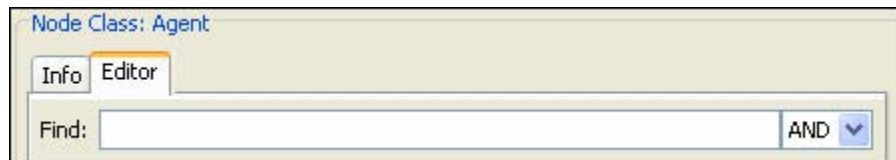


Find a Sub-set within a NodeSet

What follows are procedures for using the Find feature in ORA.

By using the **Find:** textbox and the **AND / OR** selector you can display only the nodes you want to work with. This works by searching for **Sub-Strings** within the values.

NOTE : A search for "male" will find all values of "male" as well as "female" because "male" is a sub-string of "female".



Here is the whole NodeSet with only the **gender and race** attributes displayed. The **AND / OR** toggle is in it's default AND setting.

Info Editor

Find: AND ▼

	Node ID	Node Title	gender	race
	<set filt... ▼	<set filt... ▼	<set filt... ▼	<set filt... ▼
☐	A01	col_jack_...	male	tauri
☐	A02	maj_sam...	female	tauri
☐	A03	daniel_jac...	male	tauri
☐	A04	teal'c	male	jaffa
☐	A05	jacob_cart...	male	tok'ra
☐	A06	lt_elliott	male	tok'ra
☐	A07	ren'al	female	tok'ra
☐	A08	aldwin	male	tok'ra
☐	A09	janet_frazier	female	tauri
☐	A10	maj_man...	male	tauri
☐	A11	gen_ham...	male	tauri
☐	A12	lantash	male	tok'ra
☐	A13	narim	male	tollan
☐	A14	travell	femal	tollan
☐	A15	osiris	female	gou'ald
☐	A16	yu	male	gou'ald

Select All Clear All 0 item(s) selected, 16 visible, 16 tot

Nodes

Create Delete Merge

Attributes

Create Delete Import

First **female** is typed into the textbox and ORA will display all nodes where **gender=female**.

Find: AND ▼

	Node ID	Node Title	gender	race
	<set filt... ▼	<set filt... ▼	<set filt... ▼	<set filt... ▼
☐	A02	maj_sam...	female	tauri
☐	A07	ren'al	female	tok'ra
☐	A09	janet_frazier	female	tauri
☐	A15	osiris	female	gou'ald

Next **tauri** is typed into the textbox (make sure there's a leading "space") and ORA will now only display nodes with **gender=female** and **race=tauri**.

Find:	female tauri				AND	▼
	Node ID	Node Title	gender	race		
	<set filt...	<set filt...	<set filt...	<set filt...		
☐	A02	maj_sam...	female	tauri		
☐	A09	janet_frazier	female	tauri		

But if the **AND/OR** setting is switched to **OR** the NodeSet who display everything with **EITHER gender=female OR race=tauri**.

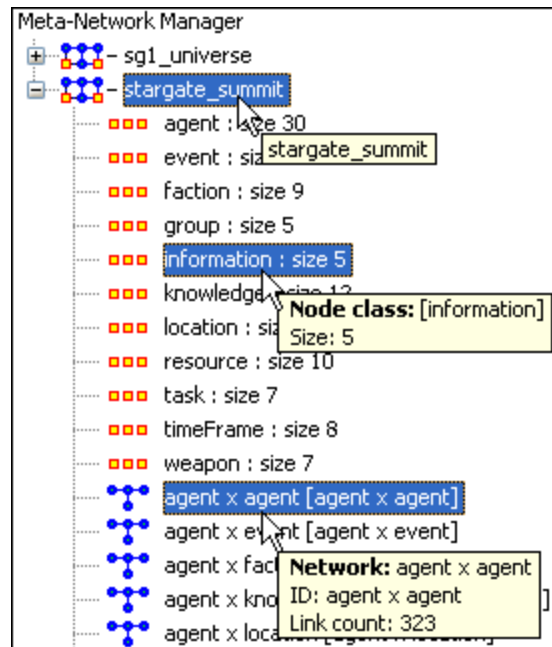
Find:	female tauri				OR	▼
	Node ID	Node Title	gender	race		
	<set filt...	<set filt...	<set filt...	<set filt...		
☐	A01	col_jack_...	male	tauri		
☐	A02	maj_sam...	female	tauri		
☐	A03	daniel_jac...	male	tauri		
☐	A07	ren'al	female	tok'ra		
☐	A09	janet_frazier	female	tauri		
☐	A10	maj_man...	male	tauri		
☐	A11	gen_ham...	male	tauri		
☐	A15	osiris	female	gou'ald		



Hovering - Tooltips

Hovering the pointer over various parts of the panels will reveal information about the Meta-Network.

Hovering over the parts in Panel 1 will reveal different information about the **Meta-Networks, Meta-Nodes, and Networks**.



Node Buttons



Node Buttons

What follows are images and descriptions of some common button items and other interface elements in the ORA gui.

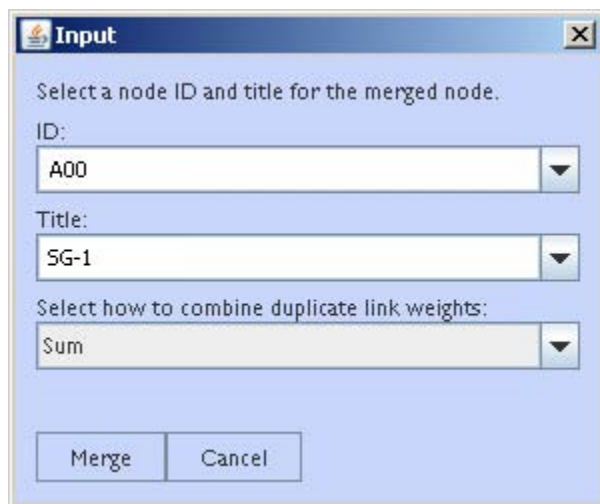
Create inserts a new node(s) into the NodeClass. You will be asked for the number of new nodes to create and a node ID. If multiple nodes are to be created then a number will be appended to each new node.

Move Moves node(s) to another NodeClass. ORA will prompt you for the movement of links associated with these node(s).

Delete Removes node(s) and all associated link(s) from the Meta-Network.

Merge removes all selected nodes and replaces them with a single node with all previous links and attributes. This is used primarily when data needs to be consolidated.

Example : A NodeClass contains two nodes, jack and **col_o'neill**. And these are actually the same person. Merge will combine their information into one node which could be named **col_jack_o'neill**.

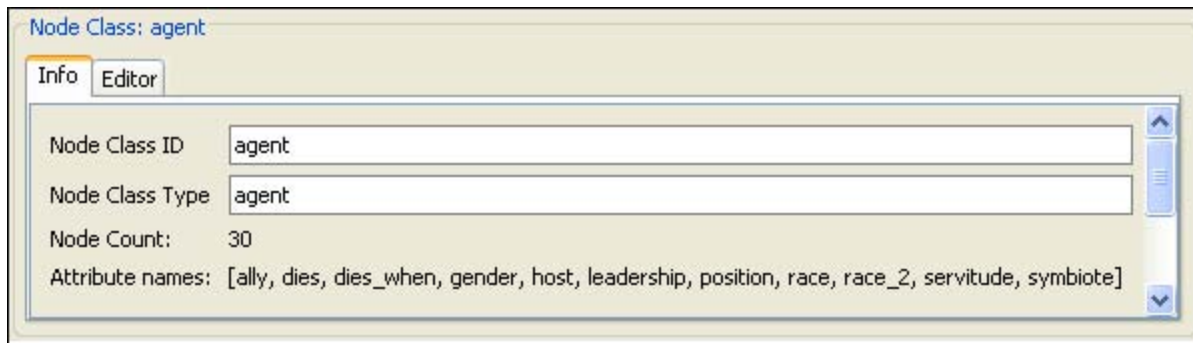
A screenshot of a software dialog box titled "Input". The dialog box has a light blue background and a standard Windows-style title bar with a close button. Inside, the text "Select a node ID and title for the merged node." is displayed. Below this, there are three dropdown menus: "ID:" with "A00" selected, "Title:" with "SG-1" selected, and "Select how to combine duplicate link weights:" with "Sum" selected. At the bottom, there are two buttons: "Merge" and "Cancel".

Clean finds all nodes whose IDs are within the edit distance of the selected node. An edit is a change of a single character.

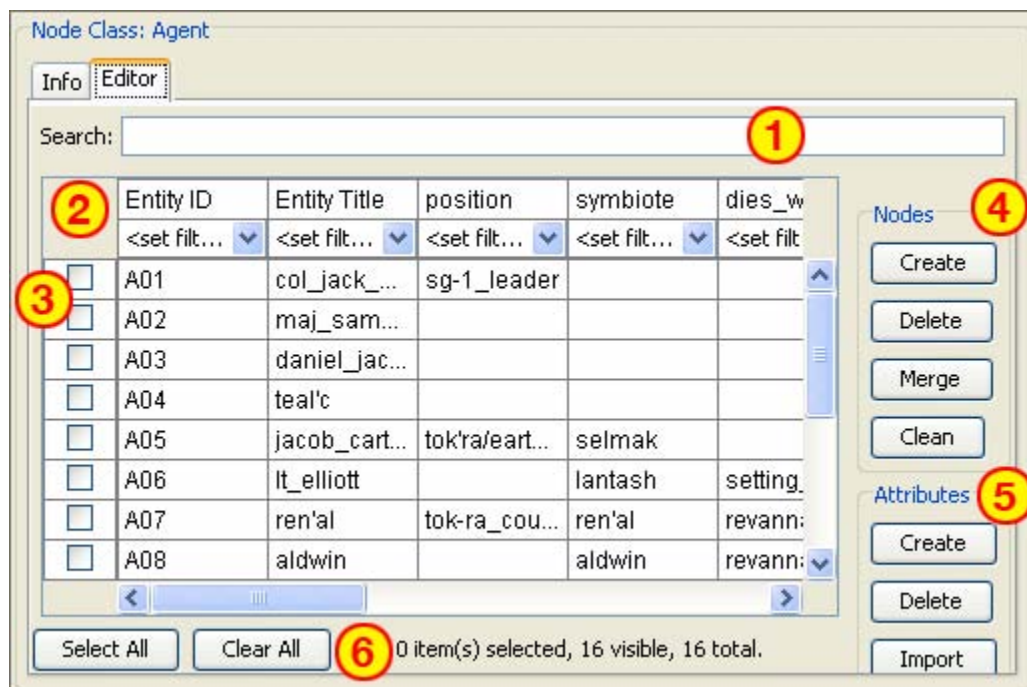
	Info Tab - Nodeset

Panel 2 contains two tabs, **Info and Editor**. The Info tab is mainly designed to display information regarding the Meta-Networks, NodeSets, and Networks. But this is the area where you can rename the **Node Class ID** and the **Node Class Type**. Place the cursor in the box, make sure the entire name is highlighted, and type in your new name.

This area also gives you the **Node Count** of the selected Node Set as well as the **Attribute Names** contained within the NodeSet.



The **Editor tab** contains most of the editing functions.



1. The **Search box** for finding particular node(s) in a set.
2. The **<set filter>** for displaying only a particular sub-set of node(s).
3. The **Checkboxes** to designate which nodes to Delete or Merge.
4. **The Nodes** buttons: Create, Delete, Merge, and Clean.
5. **The Attributes** buttons: Create, Delete, and Import.
6. Use the **Select/Clear** buttons to place, or remove, all checkmarks from section 3.



When a Network is selected there are also two tabs, **Info and Editor**.

The Info tab contains a textbox, **Network ID** in which you can change the name of any network, The Source and Target Nodesets, and whether this network is directed or not, the Link Count, and the Density.

The two buttons underneath allow the choice of **Visualize this Network** which will send the entire Meta-Network to the Visualizer or **Visualize Only this Network** which display only the currently selected Network.

Below is an image of InfoTabs and Editor Tabs in ORA.

A screenshot of a software window titled "Network: agent x agent". Inside the window, there are two tabs: "Info" (selected) and "Editor". The "Info" tab contains several input fields: "Network ID" with the value "agent x agent", "Source" with "agent", "Target" with "agent", and "Is directed?" with "true". Below these fields are two buttons: "Visualize this Network" and "Visualize Only this Network". At the bottom of the tab, it shows "Link Count: 362" and "Density: 0.41609195".

The Editor tab has two views: **Binary and Numeric**.

Binary view is used when you only need to establish a connection between two nodes with no weights. It's a simple **Yes or No** arrangement.

Network: agent x agent

Info Editor

☒ Binary View ☐ Numeric View

Row count = 30 Column count = 30

	maj_samant...	daniel_jackson	teal'c	jacob_carter...	yu	psiris
col_jack_o'Neill	☒	☒	☒	☒	☒	
maj_samant...	☐	☒	☒	☒	☒	
daniel_jackson	☒	☐	☒	☒	☒	
teal'c	☒	☒	☐	☒	☒	
jacob_carter...	☒	☒	☒	☐	☒	

Binarize Symmetrize Remove Edges

The Numeric view allows you to treat links between various nodes with more or less importance. Notice that all the **row nodes** have a check marked connection to the **column containing [yu]** in the binary mode. This denotes they know one another. But in the numeric mode this value is a 0.5 which is used to denote previous acknowledgement but is an adversary.

Network: agent x agent

Info Editor

☐ Binary View ☒ Numeric View

Row count = 30 Column count = 30

	maj_samant...	daniel_jackson	teal'c	jacob_carter...	yu	psiris
col_jack_o'Neill	5.0	5.0	5.0	3.0	0.5	0.5
maj_samant...	0.0	5.0	5.0	5.0	0.5	0.5
daniel_jackson	5.0	0.0	5.0	3.0	0.5	2.0
teal'c	5.0	5.0	0.0	3.0	0.5	0.5
jacob_carter...	5.0	3.0	3.0	0.0	0.5	0.5

Binarize Symmetrize Remove Edges



Create Meta-Network from Excel File

If you don't have a Network, you can create one from scratch. Below is step-by-step instruction on how to do this in ORA.

We will create an square, agent-by-agent Network. We say it is **square** because all row headings correspond directly to column headings. This is important as it relates to specific measures ORA can run on a graph. If the graph is not square, some measures will not work.

Open a blank Microsoft Excel work book. In **column A** we will enter the name of all the nodes that make up our social network or organization.

NOTE : When creating your spreadsheet, do not add any additional titles, notes, or other headings, which will interfere with the "square" properties of the Network.

	A	B	C	D	E
1					
2	bob				
3	carol				
4	ted				
5	alice				

Next, create column headings using the correlating names as they appear in row headings. Again, this will ensure that our Network will be square.

	A	B	C	D	E
1		bob	carol	ted	alice
2	bob				
3	carol				
4	ted				
5	alice				

Next we will create **links** between each agent. We do this by entering a **1** if a direct connection or relationship exists and a **0** if it does not. Please note that headings that cross-reference themselves are considered redundant and thus are left blank or **0**.

In the example below, **Redundant cells** are filled in with red strips to illustrate the self-loops. This redundancy should continue as a smooth diagonal line from the top left corner of your Network to the bottom right.

◇	A	B	C	D	E
1		bob	carol	ted	alice
2	bob				
3	carol				
4	ted				
5	alice				

NOE : If you don't end up with a diagonal line then your graph is not square.

Using **1**s and **0**s to establish link, complete your spreadsheet.

In the Network example, we have assigned links randomly. Within your organization or network, however, you can describe any direct connections or relationships you are interested in analyzing. For instance, you may determine that a direct connection exists if agents within your network consult with each other at least once a month; literally, it can be anything you decide.

Below is our completed Network (The red fill illustrates cells that do not require input due to their redundancy*).

◇	A	B	C	D	E
1		bob	carol	ted	alice
2	bob		1	0	0
3	carol	1		1	0
4	ted	1	1		1
5	alice	0	0	1	

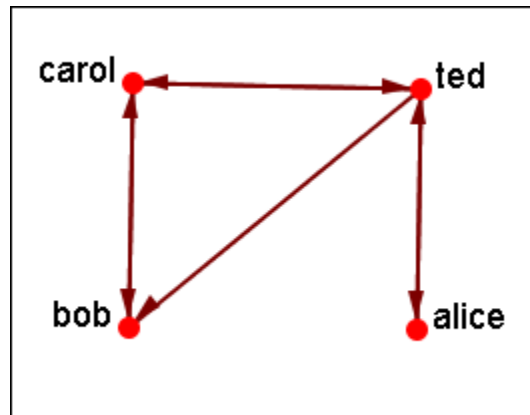
Now that we have essentially built a Network from scratch using Excel, the next step is to save it in a compatible file format ORA can interpret. For Excel spreadsheets this will be the CSV* file format.

From the main menu select **File ⇒ Save As**

Make sure you save this file as a **CSV (comma delimited)**

You have now created a Network from scratch which can be loaded into ORA.

Now return to ORA and load up your new Network. Below is a our new Network rendered in the ORA Visualizer. Notice the arrows only point from one node to another if there is a 1 in the column for a particular node. **i.e. There is a "1" in the bob column for ted but a "0" in the ted column for bob. So an arrow points from ted to bob but NOT from bob to ted.**



For a more in-depth explanation for creating Meta-Networks see the [lessons section under Meta-Network](#).



ID Names

Working with ID Names

Each Meta-Network, NodeClass, and Network can be given a distinct **ID Name**. At times this can be very helpful when working with multiple Meta-Networks it can also cause problems with certain functions.

Node Class ID: agent Node Class Type: agent	Node Class ID: those guys Node Class Type: agent
- sg1_universe - stargate_summit [agent] size: 30 [event] size: 8 [faction] size: 9	- sg1_universe - stargate_summit [agent] those ... [event] size: 8 [faction] size: 9

Here I renamed one of the Meta-Nodes to **those guys**. It is also reflected throughout all of Meta-Network Panel. You can rename any Meta-Network, NodeClass, or Network for better readability.

Areas where it's important to maintain Name ID integrity

View Measures Over Time : This function allows an analyst to see how a network measures change over multiple time periods. So in order to track measures over time it is necessary that the ID Names of the Networks are the same in all instances.

View Networks Over Time : This function allows you to set up multiple Networks that encompass various time frames and view them in succession. Since you want to see what happens over the same Network Over Time it becomes virtually important to make sure the ID Names of these Networks are all the same. Else ORA will not be able to analyze them correctly.

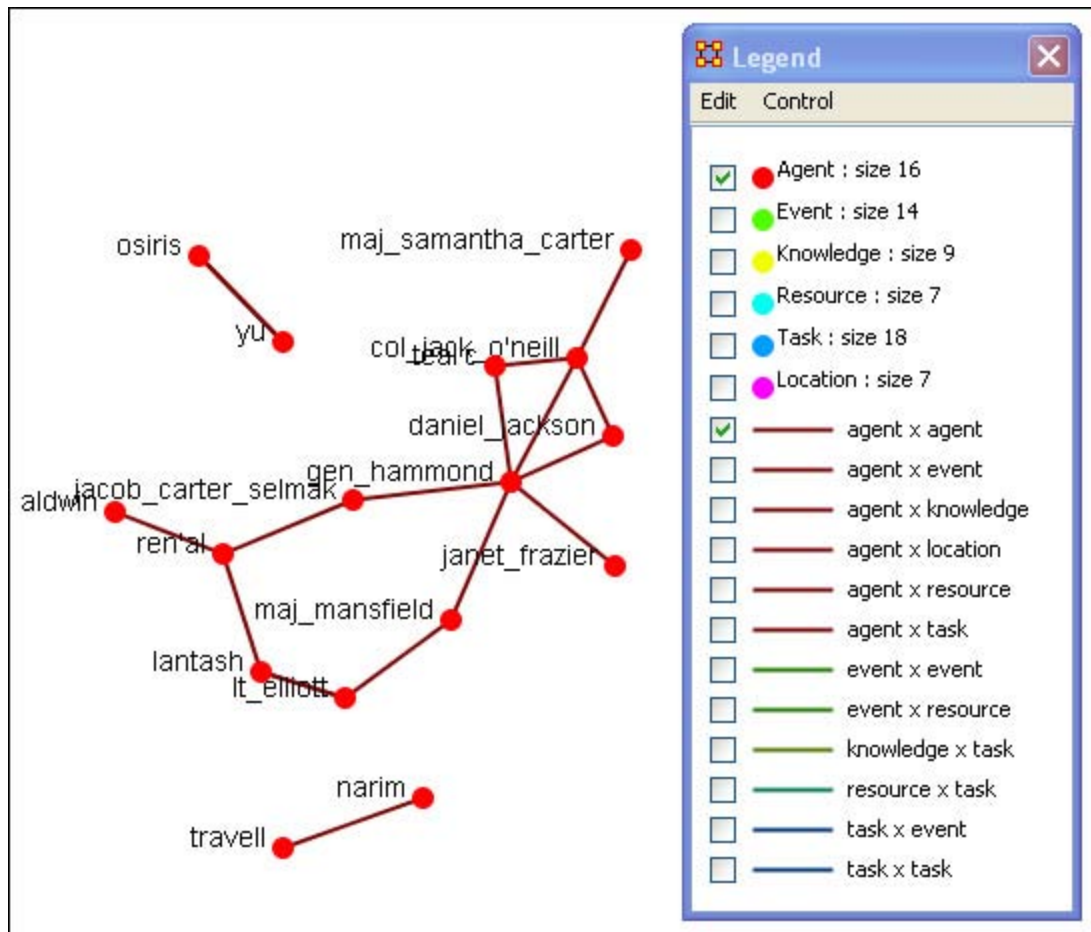
Comparing Networks : When ORA runs measures on Networks it's sometimes necessary to do have identical Network names. This will be listed in the Measures section.



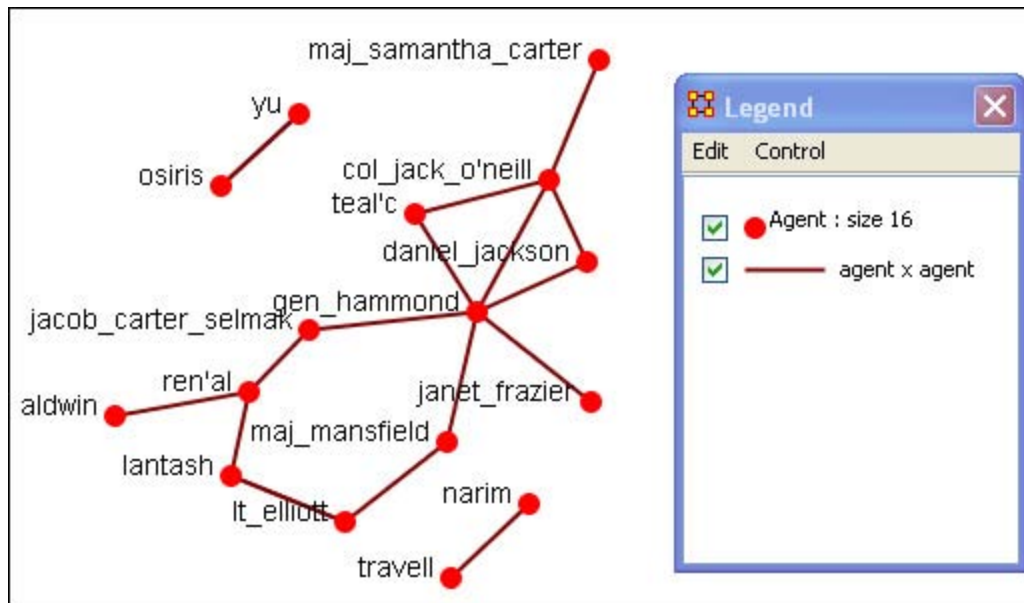
There are two **Visualize** buttons and they work slightly different.



The **Visualize this Network** visualizes the chosen Network. In the **Legend** dialog box all NodeSets and LinkSets are available.



The **Visualize Only this Network** visualizes the chosen Network. But in the **Legend** only the NodeSet and LinkSet chosen are displayed. This is a much quicker means to display a Network. ORA only makes computations for the chosen Network.



Below is an image of the File Menu accessible from ORA's main title bar menu. Further below are descriptions of the various tools accessible through the File Menu.



Open Meta-Network : opens a single Network with the following formats: DyNetML* (the native ORA xml format), .dl, .###h (UCINET), .csv* (comma separated values, Excel spreadsheet out), .txt (text files), .raw, .net (Pajek), .graphml*, .stl* (GMU model), and .lo (pathfinder).



Data Import Wizard : Contains additional options for importing Networks such as multiple file importing. See **Lessons** for more comprehensive information regarding this function.

Data Export... : Allows you to export a Meta-Network into a different format: **CSV, UCINET-Binary, UCINET-DL, Netdraw VNA, Text, Pajek, DyNetML, or C3Trace.**

Import CASOS Database...



Open Workspace... Allows you to open an entire workspace that you were previously using. A workspace consists of a set of Meta-Networks that were all open at the same time, and saved as a workspace.

CEMAP... Opens up the CEMAP Parser.



AutoMap... Opens up the program AutoMap.

Pile Sort... Opens up the program Pile Sort. Used to sort nodes into individual categories.



Save Meta-Network : This item is initially grayed out. It only becomes active when you've made a change to a Network. You can use it as an indicator whether you've made a change to the active Meta-Network. Notice as you highlight each Meta-Network the icon in the toolbar will be grayed out (no changes) or colored (changes made to that Meta-Network).

Save Meta-Network As... : Allows you to save the changes in a Meta-Network under a new filename.



Save Workspace : Saves the active Meta-Networks into a **Workspace** which can be opened up at a later date.

Exit : Closes the program.



ORA is designed to work with **DyNetML** files. However, data in a format other than DyNetML can be imported and converted.

Open Meta-Network

From the Main Menu select **File > Open Meta-Network**. to bring up the initial open dialog box. Navigate to the folder with your DyNetML file and click **[OK]**.

The selected file will then appear in **Panel 1** of the main interface.



Data Import Wizrd

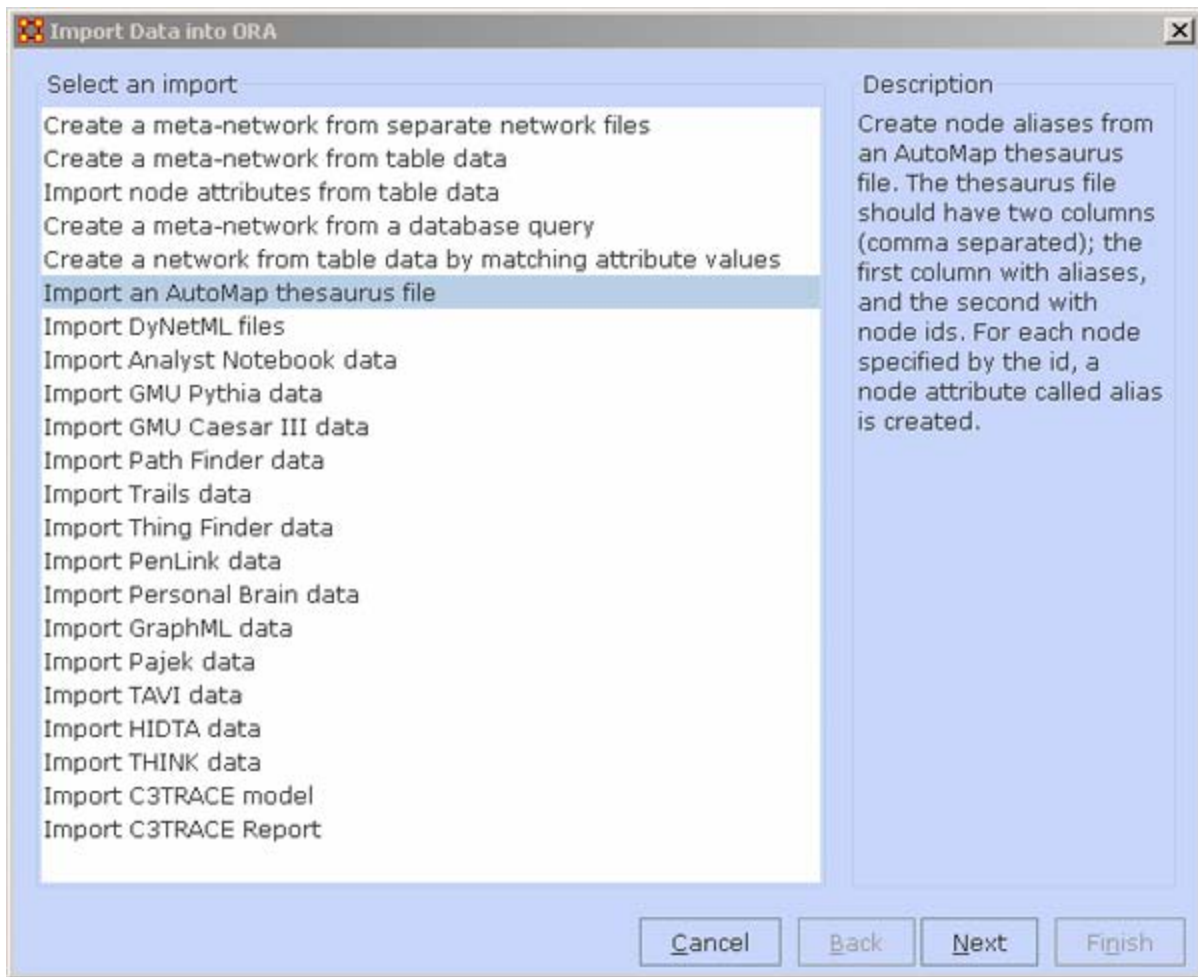
The **Data Import Wizrd** imports files in a variety of File Formats. The idea behind the data import wizard is that users come to ORA with a variety of file formats from various different network analytical tools. Very rare is it that an analyst has a Meta-Network ready to load. Moreover, network data may exist in a separate file or in a variety of file formats, which then need to be merged together.

The Data Import Wizrd is used to convert the user data from their native format and separate files and convert it into Meta-Networks and then into a DyNetML file.

The files can be in any of the following formats: **CSV, UCINET, GraphML, or Pajek**. ORA uses the file extension to determine the native file format to assign to your network. Therefore, if you change a file extension from its native extension (**e.g., GraphML file such as "example.gml" to "example.dot" ORA will not recognize the data format**).

This section will review the basics of the Data Import Wizrd. See the lesson **Creating a Meta-Network** for more comprehensive information on importing.

Data Import Wizrd is accessed either **File > Data Import Wizrd** or the icon in the toolbar. You are presented with a dialog box showing all the file format options to import. Each contains a description on the right-side of the box.



Other Functions Besides Importing

- **Create a meta-network from separate network files:** Use this option to select multiple networks in one of the several native file formats indicated above and pull them into ORA. The file formats don't have to match. ORA will then combine all the network files into one Meta-Network, which will then be saved as a **DyNetML*** file (ORA's native file format).
- **Create a meta-network from table data:** Text files in the form of **rows of Nodes and columns of Attributes** will be used to populate existing NodeSets.
- **Import node attributes from table data:** Text files used to import Attributes to a Node.



Save Meta-Network

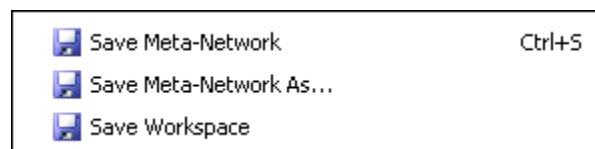
This option is initially **grayed** out when you first load a Meta-Network. This signifies that the Meta-Network is currently unchanged. Whenever you make **ANY** change within the Meta-Network the option will become full-color indicating it is time to save changes.

After clicking the icon in the toolbar, or selecting the menu item, it will become grayed out again till you change your Meta-Network once again.

No change needs saved in the Meta-Network



Changes made to Meta-Network and need saved



Save Meta-Network As...

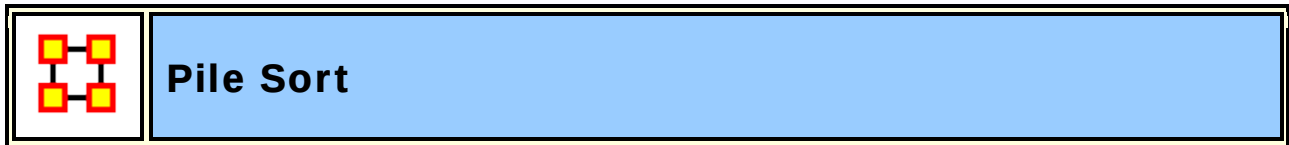
If you need to save a Meta-Network under a different name use select **File > Save Meta-Network As...**. This will leave the original file intact and create a new Meta-Network with the new file name.

Save Workspace

While working with multiple Meta-Networks you may want to retain the information of what files you had open for later use. Saving your workspace creates a file which can be opened later and will recreate your workspace as before.

From the Main Menu select **File > Save ORA Project**. After selecting **[OK]** on the initial dialog box the **Save ORA Project** dialog box will appear. Navigate to the folder where you want to save your workspace.

This Workspace can then be called up with the Load Workspace in a future session.

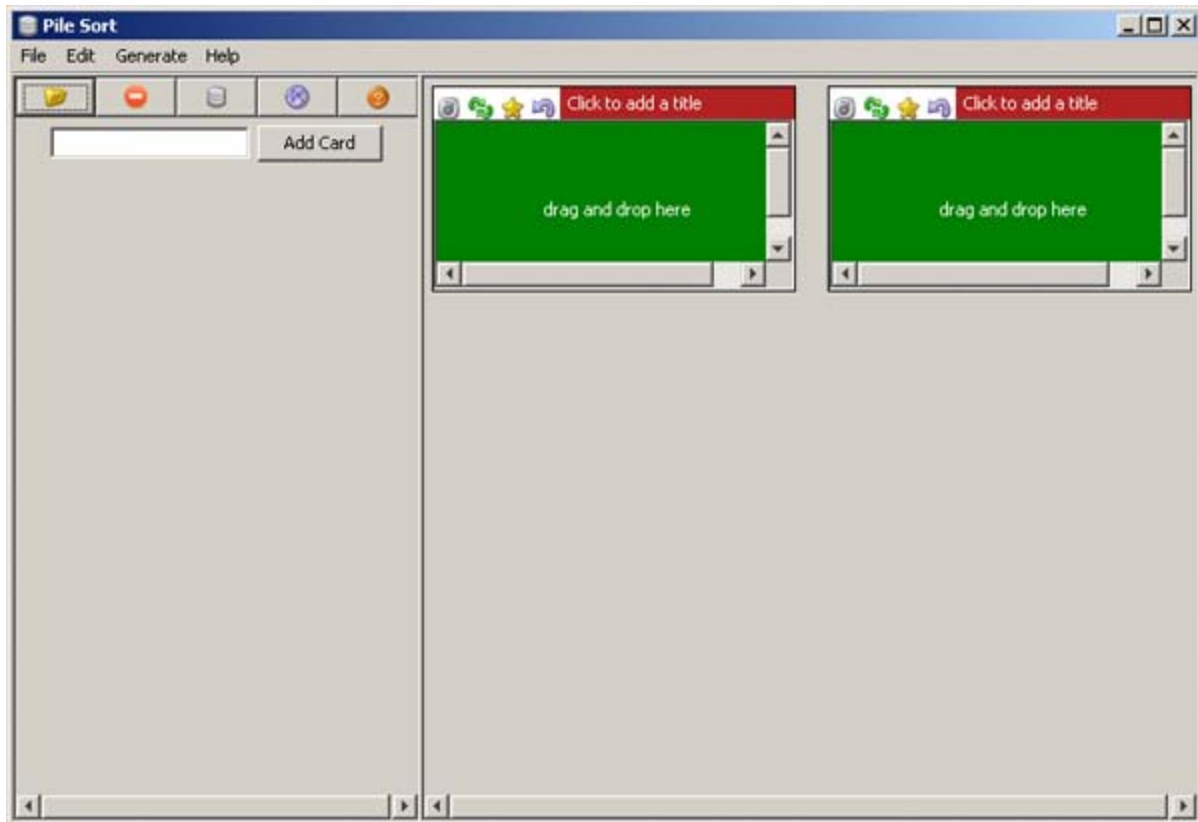


The PileSort module allows a user to load a series of entities such as concepts or people's names. These entities are displayed in a deck, which can then be organized and grouped into a pile, which will contain entities that are similar to one another. The output of the PileSort module will be a network in DyNetML format.

The user can use either a text editor or a spreadsheet to create a two-column comma-separated file (**i.e. a .csv file**). The first column contains the concept and must not be blank. The second column is **optional** and can contain metadata.

NOTE : *Concepts can not contain embedded commas.*

Pile Sort GUI



Pile Sort Interface : consists of two panes: The Side Deck and the Canvas. **The Side Deck** displays cards that have not been organized into piles, such as initially when the input file is read. **The Canvas** contains the piles where the cards are placed from the Side Deck.

Pile Sort Menus

File > Load a File :

File > Exit :

Edit > Add an Empty Pile : creates an additional empty pile on the canvas.

Generate > Create a Network DyNetML File : Creates a DyNetML file from the current state of organization. All cards in a

pile are fully connected and cards remaining in the deck are isolates.

Help > Show Help Topics : Accesses the ORA Help files

Other Functions

Add Card : takes the concept that has been filled into the text field next to the **[Add]** button and creates a card with that name at the end of the card deck.

Transfer All Cards to Another Pile : Click and hold the icon of a pile and drag it to another pile. All cards in the first pile will be transferred to the new pile.

Cycle Through the Cards in the Pile : Rotates the cards in a pile that the card currently beneath the currently highlighted card becomes highlighted. The newly highlighted card becomes the pile's representative.

Return Cards to the Side Deck : Removes all cards from a pile and returns them to the side deck.

Mark a Card as a Pile's Representative : marks the currently highlighted card as a pile's representative.

Move Card to Another Pile : Click and hold a card in a pile and drag it to another pile.

Click to Add a Title : allows the entire pile to be given a name. Either click on the title bar or use the drop down menu item.

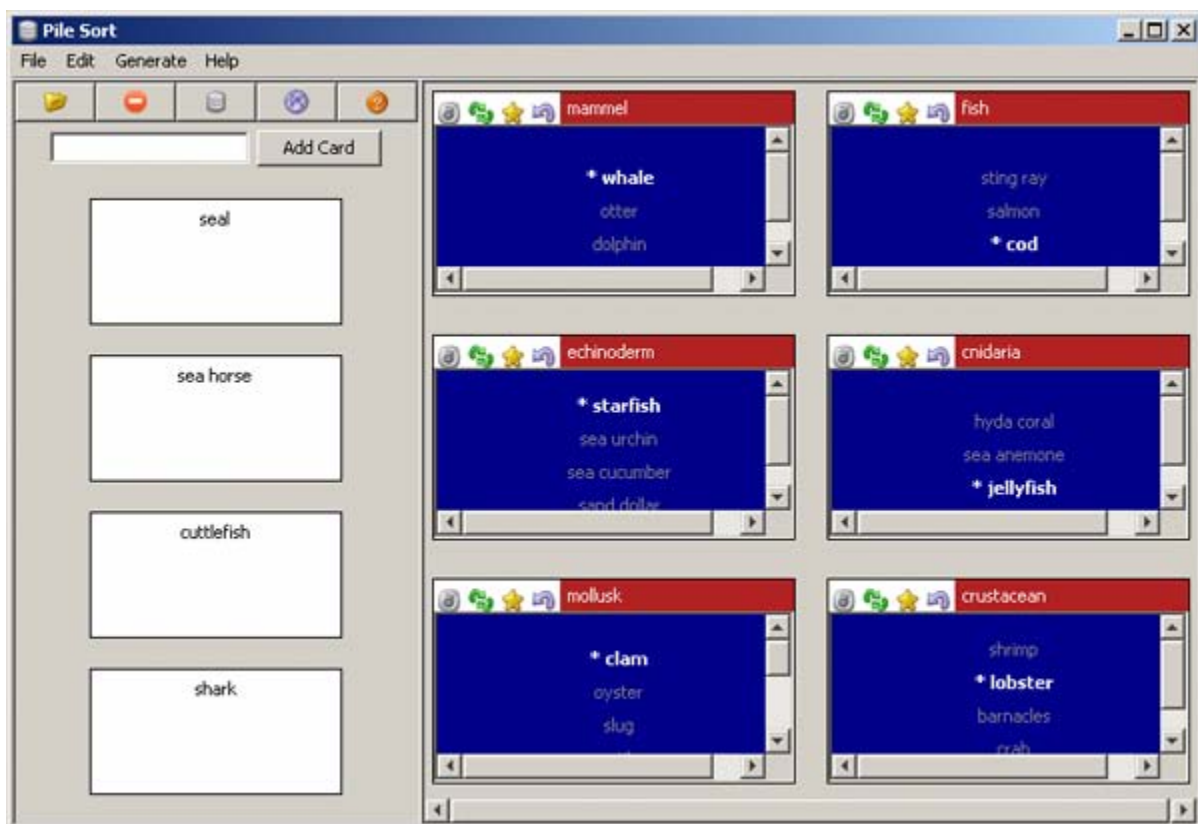
Drag and Drop Here : allows the user to drag cards from the side deck onto a pile.

Loading a list of concepts :

All piles are initially empty. The concepts appear in the side deck to the left. A scrollbar will appear if the number of concepts is greater than the screen length. An empty pile contains the banner **drag and drop here** signifying an empty pile. Once a concept is placed in a pile it will all concepts will be displayed in it's window.

NOTE : To have duplicate concepts in more than one pile requires the creation of duplicate cards.

NOTE : You can leave cards in side deck. Any card not so placed will become an isolate in the resulting network.



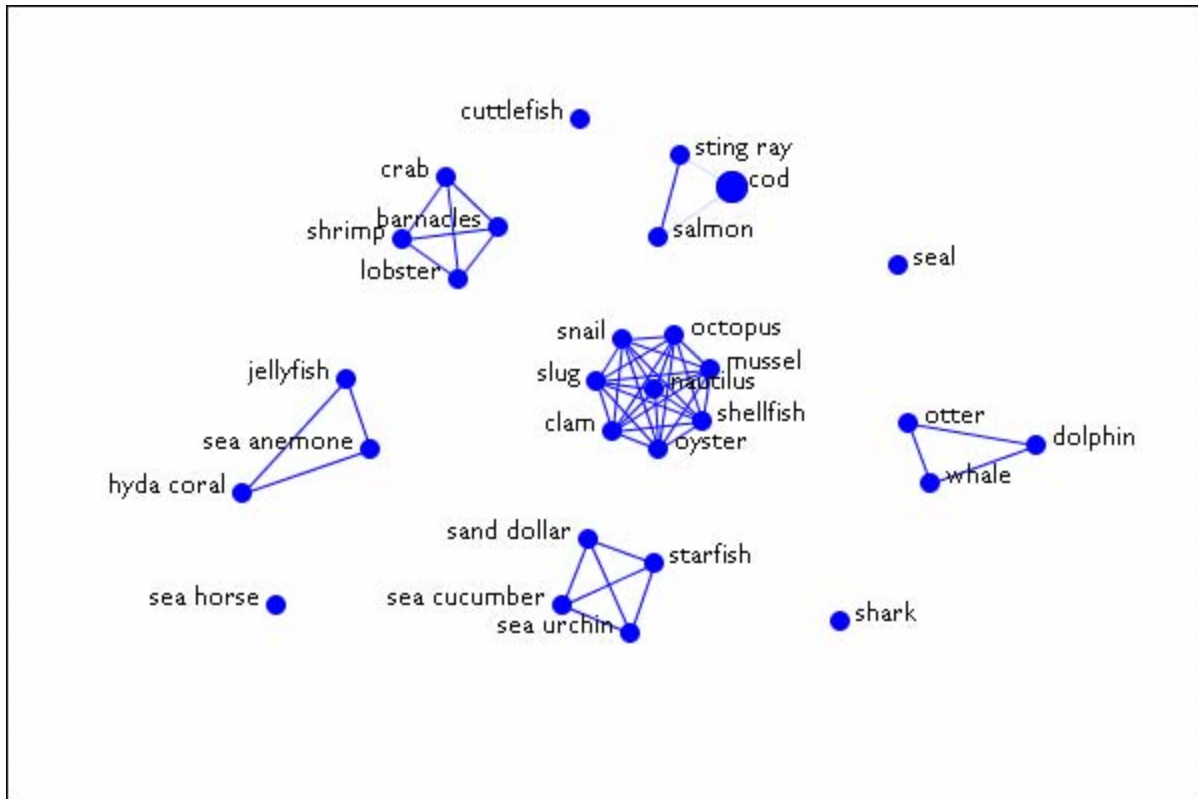
Viewing in ORA

Saving a sorted Pile : Sorted piles are saved to the DyNetML format. Networks are formed from the individual piles which include the metadata from each card.

Viewed in the Editor you can see all the saved information from Pile Sort. The column **containing_pile** is the name you gave the pile into which a card was placed. **meta-information** is the optional second column from the .CSV file originally loaded into Pile Sort. If that was empty, then the meta-information cell would also be empty.

	Node ID	Node Title	containing_pile	freq...	meta_information	relative_freq...	seconds_on_t...
	<set f... ▼	<set fi... ▼	<set filter> ▼	... ▼	<set filter> ▼	<set filter> ▼	<set filter> ▼
☐	barnacles	barnacles	crustacean	1	crustacean	1.0	0.90
☐	clam	clam	mollusk	1	mollusk bivalve	1.0	1.43
☐	cod	cod	fish	1	fish	1.0	1.03
☐	crab	crab	crustacean	1	crustacean	1.0	1.56
☐	cuttlefish	cuttlefish		1	mollusk cephaloped	1.0	0.00
☐	dolphin	dolphin	mammal	1	mammal	1.0	0.69
☐	hyda coral	hyda coral	cnidaria	1	cnidaria	1.0	0.90
☐	jellyfish	jellyfish	cnidaria	1	cnidaria	1.0	1.45
☐	lobster	lobster	crustacean	1	crustacean	1.0	0.75
☐	mussel	mussel	mollusk	1	mollusk bivalve	1.0	1.08
☐	nautilus	nautilus	mollusk	1	mollusk cephaloped	1.0	0.95

Clicking the **[Visualize this Network]** button displays your Pile in the ORA Visualizer. How networks are formed is based upon the cards placed in each pile. The four cards not placed into a pile (cuttlefish, seal, sea horse, and shark) became isolates in the Visualizer.



Below is an image of the **Edit Menu**. Further below is a description of the Edit Menu functions accessible through the Edit Menu.



Copy Editor Values : Copies the selected values in the Editor.



Paste Editor Values : After values have been copied, these can be pasted either into a different section of the matrix or the Matrix of different Meta-Network.

The copied size can be identically sized (allowing you to paste an entire column in) or a smaller, subset allowing you to choose only

a portion of the original set.



Copy NodeClass(es) : Copies one or more an entire NodeClass to the clipboard.



Paste NodeClass(es) :

Creates a copy of the NodeClass(es) from the clipboard. Used to quickly creating duplicate NodeClasses.



Copy Meta-Network : Copies an entire Meta-Network to the clipboard.



Paste Meta-Network :

Creates a copy of the Meta-Network in the clipboard. Used to quickly creating duplicate Meta-Networks.



Copy Network : Copies one or more Networks to the clipboard.



Paste Network :

Creates a copy of the Network(s) in the clipboard. Used to quickly creating duplicate Networks.

When you first start the program the **Paste Meta-Networks** is grayed out. It will only become active once you've used the **Copy Meta-Network** menu item.



ORA offers multiple options for copying Meta-Networks, NodeClasses, and Networks.

  **Copy / Paste Editor Values** : Highlight values in the Editor and select **Copy Editor Values** to copy them. Highlight a new cell in the editor and select **Paste Editor Values** to paste them. This can be used when you create a new NodeClass and only need specified values placed into the new NodeClass.

NOTE : *Highlighting and copying a 4x4 block of cells then pasting these in a new location will replace the same size block.*

  **Copy / Paste Meta-Network : Copy Meta-Network** copies a Meta-Network and **Paste Meta-Network** creates a duplicate in ORA.

NOTE : *ORA does not ask you for new names for duplicated Meta-Networks. It is advisable to give the new Meta-Network a different name in the Meta-Network ID field in order to distinguish it from the original.*

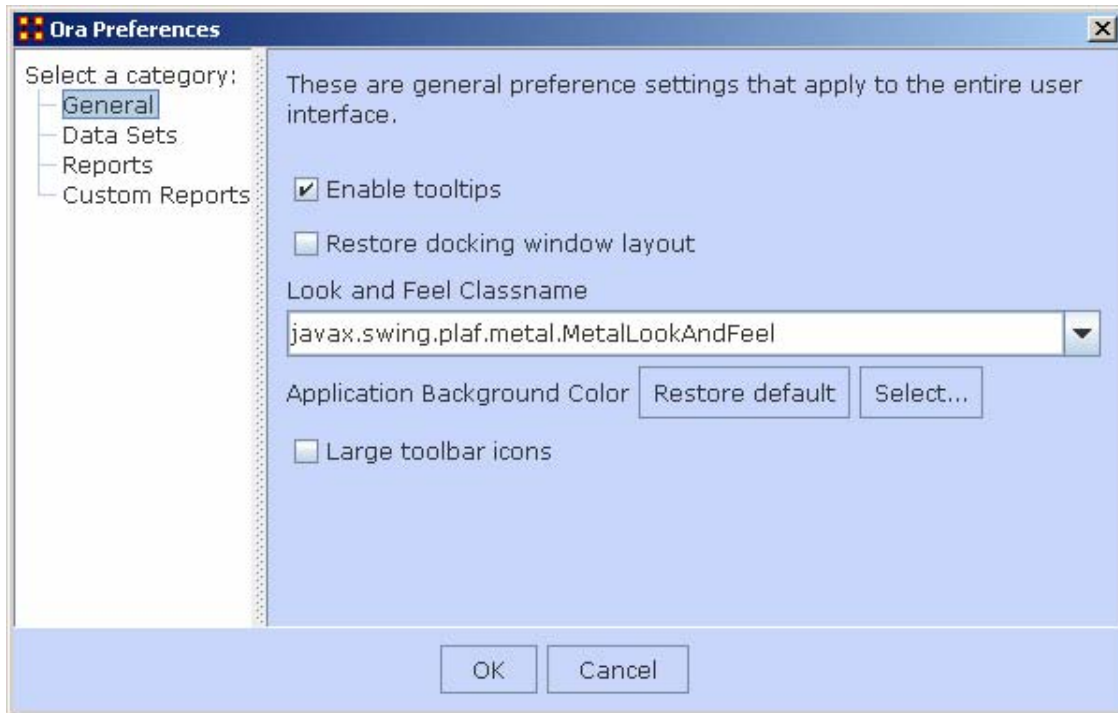
  **Copy / Paste NodeClass(es) : Copy NodeClass(es)** copies a NodeClass and **Paste NodeClass(es)** creates a duplicate it into ORA. After pasting ORA will ask you for a name for the new NodeClass. If you copy multiple NodeClass(es) ORA will ask you for multiple names.

  **Copy / Paste Network : Copy Network** copies a Network and **Paste Network** creates a duplicate into ORA.

NOTE : *The last three menu items change as is determined by what is selected in Pane 1. Currently the icons are identical*



 Preferences are global variations which control aspects of how ORA works.



General

Tooltips : Marking the checkbox shows tooltips when hovering over items. Remove the checkmark to disable tooltips.

Docking Layout : Marking the checkbox will retain the custom layout when ORA is restarted. No checkmark will fall back to the default layout.

Look and Feel : Sets the style of the ORA GUI.

Large Icons : Placing a checkmark toggles between using the 16x16 or 24x24 icons.

Data Sets

Maximum Data Files to Load : Tells ORA the maximum number of files to load upon start-up.

What To Load : You have three options for loading files when ORA is started up.

1. **Do not load any files at startup :** Ignores any files that were loaded during the last session.

2. **Restore previously loaded workspace at startup** : Loads the files that were current when ORA was last shutdown.
3. **Load specified files below**: Loads the files specified in the box below the option.

Reports

Selecting Reports to Display : Any reports with a checkmark will appear in the report generator window.

Changing / Resetting Report Names : Right-Clicking on a report name allows you to change the name. The **Reset report names** button resets all the names to their default

Import / Export Settings : If multiple people work on the same computer individual report settings can be saved for each user with **Export Settings**. Each user can use the **Import Settings** use their custom report names.

Report Headers : You can specify a header to print on the top of your reports.

Report Footers : You can specify a footer to print on the bottom of your reports.



These sets of menu items enable you to control the addition or removal of Meta-Networks, Meta-Nodes, and Networks as well as adding Attributes to a Meta-Node.

Matrix Algebra, Meta-Network Transform, and Meta-Network Union... also create new Meta-Networks, Meta-Nodes, and Networks but do it with Mathematical operations.



Meta-Network Algebra... : Performs mathematical operations on two Meta-Networks.



Meta-Network Transform... : Cleans up a Visualizer display making it easier to read.



Meta-Network Anonymize... – Resets the NodeID (and optionally the Node Title) to anonymous values.



Meta-Network Union – Creates a single Meta-Network from two (or more) existing Meta-Networks.



Add New Meta-Network : Used for adding or removing Meta-Networks from use.



Remove Selected Meta-Network : Removes any Meta-Network which is currently selected.



Add New Node Class... : Enables you to add, remove Node sets, as well as, change the size of the Node set. You can also add an Attribute to an existing Node Set. Depending on what you have selected different options may be grayed out.



Remove Selected Node Class : Removes all selected NodeClasses from the Meta-Network along with any associated Networks.



Add Attribute... : Creates a new attribute in a NodeClass. You need to give the attribute a name and also what type of attribute it is: **Text, Text Category, URI, Number Category, Number, Date**.



Add Blank Network... : Similar to Node Class in that you can add or remove Networks. This function also enables you to **Set the Diagonal** of a graph to either **-1, 0 or +1**. Useful for setting consistent values on an **agent-by-agent** Network.



Remove Selected Network : Removes all selected Networks

from the Meta-Network.



Set Diagonal : Allows user to constant values to the diagonal of a square network. If Binary View is chosen you can pick **True (+1)**, **False (0)**, or **True (-1)**. If Numeric View is chosen you can set the diagonal to any value.



Attribute Partition Tool : Creates new Meta-Networks from existing Meta-Networks using a node attribute.



Beliefs :



Randomize Links : A new Meta-Network is created with identical NodeClasses, and with networks of the same size and density, but with links distributed randomly according to Erdos-Renyi.



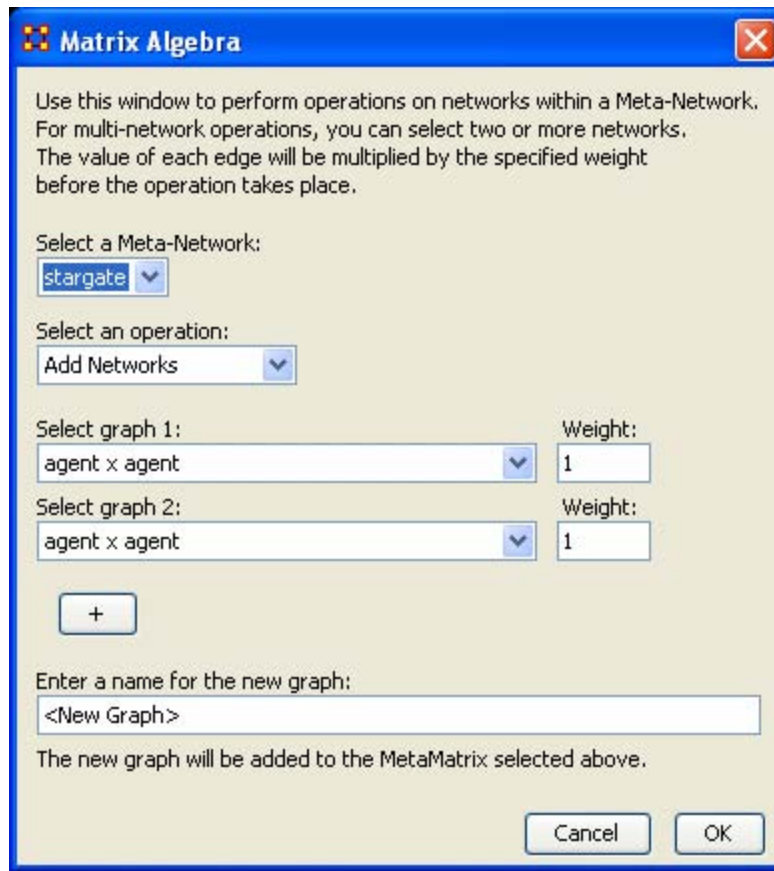
Network Algebra



Network Algebra allows you to perform mathematical operations on two Meta-Networks. The options in ORA are **addition, subtraction, and multiplication**. These functions help spot **strong and weak** connections within a Meta-Network.

NOTE : *The term Network Algebra is synonymous with Matrix Algebra in computational parlance. Also, the following images display **Matrix Algebra** in the title bar. This may or may not be the case for the most recent version of ORA.*

I start with one Network loaded.

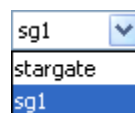


From the menu select **Data Management ⇒ Network Algebra...**

The Network Algebra dialog appears. There are six areas which you can manipulate. These are each described below the dialog box.

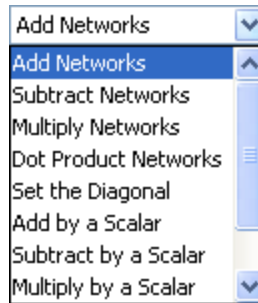
Note : Both Networks should be the same dimensions.

1. **Select a Meta-Network**



This dropdown menu will show all the Networks you currently have active. To perform a math function on a Meta-Network, highlight it in the dropdown menu.

2. **Select an Operation**

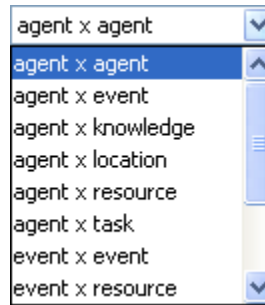


This option allows you to choose which operation, **Add, Subtract, or Multiply**, you want to perform on the Networks.

- o **Add:** Adds together corresponding cells of two different Networks.
- o **Subtract:** Subtracts corresponding cells of two different Networks.
- o **Multiply:** Multiplication is slightly different than the **add or subtract**. The number of rows in the first Meta-Network must equal the number of columns in the second. A Meta-Network can be multiplied by itself to help reveal specific **strong and weak** areas.
 - **Add Networks:**
 - **Subtract Networks:**
 - **Multiply Networks:**
 - **Dot Products Networks:**
 - **Set the Diagonal:**
 - **Add by a Scalar:**
 - **Subtract by a Scalar:**
 - **Multiply by a Scalar:**
 - **Divide by a Scalar:**
 - **Transpose:**

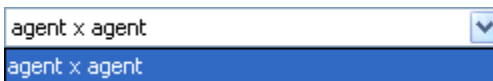
3. **Select Network 1:**

Next select the first Network you want to work with.



4. **Select Network 2:**

Then select the second Network to do the algebra on.



5. **Add Network:**

If you wish, you can add additional Networks to the equation. Different selections in the previous choices will give you different options in each dropdown.

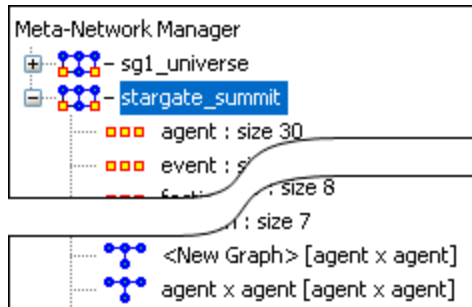


6. **Enter a name for the new Network:**

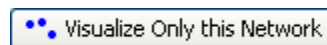
When everything is set, type in the name for your new Network.

Finally, select **[OK]** to create your new Network. You can then create more Networks if desired. When done, select **[Cancel]** to remove the dialog box from the screen.

Your new Network will now appear in the box with your Meta-Network. Next highlight the Network you just created.



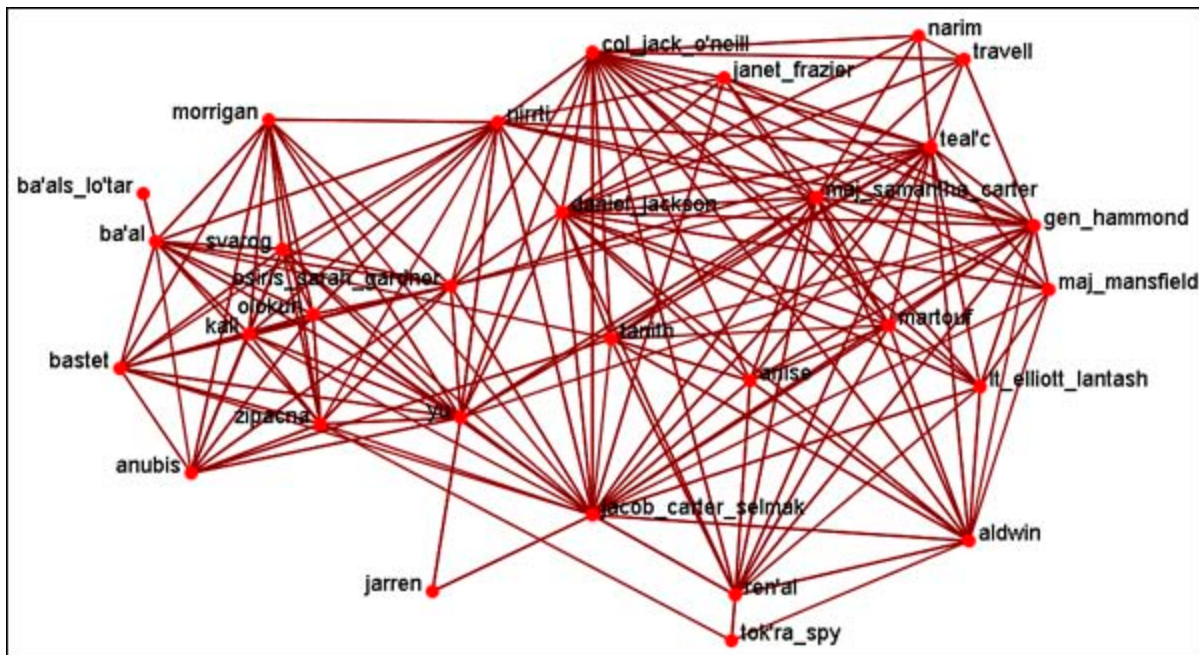
Next, select the **[Visualize Only this Network]** button



You will get a warning box asking if you're sure you want to visualize only one Network. Select **[OK]** to run the Visualizer or close the box.



This will bring up the Visualizer displaying the Network. Your display will depend on the Network selected. In this particular example there are only **Agents** and **Links connecting Agents** displayed in the Visualizer and the Legend.



Now we'll create a second Network by using the multiply operation. The second Network will put knowledge into the mix.

Note : Remember to name your file something different.

Matrix Algebra

Use this window to add, subtract, or multiply graphs within a MetaMatrix. You can select two or more graphs. The value of each edge will be multiplied by the specified weight before the operation takes place.

Select a MetaMatrix:
stargate_summit

Select an operation:
Multiply

Select graph 1:
<New Graph> [agent x agent] Weight: 1

Select graph 2:
agent x knowledge [agent x knowledge] Weight: 1

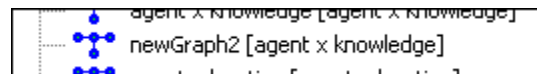
+

Enter a name for the new graph:
newGraph2

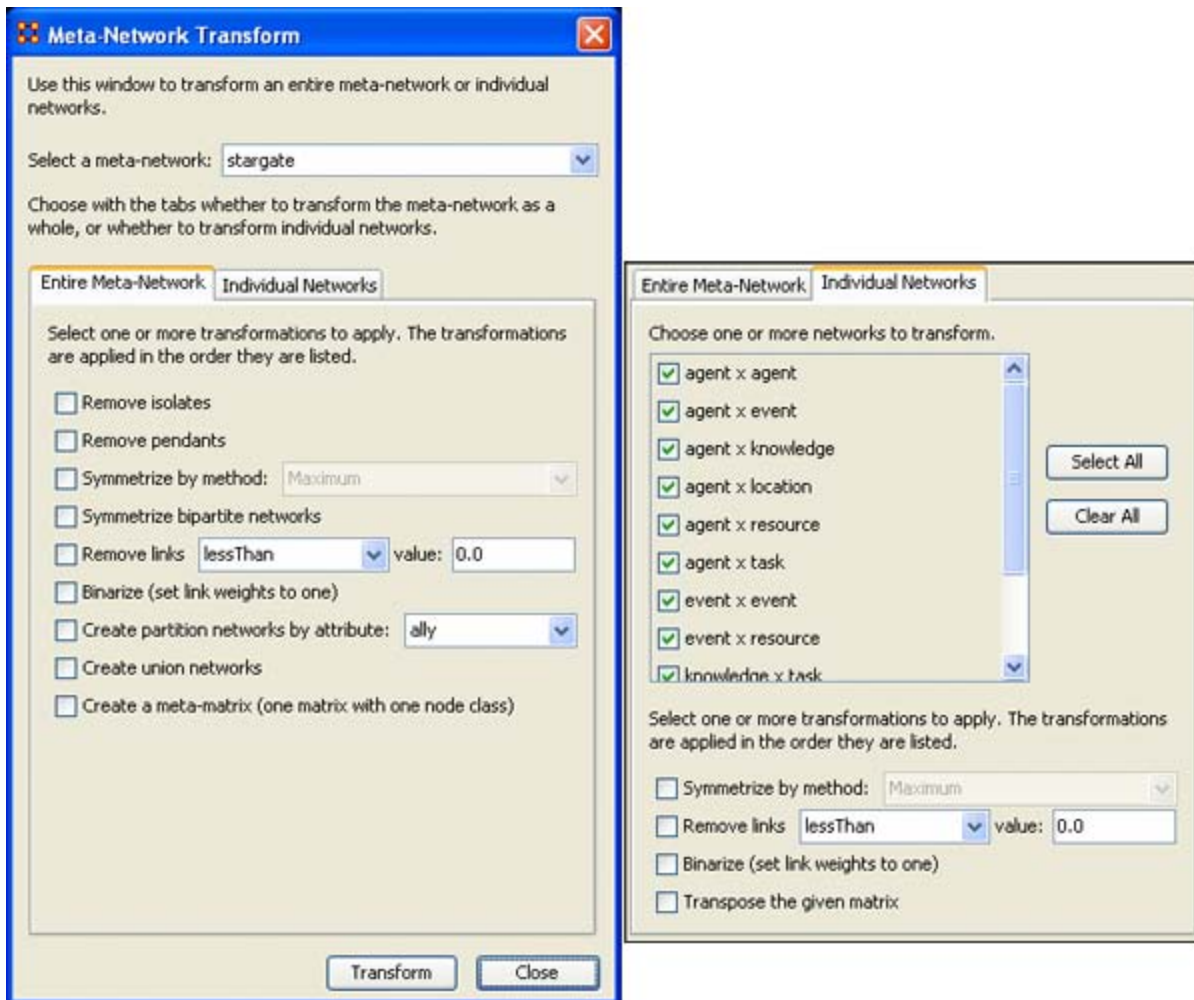
The new graph will be added to the MetaMatrix selected above.

Cancel OK

Highlight your newly created Network and select the **Visualize Only this Network** once again and select **OK** in the dialog box.



This time, since a Network with knowledge was selected the Visualizer and Legend display both **Agents and Knowledge** and also the **Links connecting them all**. Also the Matrix Algebra selected was multiplication it creates links which were not in the original Network.



The **Meta-Network Transform** dialog box will appear. It consists of three sections. The top section displays a dropdown menu with all the currently active Meta-Networks. Use this menu to select the Meta-Network. The bottom section has two tabs. The **Entire Meta-Network** contains choices on how to transform the Meta-Networks. The **Individual Networks** tab allows you to select to work on **only** individual networks.

The "Entire Meta-Network" tab

Remove Isolates

Removes any [isolates](#)* from the selected meta-network.

Remove Pendants

Removes any [pendants](#)* from the selected meta-network.

Symmetrize by Method

Symmetrize turns **directed** or **asymmetric** network data into **undirected** or **symmetric** data. All three methods use a pair of values from the upper and lower portions of the table (**e.g. cell 1, 3 is compared to cell 3, 1**). If a network had a link from A to B but not from B to A then symmetrizing the network would create a reciprocal link from B to A.

- **Maximum** Compares the values and uses the larger of the values. This is called **using the strongest value**.
- **Minimum** Similar to **Maximum** only it uses the lower, or weaker, value.
- **Average** takes the two values and averages them.

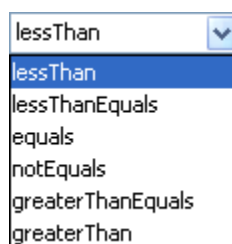
Symmetrize bipartite graphs:

Symmetrize [bipartite graphs*](#) combines networks in the Meta-Network that are transposes of each other; for example, if there is an Agent x Location Network and a Location x Agent Network, then a single Agent x Location Network is created by combining the edges from both Networks.

This is used to reduce the number of Networks in a Meta-Network when Link direction does not matter.

Remove Links:

When using **weighted links** this functions allows for links to be removed from view. You can choose from **six** options for the removal of links.



Binarize (set link weights to one):

[Binarize*](#) takes **all** links weighted greater than 0 and make them all equal to **"1"**. All links will be either **1** or **0**.

Create partition Networks by attribute:

This partitions the Node Set according to the values of the specified entity attribute and then creates a group of new graphs based on the partitioned Meta-Node. This kind of grouping is often done in network analysis to understand how some Meta-Nodes are **embedded** in various social roles or how they interact within larger Meta-Nodes. The dropdown menu will contain all the attributes in the meta-network.

*Example, if you have an Agent Meta-Node that has a **gender** attribute for each node that takes on values **male** and **female**, then using this feature four new Agent x Agent Networks would be created that contained links from males to males, males to females, females to males, and females to females. No new Meta-Node is created and no data is changed.*

Create union matrices

This creates new graphs that are the union of all graphs of the same type. If the Meta-Network had two Agent x Agent Networks, then using this feature would create a new Agent x Agent Network which would contain all the links that were present in the original two Networks.

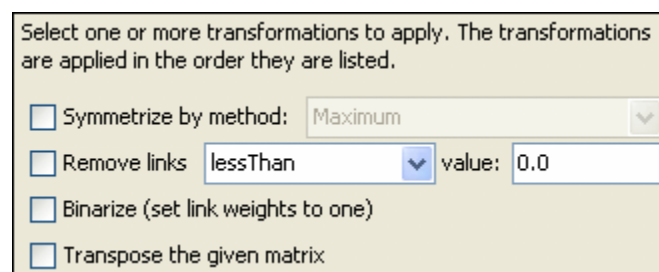
Create a meta-matrix (one matrix with one node class)

Creates a new Meta-Network with **a single** NodeClass and **a single** Network. The nodes are prefixed with the name of the NodeClass they were taken from.

The "Individual Networks" tab

Choose one or more networks to transform by placing a checkmark in the box. If you want to exclude a network, remove the checkmark.

Then select one or more transformations to apply :



Select one or more transformations to apply. The transformations are applied in the order they are listed.

- ☐ Symmetrize by method: Maximum
- ☐ Remove links lessThan value: 0.0
- ☐ Binarize (set link weights to one)
- ☐ Transpose the given matrix

Symmetrize by method :

Symmetrize is a tool that is used to turn **directed** or **asymmetric** network data into **un-directed** or **symmetric** data. All three methods use a pair of values from the upper and lower portions of the table (**e.g. cell 1, 3 is compared to cell 3, 1**)

Remove links :

When using weighted links this functions allows for links to be removed from view. You can choose from six options for the removal of links.

Binarize (set link weights to one) :

Will take any weighted link and make them all equal to "1".

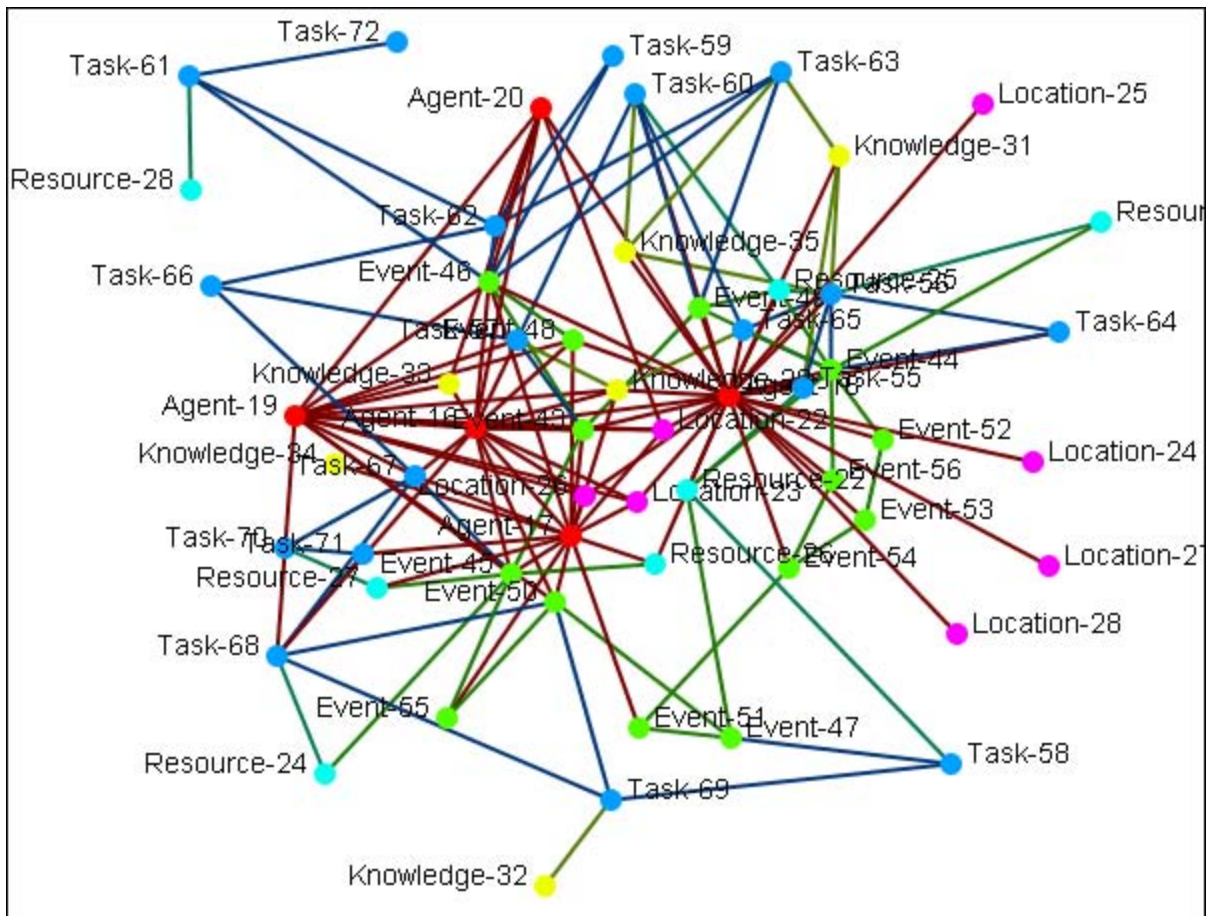
Transpose the given matrix :



 **Meta-Network Anonymize** tool removes IDs (and optionally Titles) from any chosen NodeClass. This is particularly helpful if you are discussing sensitive network information about real people and wish to remove their names from the network model.

The Visualizer

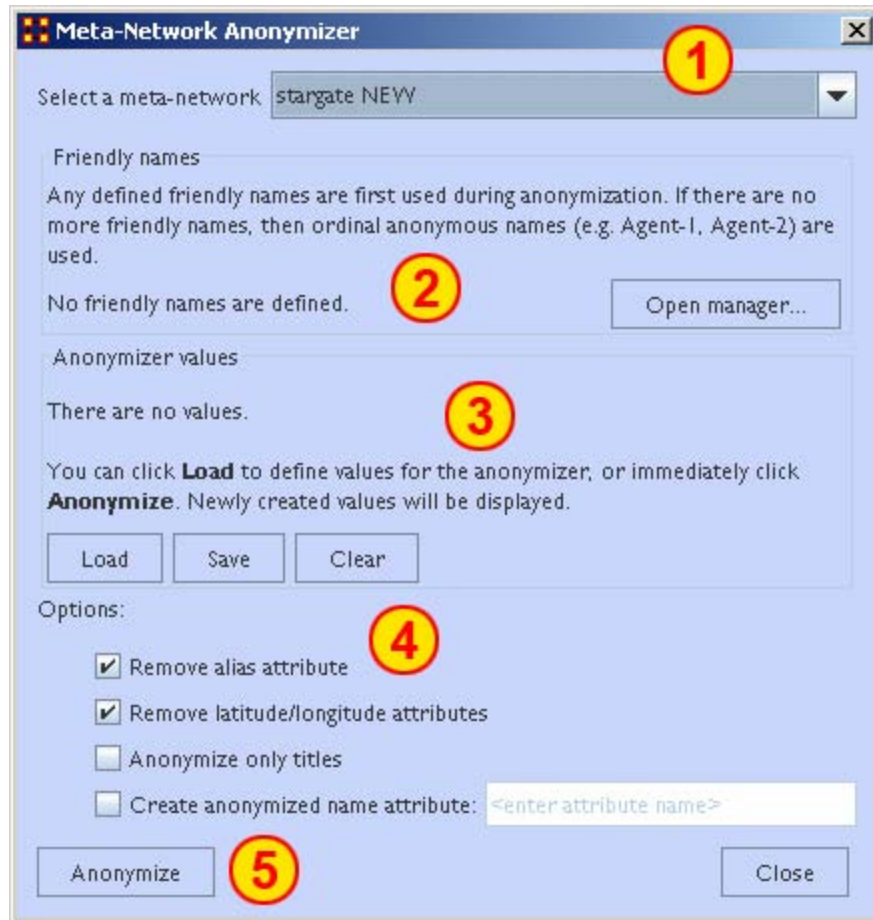
Visualizer Before Anonymizing : When you load your network model into the Visualizer, you will see (by default) the names of your agents or applicable entity class nodes. You may, for a number of confidentiality reasons, wish to hide this information from your audience yet still show them visually what the network can reveal.



Meta-Network Anonymizer dialog

From the main menu select **Data Management > Meta-Network Anonymize....**

The Meta-network Anonymizer tool will appear in a pop-up window. Here you can select a number of parameters pertinent to the node classes you wish to anonymize.



1. **Select a Meta-Network** : All active Meta-Networks appear in the drop-down menu. Select the Meta-Network to anonymize.
2. **Friendly names** : The user can create a list for each NodeClass of names that will not be anonymized.
3. **Anonymizer values** :
4. **Options** :
 - o **Remove alias attribute** :
 - o **Remove latitude / longitude attributes** : Removes geospatial attributes from the Meta-Network.
 - o **Anonymize only titles** :
 - o **Create anonymized name attribute** : If you would like to use descriptions other than Titles or IDS, you can generate your own terms. This is intended to be used with the friendly Anonymizer

tool but can be used for whatever reasons you deem fit. To do so, be sure the **create Name Attribute** is checked then enter your own term.

5. **Anonymize button** : Click the button when you are ready to crate an anonymized file.

Writing an Anonymized file : When the **[Anonymize]** button is selected ORA writes a **.CSV** file. The Save box allows the user to navigate to a directory to save the file.

Encoded ID,Original ID

A-1,A01

A-2,A02

A-3,A03

A-4,A04

Node Title : If the **Anonymize node title** is selected then ORA will also write the original Title to the file.

Encoded ID,Original ID,Title

E-1,E01,revanna_meeting

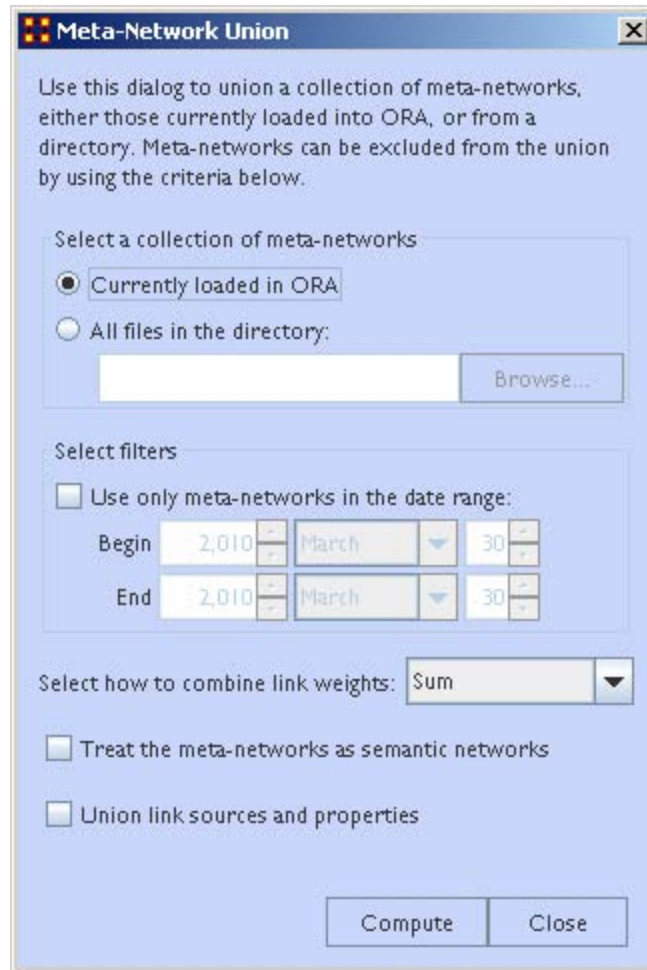
E-2,E02,summit_meeting

E-3,E03,revanna_bombardment

E-4,E04,sgc_meeting



 **Meta-Network Union** is used to combine two or more Meta-Networks together. There are tools to select which Meta-Networks to use or exclude and how to combine the link weights. ORA can save out the result as an entirely new Meta-Network file.



Select a collection of meta-networks : allows the user to define the Meta-Networks to combine. It has two options.

1. **Currently loaded in ORA :** will create a new Meta-Network using all the currently loaded Meta-Networks.
2. **All files in the directory :** will create a new Meta-Network from all the files in a specified directory.

Select filters : narrows the Meta-Networks to use. If the **Use only meta-networks in the date range:** is checked you will need to fill in the **Begin** and the **End** dates. This will filter out Meta-Networks which fall outside those dates.

Select how to combine edge weights: contains the options for how to reduce the amount of edges within a Meta-Network. The options are **Minimum, Maximum, Average, Binary, and Sum.**

Treat the meta-networks as semantic networks :

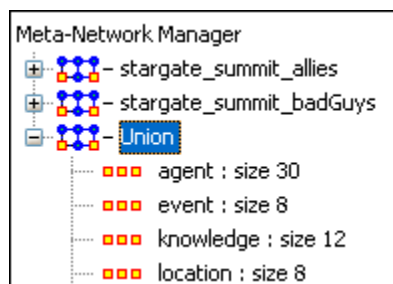
Union link sources and properties :

Example

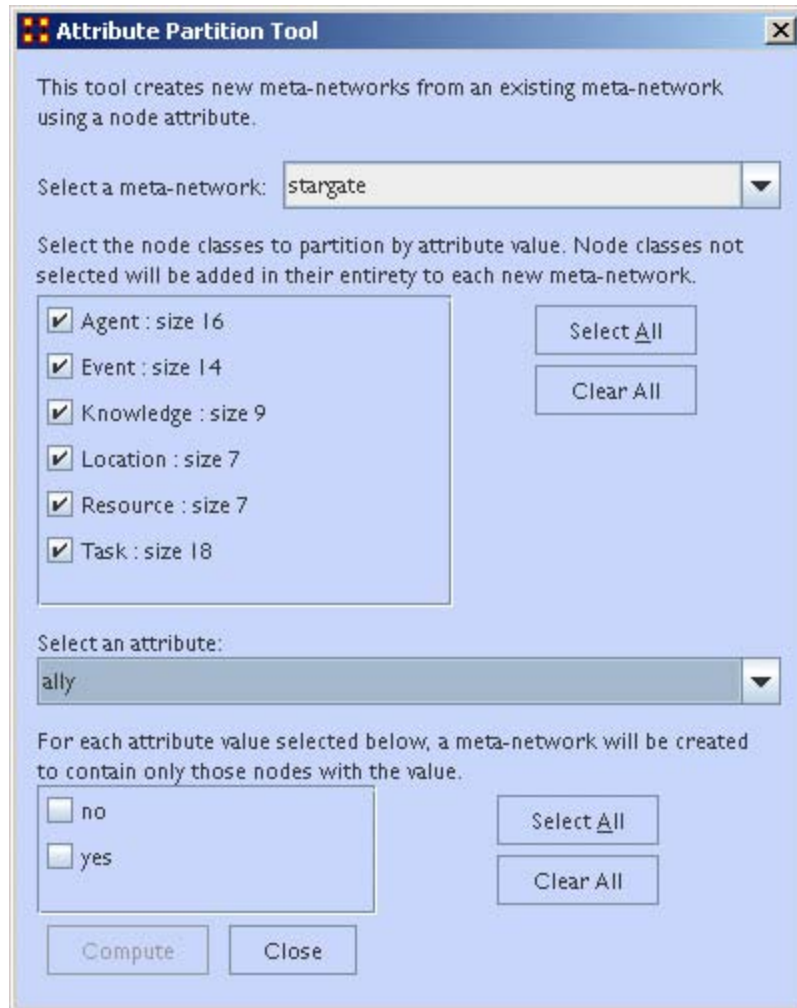
There are two Meta-Networks currently in ORA, **stargate_summit_allies** and **stargate_summit_badGuys**. These will be joined together into a single Meta-Network using the **Sum** option. Both the existing Meta-Networks contain 15 nodes.



There will appear in Pane 1 a new Meta-Network called **Union** which is a combination of the two other Meta-Networks.



 To create new **Meta-Networks** which are a subset of nodes use the **Attribute Partition**. Select an Node-Class(es), select the Attribute set, then select the individual attribute(s) to form a new Meta-Network.



There are four sections to the dialog box:

Select a Meta-Network: The dropdown menu lists all the currently open Meta-Networks

Select Node Class(es): Place a checkmark in the box(es) of the NodeSets you want included.

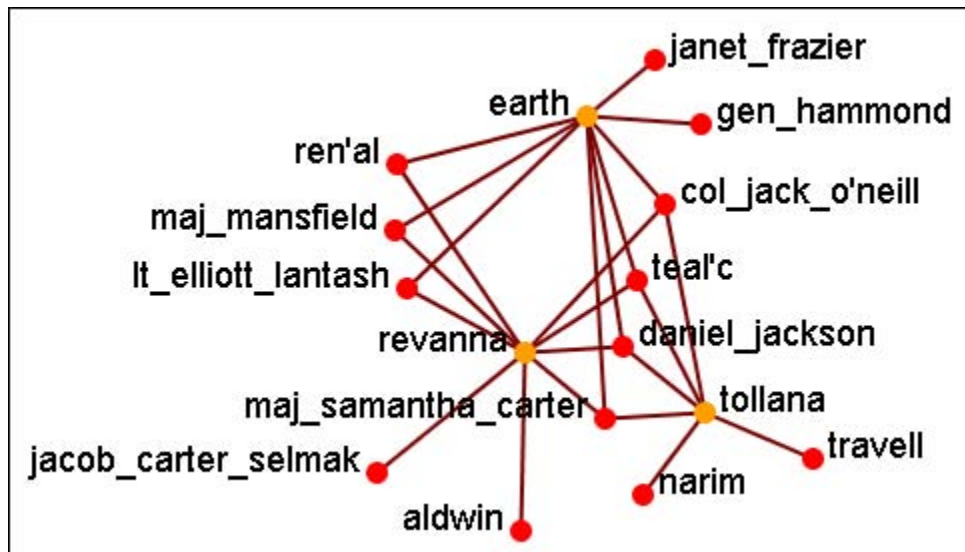
Select an attribute: This drop-down menu shows all the attribute(s) contained within the selected NodeSet(s). If you change the NodeSet(s) the choice of attribute(s) will be reflected in this dropdown.

Attribute Value: Place a checkmark in the box(es) of the attributes you want included in the new Meta-Networks. Each attribute check marked will create a separate Meta-Network.

When you click the **[Compute]** button ORA will tell you how many new Meta-Networks were created and you will see them in pane 1 of the GUI.

Example

I selected the Stargate Meta-Network and used the **ally** attribute. In the value section I selected **Yes**. IN the new Meta-Network I selected the **agent x location** network.



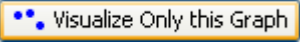
Below is the original Stargate **agent x location** network with the nodes and links not in the new network grayed out.

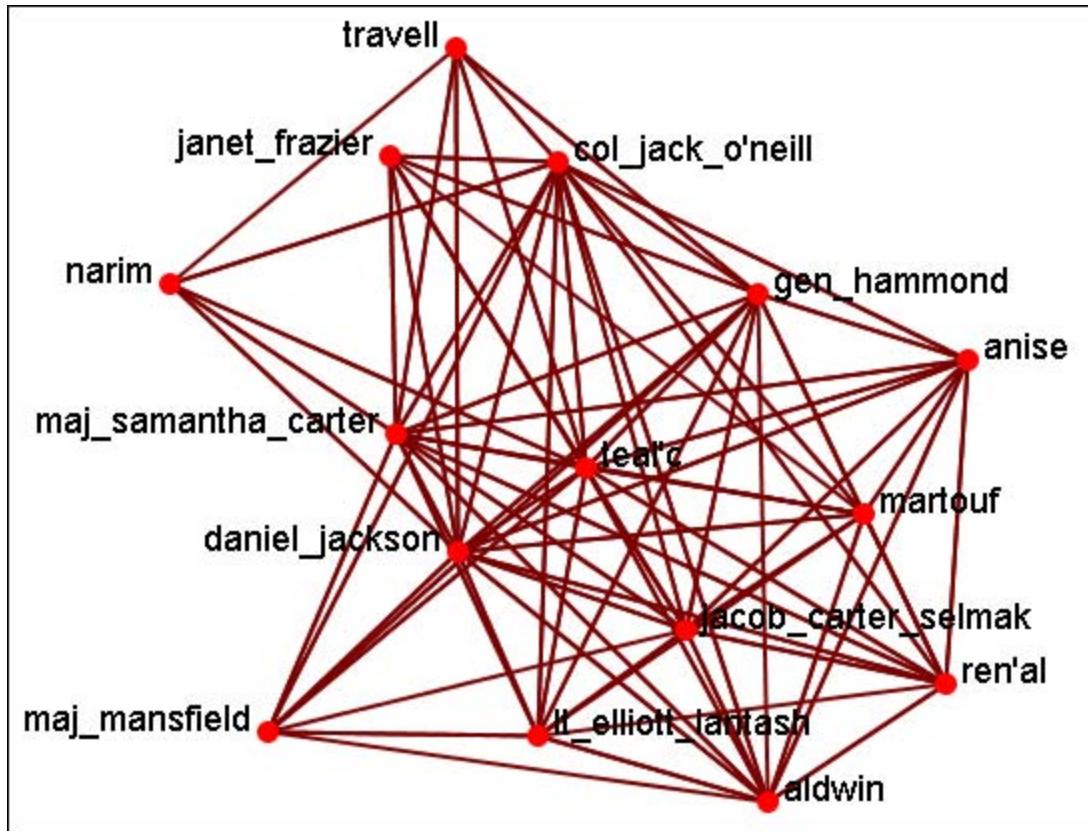
networks-the values that various probabilities converge to as n grows very large. **Percolation theory** characterizes the connectedness of random networks, especially infinitely large ones.

Random networks are widely used in the probabilistic method, where one tries to prove the existence of networks with certain properties. The existence of a property on a random network implies, via the famous **Szemerédi regularity lemma**, the existence of that property on almost all networks.

Creating a Random Graph : is a function which **randomizes** the Links in a Network. From the main menu select **Data Management > Randomize Links**. From the dialog box select from the drop-down menu. A new Meta-Network will appear in Pane 1 and it's name will denote it has been randomized.

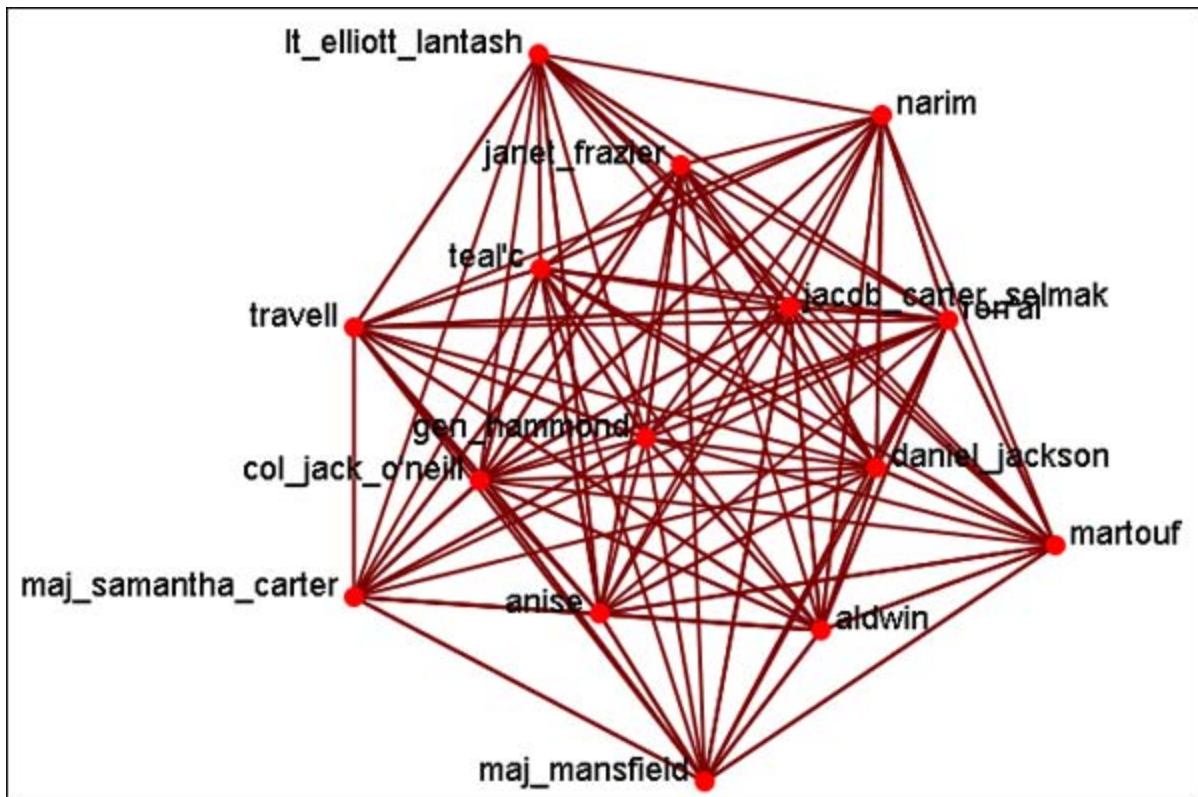


The original Meta-Network is selected and the Network **agent x agent** is chosen. From the **Info Tab** in the Editor the  button is clicked. This displays the Network as it appears in the original Meta-Network.



Now select the newly created **randomized Network** and select the **agent x agent** Network. From the **Info Tab** in the Editor the  button is clicked. This displays the Network as it appears in the randomized Meta-Network.

As shown in the Visualizer the links have been randomized.



Generate Network



Create New Meta-Network : Creates a new **blank** Meta-Network.

Influence Network Generator : Creates an Influence Network file for use in the external program Pythia.

Command and Control Structure Generator : Creates Network files for use in the external program Caesar III.



Create New Meta-Network In Visualizer : Creates a blank Meta-Network in the Visualizer which can be populated with NodeClasses and Networks from scratch.

Create Stylized Network : Generates new Networks using

various Mathematical formulas including Erdős-Rény, Core-Periphery, Scale-Free, Cellular, Lattice, and Small-World Networks.

Create Expected Interaction Network : Predicts the expected interaction of a network given known tasks and other available network data. You can create **an Expertise Correlation, a Similarity Correlation, a Distinctiveness Correlation, or a Resemblance Correlation.**



Influence Network : is a hypotheses regarding **tasks, performance, event happening, and related events**. This functions covers how to generate an influence network from a social network using ORA and examines the probability of event happenings based on the state and influence of supporting nodes.

The **Influence Network Generator tool** in ORA takes a Meta-Network and outputs an influence network that is readable by another software program, **Pythia**. Pythia, a software tool developed by George Mason University, has the ability to reason about an influence network's structure extracted by ORA. Therefore, ORA and Pythia can work in conjunction to perform an influence network analysis. Essentially, ORA generates the network and Pythia tells you something about it.

ORA generates influence nets for Pythia from Meta-Networks. ORA can also read in a Pythia influence net and assess its structure. After ORA generates an influence network, the user then has to work with Pythia and a SME (subject matter expert) to get the probability distributions to make sense. The key advantage is by inferring the influence network from the meta-network via ORA you save a lot of the start-up time in performing an influence network analysis.

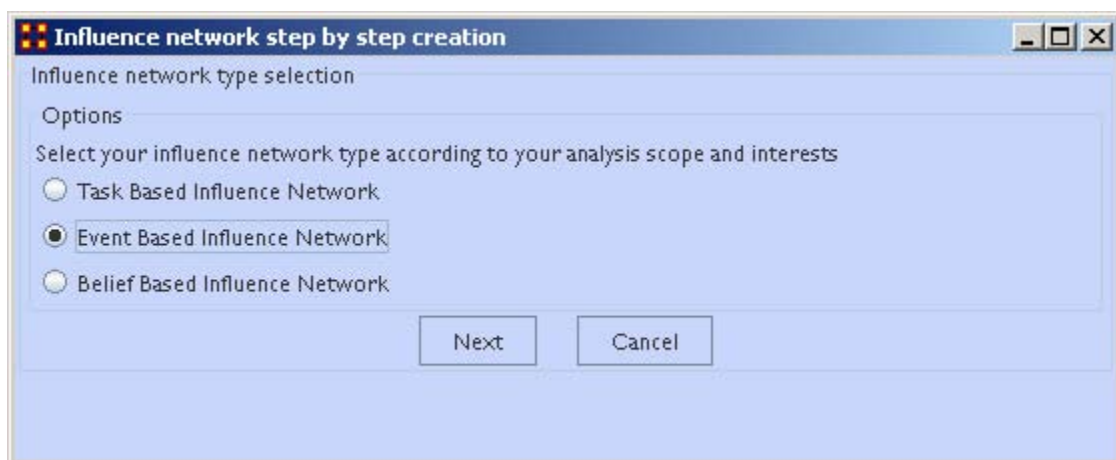
The ORA file generated by this function is directly loadable in Pythia. It is not a complete influence network and the user will need to make adjustments to the generated networks. It uses basic **ontological** interpretations and inferred baseline probabilities where the user specifies positive/negative probability.

We create an influence network based on: Extracting a task network which directs the target task to analyze. Then examine the complexity, importance, personnel/resource/expertise assignment of the tasks.

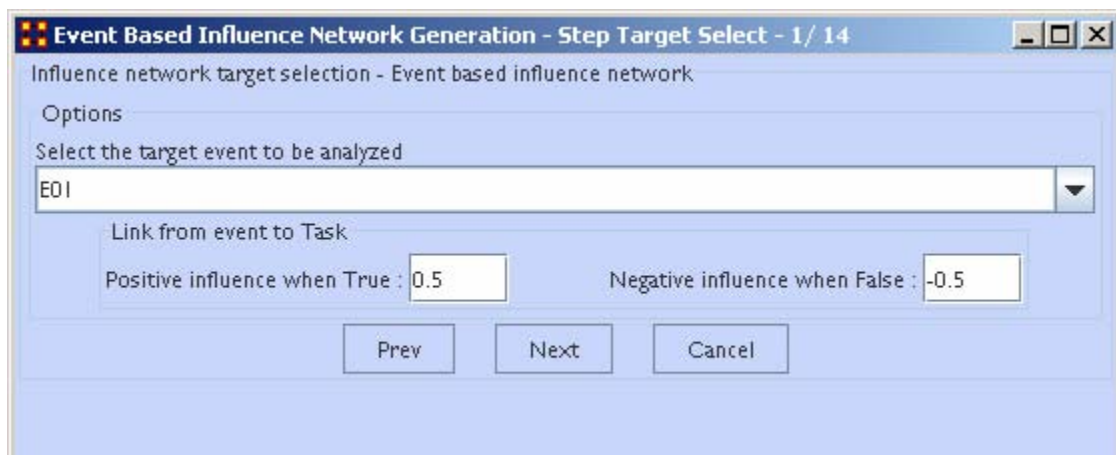
The examinations become influence network nodes containing ontological interpretation when: The task is done — the task is complex — the task is important — there are sufficient actors associated with the task — resources are available — expertise is available.

Then links are created as in the task network and background hypotheses nodes link to a task node.

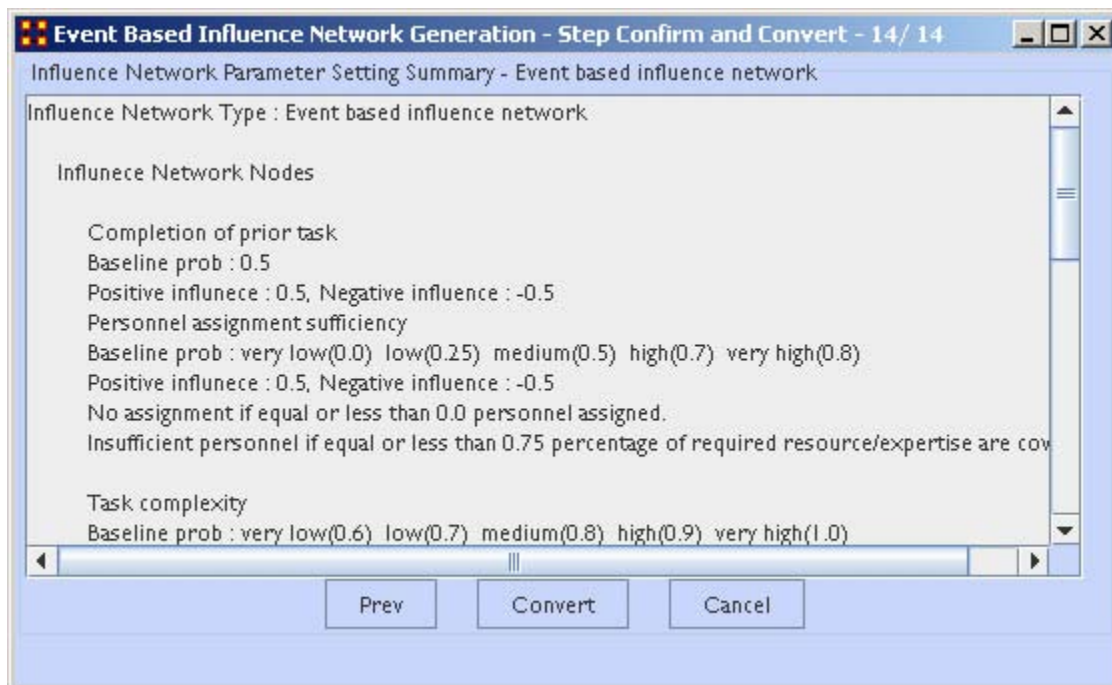
Running the Routine : From the main menu: **File > Influence Network Generator**. This brings up the **Influence network step by step creation** dialog box. There are three options: **Task Based, Event Based, and Belief Based**.



After selecting the creation type and clicking **[Next]** you will be presented with a number of steps depending on what information needs created.



Information on the thresholds you want and other data will be input in the dialog boxes until the final screen is reached.



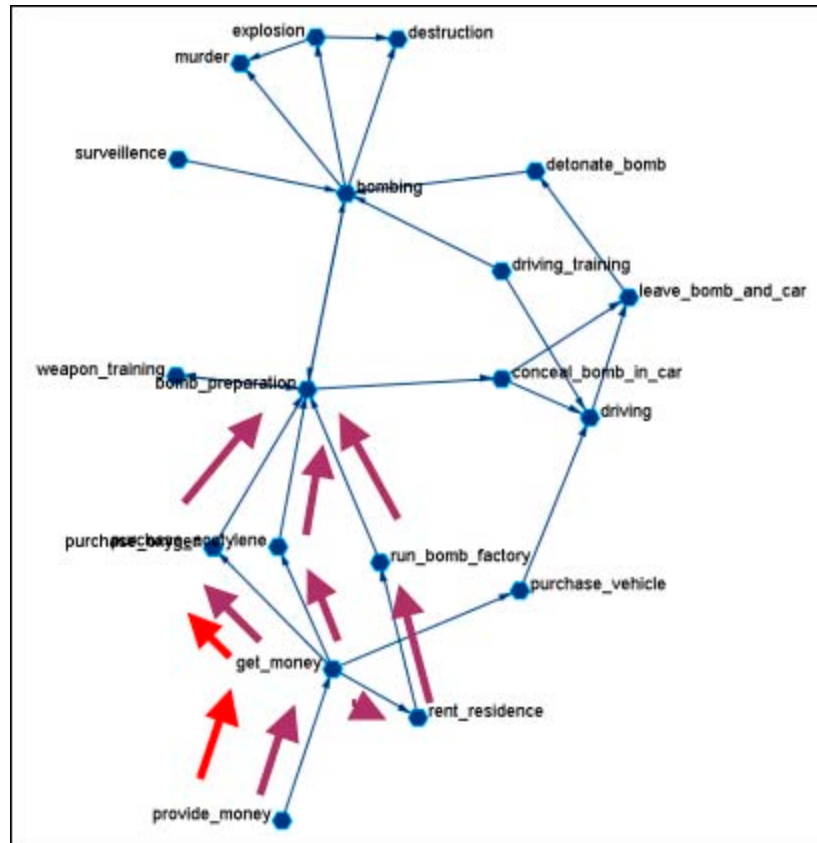
When all the information is input a dialog box with the results will display. This is the final check before clicking the **[Convert]** button and saving the file.

Il-Chul Moon, *Destabilization of Adversarial Organizations with Strategic Interventions*, PhD Thesis, School of Computer Science, Carnegie Mellon University

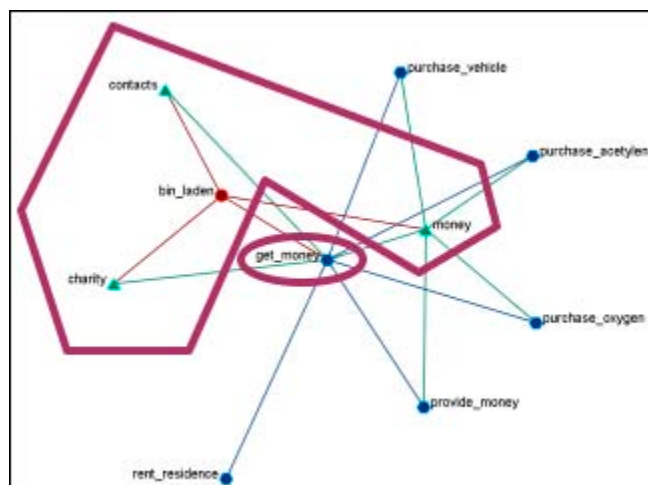
Extracting a Task Network for the Influence Network Generator

What follows are procedures to extract a Task Network for the Influence Network Generator.

In a Meta-Network there is an *event-to-event* network and a *task-to-task* network. Choose one task to analyze.

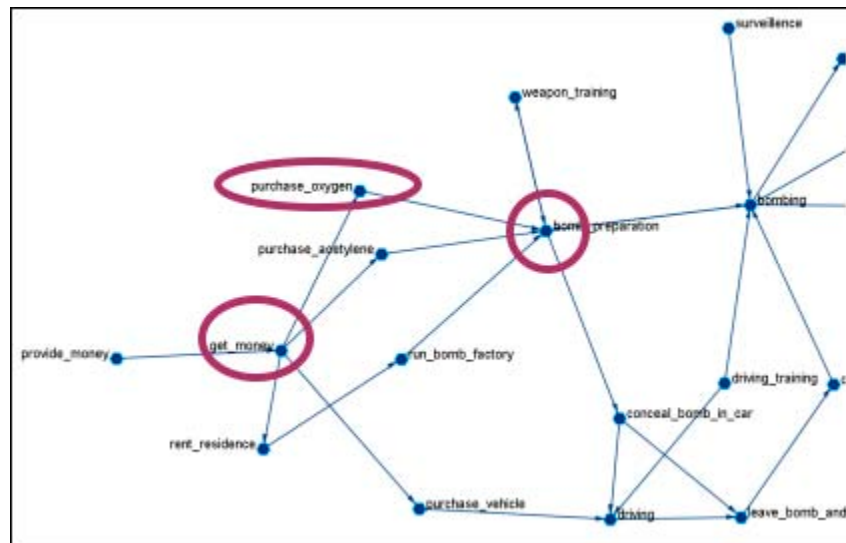


Here we look at **bomb preparation**. Find the tasks that need completed to accomplish the objective. Then trace from **provide_money**, **get_money**, **purchase_oxygen**.



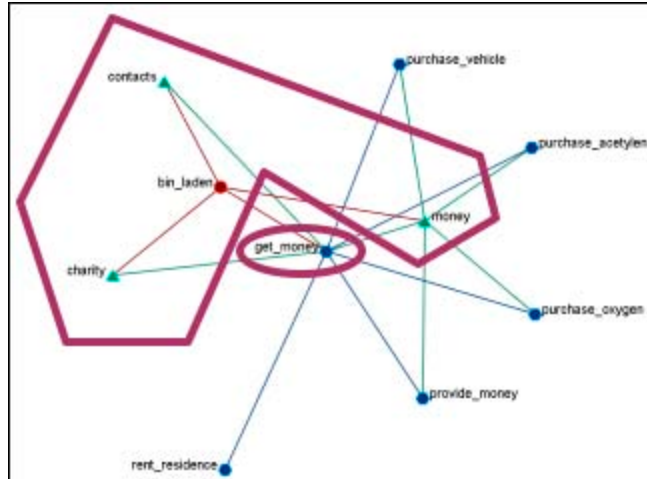
The complexity of the task depends on three items. **Resources / Expertise required and number of person required.**

- **Very Low (default baseline=1.0):** 0 resource/expertise required / 1 person required.
- **Low (default baseline=0.9):** 1 resource/expertise required / Less than 3 persons required.
- **Medium (default baseline=0.8):** Less than 4 resource/expertise required / Less than 4 persons required.
- **High (default baseline=0.7):** Less than 8 resource/expertise required / Less than 7 persons required.
- **Very High (default baseline=0.6):** More than 7 resource/expertise required / More than 6 persons required.



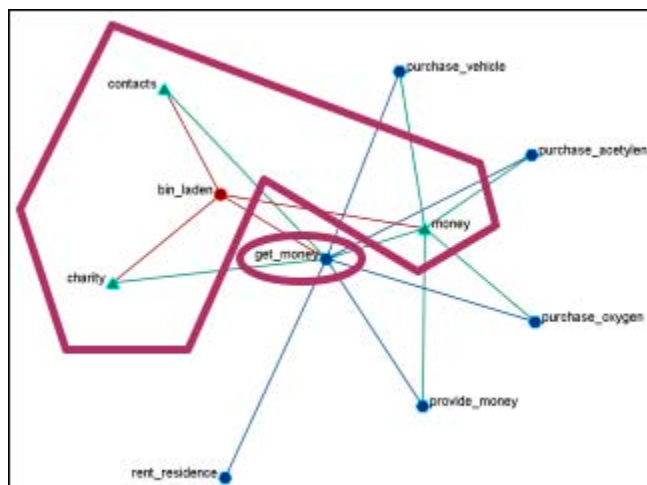
The importance of the task is determined by using **standardized degree centrality** and **betweenness** (ranging (0~1):

- **Very Low (default baseline=0.4):** Not connected to other tasks
- **Low (0.5):** Low out-degree density and low betweenness in task network
- **Medium (0.6):** Medium out-degree density and low betweenness in task network
- **High (0.7):** High out-degree density or medium betweenness in task network
- **Very High (0.8):** High out-degree density in task network



The actor assignment of the task is determined by sufficient actors, which are associated with the task.

- **No personnel (default baseline=0):** No assigned actors
- **Insufficient (0.25):** Only 75% of resources/expertise are covered by assigned actors.
- **Almost sufficient (0.5):** More than 75% of resources/expertise are covered by the assigned actors.
- **Sufficient (0.7):** At most one person associated with each resource and each expertise connected to the task.
- **More than sufficient (0.8):** More than one person associated with some resources and expertise connected to the task.



Resource / Expertise availability

Finds if **Expertise and Resource** are directly accessible. The availability is determined as follows:

- **Redundantly available / accessible baseline probability=0.75):** More than one person with the expertise associated with the task.
- **Available / accessible (0.6):** One person with the expertise/resource is associated with the task.
- **Unavailable / inaccessible (0.25):** No person with the expertise/resource is associated with the task.

Learn more...

Il-Chul Moon, Kathleen M. Carley, and Alexander H. Levis, Inferring and Assessing Informal Organizational Structures from an Observed Dynamic Network of an Organization, Management Science, 2008, Submitted and under review

Il-Chul Moon, Kathleen M. Carley and Alexander H. Levis, Vulnerability Assessment on Adversarial Organization: Unifying Command and Control Structure Analysis and Social Network Analysis, SIAM International Conference on Data Mining, Workshop on Link Analysis, Counterterrorism and Security, Atlanta, Georgia, Apr. 26, 2008

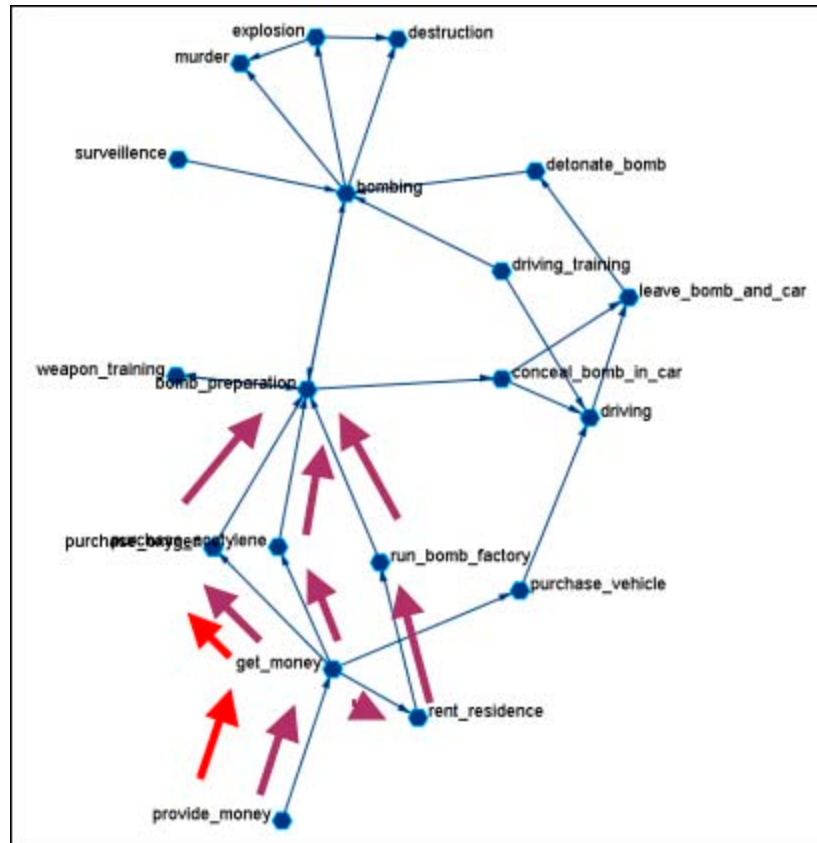


Pythia is a timed influence net application. Conversely, data from Pythia can be loaded into ORA using the [Data Import Wizard](#).

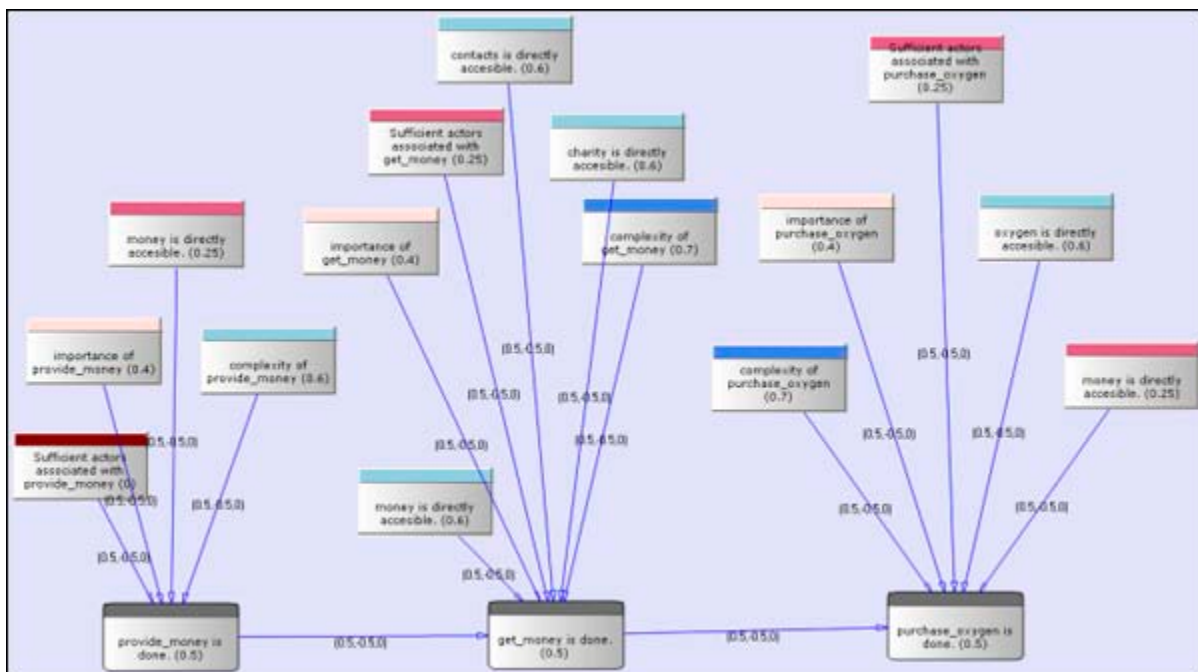
In conjunction with the Pythia application from George Mason University, data from ORA can be loaded into Pythia to create organizational displays.

What follows is a brief example of creating an organizational display using ORA with Pythia.

Start from an ORA **Task Network** (shown below)



The data can be loaded into **Pythia** to create an organizational display.



Reference at the George Mason University web site:

<http://sysarch.gmu.edu/main/software/>

Contact George Mason at the above URL for instructions on downloading Pythia and additional instructions on how to use the tool.

Learn more...

Il-Chul Moon, Destabilization of Adversarial Organizations with Strategic Interventions, PhD Thesis, School of Computer Science, Carnegie Mellon University



C2 Structure and Meta-Network

A Meta-network is a representation of a complex adaptive system. This system it has agents, expertise, resources and tasks. And inherent in this data are Meta-networks that contain the C2 structure of an organization, which are the links of a social network among commanders represented in the following ways:

- Command chains
- Information sharing relations
- Result/response sharing relations

However, meta-networks may only have one commander-to-commander network without classifying the nature of links. An analyst oftentimes needs a method to infer the nature of relations among commanders based on a given meta-network. That is where this tool can help. ORA uses the task assignment and communication directions to infer the nature of a link.

C2 structure in CAESAR III : Design View and Analysis View can be generated from a series of matrices describing the communications among decision makers (agents). The goal should be producing the matrices out of a social network. The analysis view has cognition aspects The nature of a link is determined by the timing of communication during the decision making process.

Meta-Network : Network among people (, knowledge, resources, tasks, etc). Data for statistical analysis, not exactly an analysis tool. Reveal the organizational structure, influence propagation, command and control structure, etc. Widely used in organizational science, counter-terrorism, structure reformation, etc.

C2 structure extraction in ORA : ORA provides a function, Command and Control Structure Generator. Automatic generation of C2 structure based on a target task and a social network among decision makers. Generated influence network is directly loadable in CAESAR III. It is not a complete C2 structure but a reasonable inference (or approximation).

C2 Structure Generation Procedure

Determine a target task to analyze. Extract the task network of the target task. Extract the related (assigned) agents of the task network. The other agents are aggregated and represented as the outside world (IN and OUT). Regard the agent-to-agent network as a information sharing network. Determine the network level based on the link directions and network topology. Then, extract a command chain from links bridging different network level. Determine the result sharing requirement based on the task network (i.e. the link direction between the two tasks indicate the result sharing requirement) Then, create a result sharing network based on the requirements.



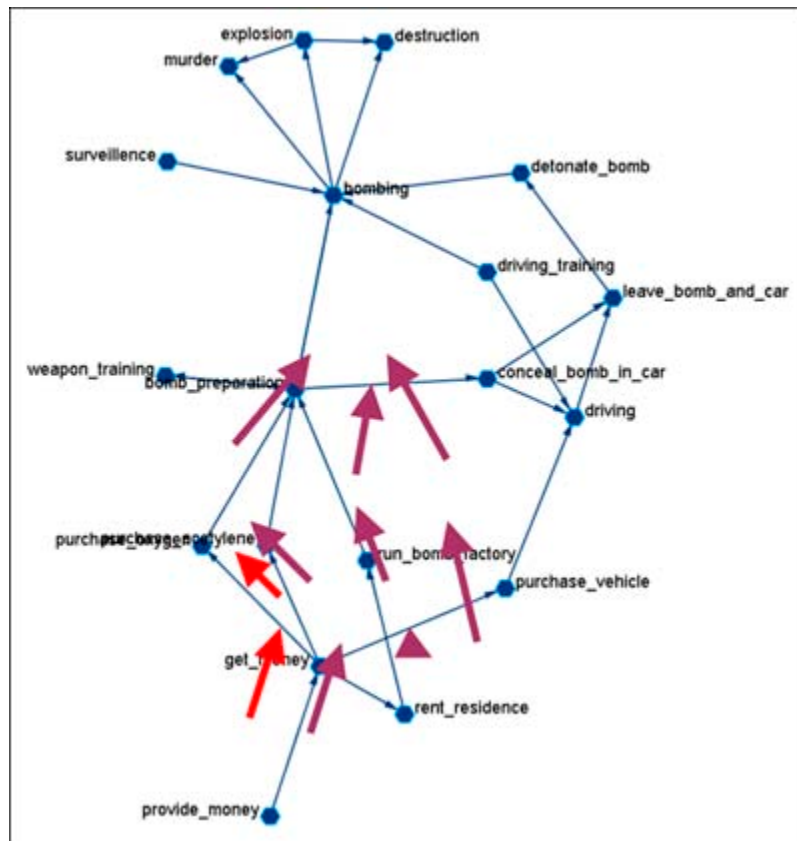
Extracting a Task Network for the Command and Control

What follows are procedures and an overview of extracting a *task network* for command and control analysis using ORA in conjunction with Caesar III, an external software tool for task network analysis.

In a Meta-Network, there are *event-to-event* networks and *task-to-task* networks contained in most data sets. We select one task to analyze and use ORA's command and control tool to discover the steps needed to complete this task from beginning to completion.

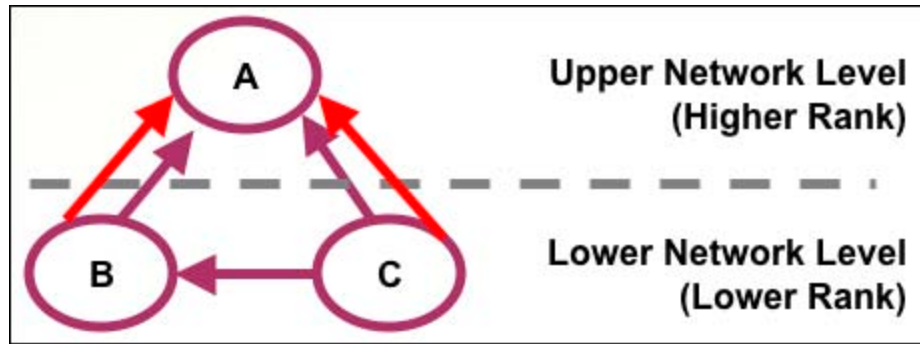
In the images below, we are extracting a task network needed for the bomb_preparation task node.

The idea is to find how tasks should be completed to accomplish the objective, bomb_preparation (e.g., *find the trace to a purchase_oxygen task. Provide_money —> get_money —> purchase_oxygen*).

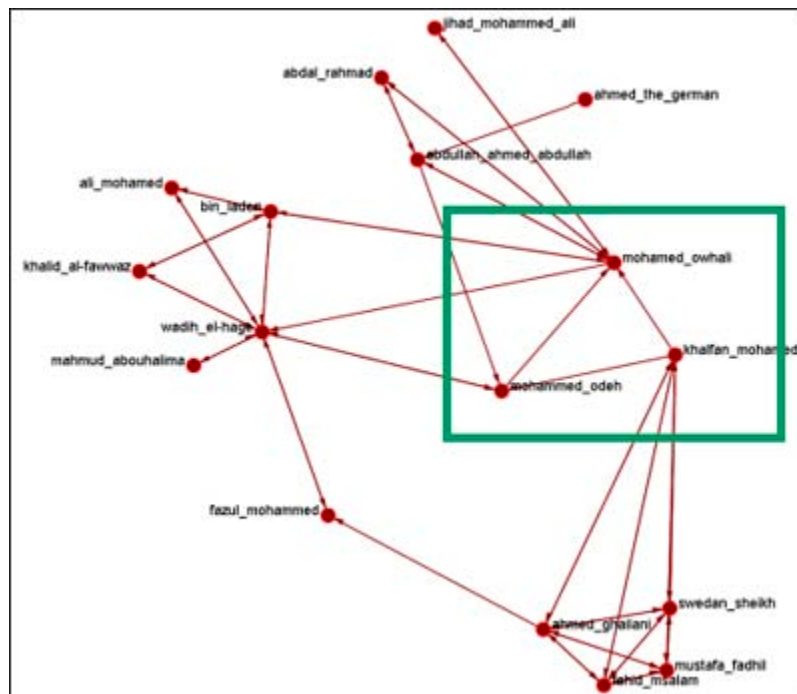


Assigned Agents

Identify the task network. Find all the assigned agents. Agents directly linked to a task in the task network.

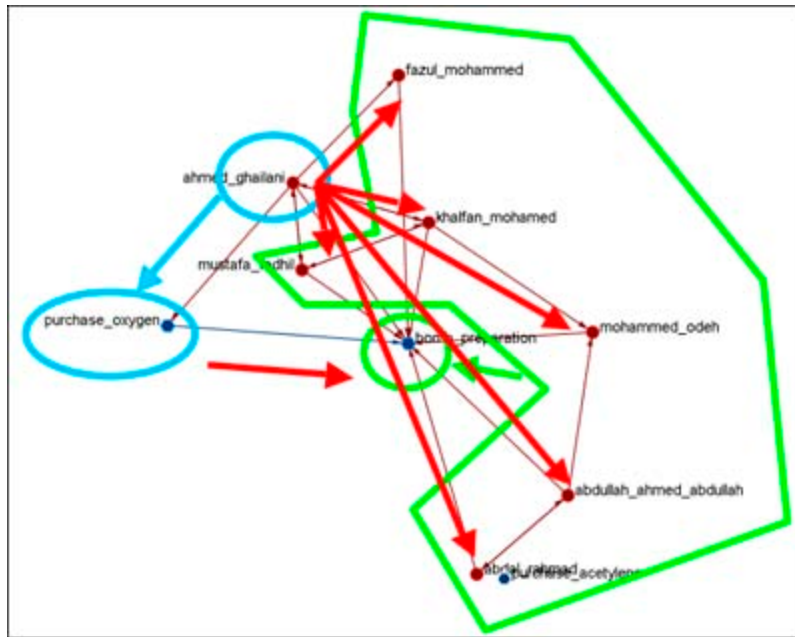


Red arrows are command chains. Purple arrows are social network links.



Inferred Result Sharing Network

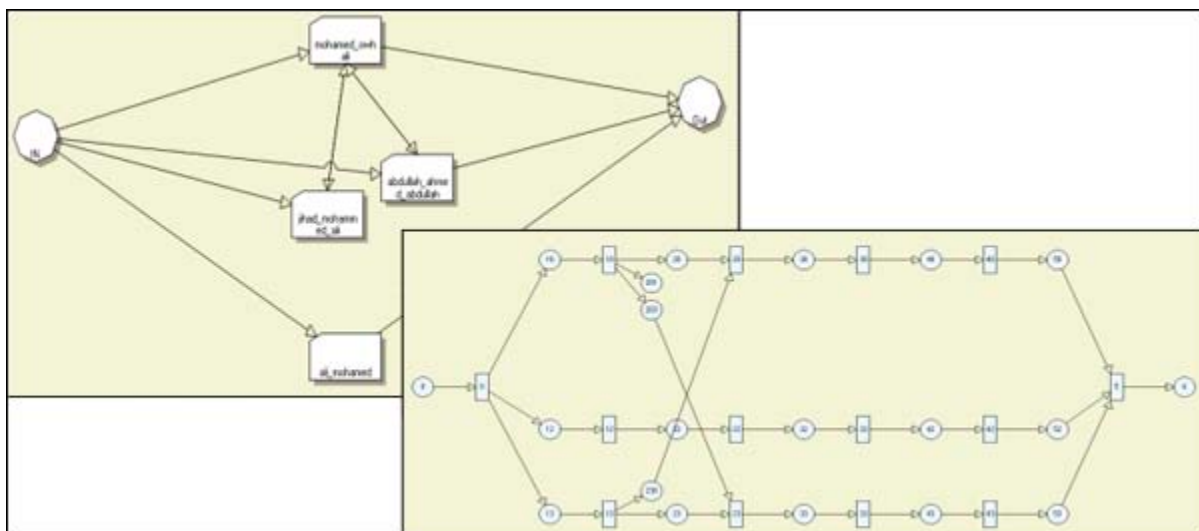
The task network defines the task prerequisites. Then, the result of a task should be informed to the agents doing the next task. Create a result sharing network by using the above inference rule.



Ahmed_ghallani should inform the result of purchase_oxygen to the agents doing bomba_preparation. Purchase_oxygen is a prerequisite of bomba_preparation.

Visualization by CAESAR III

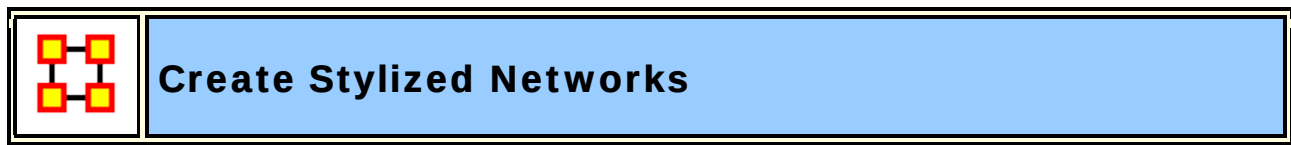
Generated by ORA. Target task : surveillance. Design view and analysis view in CAESAR III.



Learn more...

Il-Chul Moon, Kathleen M. Carley, and Lee W. Wagenhals, Estimating Task Success Likelihood by an Influence Network Generated from an Organizational Structure, Organization Science, 2008, Submitted and under review

Il-Chul Moon, Eunice J. Kim and Kathleen M. Carley, Automated Influence Network Generation and the Node Parameter Sensitivity Analysis, International Command and Control Research Technology Symposium (ICCRTS'08, DOD CCRP conference), Bellevue, WA, Jun 17-19, 2008



Stylized Networks : are models built upon common network structures evident in many real world environments.

Create Erdős-Rényi Network : A model for generating random graphs by setting an Link between each pair of nodes with equal probability, independently of other Links.

Create Core-Periphery Network : The core-periphery structure of the network has a dense central core of key agents and a large periphery of marginal agents.

The core-periphery structure is an ideal typical pattern that divides both the rows and the columns into two classes. One of the blocks on the main diagonal (the core) is a high-density block; the other block on the main diagonal (the periphery) is a low-density block. The core-periphery model is indifferent to the density of ties in the off-diagonal blocks.

When we apply the core-periphery model to actor-by-actor data (Core/Periphery), the model seeks to identify a set of actors who have high density of links among themselves (the core) by sharing many events in common, and another set of actors who have very low density of ties among themselves (the periphery) by having few events in common. Actors in the core are able to coordinate their actions, those in the periphery are not. As a consequence, actors in the core are at a structural advantage in exchange relations with actors in the periphery.

Create Scale-Free Network : Some nodes act as **highly connected hubs (high-degree)**, although most nodes are of low degree. Scale-free

networks' structure and dynamics are independent of the system's size N , the number of nodes the system has. In other words, a network that is scale-free will have the same properties no matter what the number of its entities is.

Their most distinguishing characteristic is that their degree distribution follows a power law relationship, $\mathbf{P(k) \sim k^{-\gamma}}$,

$$P(k) \sim k^{-\gamma},$$

Where the probability $P(k)$ that a node in the network connects with k other nodes was roughly proportional to $k^{-\gamma}$, and this function gave a roughly good fit to their observed data. The coefficient γ may vary approximately from 2 to 3 for most real networks.

Create Cellular Network :

Create Lattice Network : A Lattice Network is a large-world network where nodes are placed at the integer coordinate points of the **n-dimensional** Euclidean space and each node connects to nodes which are exactly one unit away from it. **(i.e. if the lattice is two dimensional and the length of the lattice is 2 along the first and 2 along the second dimension, then it has 4 nodes and they're placed at coordinates (1,1), (1,2), (2,1), (2,2))** The two nodes are connected if the difference of one of their coordinates is one or minus one and all their other coordinates are exactly the same.

Create Small-World Network : A type of graph in which most nodes are **NOT** neighbors of one another, but most nodes can be reached from every other node by a small number of hops or steps. A small world network, where nodes represent people and links connect people that know each other, captures the small world phenomenon of strangers being linked by a mutual acquaintance.

The small-world behavior is characterized by the fact that the distance between any two nodes is of the order of that for a random network and, at the same time, the concept of neighborhood is preserved.

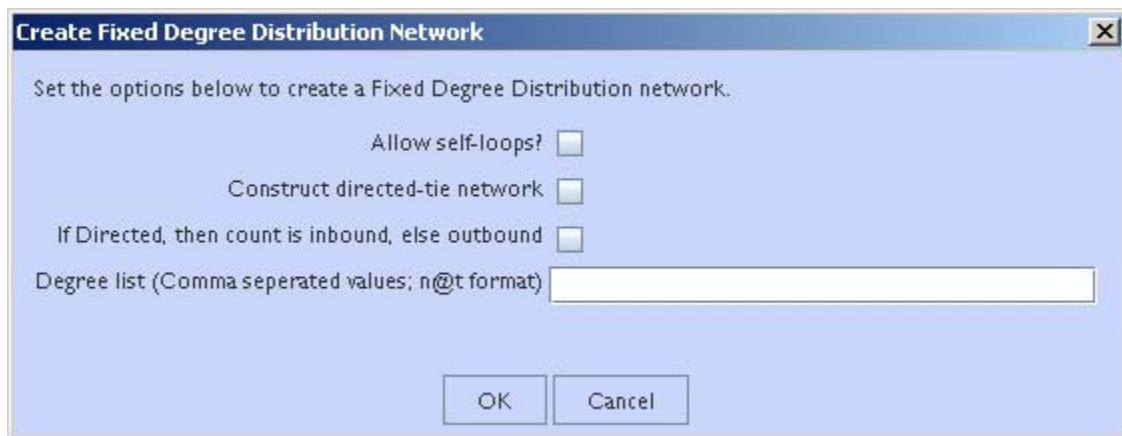
A Small-World Network is a regular network with a degree of random **long range** connections. It is rarely disrupted by the elimination of one node.

Fixed Degree-Distribution Network : A random graph is constructed by specifying as input: **(a)** the number of nodes in the network, and **(b)** the number of link for each node. The graph is random according to the input,

however it should be noted that not all degree sequences are illogical so this algorithm may produce an empty graph as a result. [read more...](#)

Fixed Degree-Distribution Network

Create Fixed Degree Distribution : creates a random graph constructed by specifying as input: **(a)** the number of nodes in the network, and; **(b)** the number of links for each node. The graph is random according to the input, however it should be noted that not all degree sequences are illogical so this algorithm may produce an empty graph as a result.



Allow self-loops : Checked allows the generation of a node tied to itself. **Unchecked** disallows the generation of a node tied to itself

Construct directed-tie network : Checked generates directed network. **Unchecked** generates an undirected network

If directed, then count is inbound, else outbound : Checked the degree list is incoming ties. **Unchecked** the degree list is outgoing ties

Degree list : Enter the degree listing – in the desired node order. The input for the degree sequence is a **comma delimited list** of the number of edges. Correspondingly, the number of nodes is determined by the number of parameters entered.

To facilitate simplified entry, a shortcut can be made by specifying the number of nodes at a specific number of edges. Further, the node id in the generated graph will correspond with the position in the input string.

Degree sequences that are illogical will be impossible to generate, e.g., *2@20* (two nodes with 20 ties each; impossible because the maximum ties a node can have in this network of size two is 1 tie.) Further, some networks can be difficult to produce due to the specific degree distribution and the random process used to construct the network, so the algorithm is designed to make up to 10 separate attempts at constructing the exact distribution. After 10 attempts, the algorithm will return the error meta-network. The user may chose to resubmit the same request for another up-to-10 attempts at making the network.

For example, the following are valid input strings (with self-loops off and undirected):

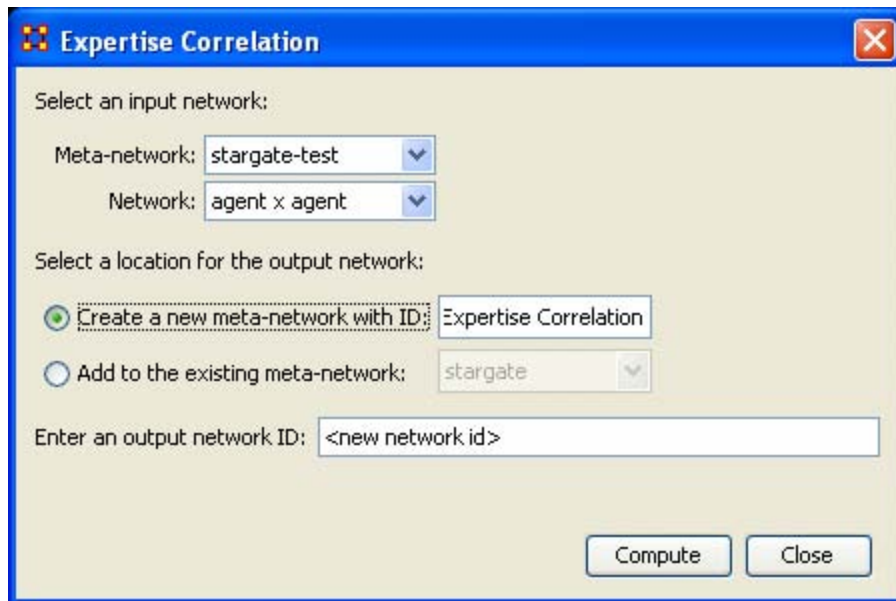
- **1,5,3,0,1** - produces a 5 node network with one isolate and 2 pendants, etc.
- **3@2, 0, 0** - produces a 5 node network with 2 isolates and 3 nodes with 2 edges.
- **10@5,10@3** - will produce a 20 node network

The following are valid input strings **but illogical**:

- **100,0,1** - is illogical and will produce a null meta-network named with an error message
- **3@2,1** - is illogical and will produce a null meta-network named with an error message
- **10@5,10@3,1** - is illogical will produce a null meta-network named with an error message

	Create Expected Interaction Networks

- Below is an image of the Expertise Correlation tool in ORA and procedures on using the various options it contains:



Expertise Correlation

Select an input network:

Meta-network: stargate-test

Network: agent x agent

Select a location for the output network:

☒ Create a new meta-network with ID: Expertise Correlation

☐ Add to the existing meta-network: stargate

Enter an output network ID: <new network id>

Compute Close

- Below are links to the **Measures section** pertaining to each Correlation.
- [Expertise Correlation...](#) : Measures the complementarity of two agents based on their knowledge.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	0.0	0.14285715	0.2857143	0.0	0.0
maj_samant...	0.14285715	0.0	0.2857143	0.14285715	0.14285715
daniel_jackson	0.16666667	0.16666667	0.0	0.16666667	0.16666667
teal'c	0.0	0.14285715	0.2857143	0.0	0.0
gen_hammond	0.125	0.25	0.375	0.125	0.0

- [Similarity Correlation](#)
- Measures the degree of similarity between agents based on the number of knowledge bits they both have.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	1.0	0.33333334	0.25	1.0	0.5
maj_samant...	0.33333334	1.0	0.25	0.33333334	0.0
daniel_jackson	0.25	0.25	1.0	0.25	0.0
teal'c	1.0	0.33333334	0.25	1.0	0.5
gen_hammond	0.5	0.0	0.0	0.5	1.0

- [Distinctiveness Correlation...](#) : Measures how distinct are two agents based on the number of knowledge bits they hold oppositely.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	0.0	0.22222222	0.33333334	0.0	0.11111111
maj_samant...	0.22222222	0.0	0.33333334	0.22222222	0.33333334
daniel_jackson	0.33333334	0.33333334	0.0	0.33333334	0.44444445
teal'c	0.0	0.22222222	0.33333334	0.0	0.11111111
gen_hammond	0.11111111	0.33333334	0.44444445	0.11111111	0.0

- [Resemblance Correlation...](#) : Measures the degree of resemblance between agents based on the number of knowledge bits they both have or both do not have.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	1.0	0.7777778	0.6666667	1.0	0.8888889
maj_samant...	0.7777778	1.0	0.6666667	0.7777778	0.6666667
daniel_jackson	0.6666667	0.6666667	1.0	0.6666667	0.5555556
teal'c	1.0	0.7777778	0.6666667	1.0	0.8888889
gen_hammond	0.8888889	0.6666667	0.5555556	0.8888889	1.0

Analysis Menu



Generate Reports – Brings up a dialog box that enables you to run any report on any currently active Meta-Network then select the format you want the results.



Report Selection Wizard – Assists you in selecting the best reports for the selected Meta-Network.



Measures Manager – The option allows you to choose which measures are to be used in generating reports for the selected Meta-Networks. The dropdown menu allows you to chose **measures lists** which divide them up into categories such as: **Slow Measures, Critical Risk Employees, and Resource Allocation Risk.**



Latent Semantic Analysis – Latent semantic analysis (LSA) is a technique in natural language processing, in particular in vectorial semantics, of analyzing relationships between a set of documents and the terms they contain by producing a set of concepts related to the documents and terms.



Correspondence Analysis :



Geary-C & Moran-I Analysis... : This function performs Moran's I test using phylogenetic and spatial link matrix (binary or general). It uses neighboring weights so Moran's I and Geary's c randomization tests are equivalent.



Generate Reports



Creates reports on the selected Meta-Networks. These reports are detailed in the **Reports Section**.

You can choose an individual report from the drop-down menu or use the **By Category** drop-down menu which forms them into groups by function. All measures are in both drop-downs.

Generate Reports - Belief Propagation

Reports: select a report from the list or by category.

Belief Propagation ▼ By category ▼

Description: Estimates belief propagation through social networks

Output formats: single meta-network, multiple meta-network comparison

Meta-Networks: select one or more to analyze in the report.

☒ stargate

Select All Clear All

Transform: select how to transform the meta-networks prior to running the report.

Options >>

< Back Next > Cancel

Transform : allows you to select the method the Meta-Networks are changed prior to running the report which can be seen by clicking the **[Options >>]** button.

General mathematical transformation :

Remove node :

Partition nodes into separate Meta-Networks by attribute value :

Click **[Next>]**

This next screen will differ depending on which report was chosen. For some reports you will be taken directly to the print screen. For others there will be additional information you need to specify.

The Final Print Screen : allows you to choose whether to write the file to a **Text, HTML, CSV, or PowerPoint** file and tell ORA where to save it. You can also choose to use a different filename for all the reports written.



 There are a lot of reports to choose from in ORA and you may have difficulty, at least initially, in determining which one is exactly right for you, especially if you are new to ORA. Likewise, the **Report Selection Wizard** helps you pick the right report by first prompting you with a series of questions relevant to the type of analysis you are seeking. Based on your answers, this tool will tell you the type of report to run and then it will run it. To access this tool in ORA, follow this path:

From the main menu select **Analysis > Report Selection Wizard**

Then you will see the following pop-up window (screen shot below):



Check the box(es) for the Meta-Network you need to analyze. Then click the **[Next]** button.

This will bring up a screen asking **Which of the following aspects do you want to focus on?** This is the **Who, What, Where, or When** choice. Select one and click the **[Next]** button.

The next dialog box presents you with the question: **Please select one of the following:**. Choose one of the questions and click the **[Next]** button.

Do you want to know about the critical actors? The key word here is **critical**. This report will then find and rank the actors that are the most critical to your network, which can lend insight to **who**, if removed, might potentially impact the network the most.

Do you want to find a path between actors? The key word here is **path**. Path refers to the connections between any two actors in your network. For example, if Bob is connected Carol and Carol is connected to John, then Bob's path to John is 2 links (via Carol).

Do you want to know who someone influences or could possibly influence? The key word is **influence**. Typically one has influence, to some degree at least, on other people one connects to in a network. This is to say, if you have a connection to Joe and you are removed from the network, then Joe's connections to you are altered. You would be said to have a form of influence over Joe. However, some individuals may have influence that extends beyond a path length of 1.

Do you want to know if there is possible missing data? The key word here is **missing**. This report will help identify possibly segments of missing data in your network if it appears certain conclusions are without proper network justification. Again, this is accomplished through algorithmic calculation. On a simple level, it might be said that if **Peter**, an accountant, has access to certain resources that only **Susan**, a director, has official access to; yet Peter uses those resources as well, it may be we are missing a link in our network data from Peter to Susan.

Do you want to know if there are groups? The key word here is **Groups**. Groups can sometimes be hard to spot visually, especially giving a complex and large Meta-Network. This report will reveal the groups present in the existing Meta-Network.

The group choices are as follows:

- Newman
- Concor
- FOG

Do you want to know what type of network this is? This question pertains to the topology of the network, or what sort of common network pattern your model could be classified into. This option will give you the **type**. For example, **cellular, lattice, small world**, etc.

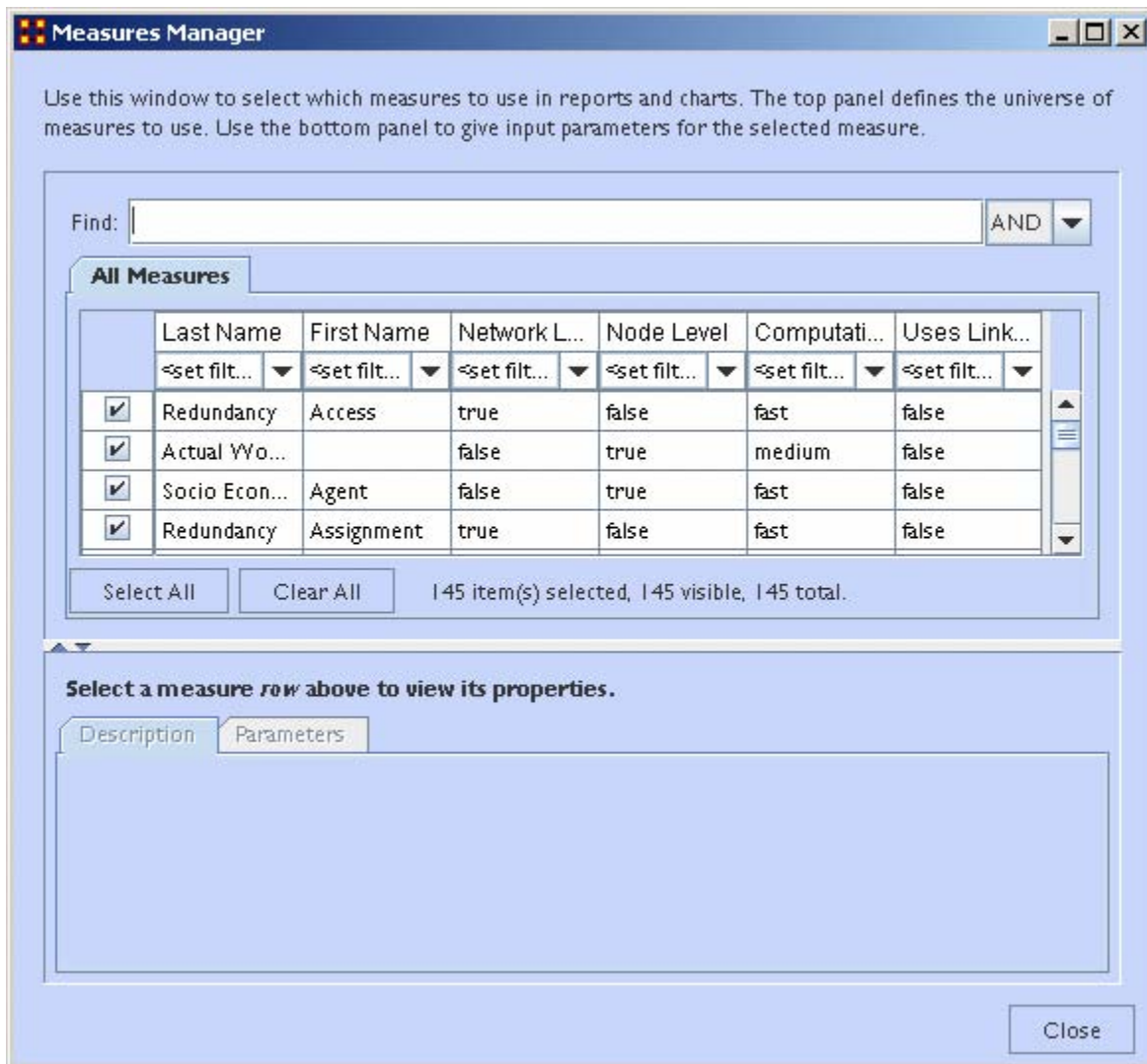
ORA will display another information pop-up box, which tells you exactly the report ORA has determined to be most appropriate based on your data and your answers as to what information you are seeking to obtain about your network model.

After selecting **[Finish]** ORA will generate it's reports and open them in both your browser and also in panel 3 of the main interface. Below is the beginning of the report run on the **Stargate** data set. Since this function has such a large number of possibilities, we will only show part of the beginning of the report in the interest of brevity.



 Before you run any measures on a **Meta-Network** you can use the **Measures Manager** to set exactly the measures you wish to compute.

Form the main interface menu select **Analysis > Measures Manager**.



The dialog box has multiple sections:

Filter Commands :

This section comprises **two radio buttons** (Match at **least one** filter | Match **all** filters) which allow for complex filtering, a **[Reset Filters]** button, and a **Search text box** used for inputting your search. Whatever searches you input in this section are reflected in the **Tabbed Window** below. It will display only the nodes which match the search(es).

item(s) Selected | Visible | Total

When first called up the **All Measures** tab defaults to showing every measures available. When started there were **137 item(s) selected, 137 visible, 137 total**.

Selecting the **Slow Measures** tab this changes to **16 item(s) selected, 16 visible, 16 total**.

Typing **Cognitive** into the search text box reduces this to **16 item(s) selected, 8 visible, 16 total** showing that only 8 out of the 16 Slow Measures contain the word Cognitive.

Furthermore you can deselect measures by removing the checkmark next to the measure's name. With each measure deselected the number of **selected** items will reduce by one.

With these tools you can select only the measures you want to run reports on.

Buttons

- **Reorder**
- **Select All** : Selects (puts a checkmark in the box) all **visible** measures
- **Clear All** : De-Selects (removes checkmarks) from all **visible** measures.

Tabbed Window

This section contains tabs which sort the measures into various categories.

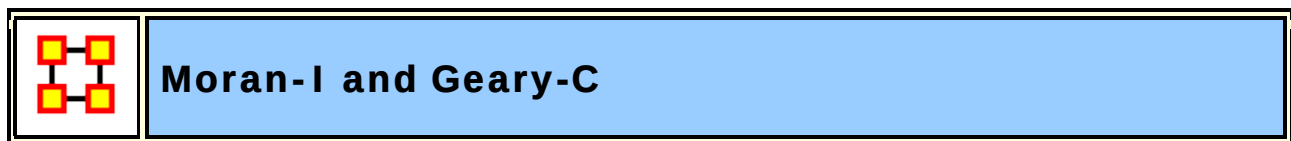
Each of the nine tabs sorts out the measures in different categories. This is very useful for large Meta-Networks when you'd prefer not run, say the [Slow Measures*](#) cause it would put too much a drain on your machine. By removing the checkboxes for the Slow Measures they are taken out of the mix and the reports will effectively ignore them. You can turn them back on when you're finished by placing a checkmark back in the box.

In the **Tabbed Window** there are four columns:

1. **Last Name** : Deals the general type of measure (**Congruence, Exclusivity, Cognitive...**). Most entries in this column will display one row as they are singular in what they need to show. Others will display two rows as it's nearly the same measure run on both **knowledge and resources**. Then a few (**like Centrality**) will display quite a few rows the types of measures written for that type of measures are somewhat varied.
2. **First Name** : Deals with the category of the measure (**Betweenness, Closeness, Centrality...**). This is a secondary factoring.
3. **Graph Level** : [Graph Level*](#) produces a single number as output.
4. **Entity Level** : [Entity Level*](#) produces one number per entity.

Drop-Down Menu

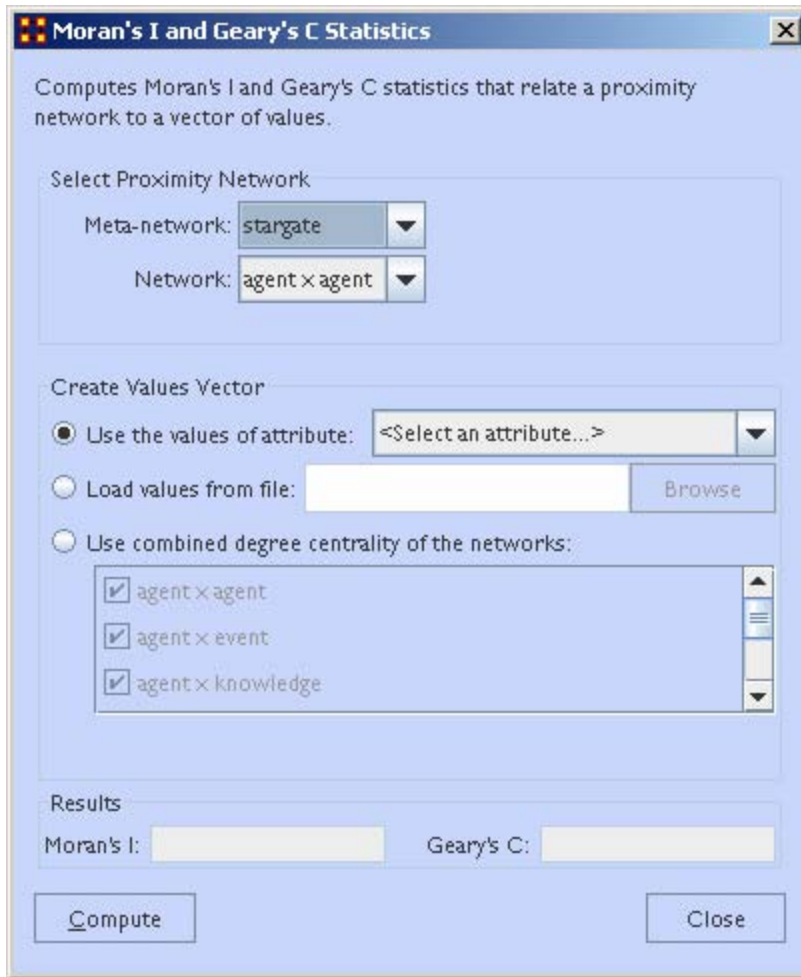
Gives the user the ability to select which currently active Meta-Network to run the measures on, as well as, which individual networks.



Description

 **Moran's-I** : The measure of spatial autocorrelation to study stochastic phenomena which are distributed in space in two or more dimensions. The values of Moran's I range from **+1** meaning strong positive spatial autocorrelation, to **0** meaning a random pattern to **-1** indicating strong negative spatial autocorrelation. This particular statistic is designed for the measurement of spatial autocorrelation of ordinal, interval or ratio data.

 **Geary's-C** : Based upon a paired comparison of juxtaposed map values and **ranges between 1 and 2**. Positive spatial autocorrelation is found with values ranging from 0 to 1 and negative spatial autocorrelation is found between 1 and 2. However, values can be found greater than 2 on occasion (Griffith, 1987). As similar values are in juxtaposition the numerator which measures the absolute difference squared between juxtaposed values will tend towards zero. Whereas, as non-similar values become juxtaposed the statistic will tend towards larger values in the numerator and thus towards its maximum value of two.



Select Proximity Network : Select a Meta-network from the first dropdown menu. The second dropdown menu will contain all the networks in the selected Meta-Network.

Create Values Vector : There are three ways to select a value

1. **Use the values of attributes :** uses an attribute within the Meta-Network.
2. **Load values from file :** browses for a file previously constructed.
3. **Use combined degree centrality of the networks :** Place a checkmark for one (or more) networks within the selected Meta-network to use. Combines the centrality to use in the formulas.

Results : Displays the **Moran-I and Geary-C** results.



Simulations



Near-Term Analysis : The **Near Term Analysis** (NTA) is a tool that allows for the removal of nodes from a given organizational structure to evaluate how the organization will likely perform as a result.

OrgAhead :



Near Term Impact Analysis

The **Near Term Analysis** (NTA) is a tool that allows for the removal of nodes from a given organizational structure to evaluate how the organization will likely perform as a result. The Near Term Analysis tool uses a multi-agent model as input, [DyNetML*](#).

The goal is to provide an answer to the question on how an organization will behave and change after considering a sequence of strategic interventions or personnel loss by way of agent removal. In other words, we want to know what happens when we remove nodes from an organization, be they people, places, resources, knowledge sets or other common [Node Classes*](#).

This example will use the **Stargate dataset (SG-1)**. This dataset is included with the version of ORA downloaded and can be found online at the following url:

<http://www.casos.cs.cmu.edu/projects/ora/sample.php>.

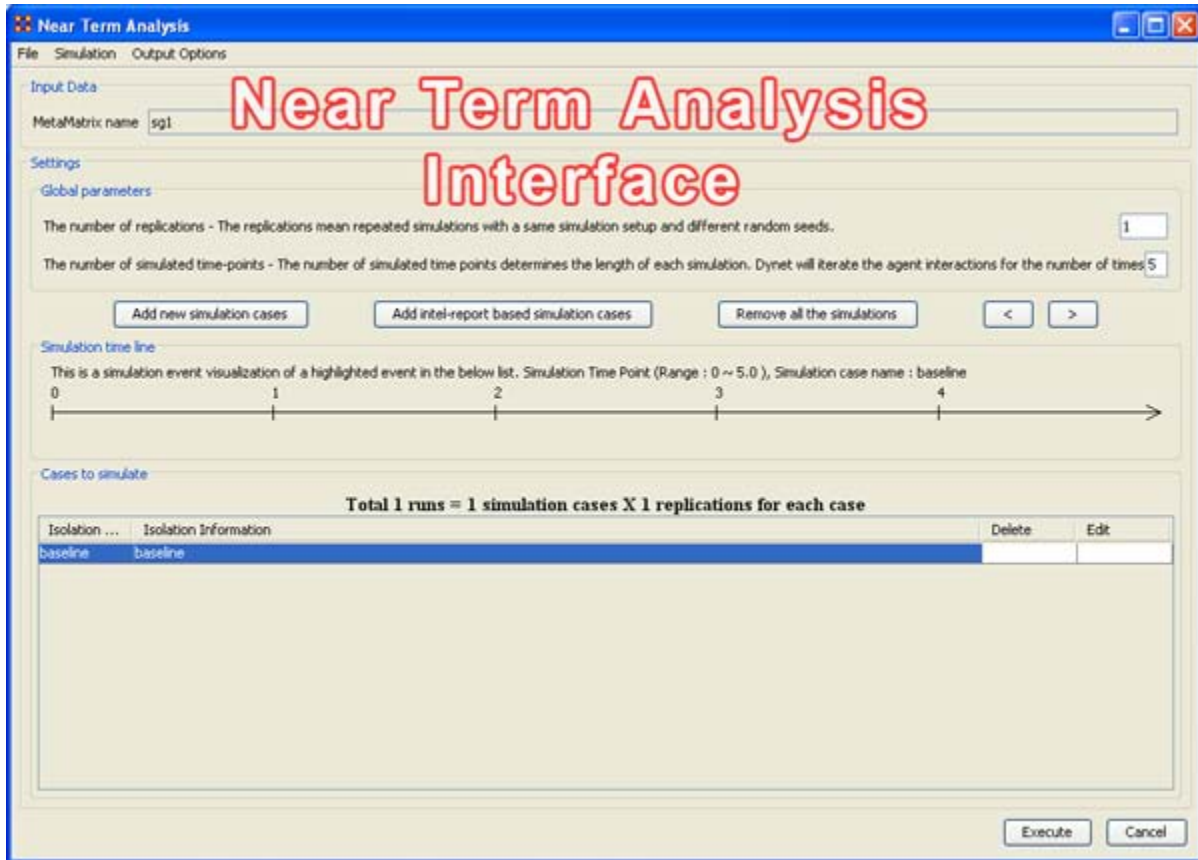
From the menu bar select **File ⇒ Open Meta-Network** then select SG1.xml.

In this example, we will remove two agents: **daniel_jackson** and **maj_samantha_carter**

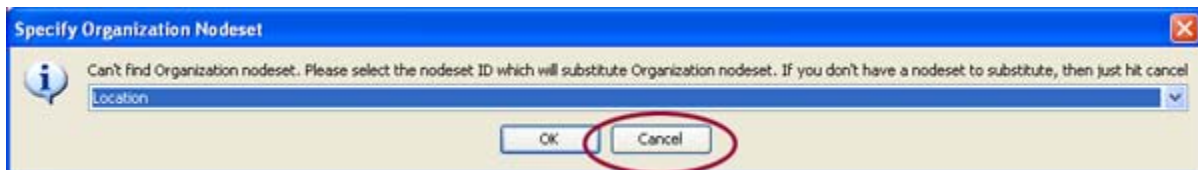
1. Open the **SG1 Meta-Network** into ORA.
2. Highlight the SG1 Meta-Network **before** starting NTA in the ORA Meta-Network Manager panel.

3. From the main menu select **Analysis** ⇒ **Near-Term Analysis**.

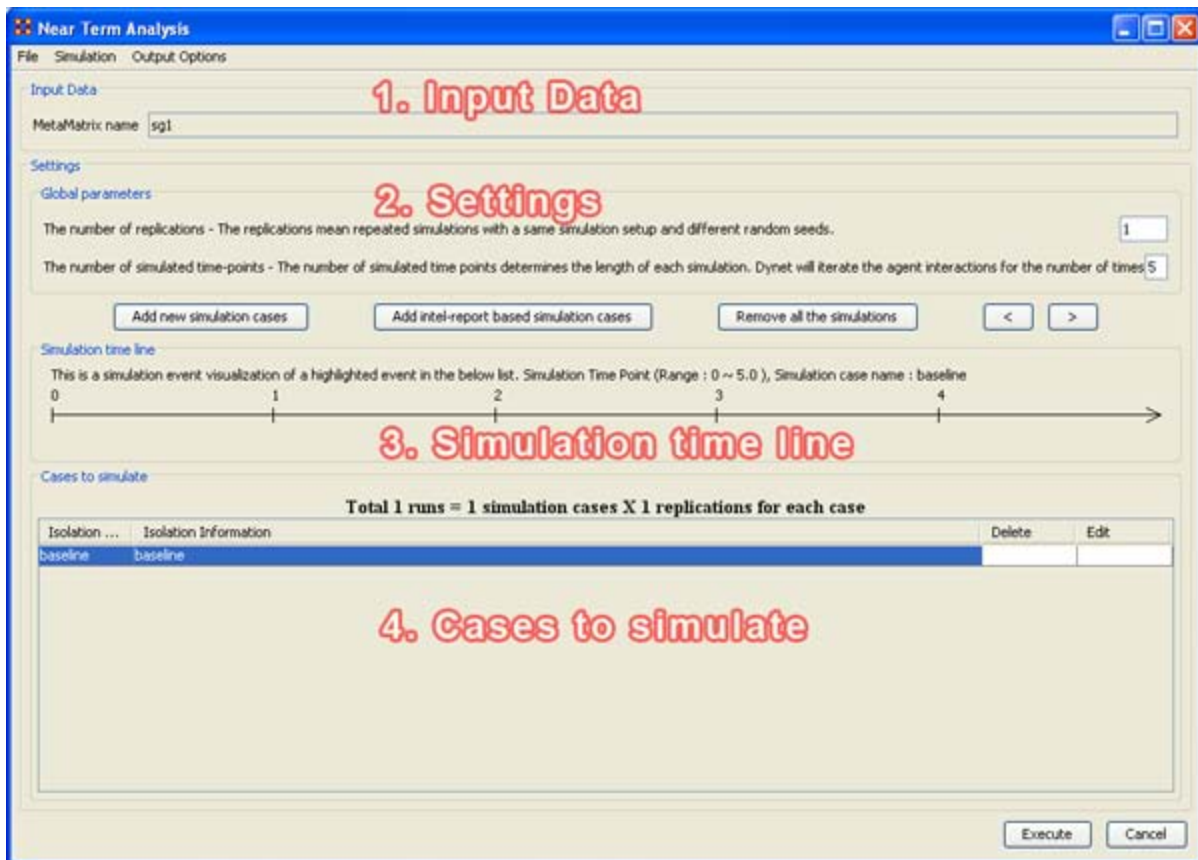
NOTE : If your dataset contains an Organization nodeset ORA will display the NTA main window. If not, it will ask for you to chose a substitute Organization nodeset.



When a Meta-Network is first loaded into ORA's the Near Term Analysis, a pop-up may appear asking for a **location** node. Select Cancel and proceed with the Near Term Analysis.



The NTA main window consisted of four sub panels: **Input Data, Settings, Simulation time line and Cases to simulate**. Below is a brief description of each panel:



1. Input Data

In this section is the file name of the Meta-Network loaded.

2. Settings (Global Parameters)

In the **Setting** area are two text boxes. The first, **The Number of replications** informs ORA how many times to run the simulation. The second, **The number of simulated time-points** defines the range in the section **Simulation time line**.

In the settings area, there are two critical factors: 1) the **number of replications** and 2) the **number of simulated time points**.

Why is this important?

The number of replications if set at a higher versus lower value, will result in more experiments being conducted on the scenario the tool is presented. Therefore, the more replications the more likely the results will mirror those in a real world example.

The number of time points determines the length of the Near Term Analysis iterations. If this number is also set to a relatively high value, the simulation will take longer.

NOTE : Be mindful of any memory considerations when running high value replications or time points.

3. Simulation time line

This are of the Near Term Analysis tool shows a visual representation of the time points selected in Settings area above.

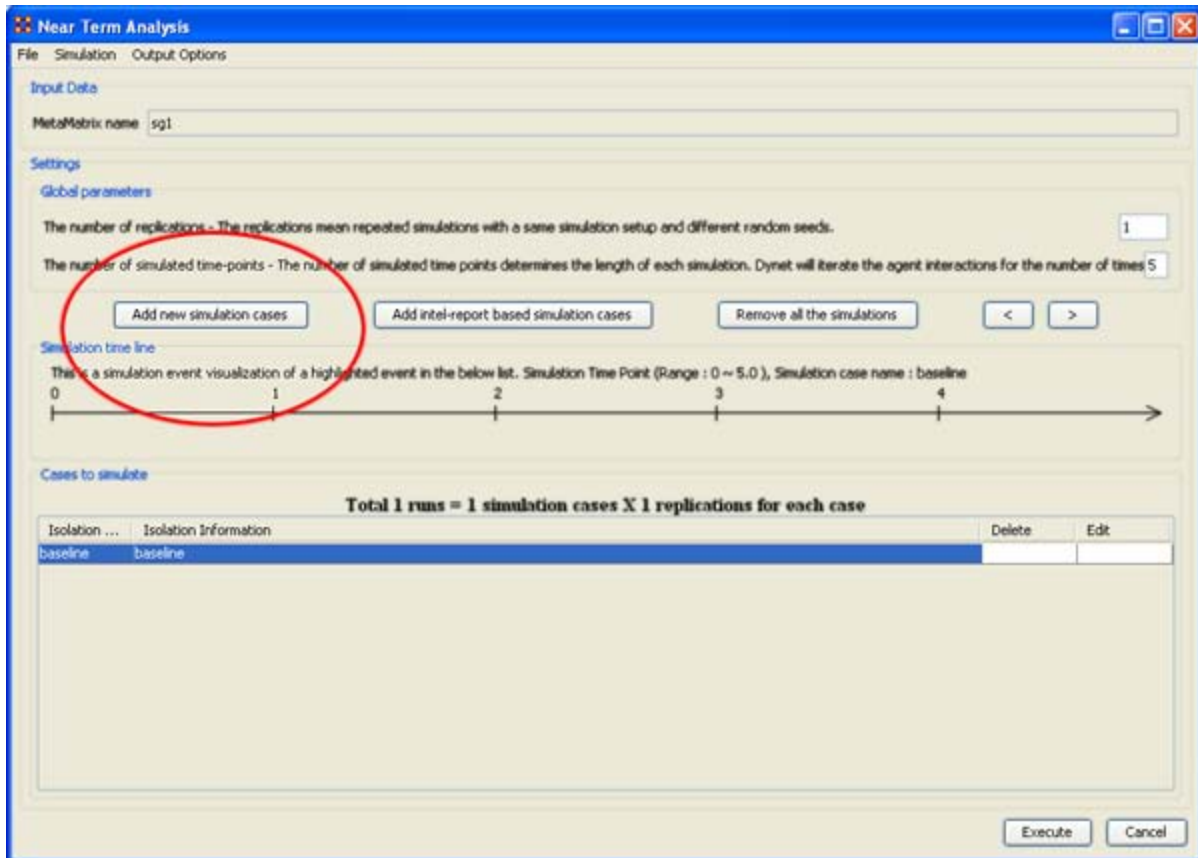
4. Cases to simulate

After the settings **(global parameters)** are set, the virtual experiment cells need set.

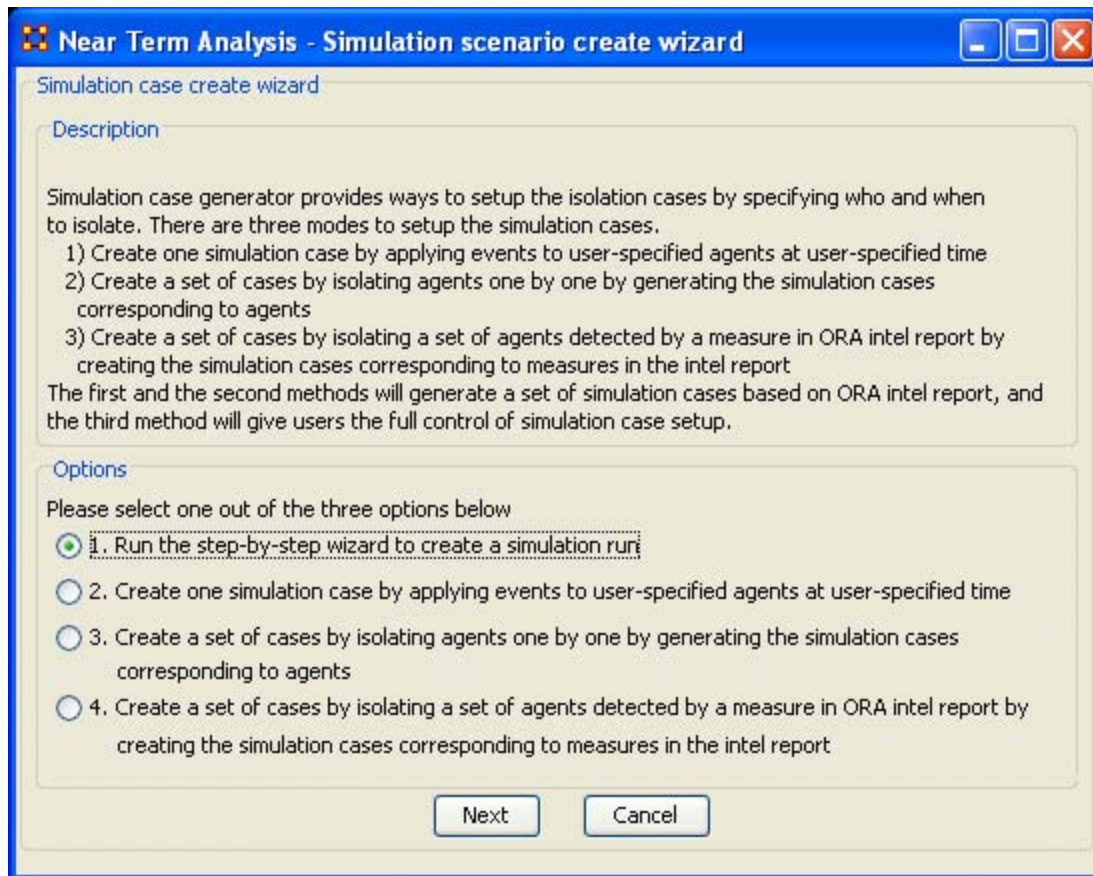
Initially, there is a pre-defined simulation cell, the **Baseline**. The Baseline is the cell without any entities removed as is the control situation when the organization does not experience any interventions. Besides Baseline, any other cells need set up. Start by selected **Add new simulation instances**, the leftmost of the four buttons.

Add new simulation cases

To run a Near Term Analysis, we will begin by selected the **Add new simulations cases** button from the main Near Term Analysis Tool (see area highlighted in red ellipse below).



After selecting **Add new simulation instances** button, a dialog box titled **Near Term Analysis– Simulation scenario create wizard** will appear. This wizard supports the creation of virtual experiment cells in three different ways. The **First** allows for the most freedom of choice. The **second** and the **third** options will ask for a set of criteria for selecting important agents in the network and make experiment cells according to the selection. Therefore, the first option gives full flexibility to users, and the second and the third option provides a systematic analysis setup method. To proceed this demonstration, select the first option and select **[Next]**.



There are four options:

The next section explores all four of the Near Term Analysis Options:

[Run the Step-by-Step Wizard](#) – This process will help walk through setting up a near term analysis experiment on the Meta-Network loaded into the Near Term Analysis tool.

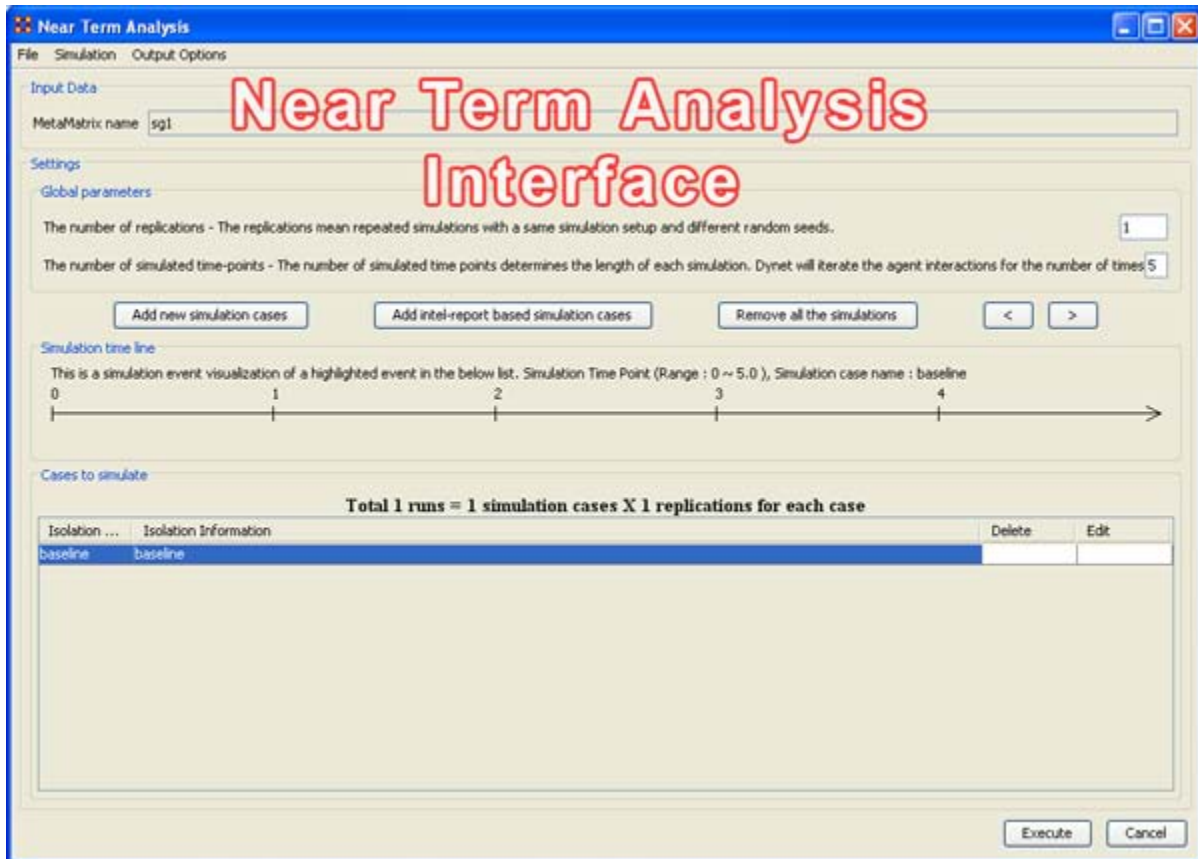
[Create one simulation case](#) – In this simulation experiment, events and user-specified time can be applied to agents.

[Create a set of cases by isolating agents](#) – This scenario isolates one agent and perform an experiment. Then the experiment can be performed again with the agent removed.

[Create a set of cases by isolating a set of agents relating to a specific measure.](#) – Based on measures contained in the ORA intel report, a set of agents can be isolated and a simulation case can be created.



Near Term Impact Menu



Save the current simulation setting: Brings up a save box where you can navigate to a directory and save **all** the current simulation settings.

Load a simulation setting from a file: Navigate to a directory to load a previously saved simulation setting.

NOTE : *This will remove any settings that are currently active.*

Close: Closes the Near TermAnalysis window.

Execute simulation cases: Begins running the simulation. Same function as the **[Execute]** button at the bottom of the window.

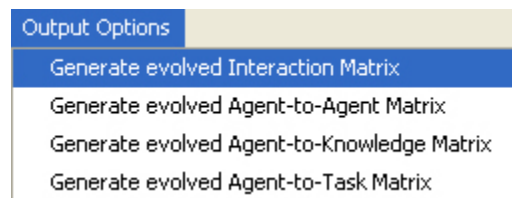
Show the add simulation wizard: Brings up the creation window. same as the **[Add new simulation cases]** button.

Add ORA-Intel report based simulation cases: Same as **[Add ORA-Intel report based simulation cases]** button.

Edit the highlighted case: Brings up the dialog box to edit parameters for selected event.

Remove the selected cases: Removes selected event from simulations.

Remove all of the cases: Same as the **[Remove all the simulations]** button.



These menu items will display in the **Near Term Results** menu:

Generate evolved Interaction Matrix:

Generate evolved Agent-to-Agent Matrix: Displays how agents interact with one another.

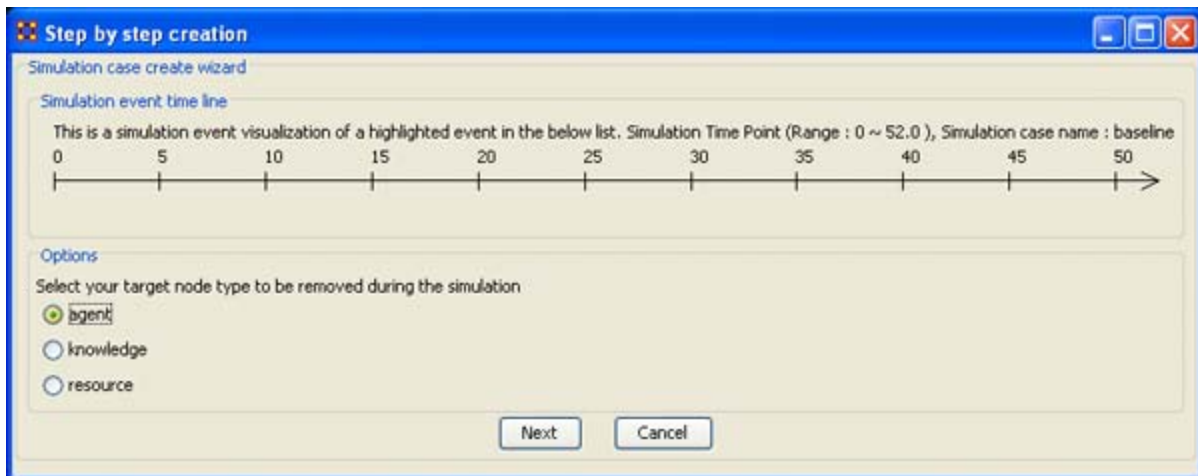
Generate evolved Agent-to-Knowledge Matrix: Displays how knowledge is diffused within the agent network

Generate evolved Agent-to-Task Matrix: Display how tasks are used within a network.

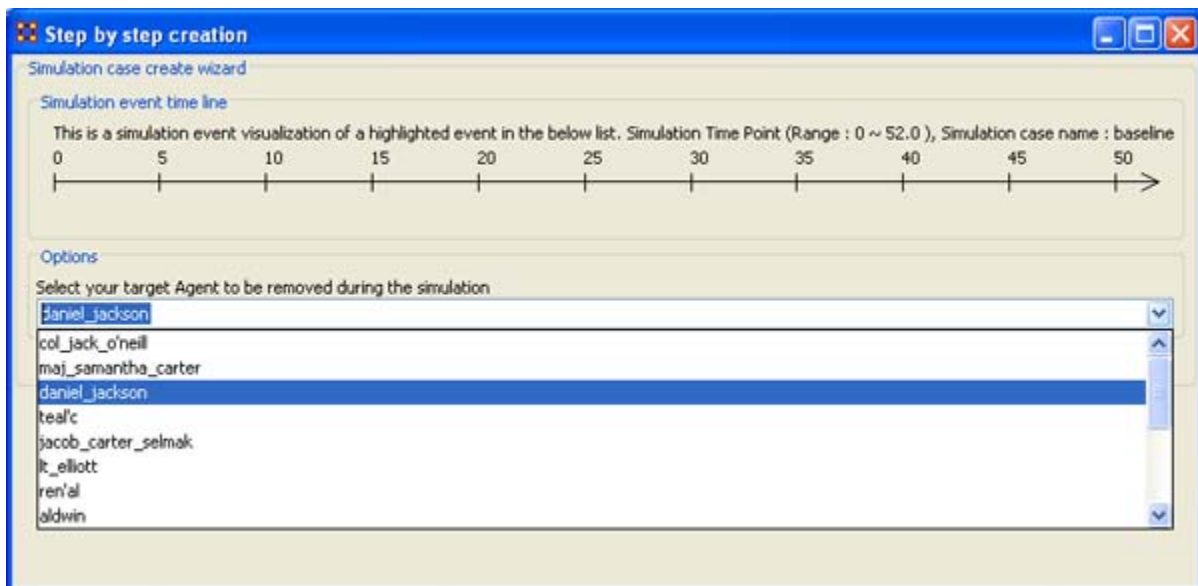


Step-by-Step wizard

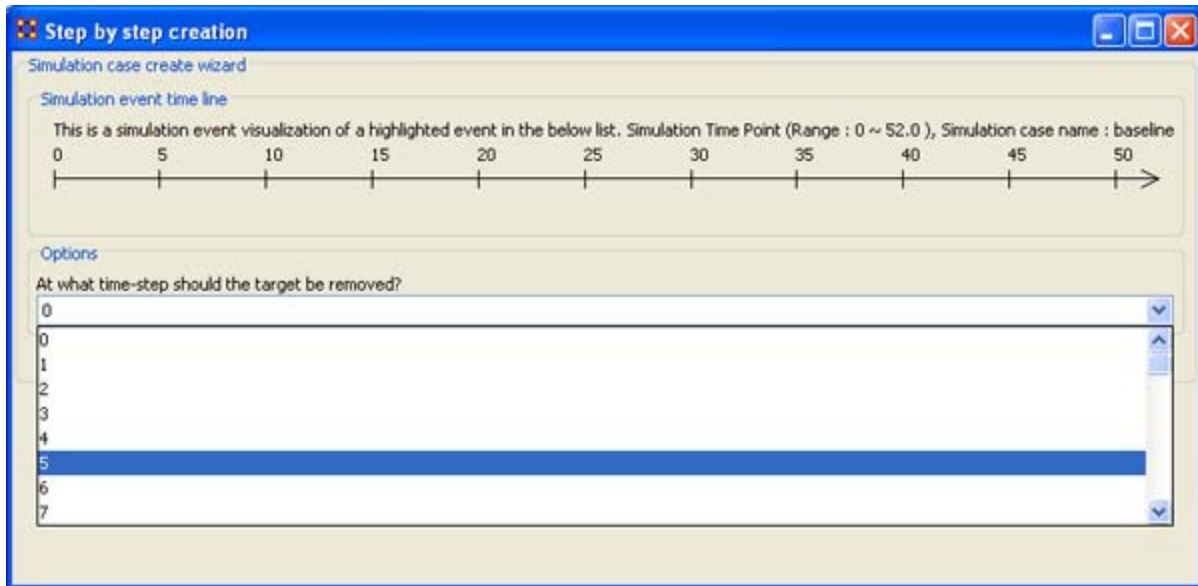
Selecting the first option brings up the **step-by-step creation** dialog box.



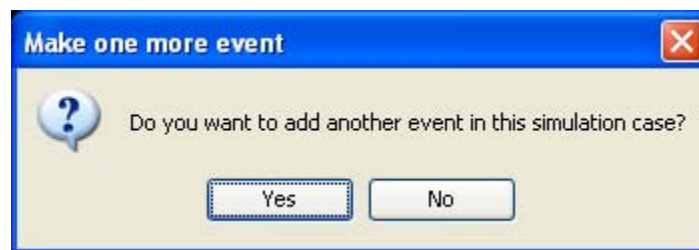
Under **Options** select whether to isolate an **agent, knowledge, or resource**. We'll leave it at agent. Then select the **[Next]** button.



Under **Options** select the agent to isolate. Here we select **daniel_jackson**. Then select the **[Next]** button.

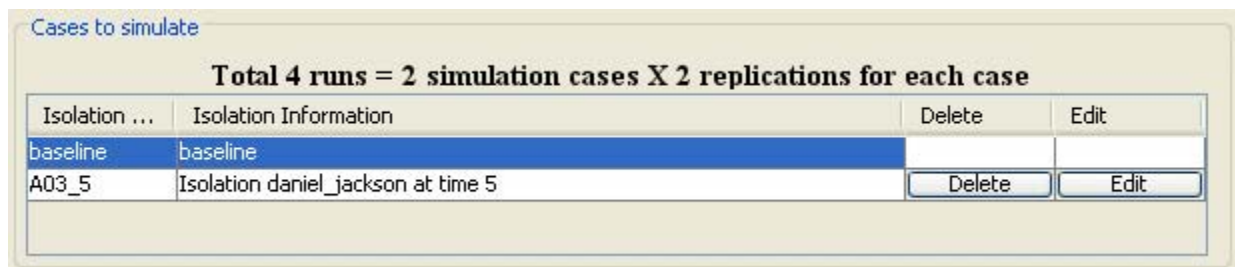


Under **Options** select the time-step to isolate the agent. For this simulation we select **5**. Then select the **[Next]** button.



At this point you are asked if you want to add more events to the simulation or not.

You can add as many **events** as you wish. But for this example we'll only use only one event. Select **[No]** to continue.



Now repeat the steps above and add a **second** simulation. But this time let's remove **daniel_jackson** at time-step 25.

Cases to simulate

Total 6 runs = 3 simulation cases X 2 replications for each case

Isolation ...	Isolation Information	Delete	Edit
baseline	baseline		
A03_25	Isolation daniel_jackson at time 25	Delete	Edit
A03_5	Isolation daniel_jackson at time 5	Delete	Edit

Now proceed to [Analysis Results](#).



Near Term Impact Option 2

Apply events to specified agents

The second option for creating simulation files is to create one simulation case and apply events to specified agents, knowledge, or resource nodes.

Select the **[Add new simulation cases]** button to bring up the wizard.

Near Term Analysis - Simulation scenario create wizard

Custom scenario setting

Simulation event time line

This is a simulation event visualization of a highlighted event in the below list. Simulation Time Point (Range : 0 ~ 52.0), Simulation case name : I

0 5 10 15 20 25 30 35 40 45 50

Simulation event edit list

Selection	Node type	Node name	Timing	Event Type
☐	Agent	daniel_jackson	5	Isolation

Remove the selected events from the event list Remove all the events

Specify an event as a user selected in the below table

Reset selection Search : dan Add events

Agent Knowledge Resource

Selection	Timing	Event	Name	totalDegr...	cognitive...	cliqueCount	between...	taskExclu...
☒	5	Isolation	daniel_jackson	0.321	0.152	25	0	0.278

Previous Add a simulation Cancel

1. Type in a search criteria to highlight only the agents to work with (i.e. typing in **dan** brought up only **daniel_jackson**.
2. Place a checkmark on the line. Notice that when you placed a checkmark in the box the **Event** automatically changed to **Isolation**.
3. Double-click in the **Timing** cell to select it and type in a number from 0 to the highest number you selected for your simulation. In this case we'll repeat with the timing of "5".
4. Select the **[Add events]** button. This places the event in the **Simulation event edit list** section.
5. If there were more events to add you could continue with the same procedure. When you are done, select the **[Add a simulation]** button at the bottom.

The two buttons beneath the **Simulation event edit list** section to remove events from the list. The **[Remove all the events]** button obviously removes everything in the **Simulation event edit list** but the **Remove the selected events from the event list only removes the events with a checkmark beside them.**

The **[Reset selection]** button removes all checkmarks placed in the bottom table and sets the Event to **No Event**.

The **[Previous]** button returns to the main Wizard screen.

When you have finished you will have created the same two simulations as in Option 1.

Cases to simulate

Total 6 runs = 3 simulation cases X 2 replications for each case

Isolation ...	Isolation Information	Delete	Edit
baseline	baseline		
A03_25	Isolation daniel_jackson at time 25	Delete	Edit
A03_5	Isolation daniel_jackson at time 5	Delete	Edit

Now proceed to [Analysis Results](#).



Near Term Impact Option 3

Create set of cases using Measures

Option 3 allows for selecting agents/knowledge/resources based on their ranking when certain measures are run on them.

Near Term Analysis - Simulation scenario create wizard

Scenarios with a single isolation

Isolate each node from Intelligence report that is identified by any measures one at a time Isolation Time : 20

Number of nodes to regard as key nodes (the cut-off to decide whether a node is a key element or not) Cut-off : 3

Select the nodeset types for isolations - if you choose a nodeset type, the key nodes of the type will be included in the isolation lists

☒ Agent
☐ Knowledge
☐ Resource

Select the measures for isolations - if you choose a measure, the measure will be used to decide key agents (you can select multiple measures by clicking a measure name while pressing a Ctrl key)

Centrality, Total Degree
Cognitive Demand
Clique Count
Centrality, Betweenness
Exclusivity, Task
Exclusivity, Knowledge

Previous Add simulations Cancel

Here are three examples run with the same **Isolation Time and Cut-offs**. Only the measures were changed.

Centrality, Total Degree

Isolation Case	Isolation Information	Delete	Edit
baseline	baseline		
daniel_jackson_20	Isolation null at time 20	Delete	Edit
jacob_carter_selmak_20	Isolation null at time 20	Delete	Edit
ren'al_20	Isolation null at time 20	Delete	Edit

Cognitive Demand

Isolation Case	Isolation Information	Delete	Edit
baseline	baseline		
ren'al_20	Isolation null at time 20	Delete	Edit
jacob_carter_selmak_20	Isolation null at time 20	Delete	Edit
daniel_jackson_20	Isolation null at time 20	Delete	Edit

Clique Count

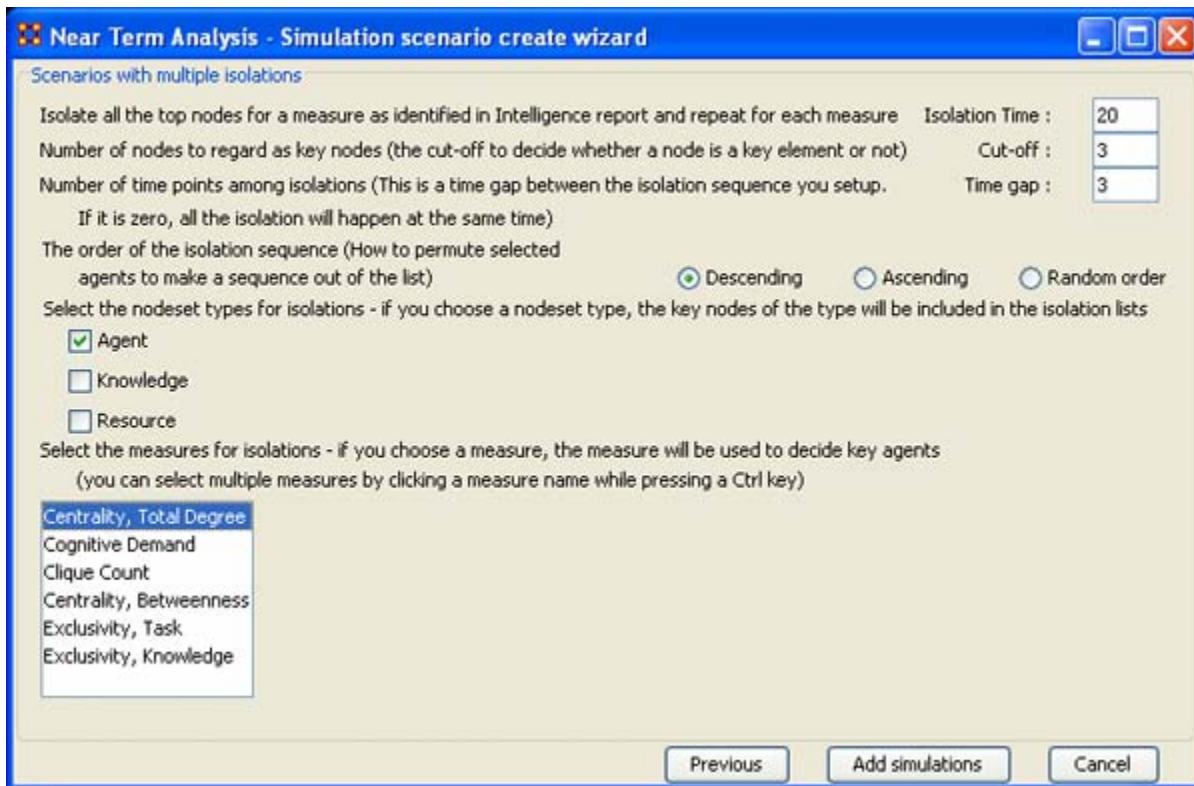
Isolation Case	Isolation Information	Delete	Edit
baseline	baseline		
col_jack_o'neill_20	Isolation null at time 20	Delete	Edit
ren'al_20	Isolation null at time 20	Delete	Edit
daniel_jackson_20	Isolation null at time 20	Delete	Edit

When you have run the measures proceed to [Analysis Results](#).



Near Term Impact Option 4

A set of agents by a set of cases by measure(s).



Option 4 allows the addition of adding **Time gaps** between the isolations and whether to isolate them in descending, Ascending, or Random order.

Now proceed to [Analysis Results](#).



Near Term Impact Results Menu

Save the Construct launch scripts : Information on Construct can be obtained at the following URL:

<http://www.casos.cs.cmu.edu/project/construct/index.html>.

Show text report on the ORA main window : Displays the report in Panel 3 of the ORA Main Interface.

Save the completely evolved MetaMatrices : Will save as an ORA Meta-Network any of the simulation cases with a checkmark in the **Select** column.

Save the html report : Navigate to a directory to save an **html** file that can be displayed in a browser.

Save the text report : Navigate to a directory to save an **text** file.

Save the Knowledge Diffusion line chart : Saves the chart as a **.png** file that can be used in other documents.

Save the Task Accuracy line chart : Saves the chart as a **.png** file that can be used in other documents.

Save the Energy Task line chart : Saves the chart as a **.png** file that can be used in other documents.

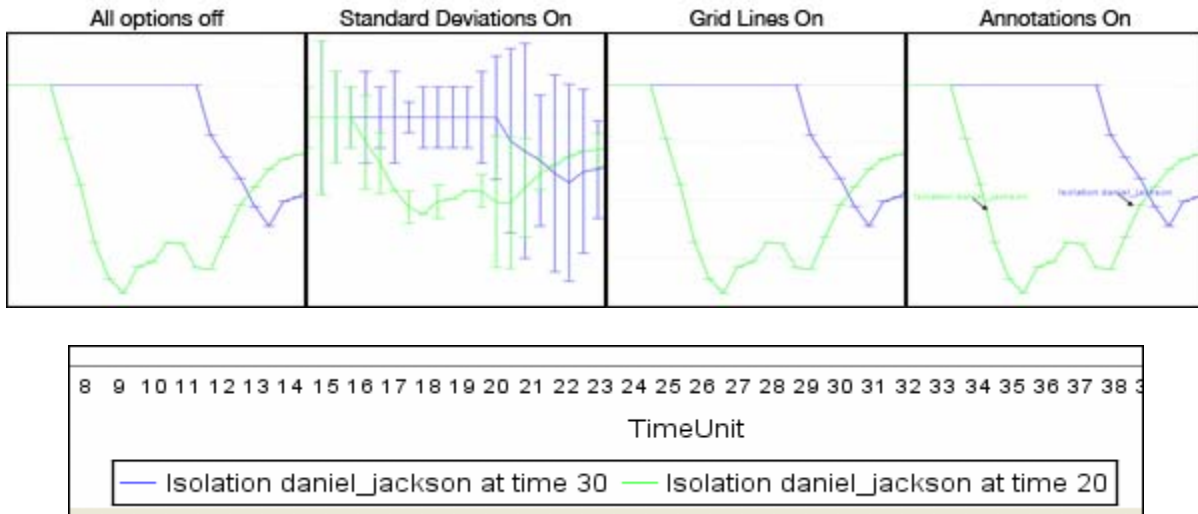
Save the Knowledge Diffusion result CSV file : Saves the results as a **.csv** file that can be used in other programs.

Save the Task Accuracy result CSV file : Saves the results as a **.csv** file that can be used in other programs.

Save the Energy Task result CSV file : Saves the results as a **.csv** file that can be used in other programs.

Close :

Copy the chart in the clipboard : Copies the window to the clipboard that can be pasted into other programs.

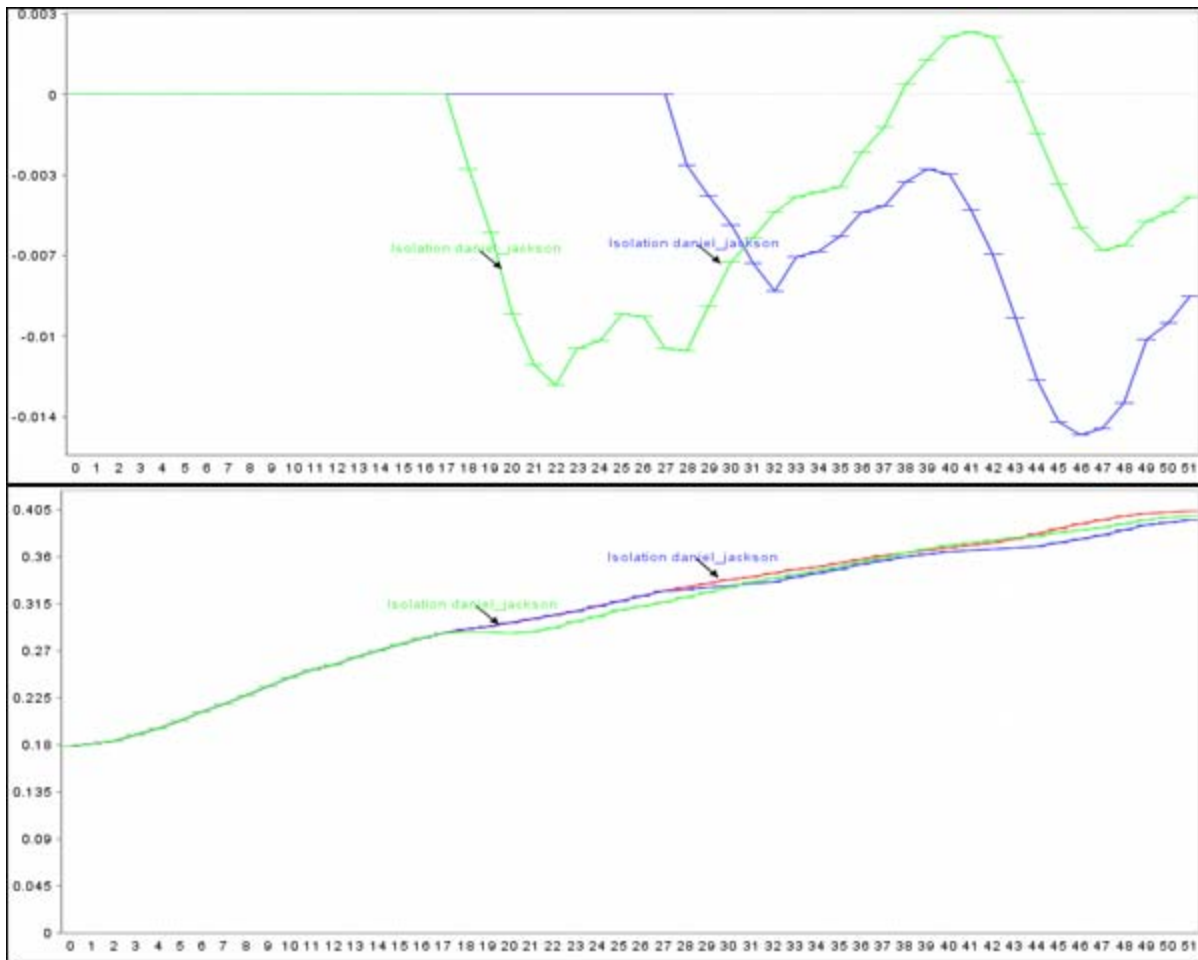


Standard Deviation ranges : [Standard Deviations*](#) displays the range of values for a particular instance.

Grid lines in the chart : Displays the grid lines for values.

Legends in the chart : Displays the legend underneath the chart.

Event annotations in the chart : Displays the event annotations within the chart.



Deviation from the baseline : Using the **baseline** numbers the chart shows the offset for the simulation.

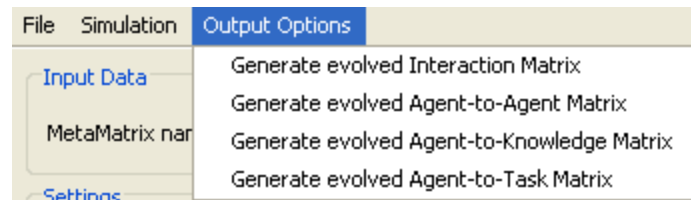
Show actual values : Uses the actual calculated values in the chart.

Background color : choose the background color of the chart of either **white or gray**.

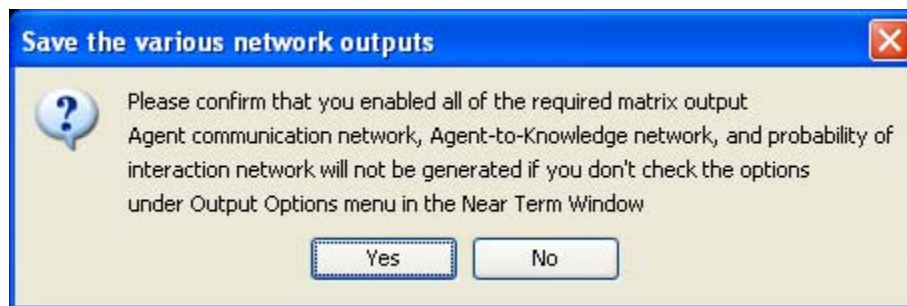


Near Term Impact Results

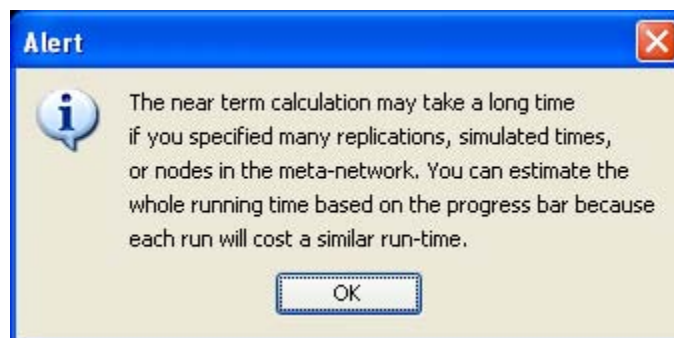
Now we're ready to Execute the simulations. But before that you must select the type of **Output Options** you want. From the Near Term Analysis menu select **Output Options** ⇒ **{any or all of the four options}**.



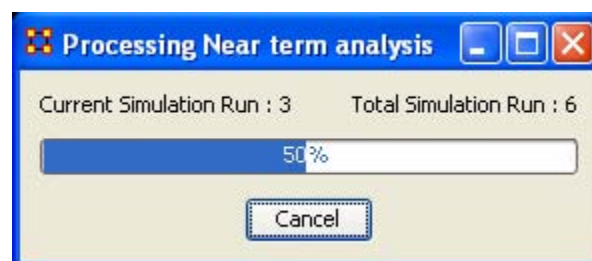
Now select the **[Execute]** button in the bottom-right corner. This will bring up two dialog boxes asking you to confirm you're selected output options and then an alert telling you that, this may take a while with a large Meta-Network and a lot of simulation runs.



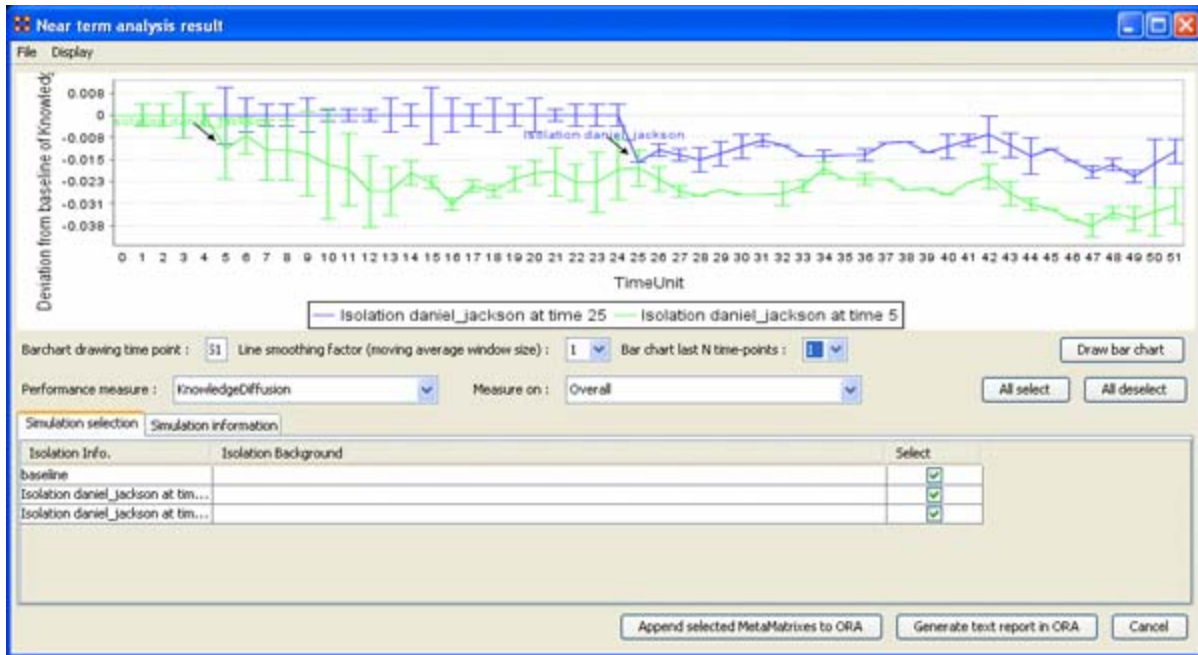
An alert box will display advising you that the near term calculation may take a long time depending on settings of your experiment.



After selected **[Execute]** the **Processing Near Term analysis** dialog will show you the progress.



Next will be displayed the **Near Term Analysis results** window.



The results of the experiment will compare against the baseline data established prior to the removal of any isolated agents. In the example above, we can see how the network was impacted in the time line when we isolated **daniel_jackson** and removed this node from the data set.

Further information can be obtained form the following references:

For knowledge diffusion and energy task

Schreiber, C. (2006) *Human and Organizational Risk Modeling: Critical Personnel and Leadership in Network Organizations*, PhD Thesis, Carnegie Mellon University, CMU-ISRI-06-120

For binary task accuracy

Lin, Z., K. Carley. 1997. *Organizational response: The cost performance tradeoff*. *Management Sci.* 43(2) 217-234.

	Visualization



Measure Charts – When run this function will plot the three graphs, **Bar Chart, Scatter Plot, and Histogram** on the chosen Network.



View Measures Over Time – Requires multiple Networks. First plots points for measure selected on each of the Networks active with the option to see a direct line from the earliest to the latest point.



View Network Over Time – Requires multiple Networks. Displays nodes and links for each of the active Networks.



Network Drill-Down– Allows for quick, plotting of nodes connected to a chosen node.



Node Cloud : Create an image with higher used concepts showing up in larger font sizes.

Color Grid : Creates a colored grid representing the networks. White cells represent no connections.



GeoSpatial Networks – Analyze, forecast, and visualize a wide variety of spatial interactions and networks within a global-scale. [See **GeoSpatial/Loom** > **GeoSpatial** for more information](#)



View Trails – Works with nodes moving between places over time. Requires the use of a trailset. [See **Loom** for more information](#)

View Networks



3D Visualization : Visualizes the selected network in the 3D Visualizer



2D Visualization : Visualizes the selected network in the 2D Visualizer



Path Finder : is used to find, not only, the shortest path between two nodes but also paths to other nodes when particular situations occur.



Sphere of Influence : Each node within a network has a unique Sphere of Influence or Ego Network. Essentially it's a direct relationship with it's neighbors as a function of specified path length. The ORA Visualizer allows you to focus on this relationship by creating an Ego Map centered on any particular node you choose.



Key Set Selector : uses information input by the user to create a simplified visualization.



Blank Visualization : Opens the Visualizer with no active Meta-Network. Allows you to create NodeClasses and Networks from scratch.



Charts Types

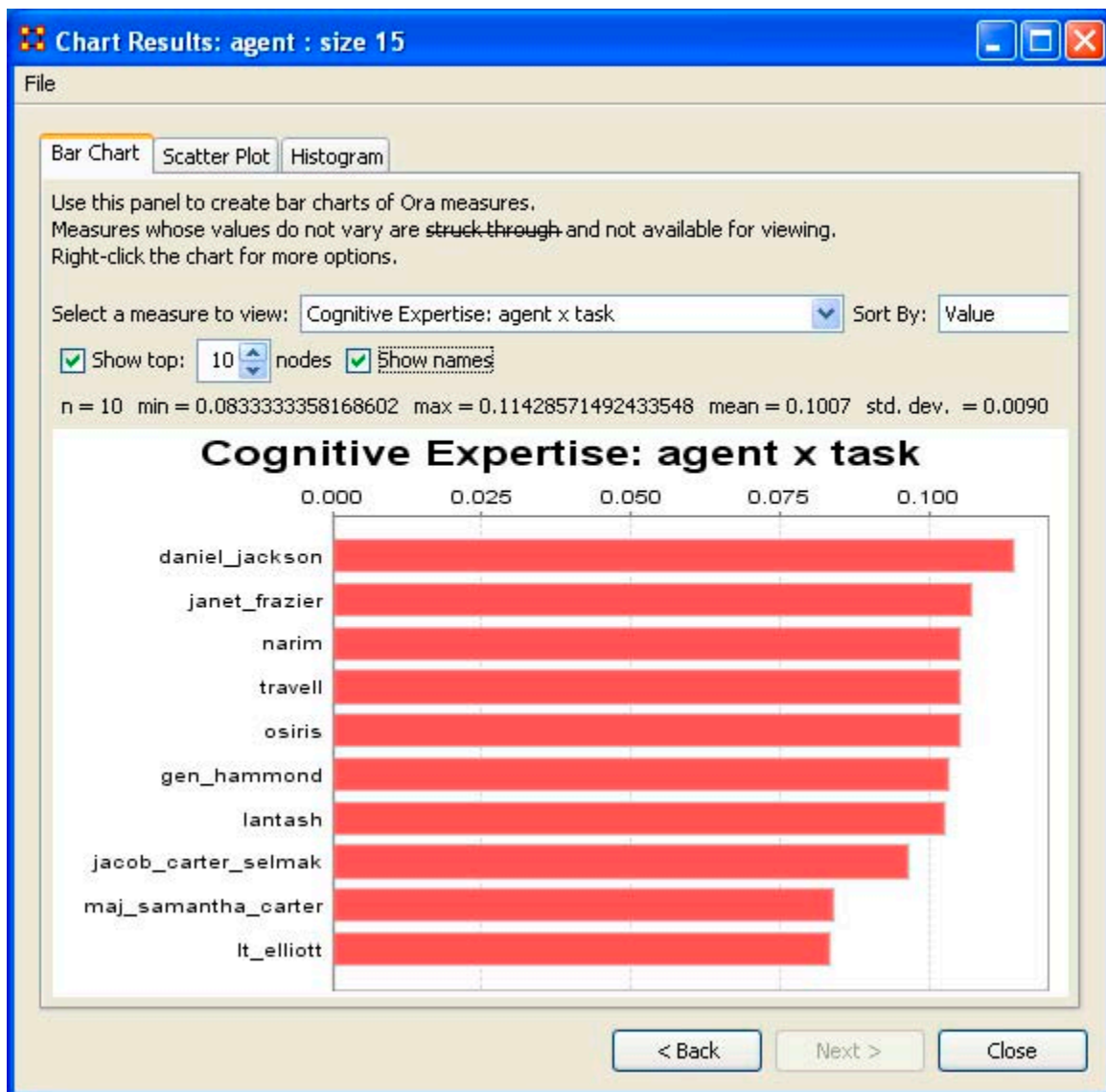


Below are examples of each type of ORA charts: **Bar Chart, Scatter Plot, and Histogram.**

Bar Chart

A **bar chart** contains horizontal bars representing the individual nodes in the set. These **rectangular bars** are usually proportional to the magnitudes or frequencies of what they represent.

Bar charts are used for **comparing two or more values**. The bars can be horizontally or vertically oriented. Sometimes a stretched graphic is used instead of a solid bar.

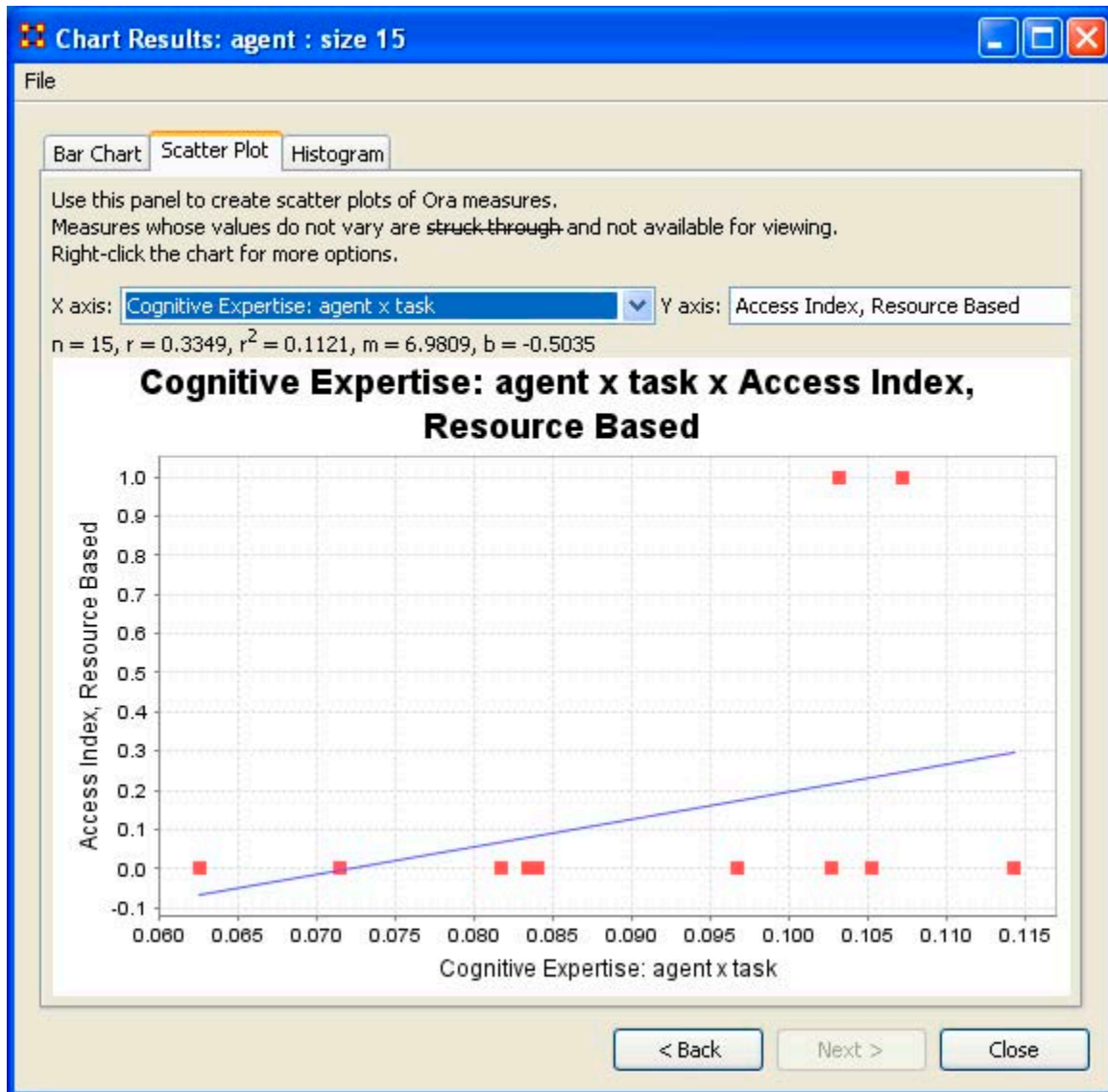


Scatter Plot

A **scatterplot** uses **Cartesian coordinates** to display values for two variables. The data is displayed as a **collection of points**, each having one coordinate on the horizontal axis and one on the vertical axis.

A scatterplot does not specify dependent or independent variables. Either type of variable can be plotted on either axis. **Scatterplots represent the association (not causation) between two variables.**

A scatterplot can show various kinds of relationships, including **positive (rising)**, **negative (falling)**, and no relationship. If the pattern of dots slopes from lower left to upper right, it suggests a positive correlation between the variables being studied. If the pattern of dots slopes from upper left to lower right, it suggests a negative correlation. A line of best fit can be drawn in order to study the correlation between the variables. An equation for the line of best fit can be computed using the method of linear regression.

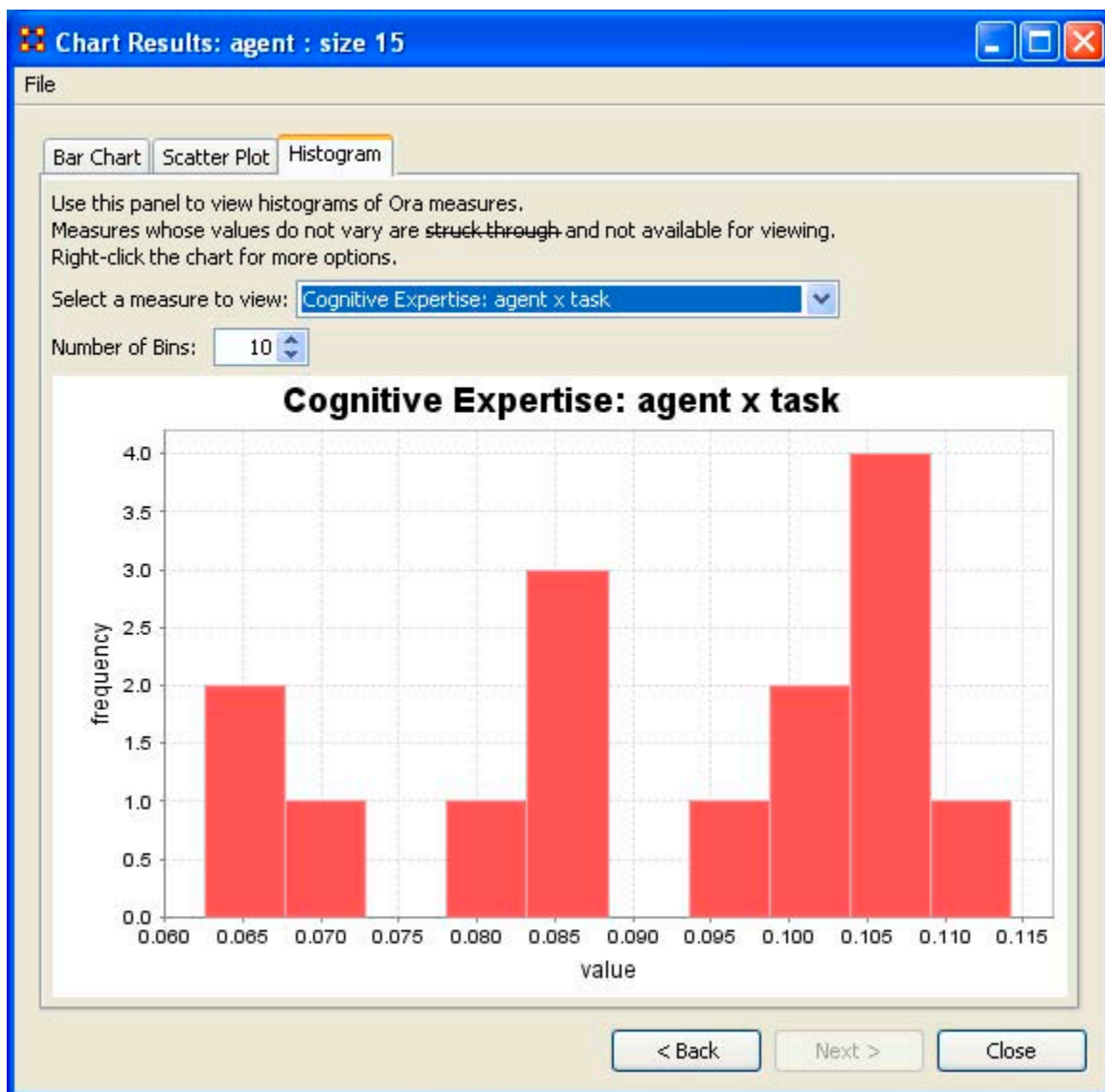


Histogram

In statistics, a **histogram** is a graphical display of tabulated frequencies. A histogram is the graphical version of a table which **shows what proportion**

of cases fall into each of several or many specified categories. The histogram differs from a bar chart in that it is the area of the bar that denotes the value, not the height, a crucial distinction when the categories are not of uniform width (*Lancaster, 1974*). The categories are usually specified as non-overlapping intervals of some variable. The categories (**bars**) must be adjacent.

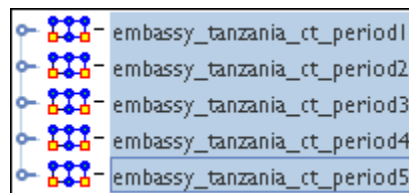
The word histogram is derived from *histos* and *gramma* in Greek, the first meaning web or mast and the second meaning drawing, record or writing. A histogram of something is thus, etymologically speaking, a drawing of the web of this something.



View Measures Over Time

 Using the **View Measures Over Time** on a Network allows an analyst to see how a network measures change over multiple time periods. If you use non-dated data, ORA will automatically represent your multiple Meta-Matrices with simple integers (i.e., 1, 2, 3, 4...)

Below is the Meta-Network Pane showing five time periods for the Tanzania dataset.



From the main menu select **Visualizations > View Measures Over Time...** A dialog box will appear stating it will run on the currently loaded Networks.

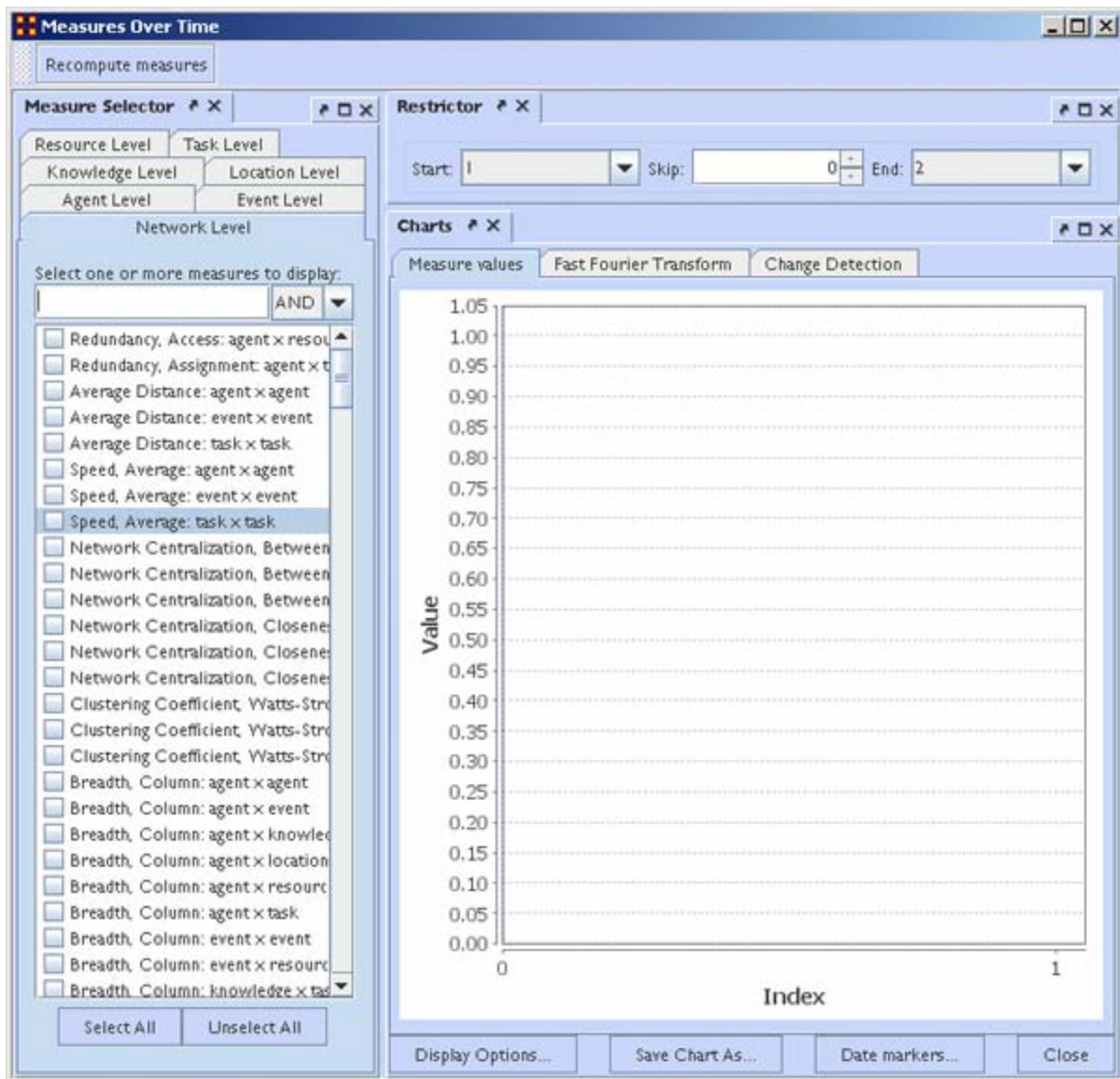
NOTE : *If you have any Networks you do not want to use in your calculation hit **[Cancel]** and remove them from **The Meta-Network Pane** before proceeding.*

NOTE : *It is of the utmost importance that the Networks in all Meta-Networks are named the same. If not, the Over Time function will not work correctly.*

Computation Parameters

First, the Computation Parameters dialog window appears. Here you can select the measures to use and whether to combine or transform the datasets. When done, click the **[Compute]** button to continue to the analysis.

Measures Over Time window



This window is divided into three panes.

The Measure Selector Pane contains tabs for all NodeClasses in addition to a Network Level tab. If the **Network Level** tab is selected you can choose which measure(s) to apply to the entire Meta-Network. If a **NodeClass** tab is chosen you can choose which Node(s) to view and in the **Select a measure:** text box select the measure to apply to them. All actions are instantly updated in the **Charts Pane**.

The Restrictor Pane allows you to set the beginning and ending time periods and additionally you can skip any number of intermediary steps.

The Charts Pane contains three tabs and a legend at the bottom showing the colors associated to which nodes.

Measures values :

NOTE : *Hovering over any measure will bring up a description of that measure.*

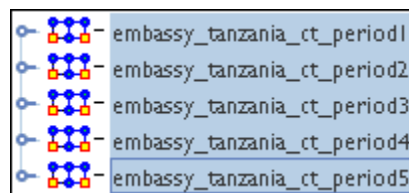
Fast Fourier Transform :

Change Detection :

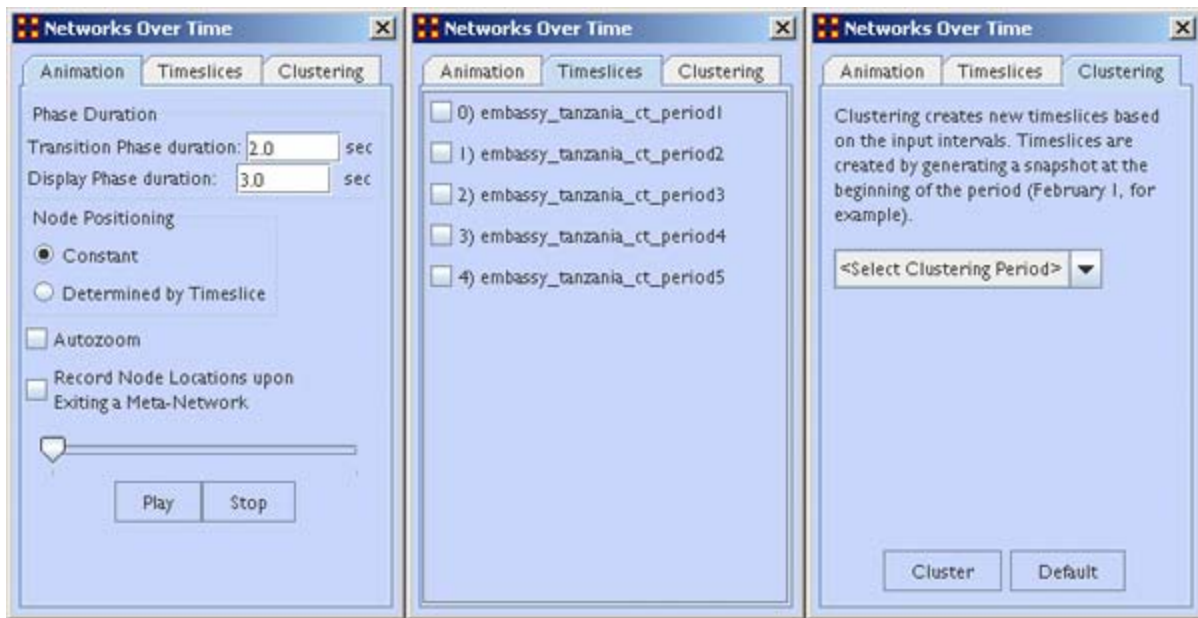


 **View Network Over Time :** Uses all selected Meta-Networks for analysis in various time frames. Select all the Meta-Networks to use in the analysis.

NOTE : *It is of the utmost importance that the Networks in all Meta-Networks are named the same. If not, the Over Time function will not work correctly.*



Now select from the menu **Visualizations > View Network Over Time**. This will bring up the Visualizer along with the **Networks Over Time** window.



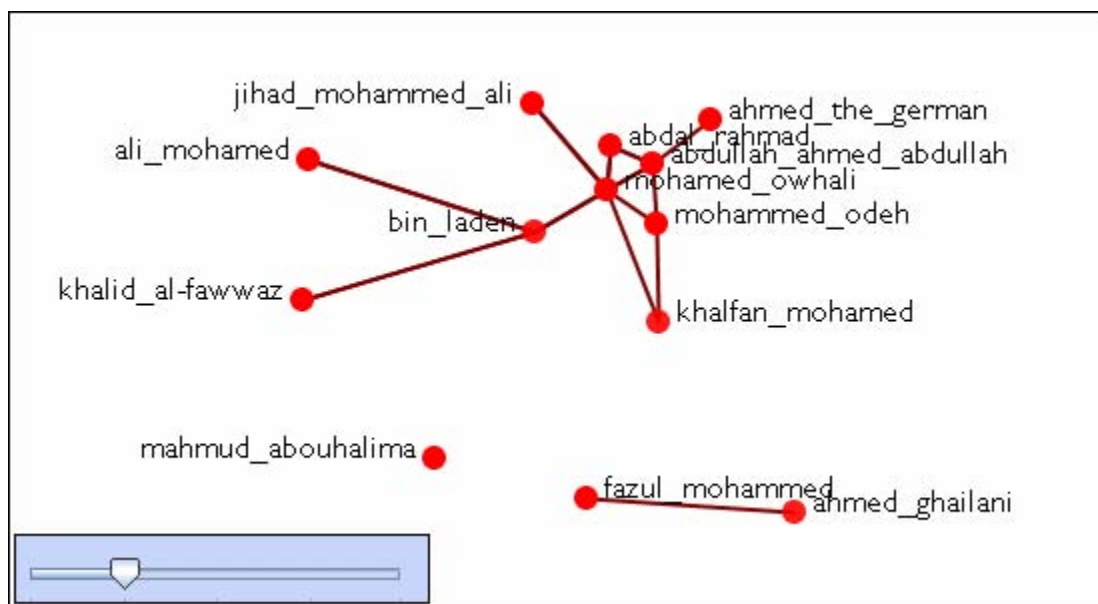
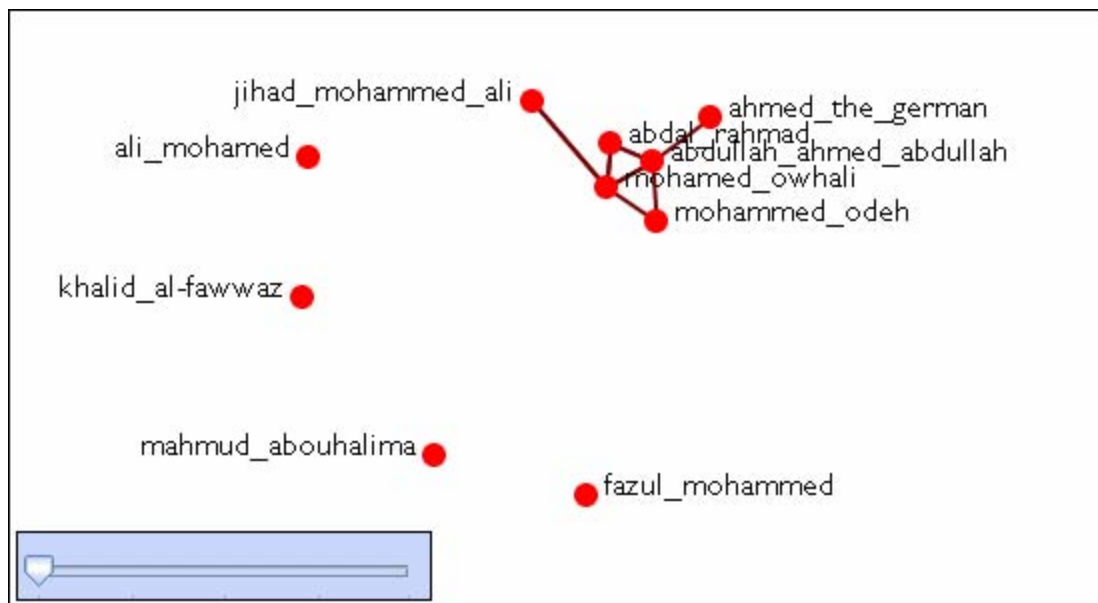
The Animation Tab controls the workings of the animation. It also contains the Play/Stop buttons.

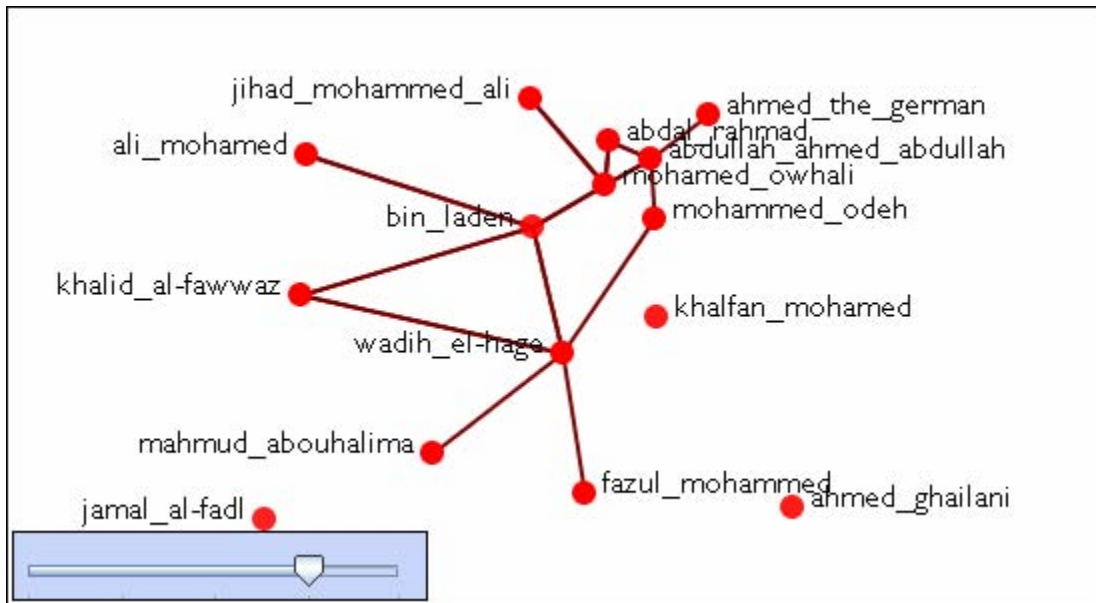
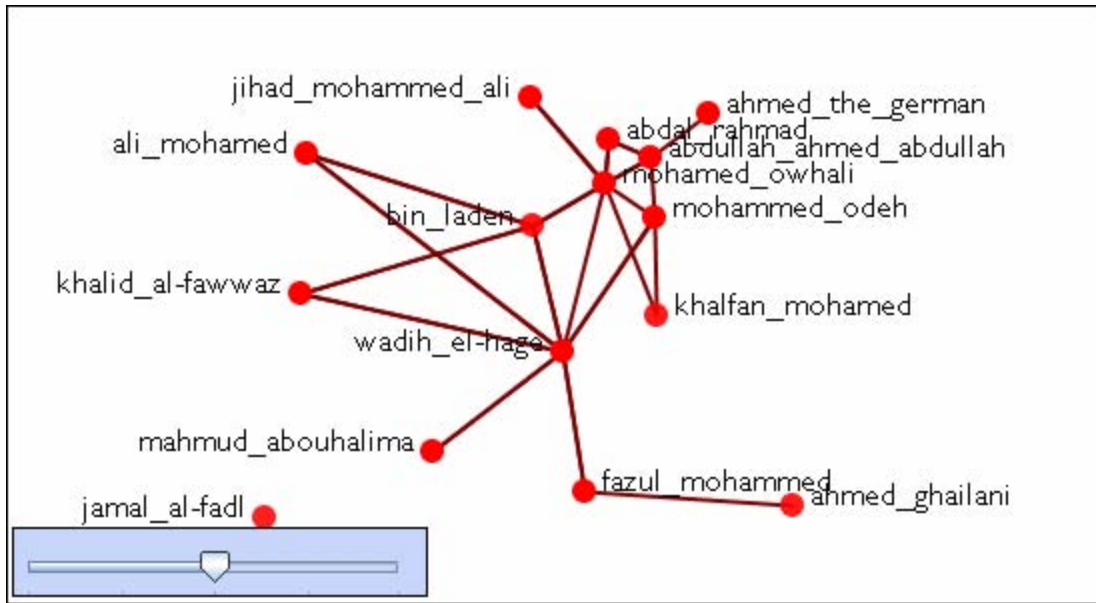
The Timeslices Tab contains checkboxes for all active Meta-Networks. Placing a check mark in the boxes will use that particular Meta-Network.

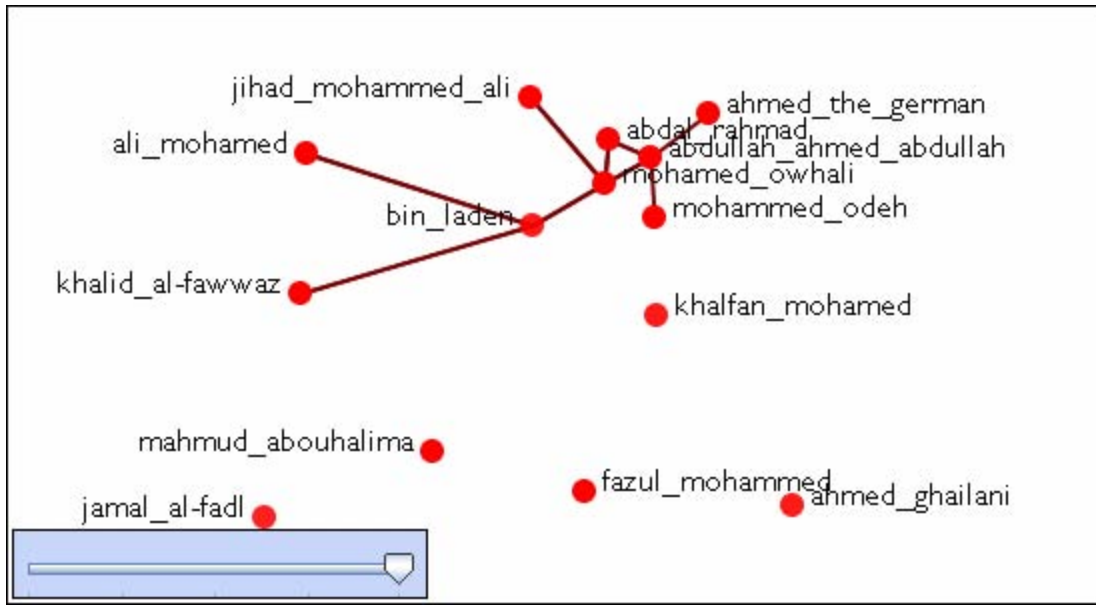
The Clustering Tab allows you to set the time frame for clustering by **day, week, month, or year**.

Animating the Display

Pressing the **Play** button will start the animation. Below are the five **agent x agent** Networks. In different time slices new nodes appear and the connections between the agents changes.



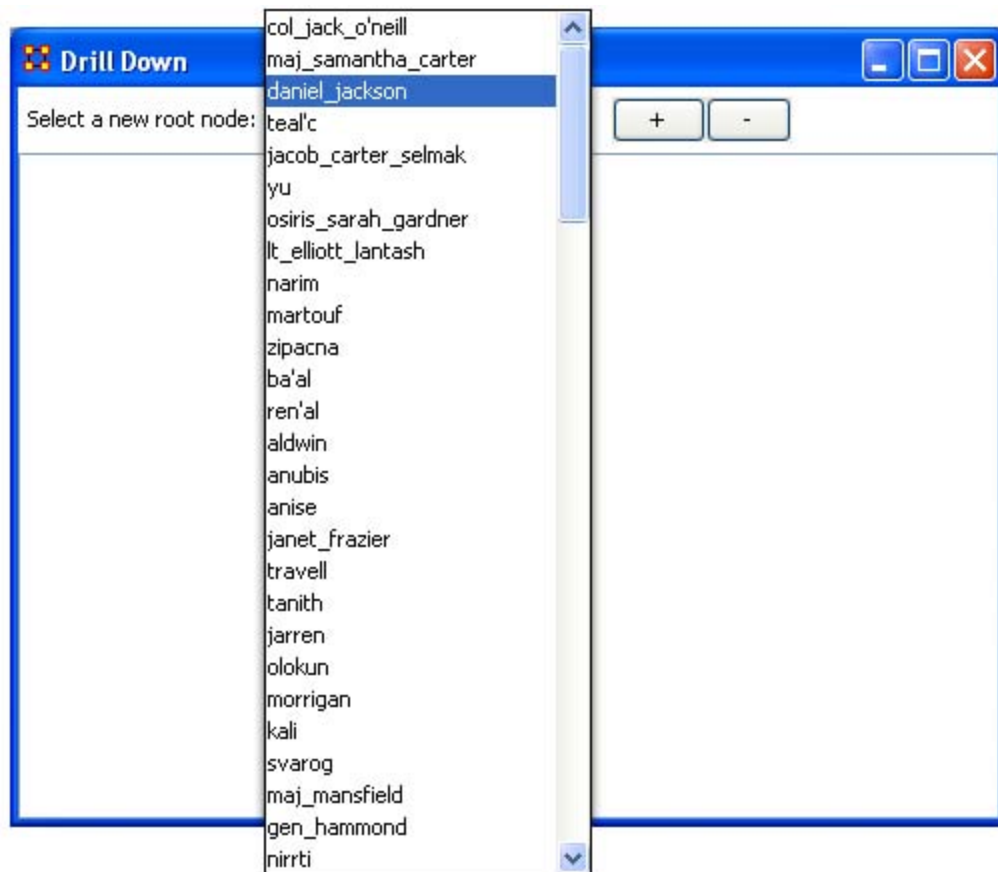




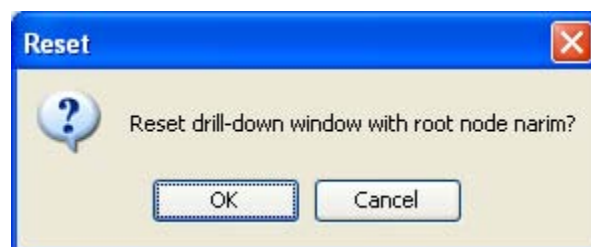
Drill Down

 DrillDown allows for any path to be followed.

From the drop down textbox select the node you wish to start with. Here we'll begin with **daniel_jackson**.



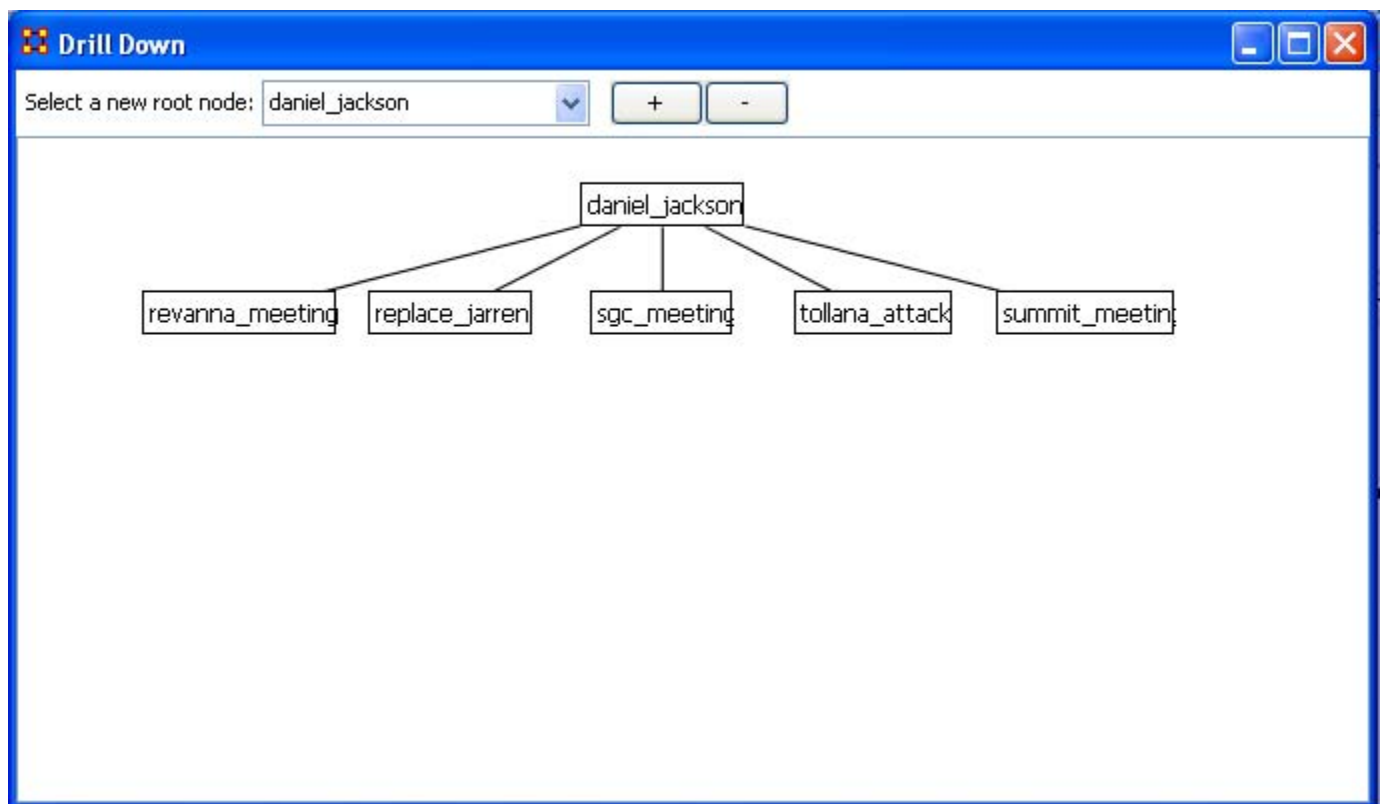
The dialog box below will appear confirming you want to discontinue your last drill-down session.



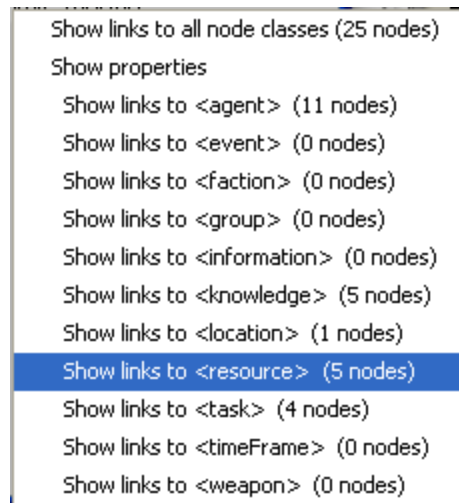
Click on the node and a contextual menu will appear with all the links it has to other nodes. I select **<event> (5 nodes)**.

- Show links to all node classes (50 nodes)
- Show properties
- Show links to <agent> (18 nodes)
- Show links to <event> (5 nodes)
- Show links to <faction> (3 nodes)
- Show links to <group> (0 nodes)
- Show links to <information> (0 nodes)
- Show links to <knowledge> (5 nodes)
- Show links to <location> (7 nodes)
- Show links to <resource> (5 nodes)
- Show links to <task> (2 nodes)
- Show links to <timeFrame> (5 nodes)
- Show links to <weapon> (1 nodes)

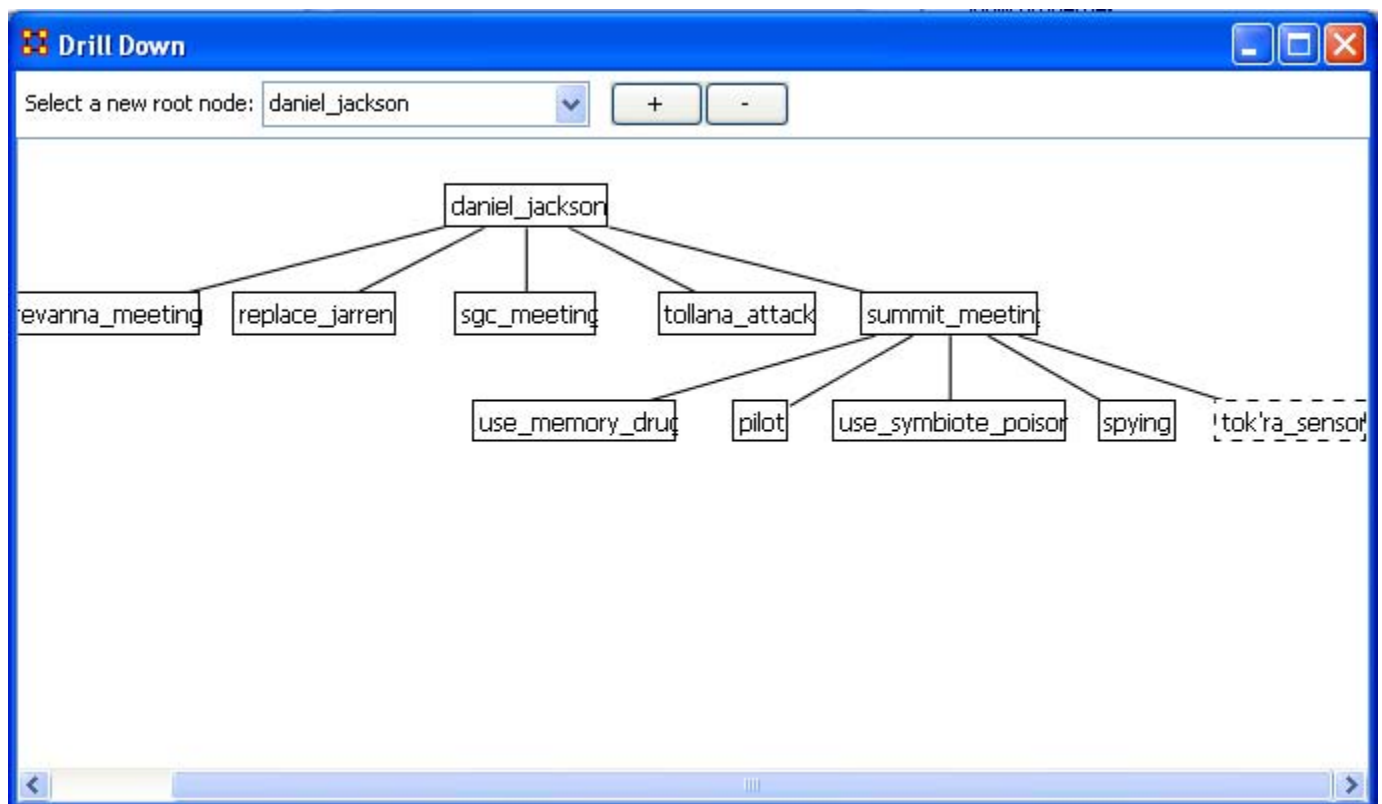
This shows the five events the daniel_jackson was at.



Next I select **summit_meeting** and from the contextual menu select **<resource> (4 nodes)**.

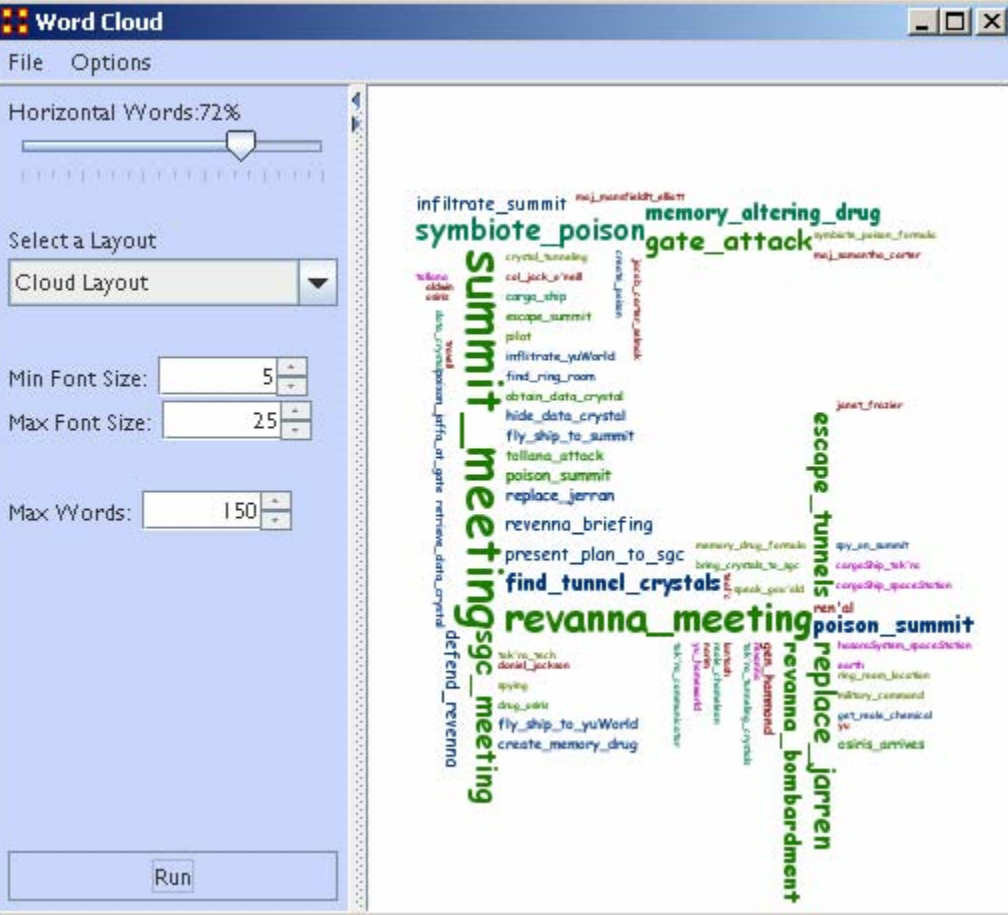


It **drills down** showing the five links to resource nodes connected to the summit_meeting.



This can be continued for as long as you need.

The **[+]** and the **[-]** buttons increase and decrease the font size.



Word Cloud Tools and Settings

File : By accessing the File Menu you can open a previously saved Meta-Network, Save an Image to the clip board, and close your Meta-Network word cloud.

Options : In options, you can choose the measure you wish to apply to your word cloud visualization.

Horizontal Words : You can use this slider to set the ratio of the horizontal words visualized to the vertical word display (e.g. changing this setting to 100% would result in all horizontal word visualizations and no vertical words. Conversely, changing this setting to zero has the opposite effect.

Select a layout : Choose either word cloud layout (default) or a square layout. The square layout will attempt to visual your word cloud in approximate equal ratio of width and height.

Min. Font Size : Sets the parameter for the smallest font size to display.
Note: if you change this setting, click "run" to have the new setting applied.

Max. Font Size : Sets the parameters for the largest font size to display.
Note: if you change this setting, click "run" to have the new setting applied.

Max Words : Sets a limit on the maximum amount of words to visualize (e.g., if you set this at 10, the word cloud will only visualize the words that appear in the top ten in terms of frequency.

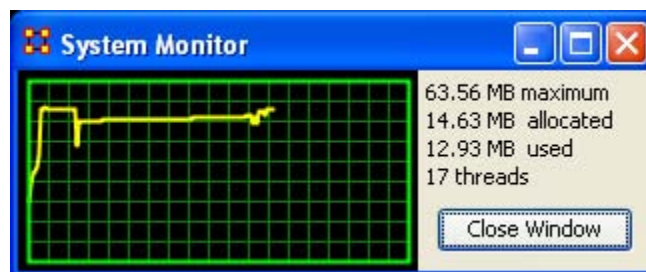
Run : Click **[Run]** to apply any changes to the settings.



The Help Menu contains information which is beneficial in running ORA.

Help Contents : Calls up this Help File System

System Monitor :



About ORA : Contains information regarding this software, the institute of origin, permissions and warranties, version and build dates, and Java usage.

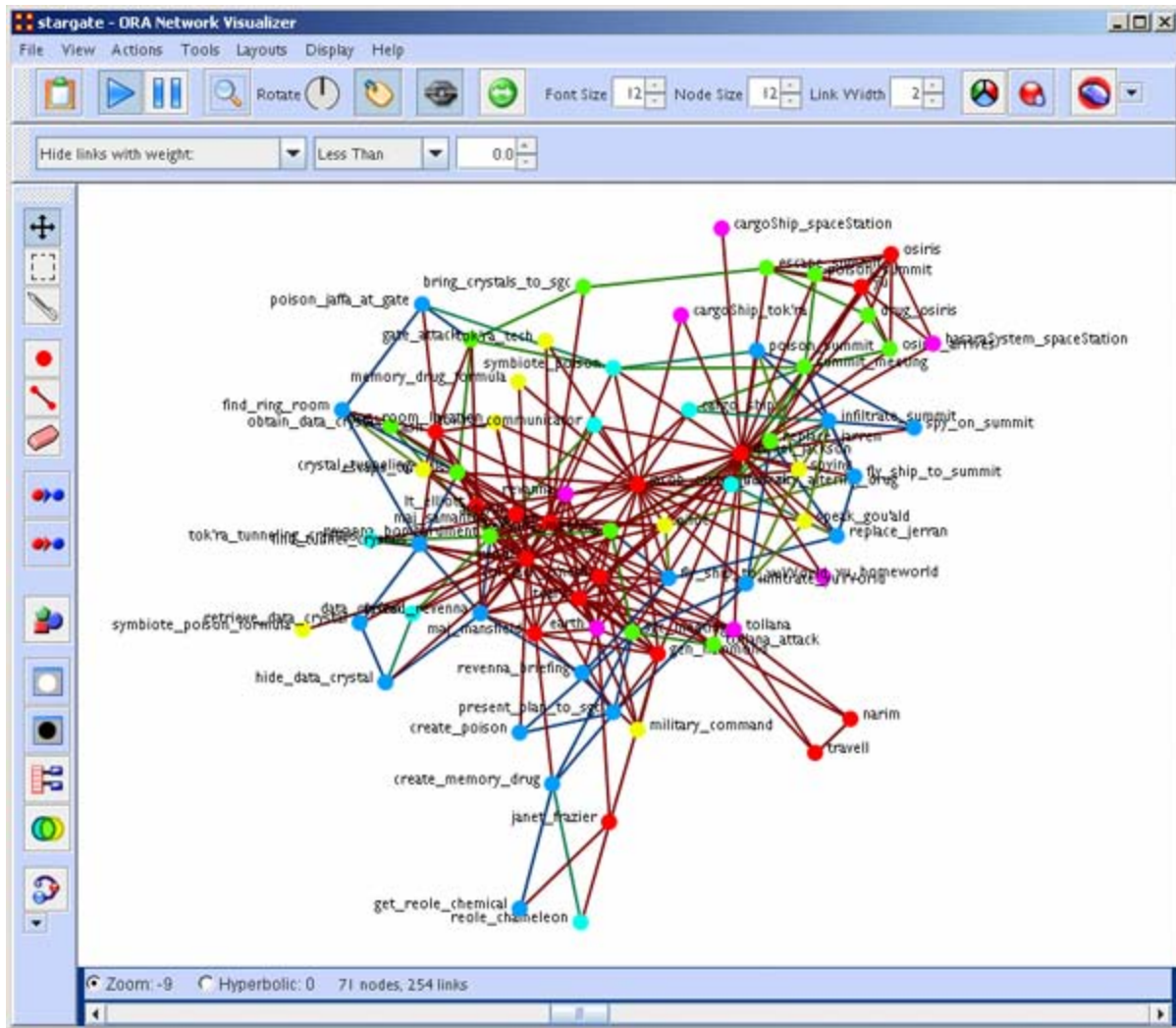


The **ORA Visualizer** produces a graphical model of a Meta-Network comprised of Links and Nodes. Moreover, you can interact with your Meta-Network model by **removing key actors, isolating certain links, focusing on any particular relationship between two nodes using tools such as the Path Finder.**

You can apply a host of grouping algorithms, look at node's Sphere of Influence, Locate Nodes, which may be hidden in complex clusters of nodes and links.

The Visualizer Interface

Below is a visualized Meta-Network displayed with the current tools available in the Visualizer. In this view all nodes and links are visualized. Note the different palette areas and options available from the Visualizer.

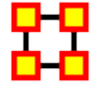


Synchronization

Synchronization allows you to work in the Editor and instantly see those effects in the Visualizer (or visa versa). Adding or removing a link in the Editor will place that link on the screen in the Visualizer.

The ORA Layout Algorithm uses a standard spring embedder algorithm. For large data sets, this has been enhanced using the Barnes-Hut Simulation for calculating the force of repulsion between any two nodes.

Reference :Nature 324, 446 - 449 (04 December 1986);
doi:10.1038/324446a0, A hierarchical $O(N \log N)$ force-calculation algorithm, Josh Barnes & Piet Hut



The Visualizer Toolbar

This section explains the function of each of the toolbar's **default** buttons. The user can add or remove buttons from the toolbars. These are explained in other sections of this help.

When you first load a Meta-Network you will see the **pause button** depressed in the Visualizer tool bar. You can **layout** the Meta-Network by clicking the **play** button. The visualization will space apart across the screen. This is called **laying out** a Network. The Visualizer is separating nodes and links that, at first, appear on top of each other. You can **pause** this process again when you think the Meta-Network is satisfactorily spaced apart or you can let ORA lay out the entire Meta-Network. Your computer speed, as well as the complexity of Meta-Network, will determine how long this takes.



Copy / Paste : This feature allows you quickly capture a visualization and save it to be pasted into another document later.



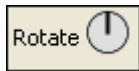
Play / Pause : The **Play Pause** function works very similar to the play pause feature on any device. The pause button (**two vertical bars**) is depressed, the Visualizer stops laying out a Meta-Network. When the play button is depressed (**right pointed triangle**) ORA Visualizer begins laying out the Meta-Network as described above. The red ellipse highlights on the tool bar where this feature is located and accessible.



Magnifying / Maximizing : The **Magnifying Glass** icon with the plus sign inside it, allows you to instantly fill the Visualizer window pane with the currently rendered Meta-Network. The red circle in the screen shot above highlights where to access this feature on the Visualizer tool bar.

If there are any nodes off screen, clicking the button once will bring all the nodes into view on the screen.

NOTE : This function works well when selecting a small part of your overall Meta-Network and magnifying it to fill the Visualizer screen.



Rotating The Visualization : To **Rotate** your visualization look for the word next to the **Noon-pointing sundial** icon in the tool bar. This feature is another way to manipulate your visualization to fill the entire Visualizer window pane.

NOTE : Use this feature in conjunction with the magnifying glass function to work your visualization into largest size possible.



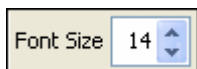
Show Labels : The **Show Labels** button allows you to toggle the labels on & off in the Visualizer. Default is **ON**.



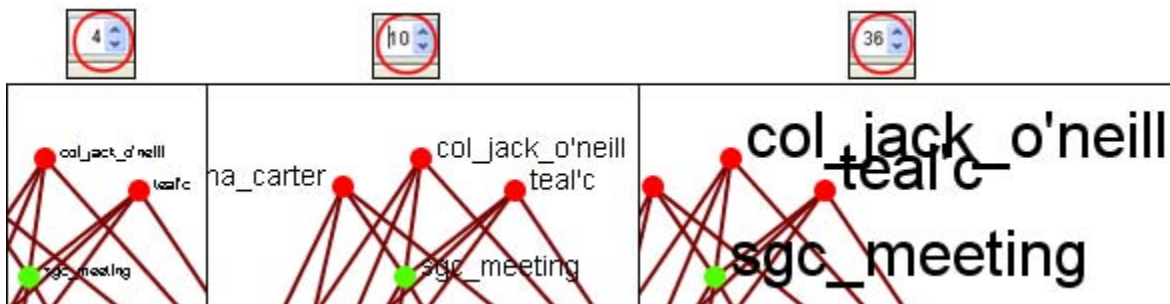
Show links : The **Show Links** button allows you to toggle the links on & off in the Visualizer. Default is **ON**.



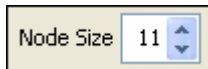
Show Arrows : The **Show Arrows** button allows you to toggle the arrows on & off in the Visualizer and show directional data. Default is **OFF**.



Font Size : The **Font Size** allows for setting the size of the font in the Visualizer. This allows you to change the size of the font to suit your needs for each individual Visualizer set. It ranges from **4**, which is almost unreadable, to extremely large numbers, which can also be unreadable by virtual of overcrowding. So pick the size of font that best suits your screen.

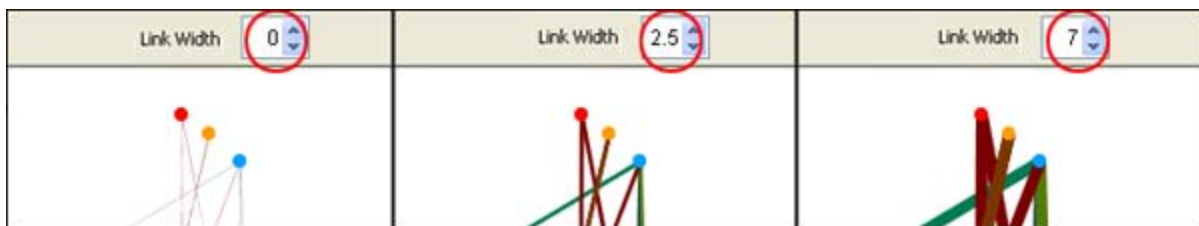


Node Size : The **Node Size** allows for changing the node size, larger or smaller by increments of one. Four is the smallest size possible and creates a very small, almost indistinguishable dot. As the number increases it becomes easier to see the individual nodes until the number gets to a point where it can simply overpower the screen. But this gives you the ability to customize the entity size to suit your needs.



NOTE : *This also affects the size of the nodes in the Legend.*

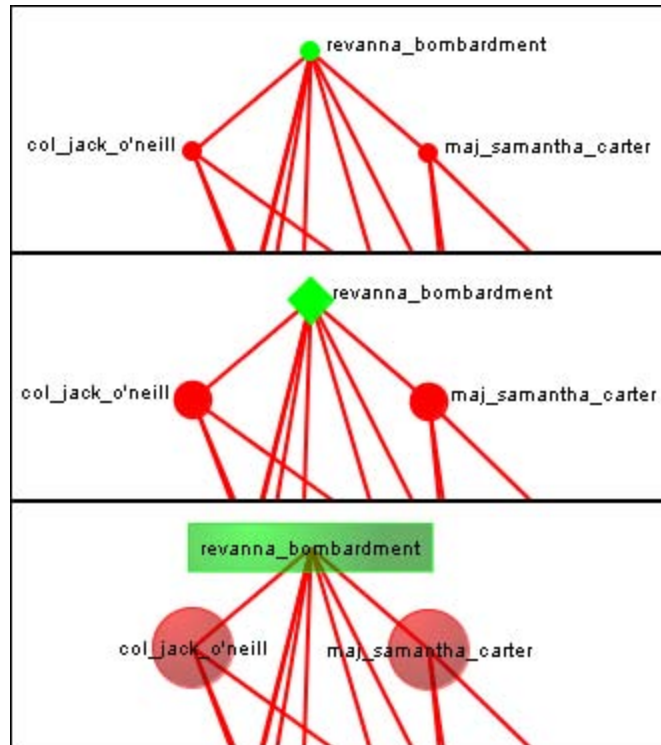
Link Width : Allows for changing the general width of the line, larger or smaller. And as the options before you can pick the exact size which best suits your needs for the display.



Meta-Node Size : Use the **Meta Node Manager** to handle creating and removing Meta-Nodes.

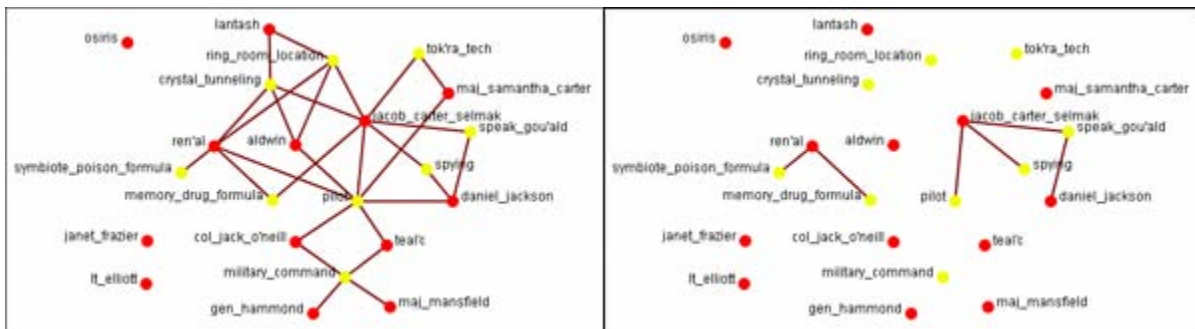


Node Sizes : The **Toggle Node Size** button rotates through three sizes for the nodes **(as seen below)**.



Hide links with weight:

Hide Links by Weight : Use the **Hide Links with Weight** to select which links to display. As long as there are links with different values you can hide links of smaller values leaving only the more important links visible. This can assist in seeing links that might normally be too cluttered to view. Below left is a Meta-Network with all links in view. Below right is the same Meta-Network with links less than 2.0 hidden.

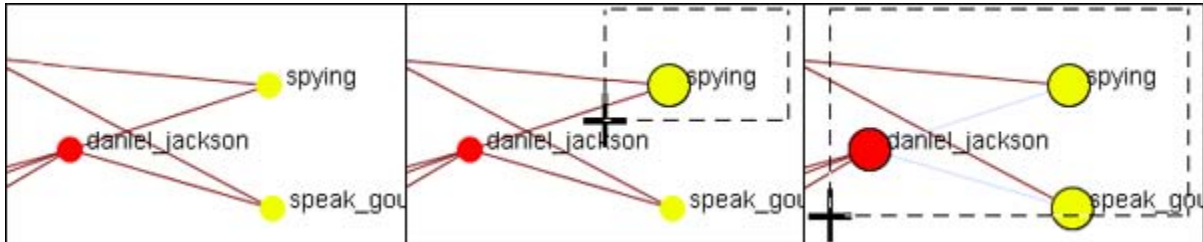


Drag : Used to move the view around the Meta-Network to see different parts. Press and hold the left mouse button and move the pointer around to view various parts of the Meta-Network.

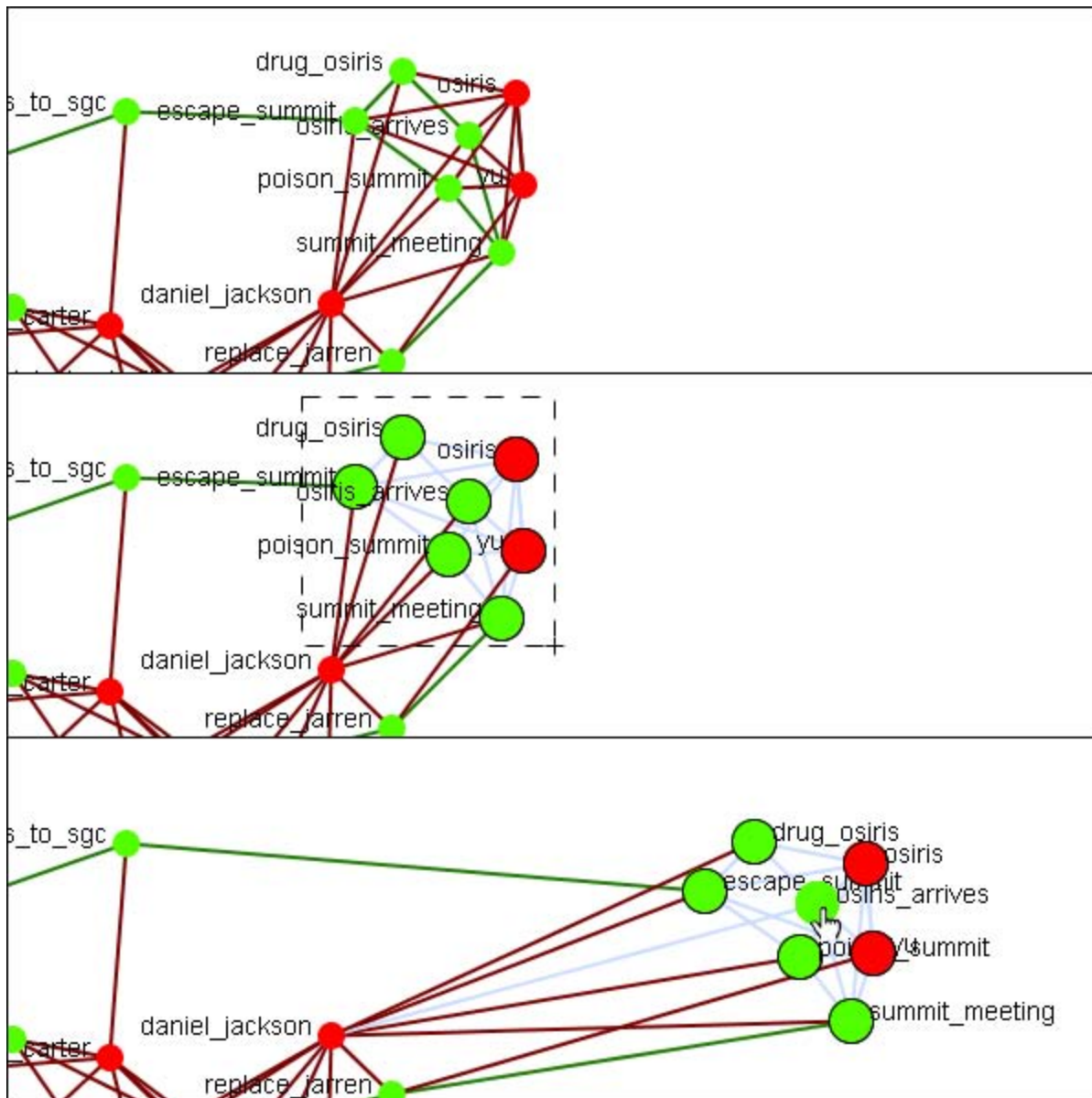


Marquee : Click and drag the marquee over nodes to select them.

After releasing the mouse button the set of selected nodes will remain enlarged enclosed in a dashed line.



After selecting a group of nodes they can be moved all together. Press the **[Pause]** button on the toolbar, switch to the **[Move]** tool, then grab and move the group. This is useful in creating displays of small portions of the Visualizer.



NOTE : Only one set of nodes can be selected at a time. Creating a second selection negates the first nodes selected.

The Paint Tool : The **Visualization Paint tool** allows you to draw on the visualization. You can select a brush size and a brush color via a small pop-up menu that appears whenever paint mode is selected. Nodes are also selected whenever you stop drawing, using the shape drawn (plus a line from the endpoints of the drawing) as a giant polygon, which selects nodes based on whether or not they're inside the polygon. There's also a "clear" button that removes all paint. "painting" works similar to using a marker on your computer screen – no matter how much you



zoom/pan/do whatever to the visualization, the marks will remain in the same place.

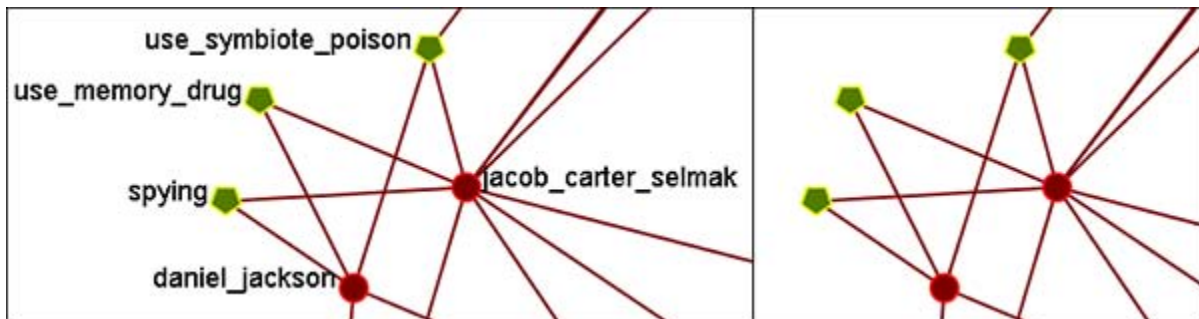
- **Node Creator** : You can create new nodes within pre-existing NodeClasses or create them in a new NodeClass.
- **Link Creator** : Click on one node then drag the pointer to a second node. A link between the two will be created.
- 🧽 **Node / Link Eraser** : While the Eraser tool is active any node or link clicked will be removed from the Meta-Network.



Show / Hide Labels

🔑 Node labels, which often prove helpful in describing Networks, can sometimes clutter a visualization. Thus, it may be necessary to eliminate labels from your visualization. To remove labels go to Visualizer tool bar and find the **Show Labels** button.

This initial screen shot shows the Visualizer with all the labels.



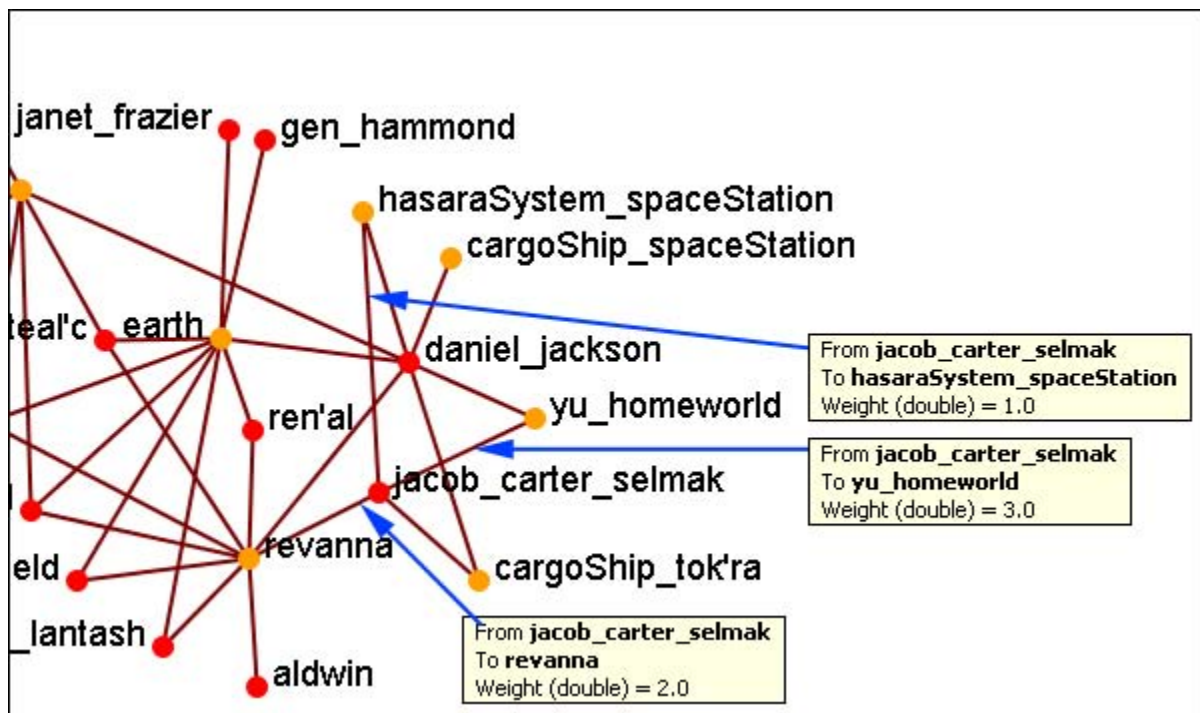
When you click the Label button on the Visualizer tool bar ORA toggles the labels on and off. Note that now a much more clearer conceptual picture of the network is produced. You can flip between the two views.



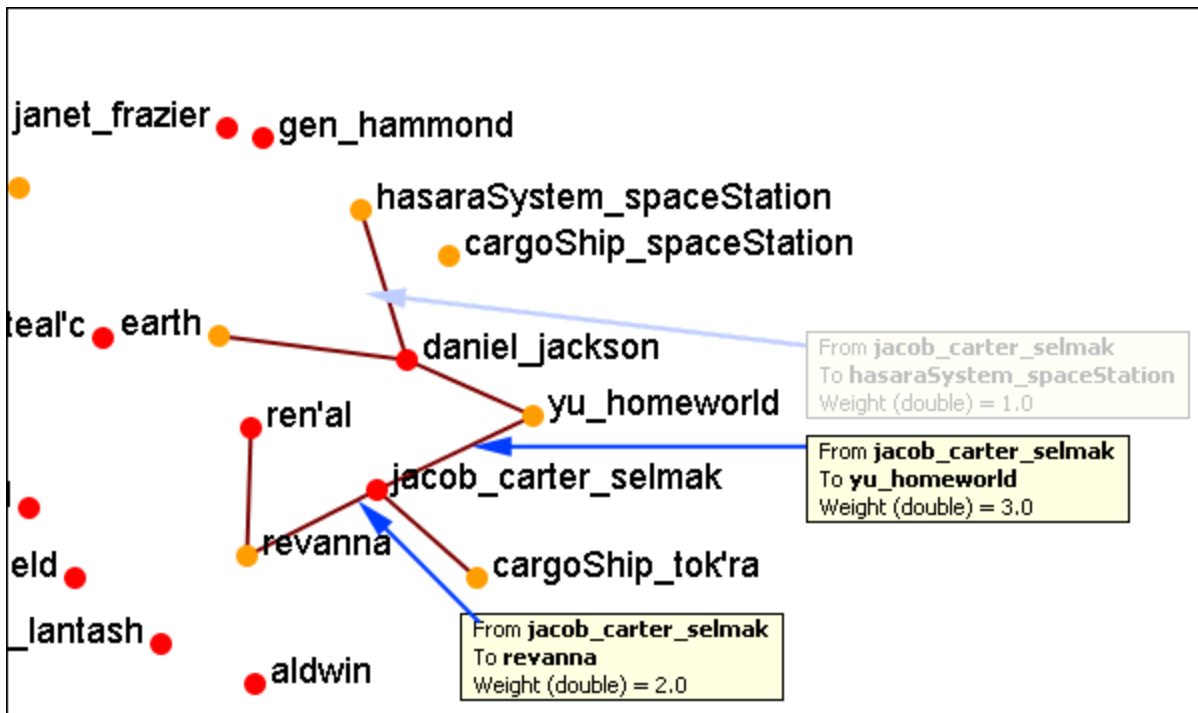
Hide Links By Weight

ORA can visualize your network with only the more **weighted** links displayed. Below are procedures to accomplish this task.

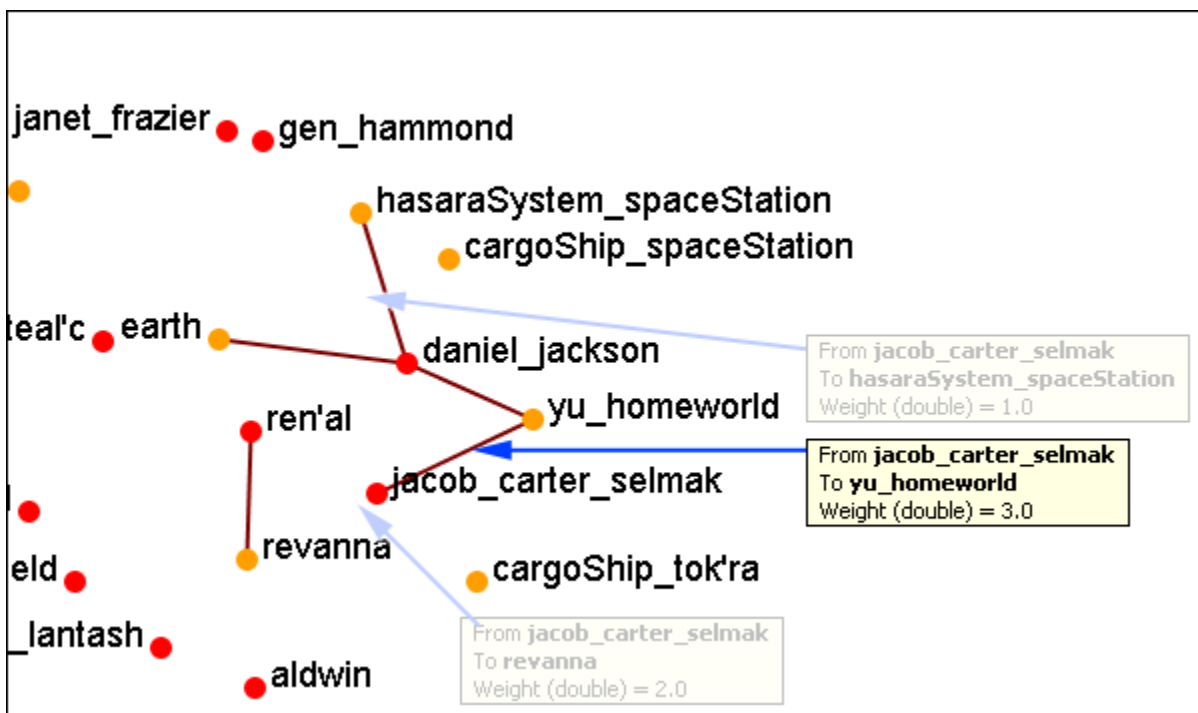
You can select to hide links either **Less Than or Greater Than** a certain value. Below is an agent x location network. And there are three tooltips displayed for jacob_carter for the values of 1.0, 2.0, and 3.0. We'll keep the hiding style as Less Than.



First we'll increase the value to 1.1 hiding all lower values. The link to the **hasaraSystem_spaceStation** is removed from view. The others, however are still on the screen.



Now let's increase the value to 2.1. This removes the link from jacob_carter to Ravenna.



If we increases to value to 3.1 then all of the links would be removed.

In this way you can remove links which are of lesser important to concentrate on a smaller set of data.



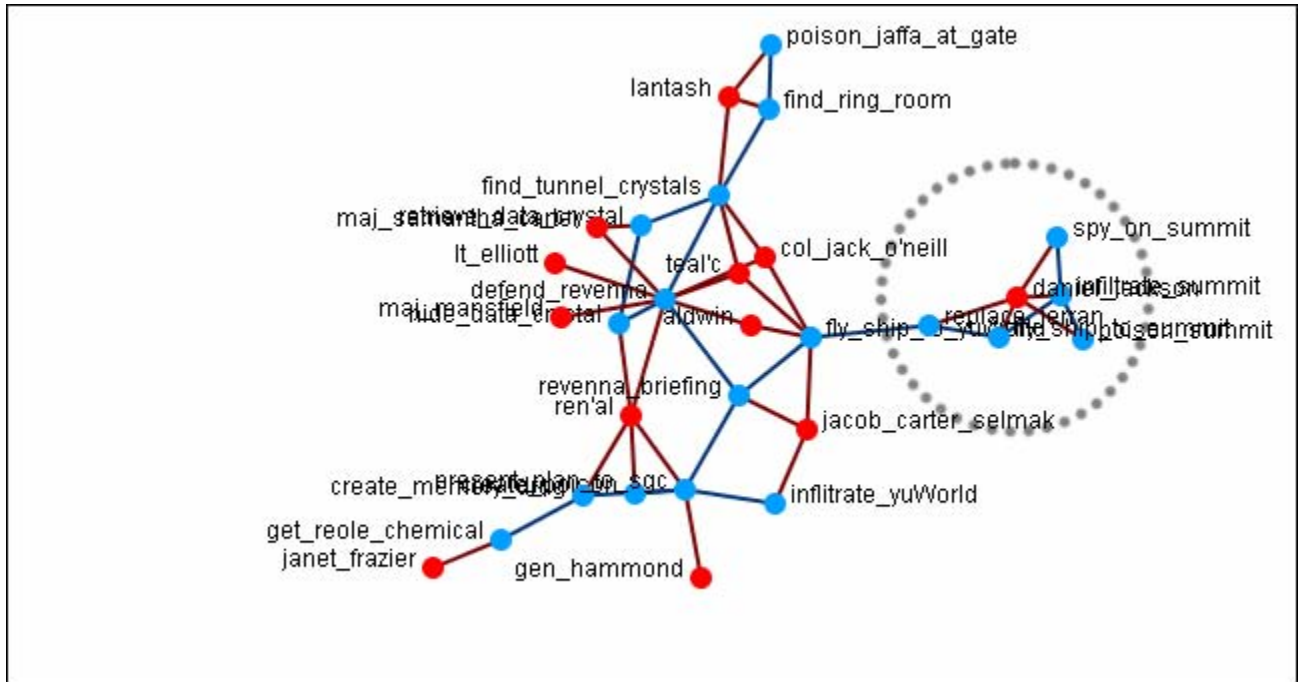
Hyperbolic View

The Hyperbolic function creates a **bulge** within your visualization adding a sense of depth. By moving the slider from right to left, you can increase or decrease this bulge effect and create different depth-added views. By moving the network around the window you can create the view you need. The **Hyperbolic radio button** and **slider** can be found at the bottom of the window.

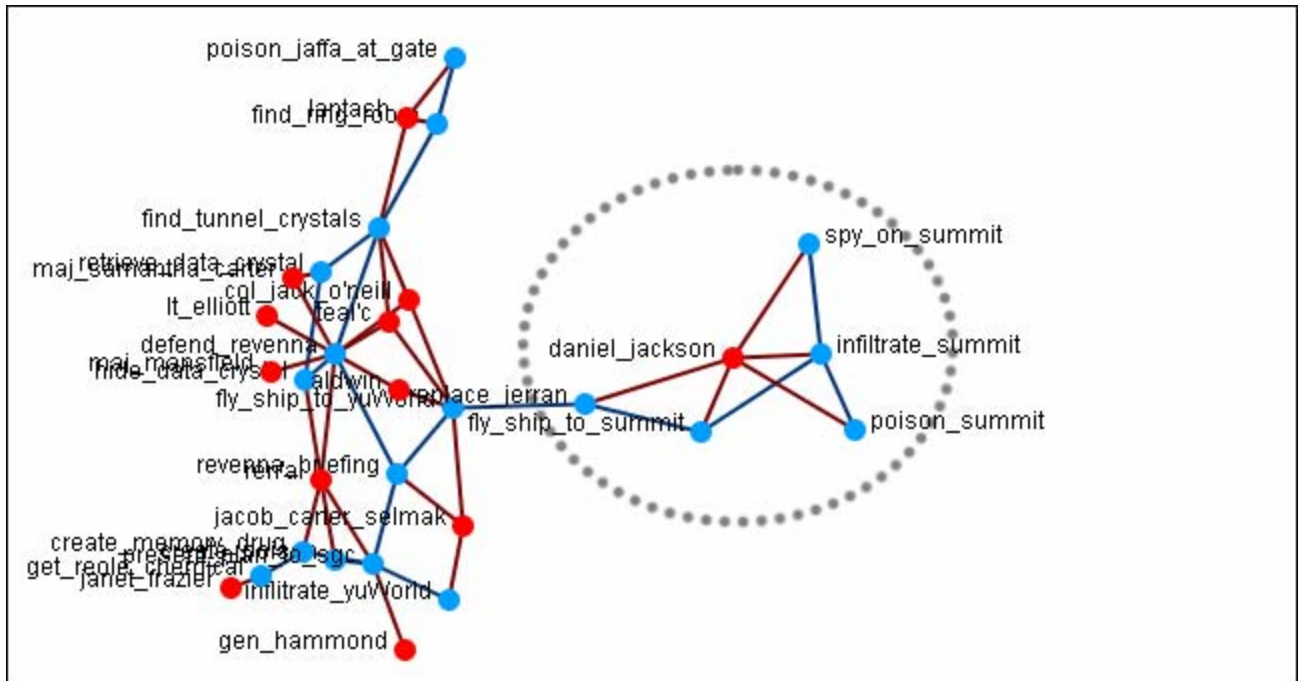
This tool is useful when nodes may be very tight on screen such as the ones in the following images. Using the Hyperbolic tool you can help space them out for easier viewing. Here is how to do so:



NOTE : The Hyperbolic function, when selected, converts the slider to this feature. This is also true of using the zoom and rotate functions. Use all three in conjunction to get your visualization just the way you want it. Scroll down below this screen shot for another when viewed with the Hyperbolic feature.



Select the Hyperbolic tool and move the slider to the right. Then click-and-hold on some part of the white background and move the entire network to the left. You will notice the space between the nodes begins to increase the closer they come to the center of the screen.



Now the nodes are able to be read much easier.

NOTE : It is useful to use this tool in conjunction with the **Rotate** and **Magnify** tools to obtain just the view you desire.

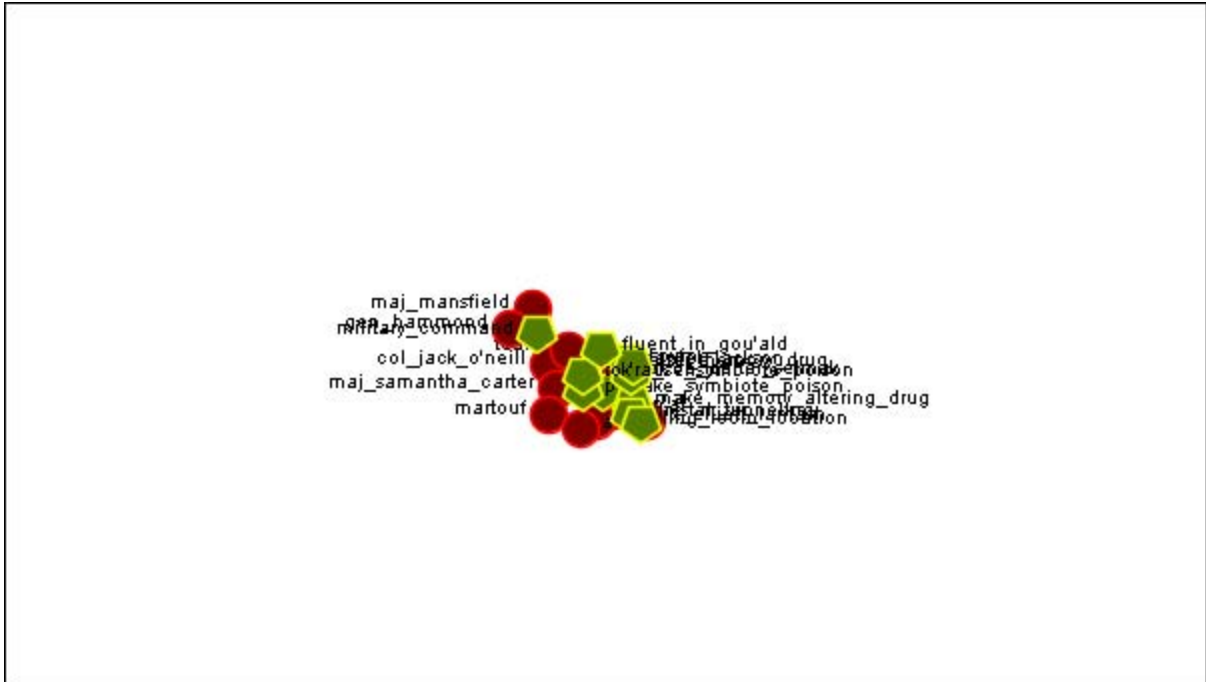


Rotating A Visualization

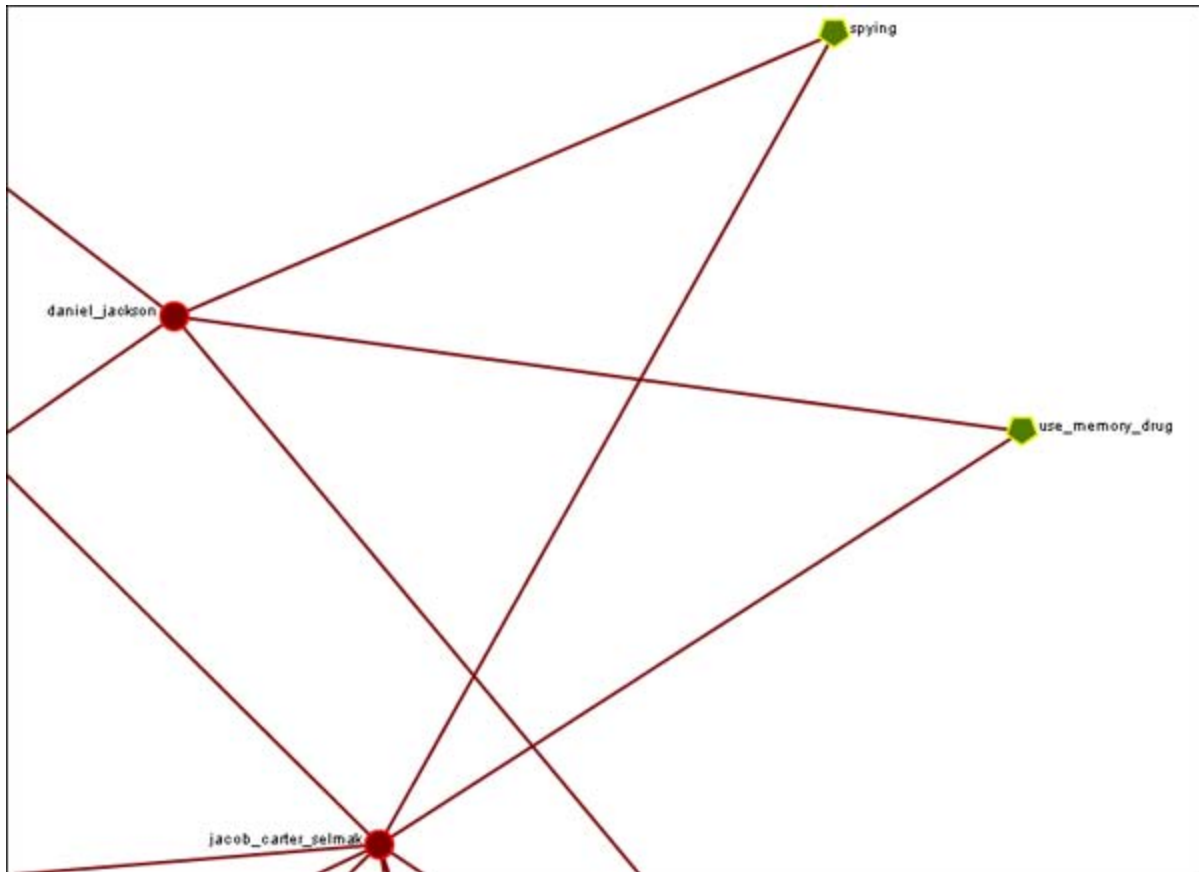
You can rotate a visualization with the slider bar at the bottom of the interface or from the tool bar at the top. To do this from the slide bar, click the rotate option toward the bottom of the interface. This activates the rotate feature.

As you move the slider from the left to right, your visualization will rotate correspondingly. From the tool bar, you can click inside the rotate icon, which will turn the visualization depending on exactly where you clicked.

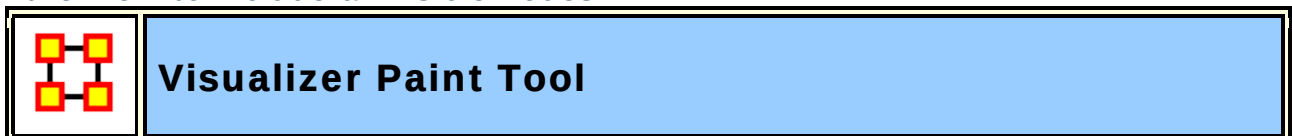
In the screen shot below, the yellow ellipses highlight where to access ORA's rotate tool both at the bottom and top of the Visualizer interface.



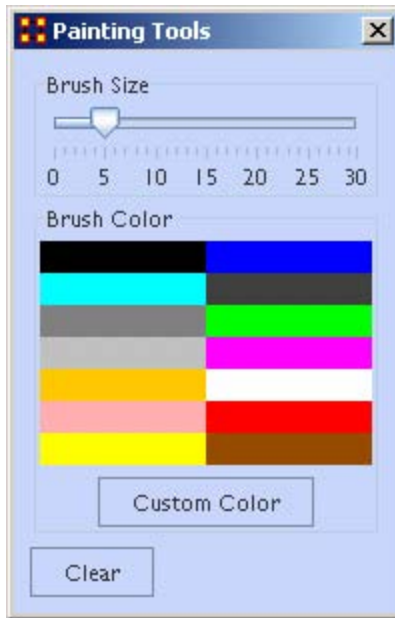
In the next shot the zoombar has been placed almost to the far right, absolute zoom in. It allows for extreme close-ups of various parts of the Meta-Network.



NOTE : Clicking on the **Magnifying glass** in the Visualizer tool bar will set the view to include all visible nodes.



 The **Visualization Paint tool** allows you to draw colored lines on a visualization. You can select a brush size and a brush color via a small pop-up menu that appears whenever paint mode is selected.

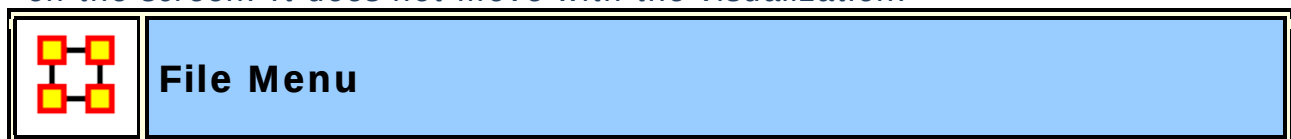


Nodes are also selected whenever you stop drawing, using the shape drawn (plus a line from the endpoints of the drawing) as a giant polygon, which selects nodes based on whether or not they're inside the polygon. There's also a **clear** button that removes all paint. Painting works similar to using a marker on your computer screen - no matter how much you zoom/pan/do whatever to the visualization, the marks will remain in the same place.

From the Paint Palette you can select a **brush size** by adjusting the slider. Then choose a color by clicking a pre-set colour or clicking the **[Custom Color]** button and select any color. Clicking the **[Clear]** button sets everything back to default. Once brush size and color are selected, you can draw on the Visualization.

To undo your drawing click the **[Clear]** button.

NOTE : *If you pan the visualization, the paint drawing will remain stationery on the screen. It does not move with the visualization.*



Open Meta-Network : This opens an **Open File** dialog box so you can navigate to a directory and open a Meta-Network into the Visualizer.



Open ORA-Image :



Save Image to File : This opens a **Save As...** dialog box and allows you to save an image of the current Visualizer in one of the following formats: **PNG, JPEG, SVG (scalable vector), or PDF.**



Save Meta-Network to File : After you've made changes to the information you can save the current status of the Meta-Network into a new file in a **DyNetML*** format.

Save Special :



Save Meta-Network (Only Selected Nodes) :



Save Grouping to New Meta-Network :



Save Meta-Network (No Dotted Links) :



Save Meta-Network (Only Dotted Links) :



Copy Image to Clipboard :
Similar to the **Save Image to File...** only saves it to the clipboard where you can paste it into an image-editing program.



Add Meta-Network to ORA :
Save the currently **visible** network into a new Meta-Network titled, **New Meta-Network**. This new Meta-Network can be renamed accordingly.



Add Grouping to Current Meta-Network :



Add MetaNodes to Current Meta-Network :



Visualize in 3-D :



GeoSpatial Networks :



Node Cloud :

Close : Close the Visualizer and returns to the Main Interface.



Save Image to File

An image can be captured from the Visualizer and saved in one of four formats:

- **PDF :** This format is usable with Adobe's Acrobat and Reader programs.
- **JPEG :** A standard compressed format for image editing.
- **PNG (Portable Network Graphics).** PNG is a bitmapped image format that employs lossless data compression. PNG was created to improve upon and replace the GIF format.

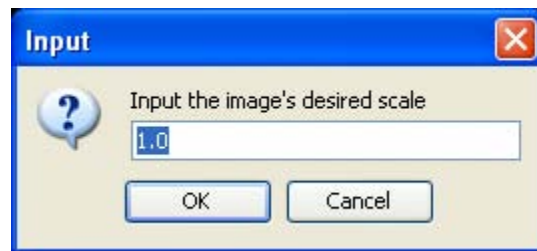
“ORA Images” are functional in regards to PNGs. Whenever you save a PNG, relevant information about the visualization gets stored inside the image. This makes saving a little longer, but not so long that you'd notice if you were not looking for it. These images **Node Colors**, **Node Location**, **Screen Center**, and **Zoom Value**.

Loading images into a Visualizer will re-create the image inside the Visualizer. Loading an image is as simple as *dragging-dropping* it onto the Visualizer.

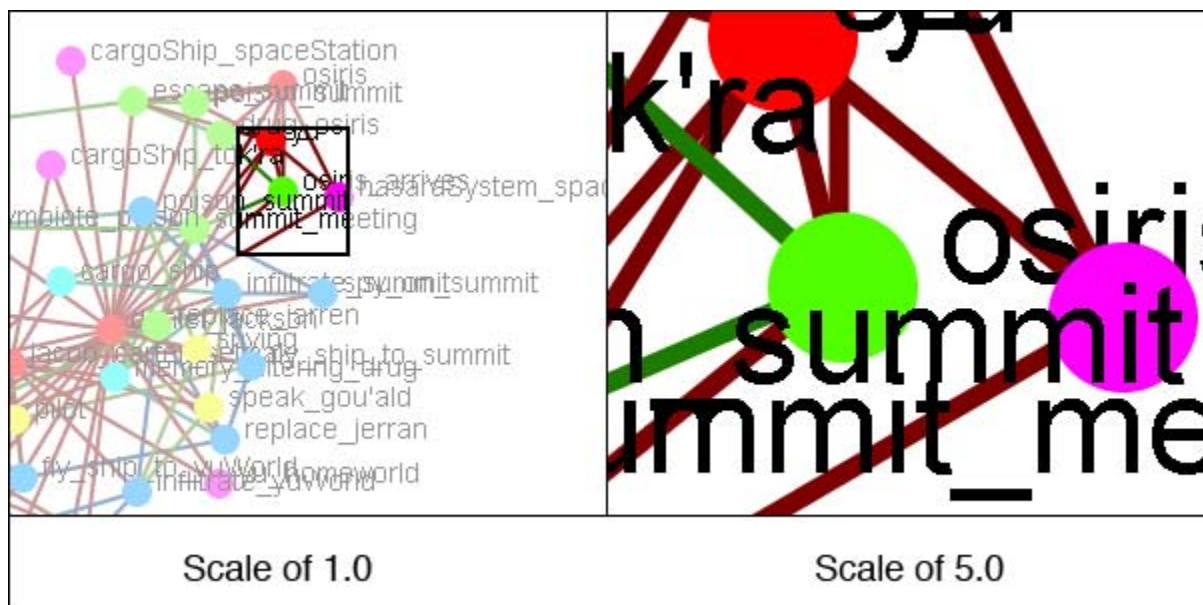
- **SVG** : Stands for Scalable Vector Graphics. SVG is an XML specification and file format for describing two-dimensional vector graphics, both static and animated. SVG can be purely declarative or may include scripting. Images can contain.

Selecting Image Resolution on Save

After choosing a format from the drop-down menu and specifying a filename press **[Save]**. A dialog box will appear asking for the quality of the image. The **1.0** saves the image in the same resolution. A higher number will result in a higher resolution image.



Below are examples of an image saved with a scale of **1.0** (on the left) and then saved with a scale of **5.0** (on the right). Use a number higher than 1.0 if there is a need for a higher resolution image.



NOTE : Values less than 1.0 are ignored when scaling images.

	Actions

This section of the help contains a description of the functions of the **Action Menu**:



Undo : Undoes a variety of actions performed in the Visualizer.



Add Node(s) : Function for adding Nodes directly into the Visualizer. These can be added to existing NodeClasses or within newly created NodeClasses. You also have the option of the number of nodes to create.

Add Node (with links or attributes) : Allows you to add a Node directly into the Visualizer. In addition you can create links and assign weights to these new links. You can also select attributes and assign values to these attributes.



Add Link : Allows you to create new links in a Meta-Network in the Visualizer. Then select the source and target nodes and then select the network. You have the option of creating a new network for this link. Lastly you can select the weight of the new link.

Notes on Display of Multiple Edges : *If your Meta-Network contains graphs with “multiple edges between two nodes” **ORA will display the edges as curved lines** so as to allow visualization of overlapping Edges. This is to say that if there is represented two nodes with four edges coming from four different graphs.*

*Please note that **Tool tips are currently handled by math looking at the edge as if it were a straight line**. Since our line is not straight anymore, it will only be highlighted if the cursor's in the middle – nowhere near the edge. But otherwise, you should still see tool tips.*



Pin All Nodes : Set all nodes as unmovable



Unpin All Nodes : Release all nodes and allow them to be moved independently.

Isolates



Hide Isolated Nodes : Remove any node which has **zero** links connecting it to other nodes.

Periphery : Moves Isolates back to their original position.



Combine into MetaNode : Collects all the Isolate nodes into a Meta-Node.



Move into Column : Moves all isolates to the right side of the screen in a column. The isolated nodes can be moved back using the Periphery option.



Hide Pendant Nodes : Remove any node which has **only one edge** connecting it to another node.



Recursively Hide Pendants : This function will run the both the **Hide Pendant** routine until there are no more Pendants.



Recursively Hide Pendants and Isolates : This function will run both the **Hide Pendant and Hide Isolate** routines until there are no more Pendants or Isolates.



Show All Nodes: Any nodes that were previously hidden will be revealed.

Show All Nodes Except Isolates : Reveal any nodes that were previously hidden with the exception of nodes that have no links connecting them to another node.



Compute Standard Measures for Visible Network : Compute Standard measures computes the following collection of measures on the visible network: Total Degree Centrality, Betweenness Centrality, Eigenvector Centrality, Cognitive Demand, Resource Exclusivity, Task Exclusivity, Knowledge Exclusivity. The measure values can then be viewed within the Entity Status Window.

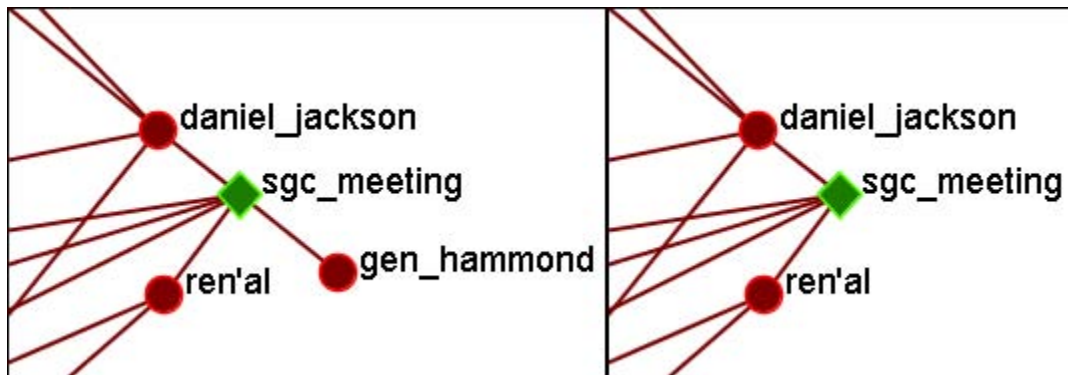


Hide Pendants

Pendants share links with only **one** other node. Their linkage is tangential and therefore isolated from the core linkages you may be interested in examining. **Pendant Nodes**, like **Isolated Nodes**, can be hidden.

From the drop down menu in the Visualizer select **Tools > Hide Pendant Nodes**.

Below is a **Before / After** screen shot of the visualization before showing the removal of the pendant nodes.



Add Node

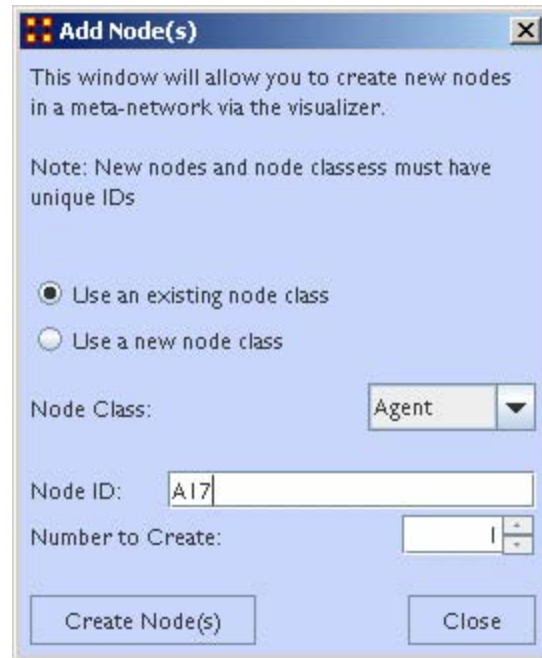
IMPORANT NOTE : Changes done using Add Node(s) and Add Link(s) are transient. Be sure to use either the **File > Save Meta-Network As...** (to save the entire Meta-Network with additions) or **File > Add Meta-Network to ORA** (to create a new Meta-Network using only the currently visible nodes). Changes can not be saved back to the currently open Meta-Network.

The **Add Node(s)** function allows addition of nodes to the current Visualizer. These **added Nodes** are not added to the currently open Meta-Network. If there is a need to save the Meta-Network with the added nodes then use the menu item **File ⇒ Save Meta-Network to File...** and create a new Meta-Network.

Below is the NodeSet for **Stargate** with the original 16 node NodeSet.

	Node ID	Node Title
	<set filt... ▾	<set filt... ▾
☐	A01	col_jack_...
☐	A02	maj_sam...
☐	A03	daniel_jac...
☐	A04	teal'c
☐	A05	jacob_cart...
☐	A06	lt_elliott
☐	A07	ren'al
☐	A08	aldwin
☐	A09	janet_frazier
☐	A10	maj_man...
☐	A11	gen_ham...
☐	A12	lantash
☐	A13	narim
☐	A14	travell
☐	A15	osiris
☐	A16	yu

From the main menu select, **Actions ⇒ Add Node(s)** which brings up the Add Node(s) dialog box.



1. Use an Existing nodeset :

allows for a NodeSet selectable in option 2 or **Use a new nodeset** creates a new empty NodeSet.

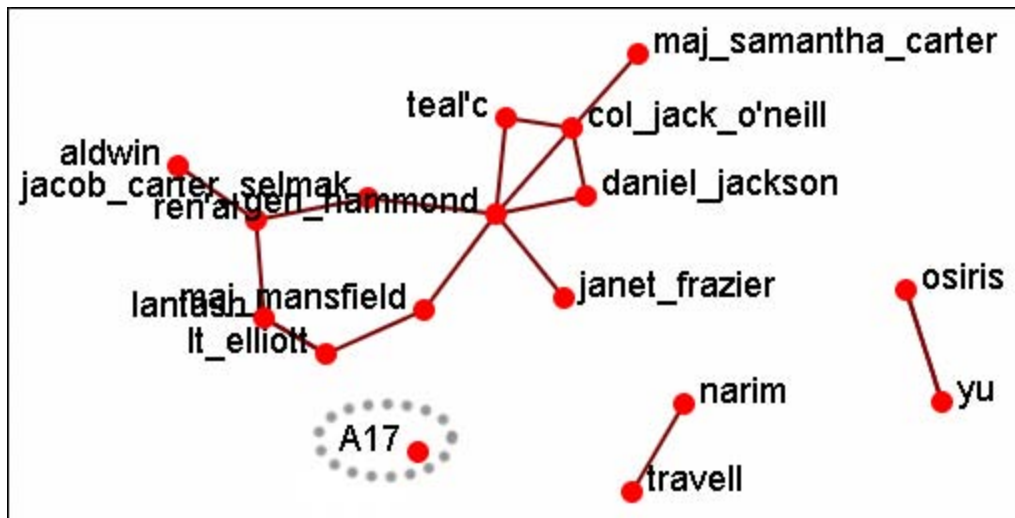
2. This dropdown gives the option for selecting a pre-existing NodeSet to place the new node.

3. The **Node ID:** textbox is used for giving the new node an ID.

4. The **Number to Create:** specifies the number of new nodes.

NOTE : *If the **Number to Create** is larger than 1 then the text placed in section 3 for Node ID will be used as a prefix for all new nodes crated.*

After inputting the information to add node A17, the Visualizer will now display the new node as **A17** with no connections. In order to display this node with a **title** will require saving the Meta-Network and changing the information within the ORA Editor.

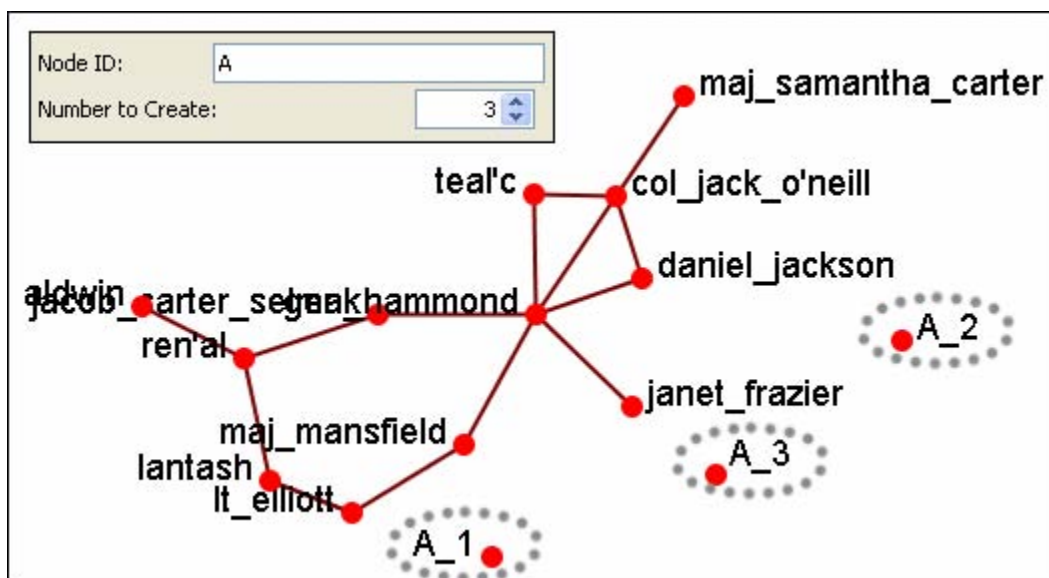


Adding Multiple Nodes

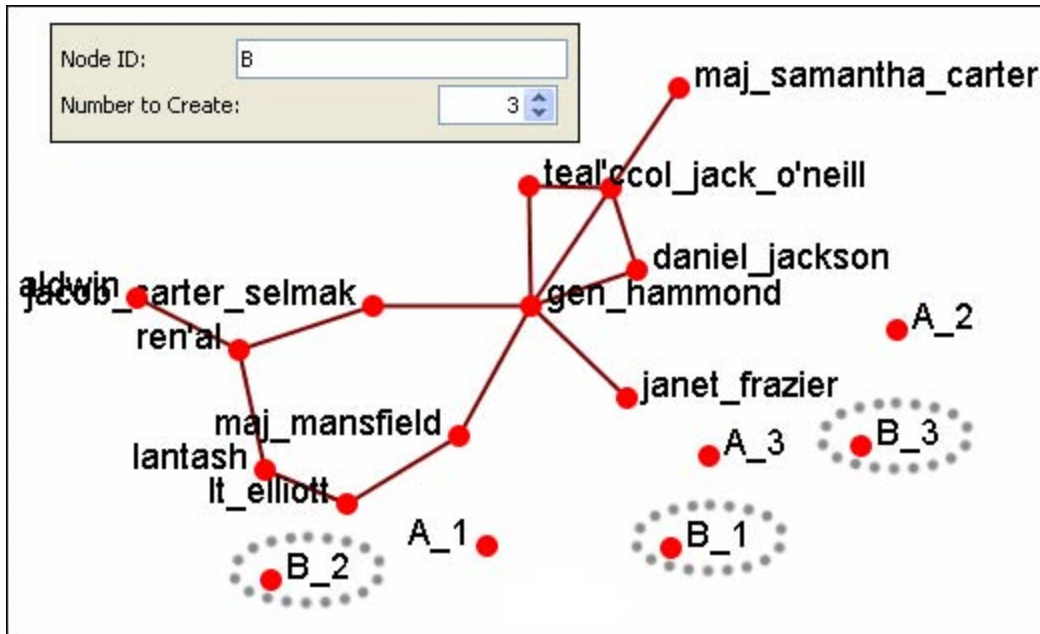
The procedure for adding multiple nodes is similar to adding a single node. The exception is the text in the **Node ID:** textbox. When adding multiple nodes only use a prefix. ORA will attach numbers, starting at 1, for each node.

Here's the addition of three new nodes and the prefix **A** will be used. Three nodes, **A_1**, **A_2**, and **A_3** are created on screen.

NOTE : You can only use a prefix **ONCE**. ORA will not accept any previously used prefixes a second time.



To add additional nodes use a **different** prefix.



NOTE : Now either save the altered Meta-Network using the **File > Save Meta-Network As...** to a new filename or continue with [Add Link\(s\)](#).



Allows you to create links between nodes in the Visualizer and place them in an existing NodeClass or create a new NodeClass. You can also set the weight for the new link.

Add a Link

This window will allow you to create new links in a meta-network via the visualizer.

Select the source and target nodes, then select the network (or create a new one)

Note: New networks must have unique IDs

Start node

Node class: com : size 53

Node: susan

End node

Node class: com : size 53

Node: susan

☐ Insert Nodes as they're clicked

☒ Use an existing network

☐ Use a new network

Network: com x com

Link Weight: 1.0

Create Link Close

NOTE : Changes done using Add Node(s) and Add Link(s) are transient. Be sure to use either the **File > Save Meta-Network As...** (to save the entire Meta-Network with additions) or **File > Add Meta-Network to ORA** (to create a new Meta-Network using only the currently visible nodes). Changes can not be saved back to the currently open Meta-Network.

1. **Start node :** The start of a directed edge.
2. **End node :** The end of a directed edge.
3. **Insert Nodes as they're clicked :** Fills in the textboxes for **Node**. The first click adds the node in the **Start node** section. The second click adds the node to the **End node** section. Any further clicks will make the previous End node the start node and the newly clicked node becomes the new End node.

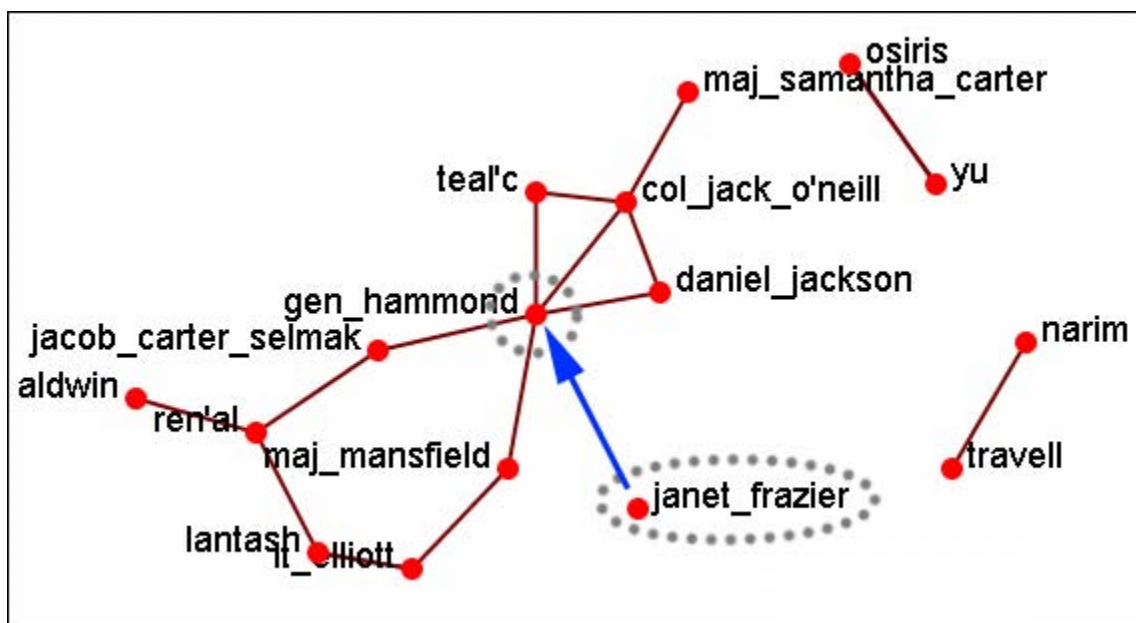
4. **Use an Existing network** : will place the links within the chosen network from the dropdown menu and **Use a new network** creates a new network from the name in option 5.
5. **New Network ID** : is the name for the new network from option 4.
6. **Network** : allows you to choice the Network to create the link in.
7. **Link Weight** : The weight to assign the edge between the nodes.

NOTE : Since this function creates **directed links** a second link would need created for reciprocal action.

Example : If a connection was made starting with A to B, a second connection would need to be made starting with B to A.

Adding a Missed Link

If after the Meta-Network was constructed and it's noticed an link is missing (e.g. janet_frazier should have been connected to gen_hammond), the missing link can be added immediately without returning to the editor.



From the Visualizer menu select **Actions > Add Edge(s)**.

Add a Link

This window will allow you to create new links in a meta-network via the visualizer.

Select the source and target nodes, then select the network (or create a new one)

Note: New networks must have unique IDs

Start node

Node class: Agent : size 16

Node: janet_frazier

End node

Node class: Agent : size 16

Node: gen_hammond

☒ Insert Nodes as they're clicked

☒ Use an existing network

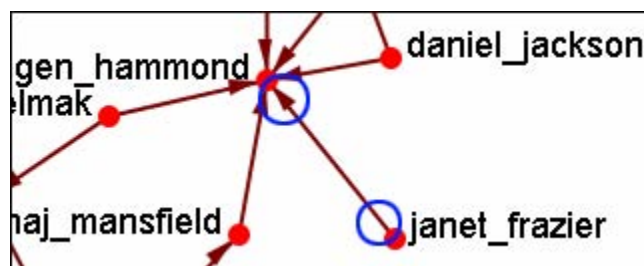
☐ Use a new network

Network: agent x agent

Link Weight: 1.0

Create Link Close

Be sure that the **Insert Nodes as they're clicked** has been check marked and that **Use an existing network** is selected with the correct network is visible in the dropdown. Then select the **[Create Edge]** button.



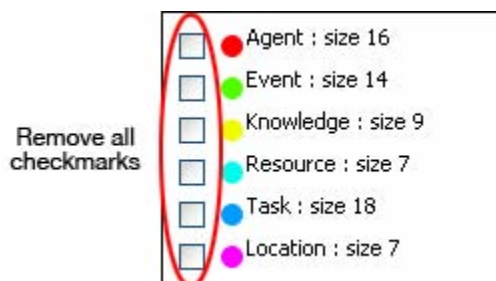
The two nodes are now connected with a **directed link**.

NOTE : this created a directional link from **janet_frazier** to **gen_hammond** but not the other way. To make it go both ways, a second link from **gen_hammond** to **janet_frazier** would need to be created.



Add Network From Scratch

This function also allows the *creation of Networks from Scratch*. First, remove the checkmarks from all the NodeSets in the Legend to remove them from the screen.



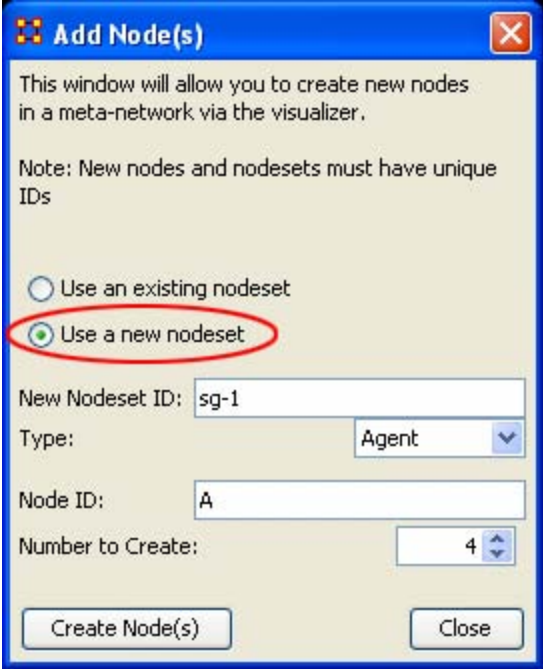
The DataSet

Next prepare your data for inclusion. Here is a small, five node, NodeSet.

A01	col_jack_o'neill
A02	maj-samantha_carter
A03	daniel_jackson
A04	teal'c
A05	gen_hammond

From the main menu select **Actions > Add Node(s)**.

In the dialog box activate the **Use a new nodeset** radio button. Underneath, in the **Type:** dropdown menu, select the type of NodeSet. Then in the **New NodeSet ID:** textbox give it a name. Then select the **[Create Node(s)]** button.



Add Node(s)

This window will allow you to create new nodes in a meta-network via the visualizer.

Note: New nodes and nodesets must have unique IDs

☐ Use an existing nodeset

☒ Use a new nodeset

New Nodeset ID: sg-1

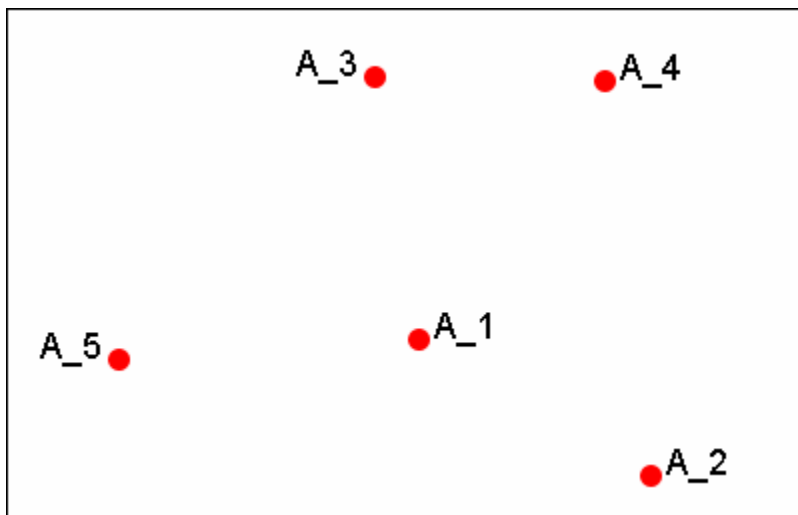
Type: Agent

Node ID: A

Number to Create: 4

Create Node(s) Close

The five nodes will appear in the Visualizer with the prefix and attached numbers. Now it's time to connect the nodes.



From the Visualizer menu select **Actions > Add Link(s)**.

Add an Edge

This window will allow you to create new edges in a meta-network via the visualizer.

Select the source and target nodes, then select the network (or create a new one)

Note: New networks must have unique IDs

Start node

Node class: sg-1 : size 4

Node: A_1

End node

Node class: sg-1 : size 4

Node: A_2

☒ Insert Nodes as they're clicked

☐ Use an existing network

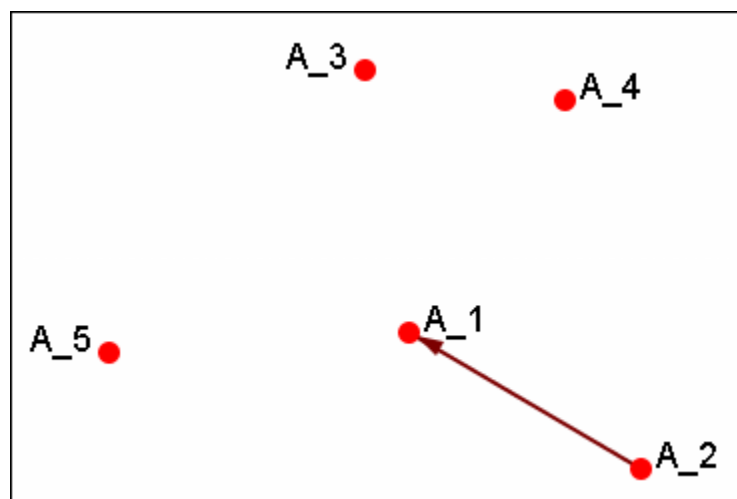
☒ Use a new network

New Network ID: sg1 x sg1

Edge Weight: 1.0

Create Edge Close

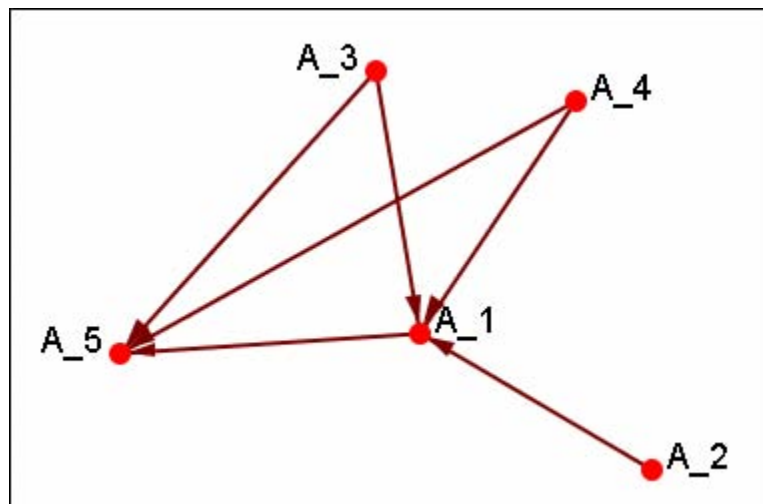
After selecting **[Create Link]** a new link will be drawn in the Visualizer.



Now switch the NodeSet to use to **Use an existing network**, select the newly created NodeSet in the dropdown, and create the rest of the links.

☒ Use an existing network
☐ Use a new network

All of the links are now complete.



Save the Meta-Network with either **Save Meta-Network As...** or **Add Meta-Network to ORA** and use the ORA editor to add in titles and attributes.



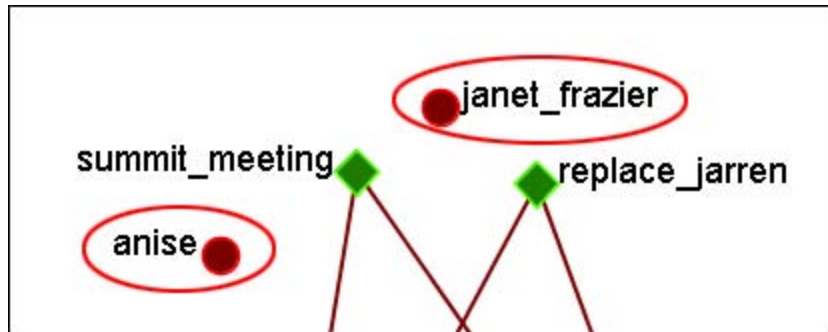
Periphery

Places isolates that were moved into column back to their original positions.

Hide Isolate Nodes

To further simplify a visualization, it may prove useful to remove isolated nodes from the visualization.

Isolated nodes are not directly linked or connected to other nodes, which share direct links with each other. In the screen shot below, the red ellipses highlights an isolated nodes which need removed.



Select from the Main Menu: **Actions** ⇒ **Hide Isolated Nodes**.

In the screen shot below, after removing isolated nodes, the visualization is further simplified.



Combine into MetaNode

This option will combine all the Isolates into one MetaNode. This can be expanded right-clicking to bring up the contextual menu.

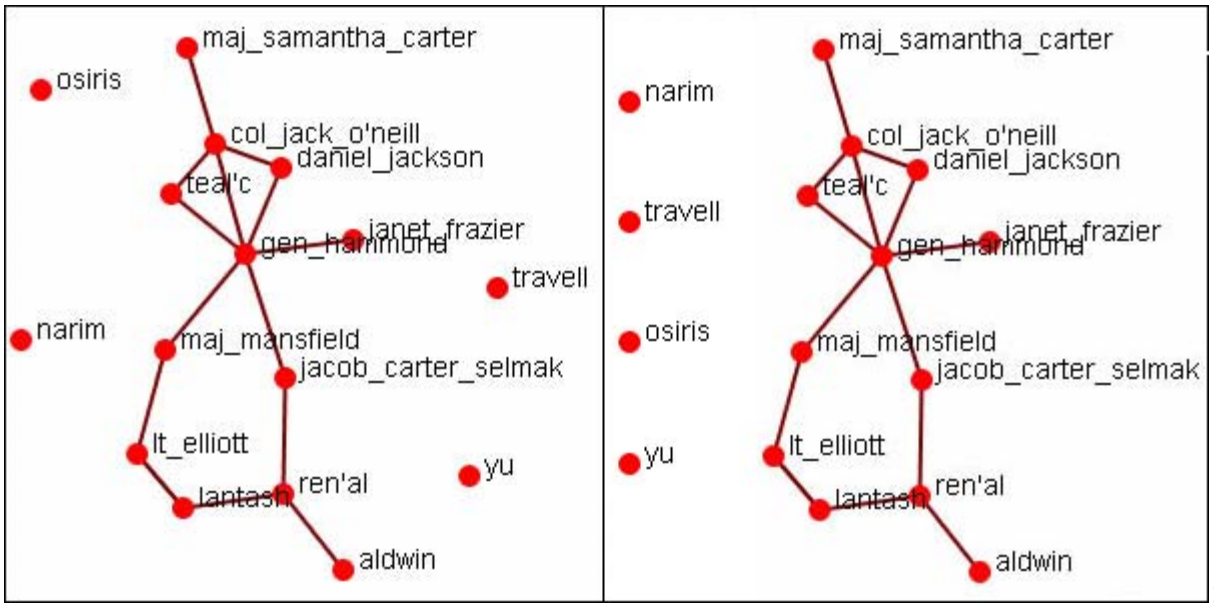
Move into Column

This function is used to move isolate nodes from the main viewing area to move easily view the connected nodes. These will be lined up on the left side of the screen.

NOTE : *The original dataset was changed in order to create the isolates.*

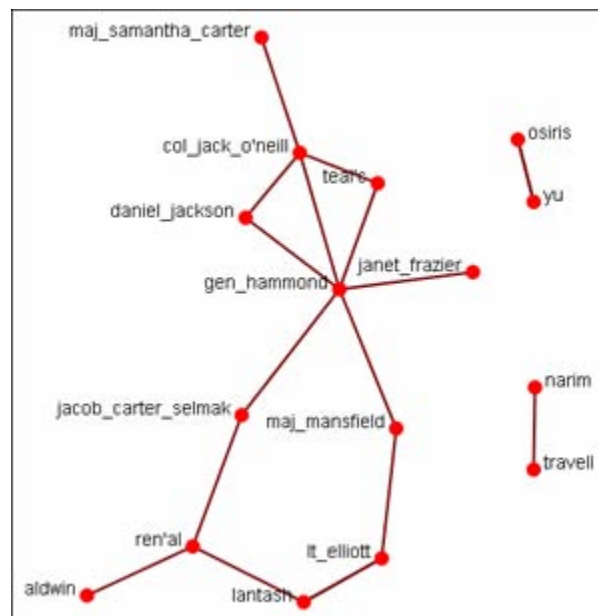
NOTE : *If the names are unviewable and off the screen, change the position of the labels*

The isolates can be returned to the original position using the Periphery options.

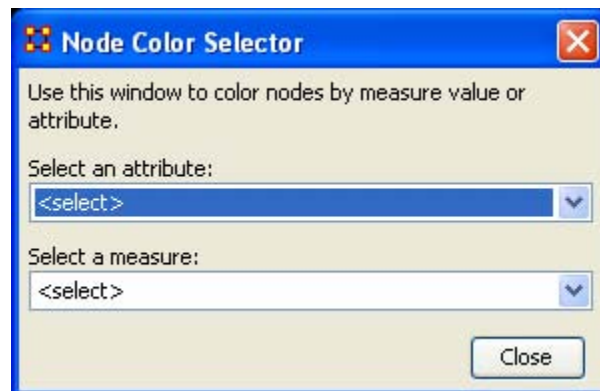


Color Nodes By Attribute

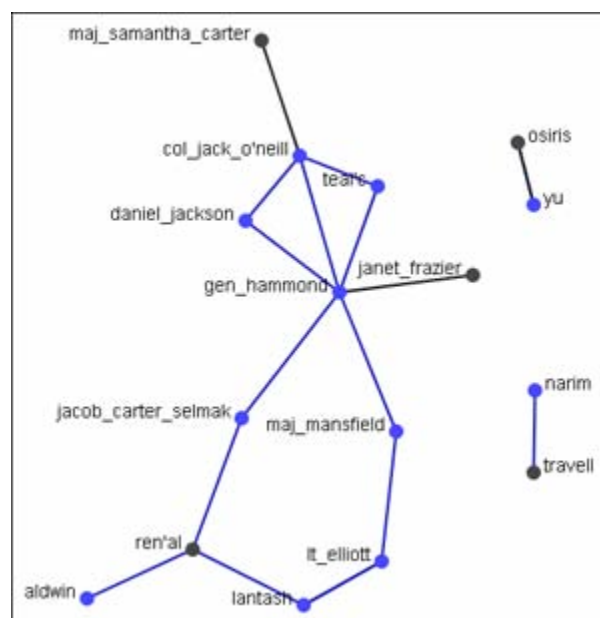
When the **agent-by-agent** network is opened all the nodes default to the color **red**. ORA has default colors for all the various NodeSets. But ORA can also color the nodes based on their individual attributes. Here's the default **agent-by-agent** NodeSet in red.



From the Visualizer main menu select **Actions ... Color Nodes by Attribute or Measure**. This brings up the **Node Color Selector** dialog box.

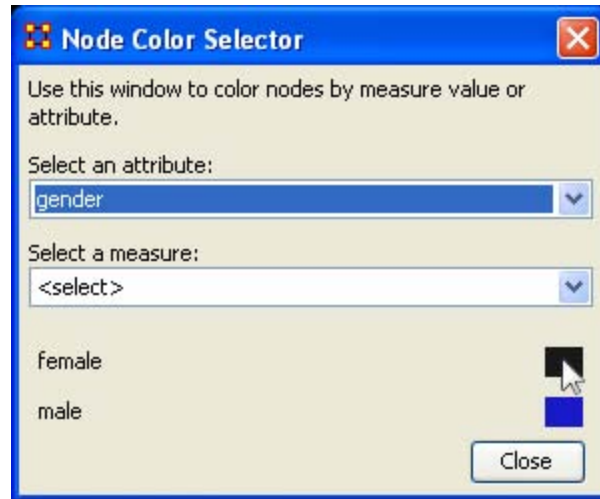


Selecting the **down arrow** for **Select an Attribute:**. Highlight an attribute from the list. ORA gives **default colors** to the nodes.



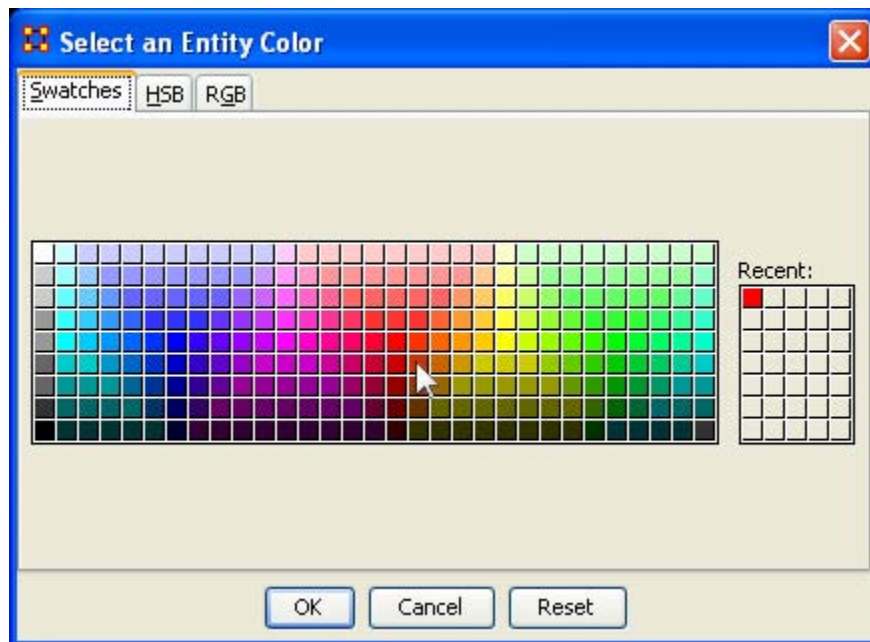
In some instances the color distinction isn't highly visible. And for presentation purposes a good contrast is necessary.

To bring up the **Color Selector** click on the color you want to change.



Note: By [hovering](#) over the measure or attribute, you can bring up detailed tool tips.

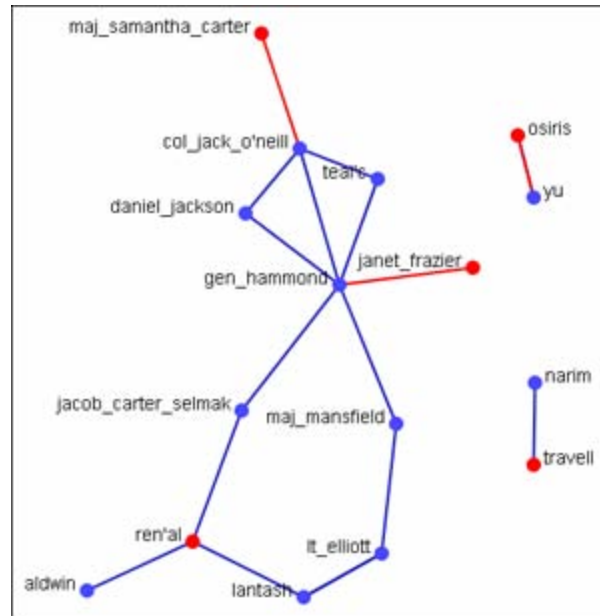
Select a new color from the swatches. Then select **[OK]**



Your new color choice is now reflected in the dialog box.



And the nodes with the attribute you selected are now a new, and brighter, color.



Resize Nodes By Attribute

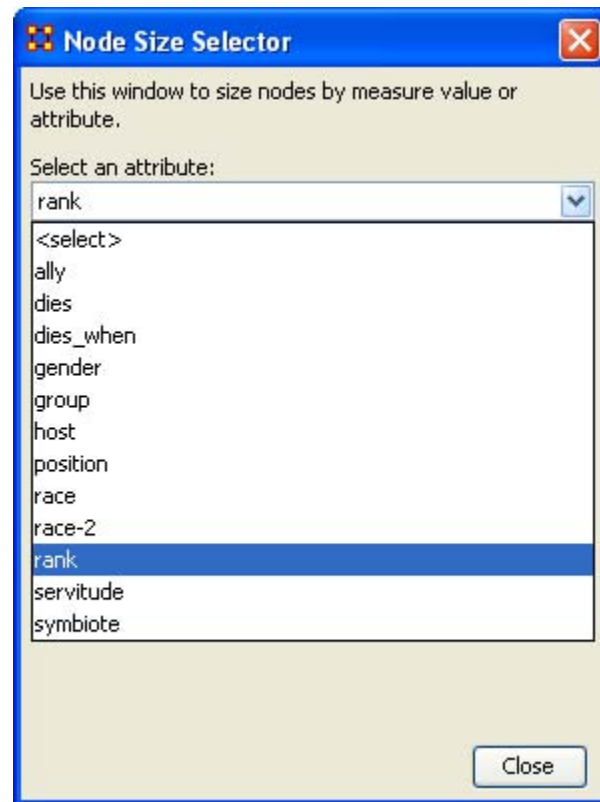
Resize by Attribute uses the numerical value of an attribute to size the nodes. Sizes will be scaled accordingly. Below is an attribute created for this example.

The numbers range from 0 to 10 and denote approximate rank. **10** denoting general/leader down through the ranks to **5** for civilians and finally **0** for persons not involved.

	Node ID	Node Title	rank
	<set filt... ▾	<set filt... ▾	<set filt... ▾
☐	A01	col_jack_...	9
☐	A02	maj_sam...	7
☐	A03	daniel_jac...	5
☐	A04	teal'c	5
☐	A05	jacob_cart...	5
☐	A06	lt_elliott	6
☐	A07	ren'al	10
☐	A08	aldwin	5
☐	A09	janet_frazier	5
☐	A10	maj_man...	8
☐	A11	gen_ham...	10
☐	A12	lantash	7
☐	A13	narim	2
☐	A14	travell	10
☐	A15	osiris	0
☐	A16	yu	0

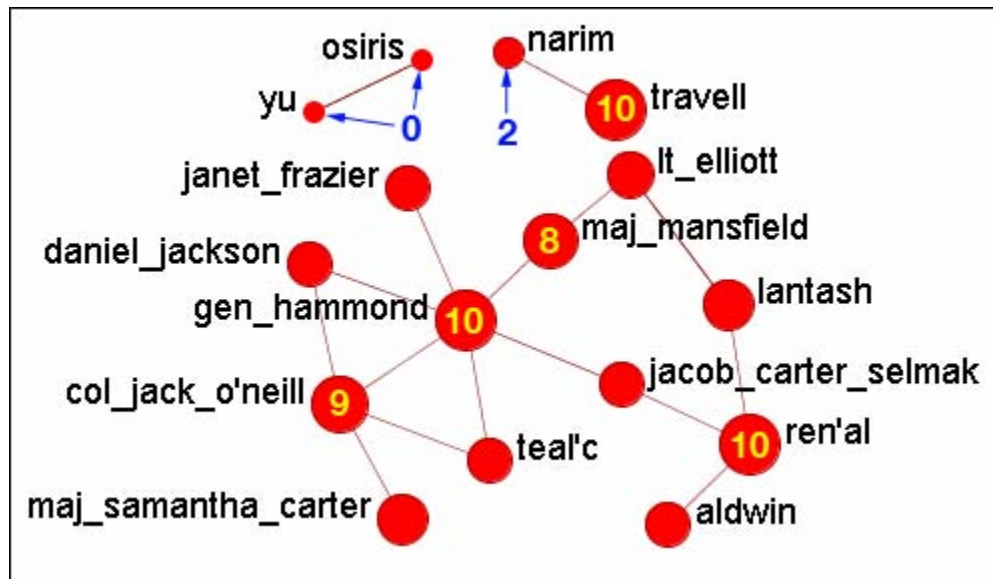
From the main menu select **Actions ⇒ Size Nodes by Attribute or Measure**. Then select the attribute to use for the sizing. When finished, select **[Close]**.

NOTE : Sizing nodes by attributes only works with attributes of **numerical content**. Alpha content will have no affect on the size of the nodes.



Each node will now be displayed according to the value in the chosen attribute.

NOTE : The numerals are **not** displayed in ORA and are shown only for display purposes.

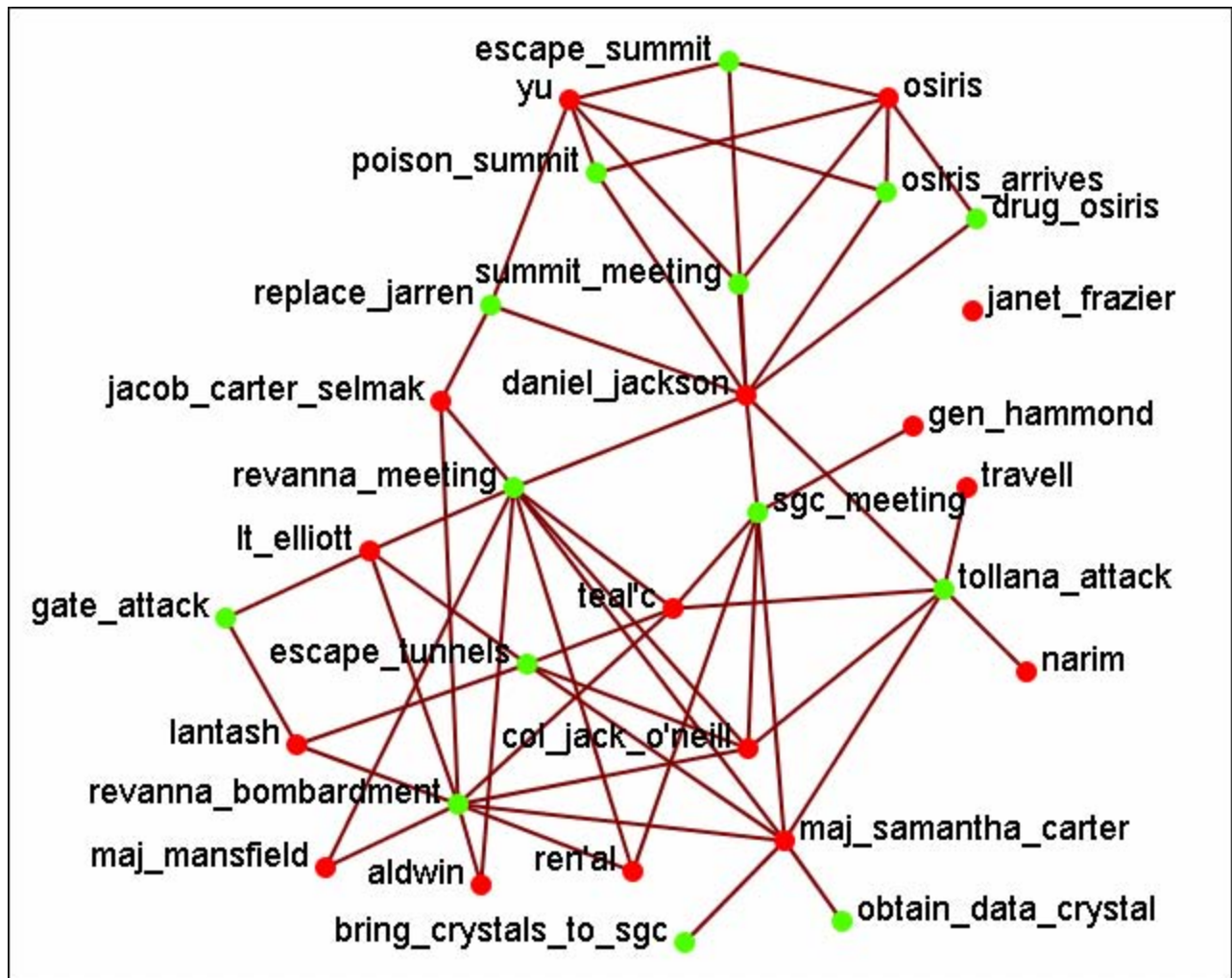


Resize Nodes By Measure

ORA has the capability to visualize nodes by scaling them relative to each other in relation to common SNA Measures or Attributes as selected within the ORA Visualizer.

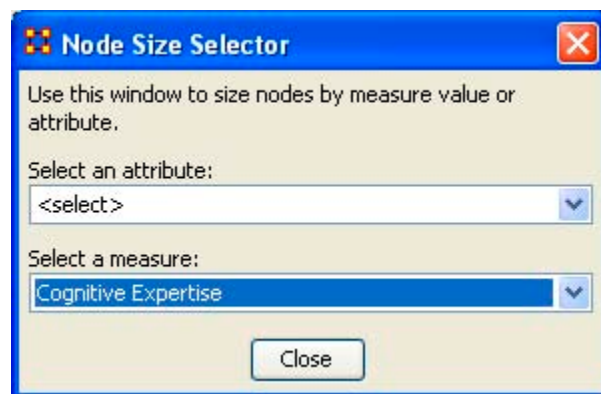
The key benefit to sizing nodes by Measure or Attribute is the ability to conceptually capture which nodes in your network figure more prominently in terms of measures by simply gauging their size visually and intuitively.

First, visualize one of your networks. Below is the Stargate **agent x event network** to find the agent with expertise regarding events in the scenario.

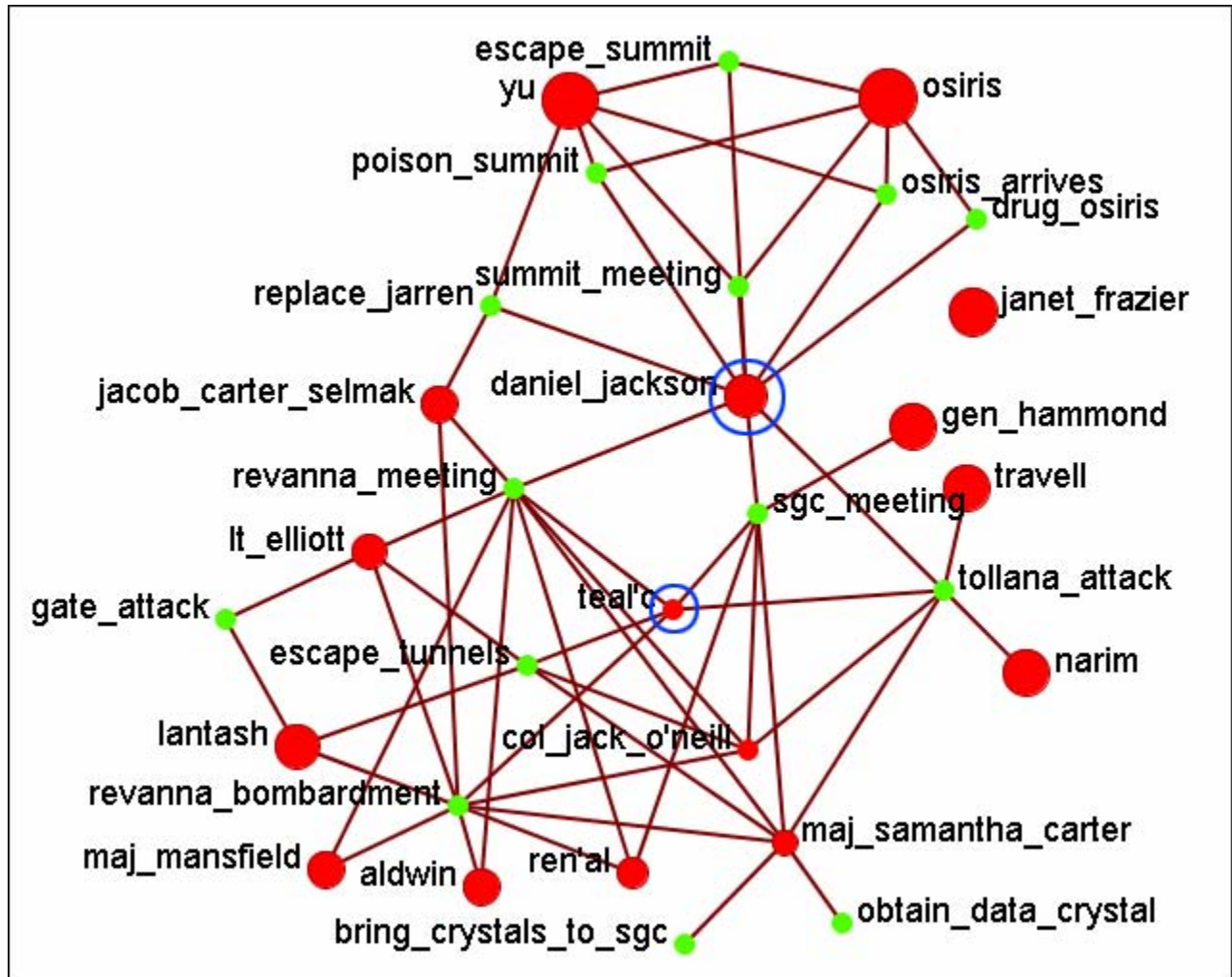


From the main menu select **Actions ⇒ Size Nodes by Attribute or Measure**.

From the bottom textbox I selected **Cognitive Expertise**. Each of the nodes in turn grows to reflect it's value from that measure.



The display now changes to reflect each node's value by size.



We'll compare two nodes: **daniel_jackson** and **teal'c**.

daniel_jackson's cognitive expertise value is 0.2400 and is displayed with a large red circle while the value of teal'c is 0.1556 is displayed by a much smaller red circle. The values can be read in the **Node Status** dialog box.

Cognitive Measure for daniel_jackson

General Info	Attributes	Measures	Neighbors
Measure		Value	
Cognitive Expertise		.2400	

Cognitive Measure for teal'c

General Info Attributes Measures Neighbors	
Measure	Value
Cognitive Expertise	.1556



Compute Standard Measures

This functions runs four standard measures:

Cognitive Demand: Cognitive Demand measures the total amount of effort expended by each agent to do its tasks. Individuals who are high in cognitive demand value are emergent leaders. Removal of these individuals tends to be quite disruptive to networks.

Centrality, Betweenness: Betweenness tells us which node is the most connected to other parts of a network. For example, Betweenness can tell us which person in a network is the most central to the network as a whole. Betweenness measures the number of times that connections must pass through a single individual to be connected.

Centrality, Eigenvector : Eigenvector Centrality reflects one's connections to other well-connected people. A person connected to many isolated people in an organization will have a much lower score in this measure then those that are connected to people that have many connections themselves. This would be true even if such a WHO might have a high amount of actual connections (i.e. high degree centrality).

Centrality, Total Degree: Degree Centrality tells us the relative number of direct connections a WHO might have in a network; the higher the score the more likely a WHO might be likely to receive and potentially pass on critical information that flows through the organization.

These values can be viewed either by hovering over a node and revealing the tooltip or double clicking a node and bringing up the Node status dialog and selecting the Measures tab.



Visualizer Tools

The **ORA Visualizer** provides a suite of tools to visually analyze your Meta-Network. The Visualizer Tools can be located accessed from within Visualization mode on the main menu bar (image below):



Drill Down : With the ORA Drill-Down Wizard you can quickly visualize ego networks by overall node class **knowledge, tasks, resources, agents**) or by choosing individual nodes from a checklist. The ORA Drill-Down Wizard is only accessible through the Visualizer:



Node Status: The Node Status Window is selected by default. It first pops-up when you select any node in the Visualizer. This window provides you with a snapshot of the currently selected node by displaying that nodes unique Attributes, Measures, and Neighbors.



Group Viewer : Allows viewing of current display to be viewed in various grouping: **CONCOR, Newman, Johnson, FOG, and K-FOG**

Propagation Dialog :



Key Set Selector : Helps put a set of arbitrary items on the screen.



Legend : Allows for toggling visibility of nodes and links on the fly.



MetaNodes : A Meta-Node contains multiple nodes collapsed into one. You can create Meta-Nodes based on the NodeClasses in your organization, or you can create Meta-Nodes based on the attributes of the nodes. To create Meta-Nodes, you must access the Meta-Node Manager.



Path Finder : The Path Finder allows you to focus or **drill down** on a particular node, or multiple nodes, that you may be interested in analyzing in greater detail.



Sphere of Influence : Each node within a network has a unique **Sphere of Influence** or **Ego Network**, essentially it's direct relationship with it's neighbors as a function of specified path length.



Block Maps : Block Maps display varying intensities of data by displaying "blocks" correlating to the value of data. For instance, a block map displaying node centrality values would reserve the largest block for the node highest in that value. Color is used to as well to visualize different values with the darkest color reserved for the highest value. Block Maps can also be referred to as heat maps.



Node Locator : Brings up a window with the Meta-Network in a collapsible tree structure. Selecting any node within this tree will highlight the node, enlarge it, and bring it to the center of the display.

Micro Simulation :



Networks Over Time : Allows you to view a version of your network across multiple time periods.



Vector Maps :

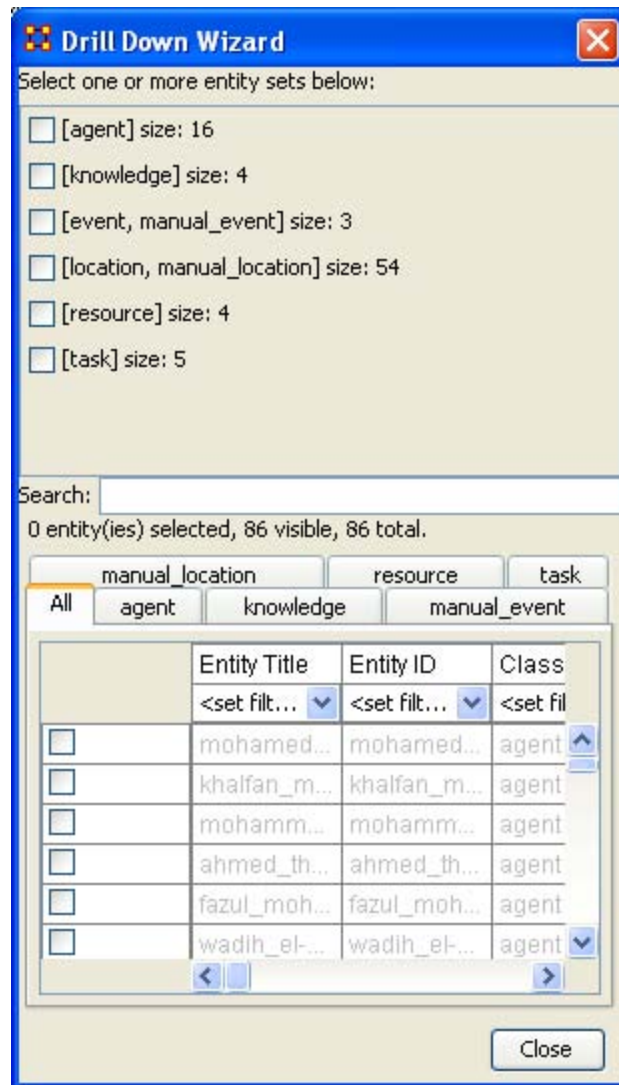


Drill Down Wizard

With the ORA Drill-Down Wizard you can quickly visualize **ego networks** by overall node class (**knowledge, tasks, resources, agents**) or by choosing individual nodes from a checklist. The ORA Drill-Down Wizard is only accessible through the Visualizer:

From the ORA Visualizer Main Menu select **Tools ⇒ Drill Down**.

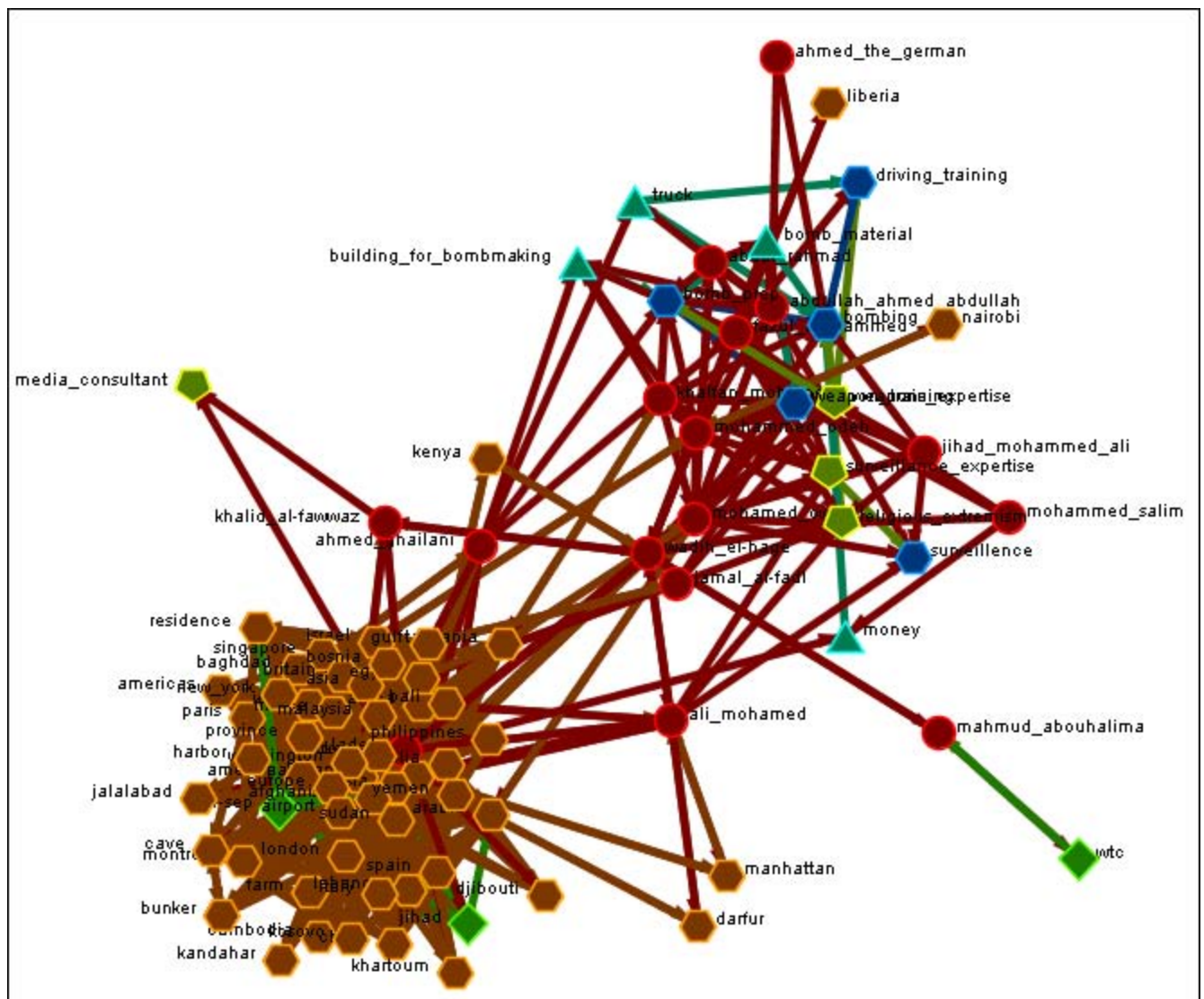
The following window box will appear.



The top sections allows you to chose the nodes for use. The bottom tabs allow for choosing specific nodes within a set.

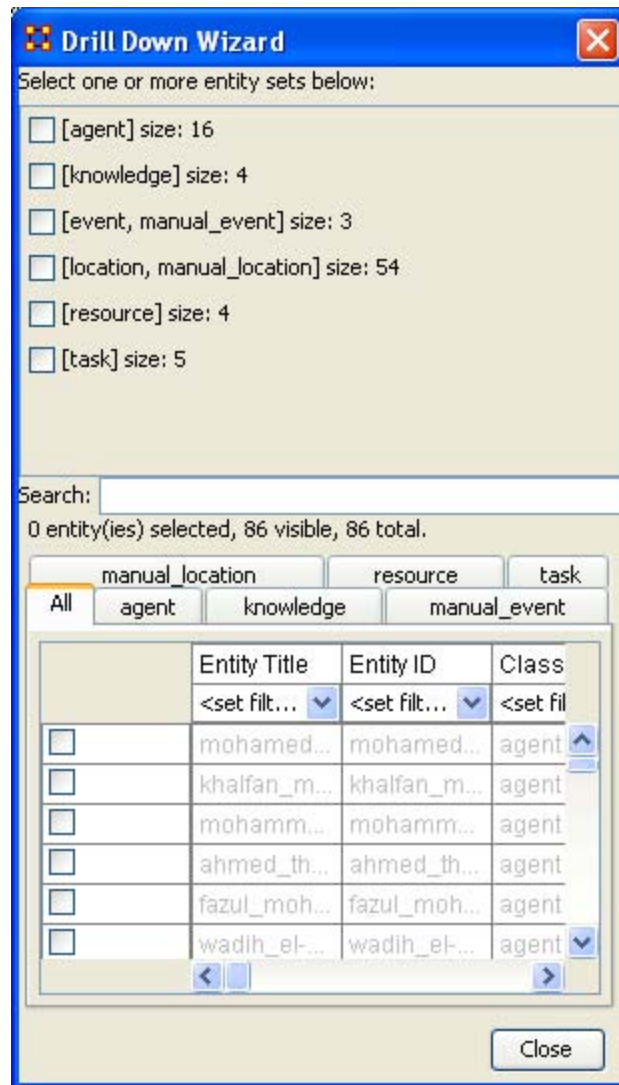
Drill Down Wizard Example

Using the Embassy Meta-Network, we will render the various node classes using the Drill-Down Wizard Tool. The screen shot below displays the Embassy Meta-Network as it should first appear in the Visualizer.

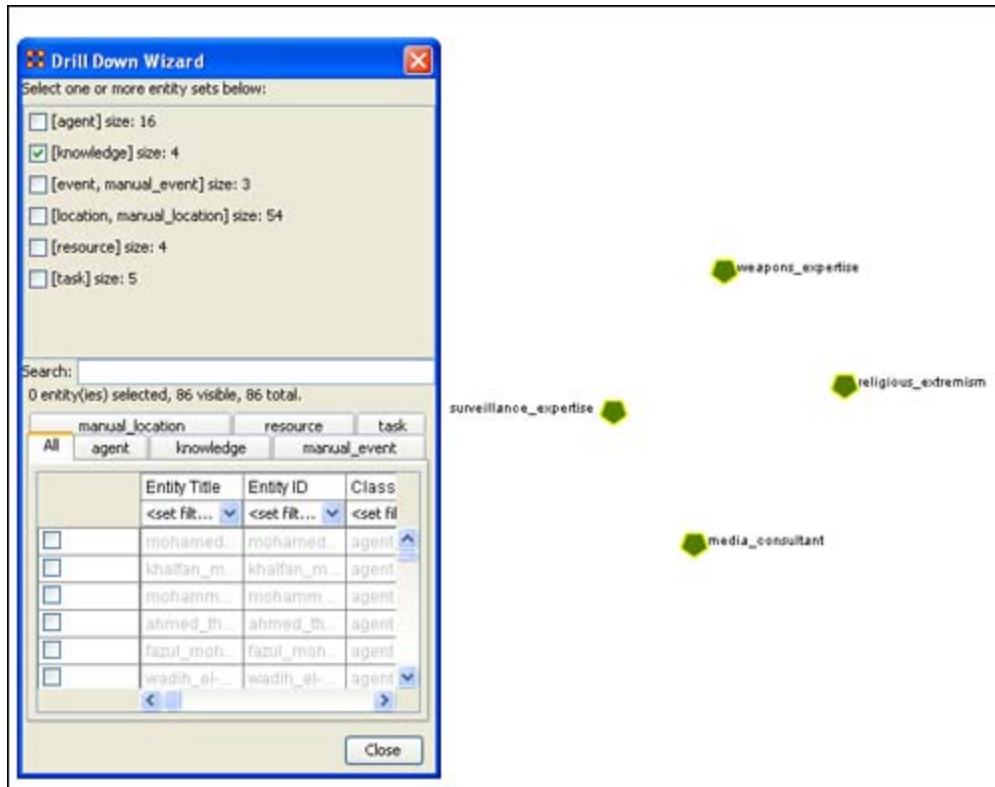


From the Main Menu select **Tools ⇒ Drill Down**.

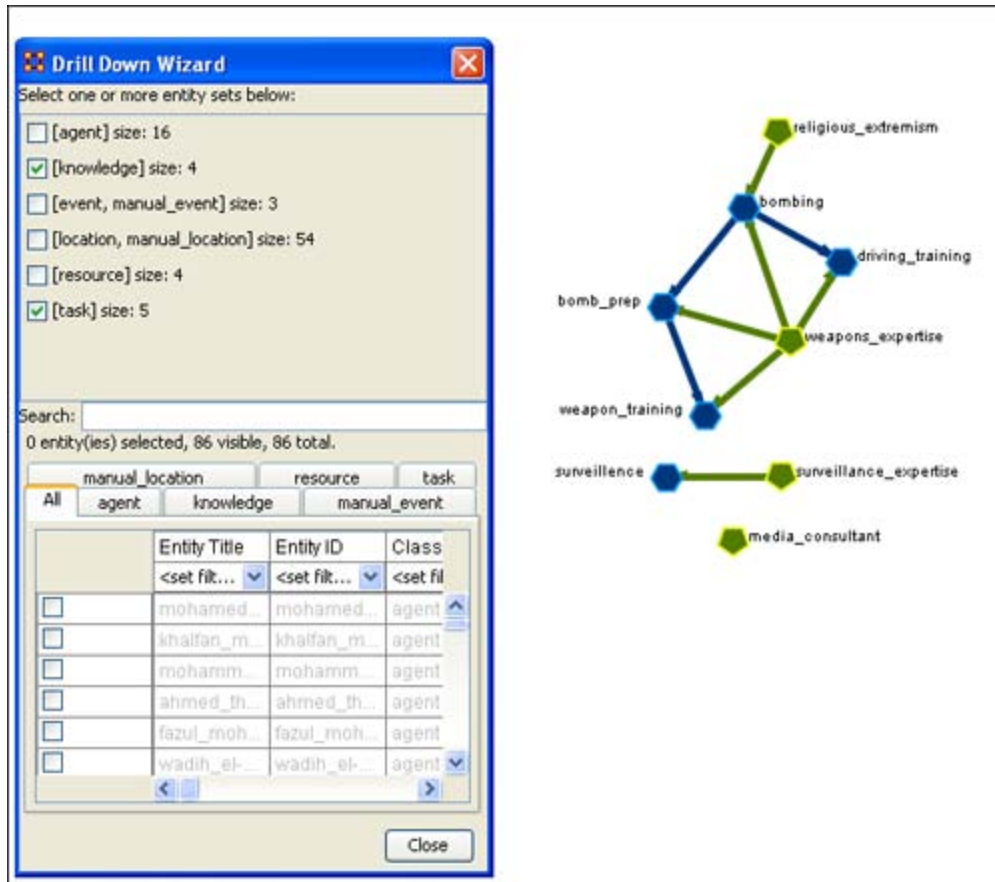
This will bring up the **Drill Down** dialog box as shown below).



Here, select the **node class Knowledge** by selecting the Knowledge check mark box. The screen shot below, displays the end result that you should now see in the Visualizer.

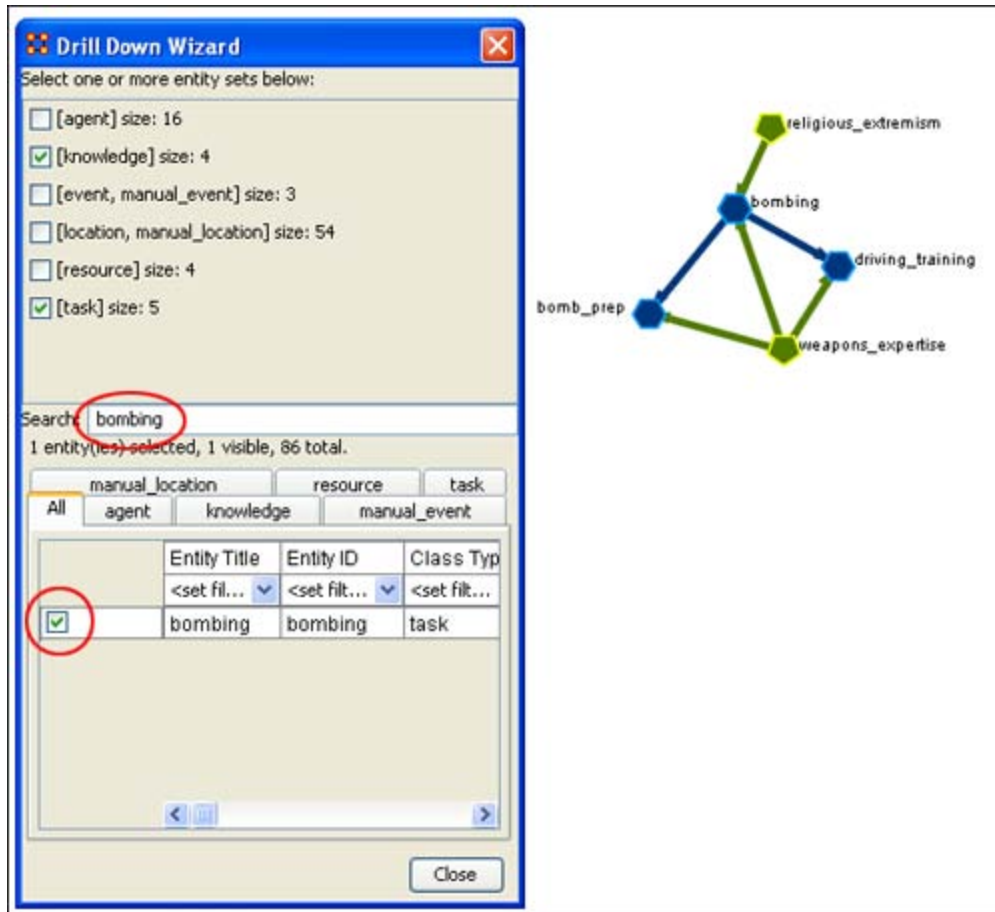


Next, with the Knowledge node box checked, add the **node class Task**. The screen shot below displays the end result.



Next use the search bar feature of the Drill-Down Wizard to narrow the search.

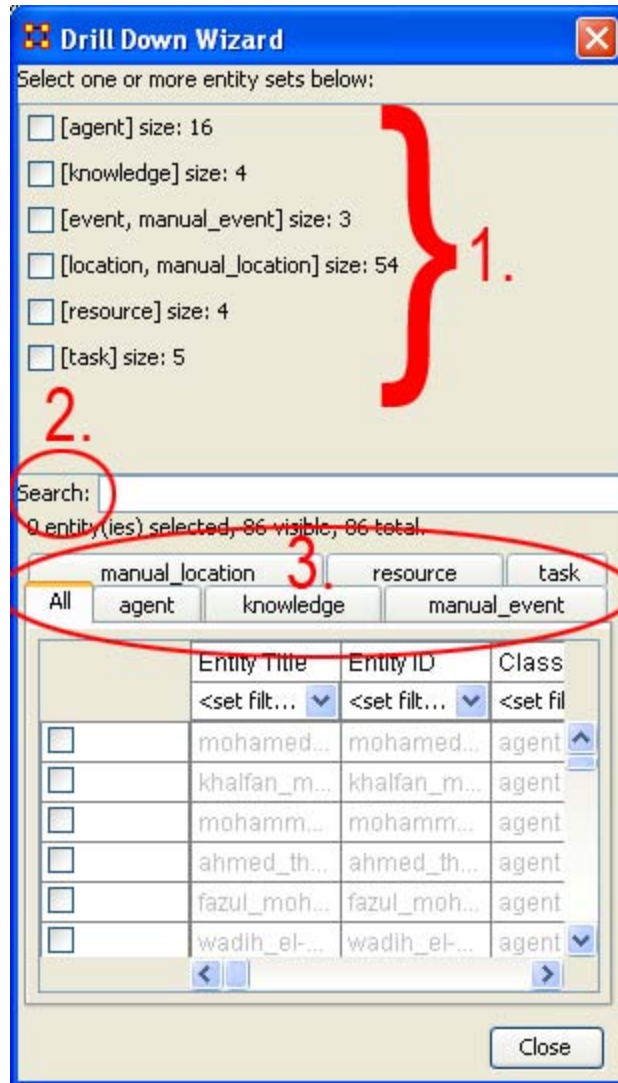
Enter the word **Bombing** in the Visualizer search field below. Then select the check box on the bombing row. The screen should now reflect your new search parameters. Everything not associated with **bombing** has been turned off.



Drill Down Wizard Explained

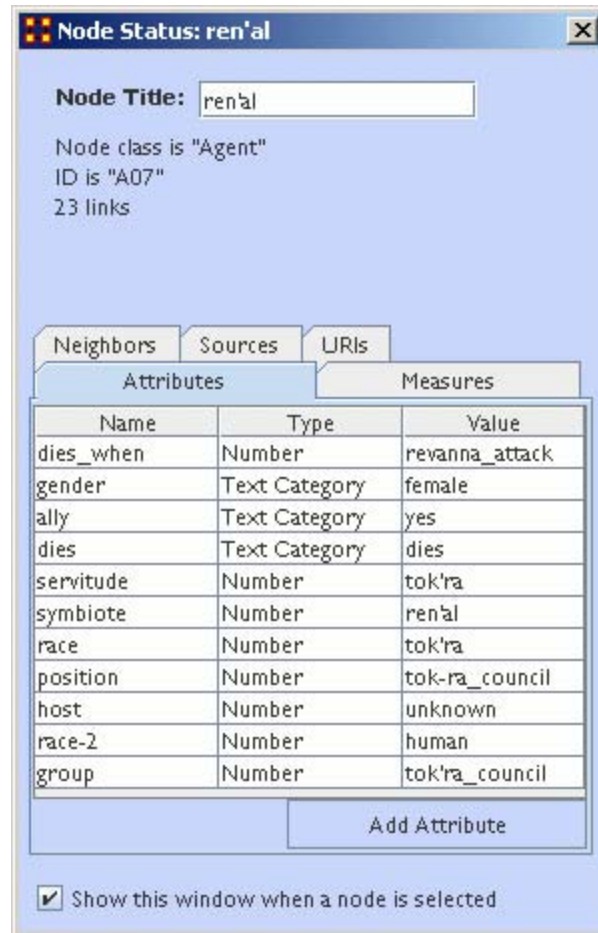
The ORA Drill Down Wizard can be broken down into three primary sections of input:

1. **Section 1:** enables you choose individual node sets or combination of node sets to display in the Visualizer.
2. **Section 2:** of the Drill Down Wizard enables you to search for a particular node within your Meta-Network. This can be handy when you dealing with large nodesets and the one you are interested in finding is not easily located.
3. **Section 3:** enables you **check mark** an individual node within your Meta-Network by node class if so desired.



Node Status

The **Node Status Window** is used to reveal pertinent information about one selected node. The window can be brought up by either selecting it from the main menu, **Tools > Node status** or by double-clicking the node in the Visualizer. The dialog box below will appear.



The top of the box will contain general information about the selected node. Underneath there are five tabs available which will display the node's information. You can switch nodes by selecting any other node in the Visualizer. ORA will automatically change the display.

Neighbors : displays the nodes which are linked to the selected node. It also displays the weight of each link.

Sources :

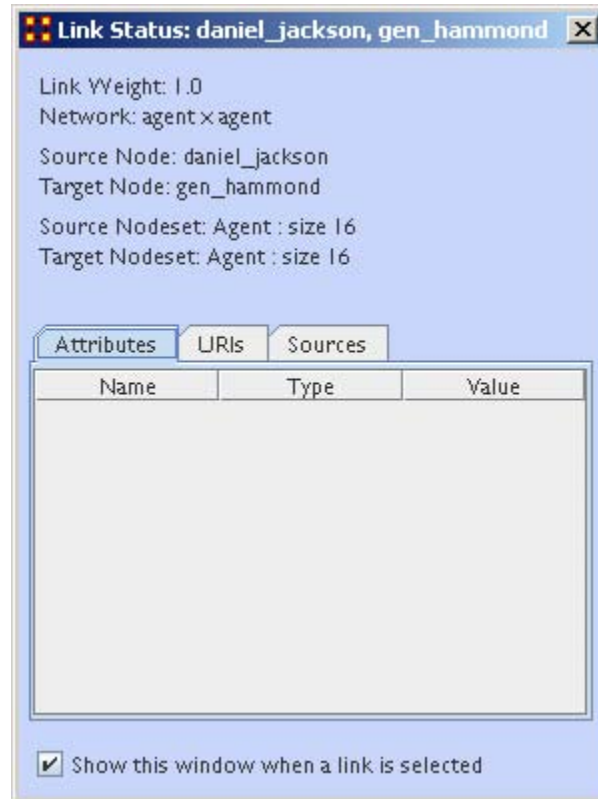
URIs : If there are any URIs attached to the node they are display under this tab.

Attributes : Types and Values of all attributes are displayed under this tab.

Measures : If Measures were run on the Meta-Network their values are displayed under this tab.

Link Status

The **Link Status Window** is used to reveal pertinent information about one selected link. Active the window by right-clicking the link and selecting **Link Status** or by double-clicking the link in the Visualizer. There are several tabs available which will display the node's information.

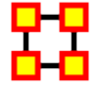


The top section displays information about the link. The weight and to which Network it belongs. It also shows the Source and Target Node and Nodeset.

Attributes : The Link contains any attributes they will be listed under this tab.

URIs : Any URIs this link refers to will be listed under this tab.

Sources :



Group Viewer

The Group Viewer helps separate nodes into distinct groups.

We'll use one of the networks for each of the groups to further examine the breakdown.

There are six groupings which can be called up:

Clique :

CONCOR :

Johnson :

Newman : Used to find clusters in a network.

FOG :

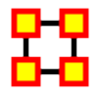
Alpha-FOG :

ORA implements the Newman algorithm presented in the following paper:

Finding community structure in very large networks, Aaron Clauset, M. E. J.

Newman, and Cristopher Moore, Phys. Rev. E 70, 066111 (2004). The algorithm uses link weights. It is not the Newman-Girvan algorithm based on betweenness centrality.

Please note, Newman developed this algorithm as it scales better than the Newman-Girvan for large networks.



Group Viewer-Cliques

Below is an image of the Group Viewer box and procedures for using this tool.

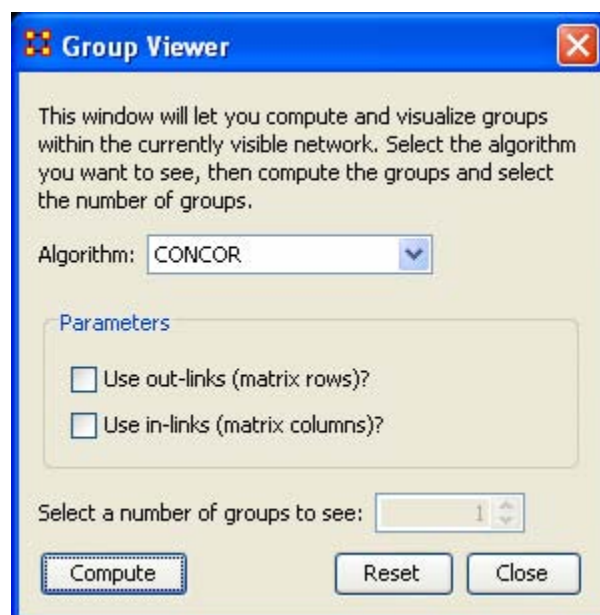


Parameters

Minimum clique size :



Below is an image of the Group Viewer window and procedures for using this tool.



Parameters

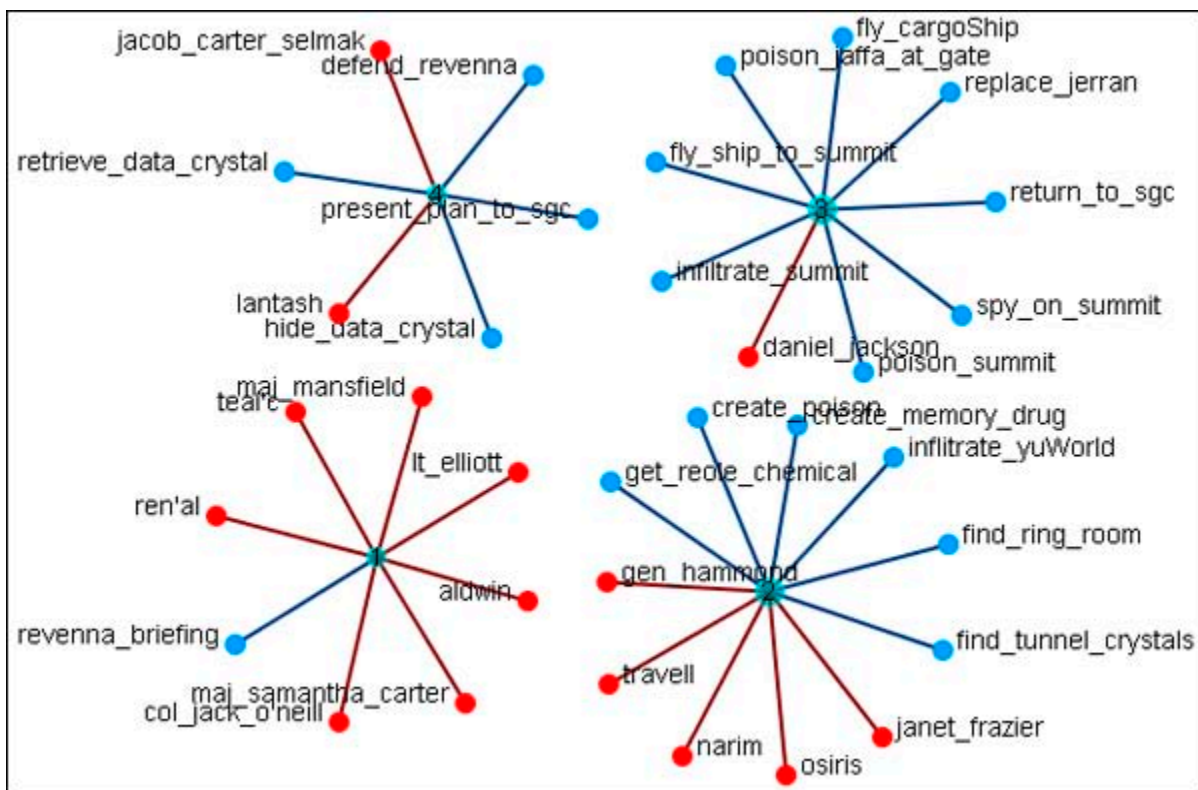
Use out-links (matrix rows)? The links leading **out of** the chosen node into another node.

Use in-links (matrix columns)? The links leading **into** the chosen node from another node.

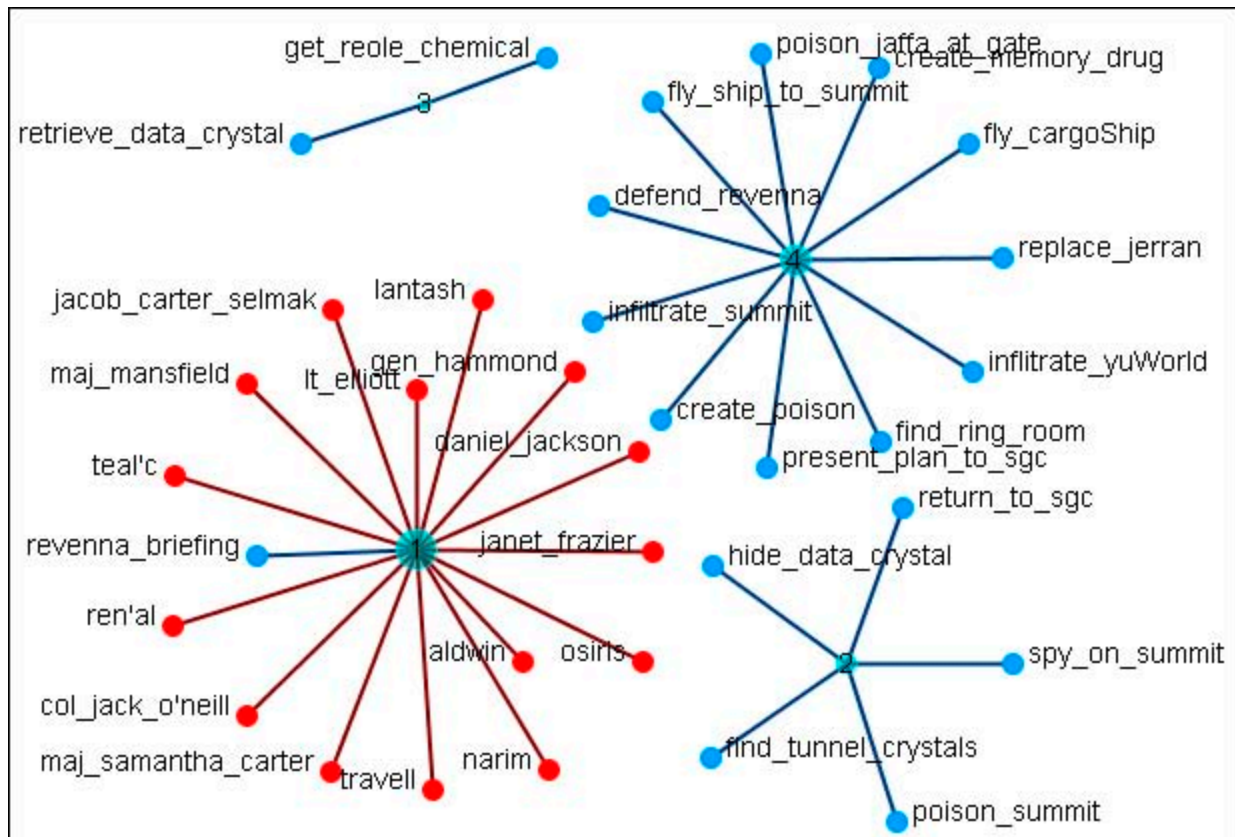
Example

The example uses the network **agent x task**. For each of the three possibilities **in**, **out**, **both** the display is shown with the number of groups set to **4**. The resulting displays show how the in and out links affect the groupings.

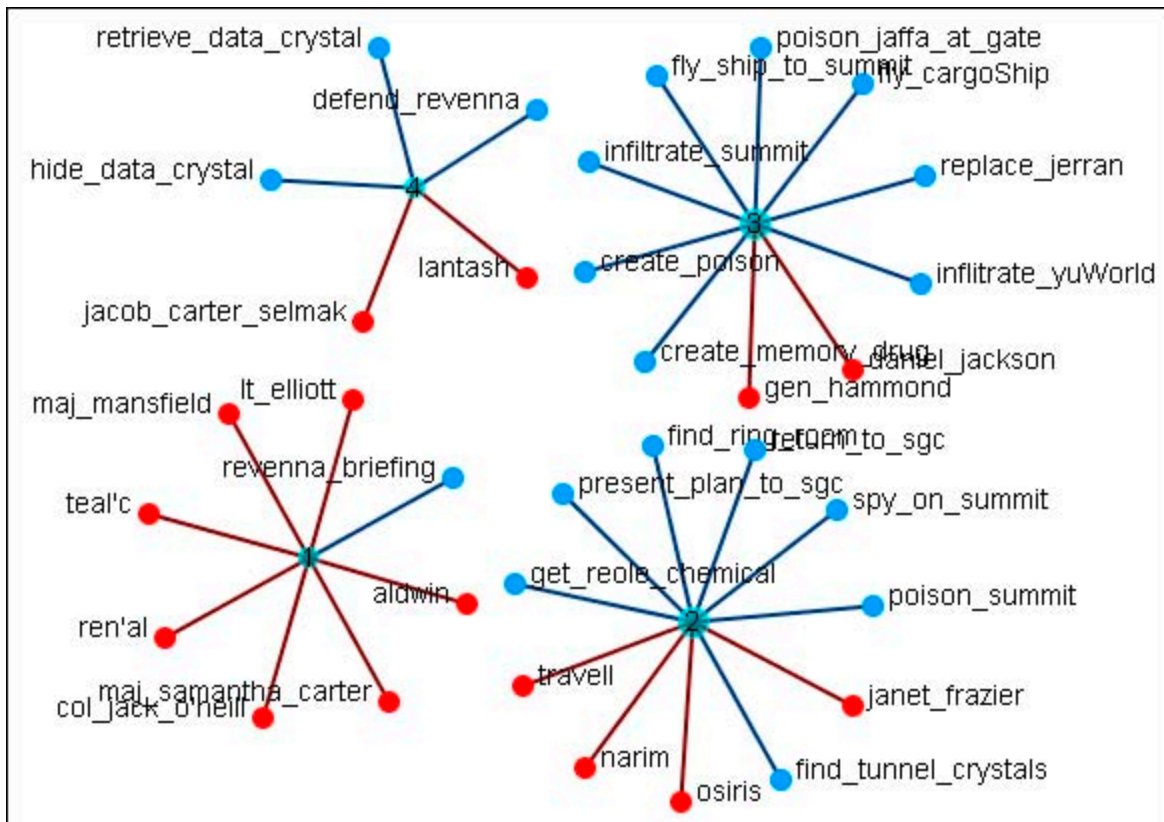
Use both in-links and out-links



Use in-links

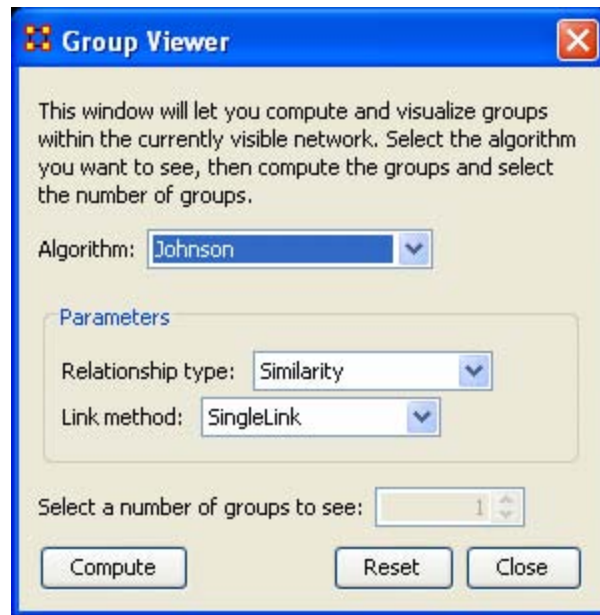


Use out-links



Group Viewer-Johnson

Below is an image of the Group Viewer Johnson window and procedures for applying the Johnson algorithm.



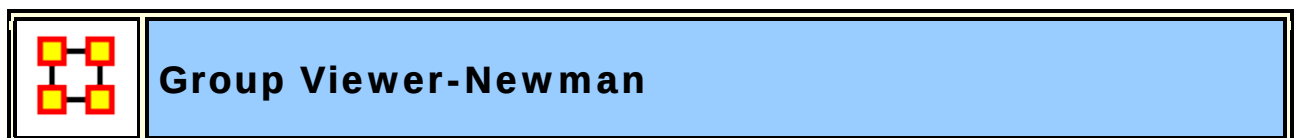
Parameters

Relationship type:

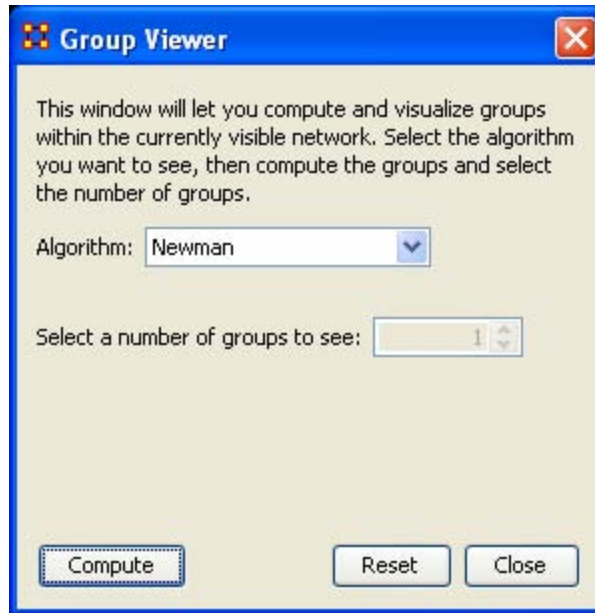
- Similarity
- Dissimilarity

Link method:

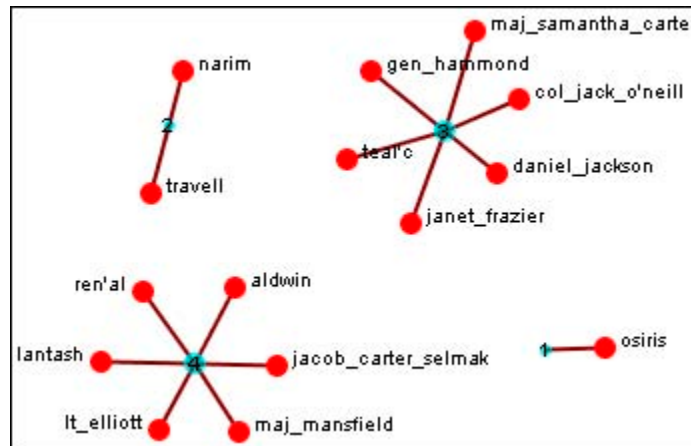
- SingleLink
- CompleteLink
- AverageLink



- Below is an image of the Group Viewer window and procedures for applying the Newman grouping algorithm:



- The Newman grouping is used to find clusters in a network. I began increasing the number of groups to view until the larger cluster began to break up.



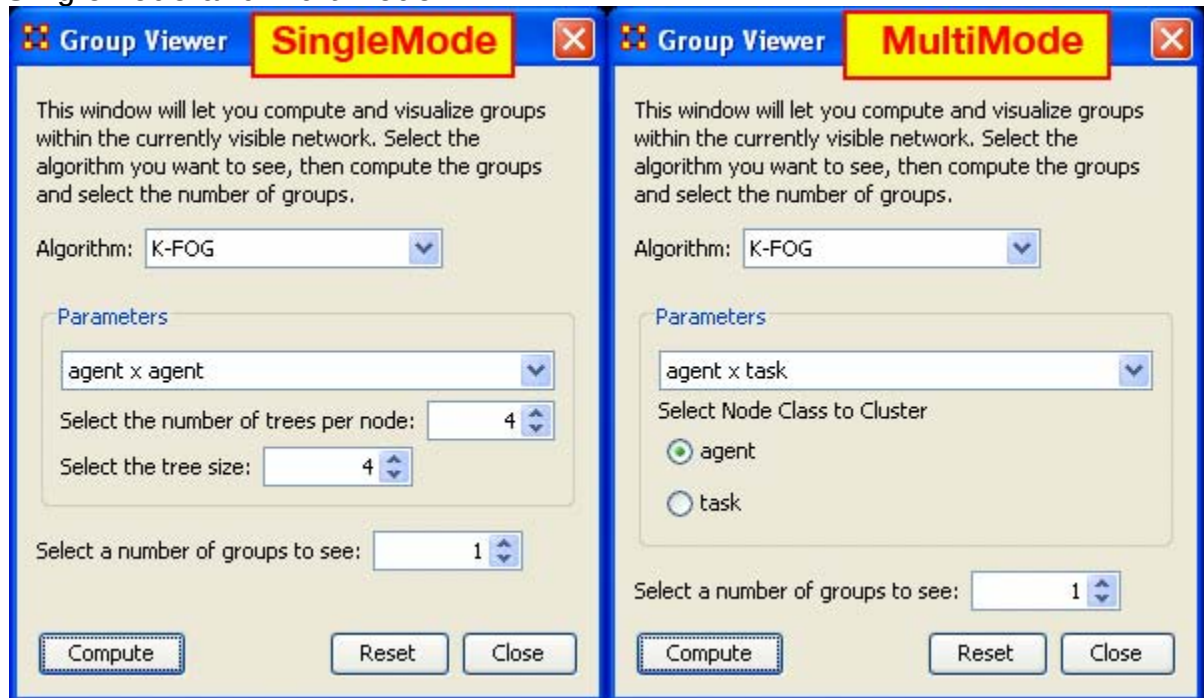
- In this case the nodes remained clustered (with only one or two nodes breaking off) until I reached **4 as the number of groups**. Then the network broke up into two large and two small clusters. The nodes in each of the two large clusters have a commonality as to the organizations they belong to and the tasks they were assigned.

	Group Viewer - K-FOG

- **FOG (or Fuzzy Overlapping Groups)** works in either square-mode (NodeSet-1 x NodeSet-1) or multi-mode (NodeSet-1 x NodeSet-2). The multi-mode is the more natural procedure. it's prime function is to

form nodes into groups (clusters or communities) and show which nodes share the secondary functions.

- **REMEMBER : Groups produce tasks - people participate in tasks.**
- Below are images of the Group Viewer K-Fog window for both SingleMode and MultiMode.



- **Parameters**
- SingleMode and MultiMode
- **Select a Network:** The same in both. The dropdown menu lists all the available networks in the selected Meta-Network.
- **Select a number of groups to see :** Number of groups to divide the nodes into. Generally the analyst would have an idea of the number of groups that are necessary.
- SingleMode
- **Select the number of trees per node :** The number of sample events to generate.
- **Select the tree size :** The number of people involved in each group
- MultiMode
- **Select Node Class to Cluster :** Selects, via the radio buttons, the node class to display using the other node class as it's base.
- **Links**
- The thickest link is usually the leader of the group. The question to ask is **WHY** is that particular person the strongest link. It is important to look at the composition of the group(s) involved.

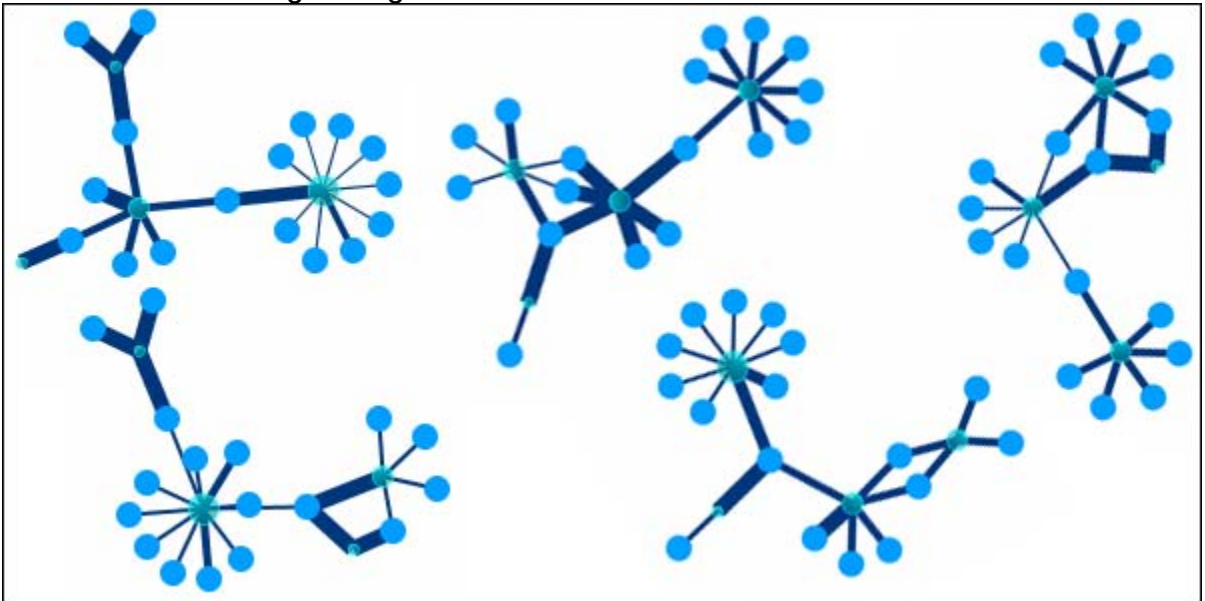
- If the weights are Lopsided (many strong and/or weak links) the analyst needs to look at the association of the [interstitial*](#) actors whose information will assist in analyzing the groups.
- If a node is connected to only one group and that group has few actors then it is considered somewhat **insular**.
- **SingleMode Example**
 - Run on the **agent x agent** network with a number of threes per node set to "2", the tree size set to "2", and the number of groups to see set to "2". The header designation is "S=the set (1-5)" and "G=first or second group".

	S1-G1	S1-G2	S2-G1	S2-G2	S3-G1	S3-G2	S4-G1	S4-G2	S5-G1	S5-G2
col_jack_o'neill	0.2	0.125			0.1667	0.1667	0.2381	0.2		
gen_hammond	0.4375	0.5	0.375	0.5	0.1667	0.5	0.2857	0.6	0.5789	0.1176
osiris			0.125	0.1	0.25	0.0416	0.0952	0.1334		
yu					0.3334	0.0416				
lantash					0.25	0.0416			0.0588	0.1052
daniel_jackson					0.0833	0.0416				
travel							0.0476	0.1334		
anubis							0.0476	0.2667	0.1579	0.1176
ren'al							0.0476	0.2667		
maj_samantha_carter									0.1579	0.0588

maj_mansfield									0.05	0.05
d									26	88

• MultiMode Example

- The **agent x task** network is used and the **Task Node Class** is selected to Cluster. The number of groups to see was set to "4". The results of hitting **[Compute]** five times are shown below. Each of the results is different but there is an overall pattern. In four of them there is a distinctive single large cluster of nodes.



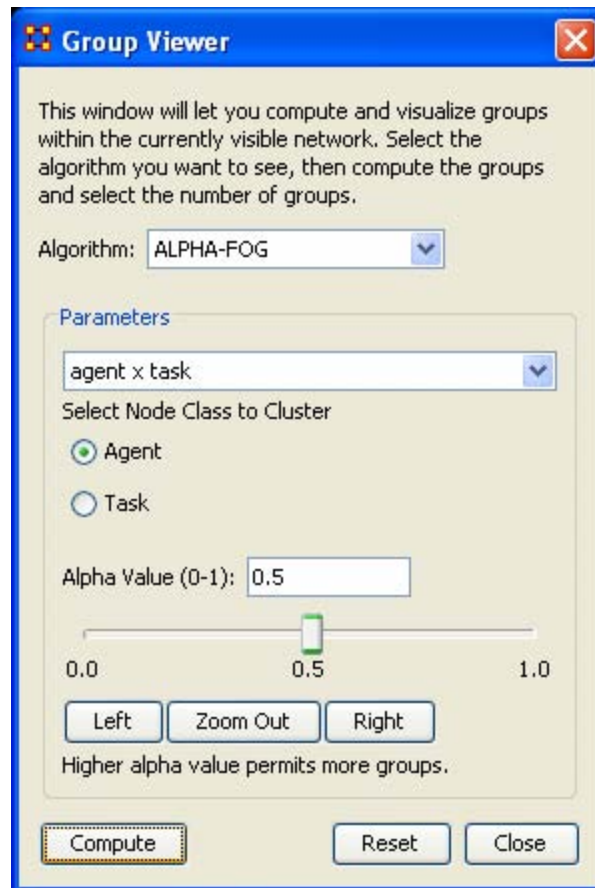


Group Viewer-ALPHA FOG

Alpha-FOG is similar to K-FOG in it clusters nodes into groups. The difference between the two is Alpha-FOG is used when the analyst is not quite sure of the number of groups.

The trade-off between K-FOG and Alpha-FOG is accuracy vs. insight.

The ALPHA-FOG dialog box



Parameters

The dropdown menu contains all the networks in the Meta-Network. After selecting a network OA will display the two NodeSets in the network below in a set of radio buttons. Select one to display. The other will be used as the tasks set.

Alpha Value (0-1):

The slider bar controls the ALPHA-value. It defaults to 0.5. You can manually move the slider right or left then press **[Compute]**.

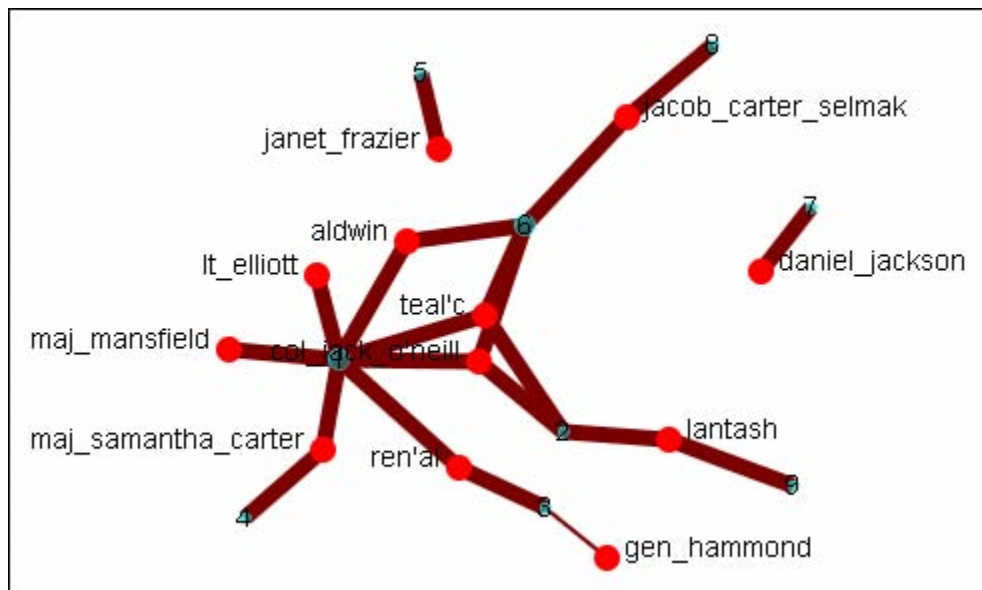
Below the slider are three buttons, **[Left]**, **[Zoom Out]**, and **[Right]**.

- Pressing the **Left button** will reset the three values. The left value will remain the same, the right values will be reduced by half, and the middle value will be the value unequally between the two. Each press of the Left button will repeat the sequence. Pressing the Right button will do the same, but in the opposite direction.

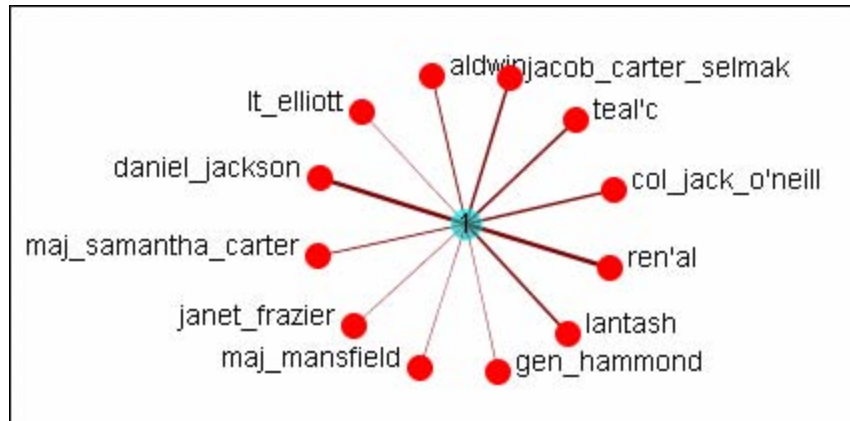
- The **Zoom Out** button reverse the above procedure in the exact order (i.e. if you pressed **Left, Right Right, Left, and Left** the **Zoom Out** button would undo then as **Left, Left, Right, Right, Left**).

The buttons at the bottom control the display. The **[Compute]** button uses the current Alpha value and re-display the network. The **[Reset]** button removes all groups and resets all the nodes to default. The **[Close]** button closes the dialog box.

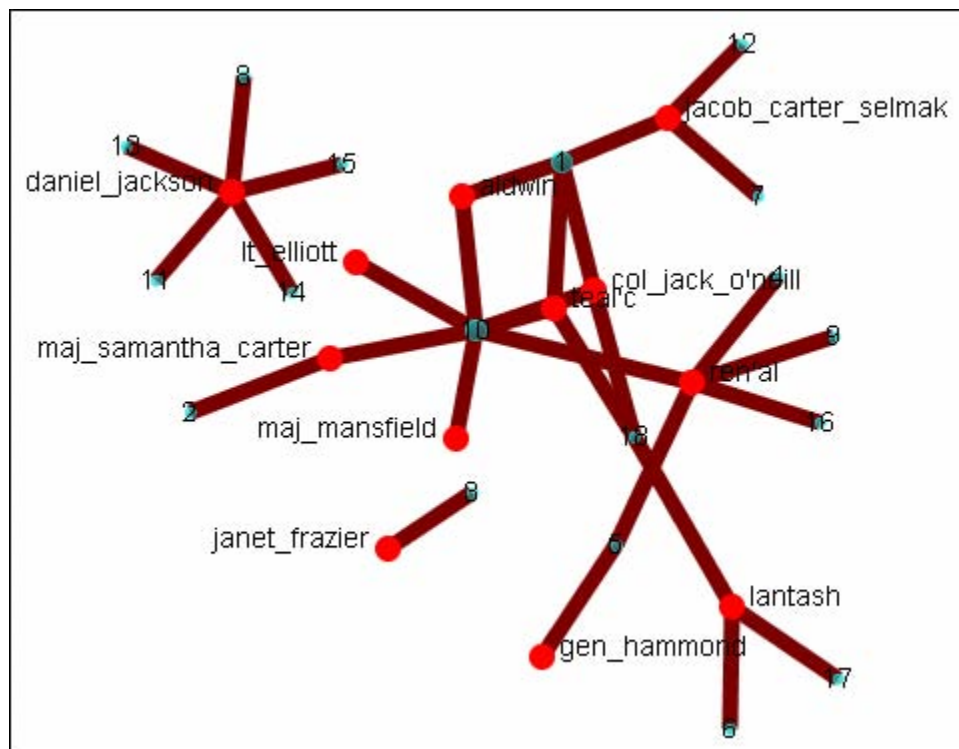
Below is the initial display using the default of **0.5**. It doesn't really tell us much about the grouping of the network. There are some groupings but there are also four groups with one node only and many small "almost" groupings. Also all the links are the same weight which does not indicate the leader of any group.



Setting the slider bar to **0.0** groups all the nodes into a single group. This contains the opposite problem as there is only one group.

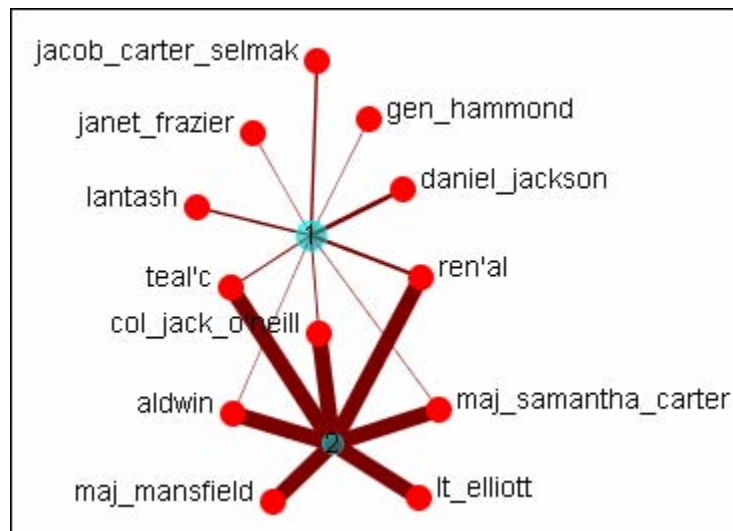
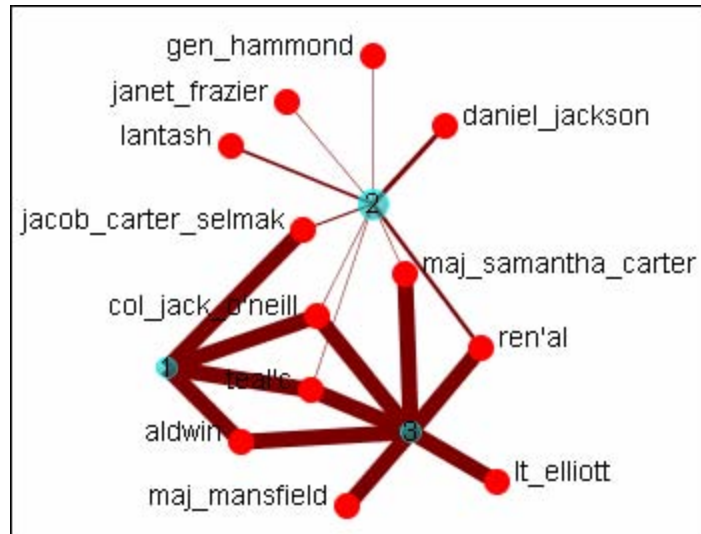


Setting the slider bar to **1.0** divides the tasks into **18** groups, none of which are distinctive. There is definitely no groupings here.



It's necessary to find the optimum setting.

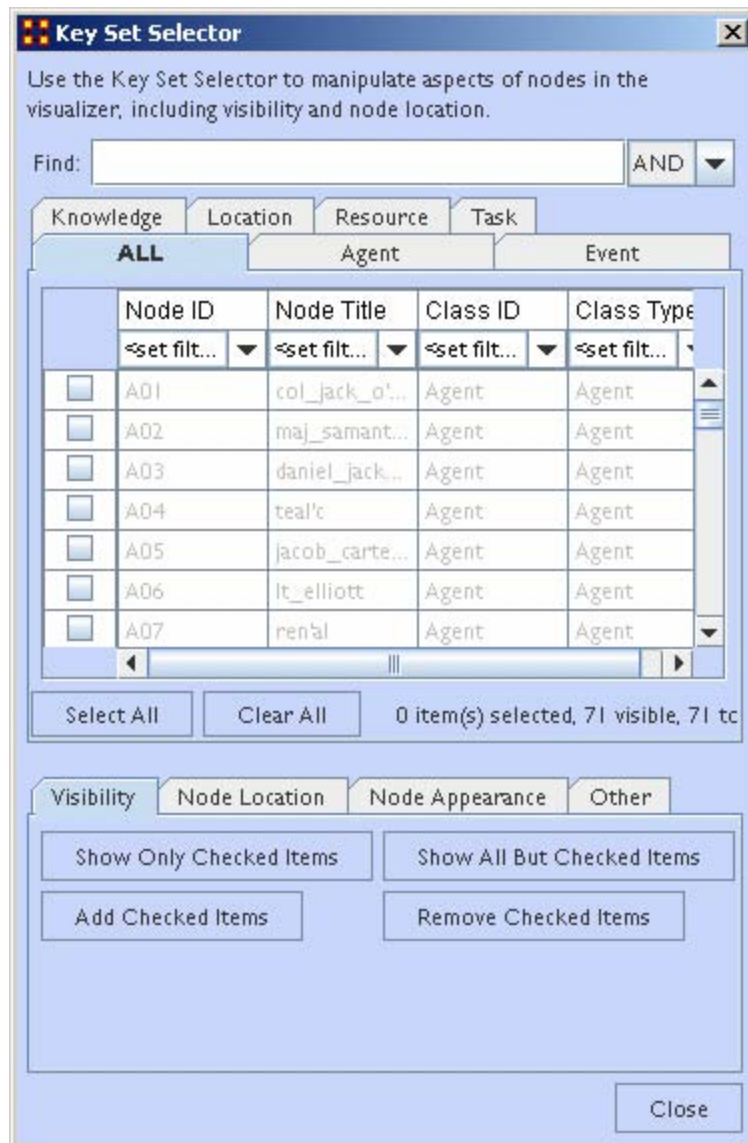
Starting from the default setting I clicked Left. The range was from **0.0 - 0.5**. got three groups which looked fairly good. But I decided to check out the other options. I clicked Left again and the range changed to **0.0 - 0.25**. But it combined all the nodes into one group. Definitely was he correct grouping. I clicked Right and the range changed to **0.125 - 0.25**. It split them into two groups.



KeySet Selector in Visualizer Tool

Note : A slightly different version of this tool is available in the ORA Main Menu interface (i.e., non-Visualizer tool).

You can use the Key Set Selector to simplify complex visualizations. The Key Set Selector tool is accessible from the Visualization tool bar at the following path:



Key Set Selector Tabs

Visibility : Contains options for manipulating the display of nodes depending on whether or not nodes are selected. You can also add or remove selected items

Node Locations : All selected nodes can be moved to a column to the right or left side of the screen.

Node Appearance : Selected nodes can have their labels shown/hidden and the node color changed.

Other : Create Meta-Node combines all selected nodes into a Meta-Node.
Highlight Checked Items

Create Meta-Node - All selected items are combined into a Meta-Node on the screen.

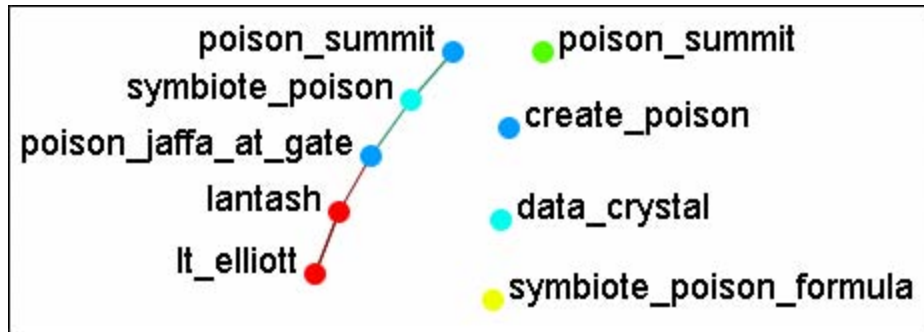
Keyset Selector Examples

Following is a short example of the KeySet Selector. It covers the main aspects of the tool only.

The screenshot shows a 'Filter Commands' dialog box. At the top, there is a 'Find:' text box containing the word 'poison'. Below it, there are two radio buttons for the 'Rule:' section: 'Match at least one filter' (unselected) and 'Match all filters' (selected). A 'Reset' button is to the right. Below the rule section, there are tabs for 'ALL', 'Agent', 'Event', 'Knowledge', 'Location', 'Resource', and 'Task'. The 'ALL' tab is selected. The main area is a table with columns: 'Node ID', 'Node Title', 'Class ID', and 'Class Type'. Each column has a dropdown menu with '<set filt...'. The table contains 9 rows of data, all of which have a green checkmark in the first column. At the bottom, there are 'Select All' and 'Clear All' buttons, and a status bar that reads '9 item(s) selected, 9 visible, 71 total'.

	Node ID	Node Title	Class ID	Class Type
☒	A06	It_elliott	Agent	Agent
☒	A12	Iantash	Agent	Agent
☒	E14	poison_s...	Event	Event
☒	K01	symbiote_...	Knowledge	Knowledge
☒	R01	symbiote_...	Resource	Resource
☒	R06	data_crystal	Resource	Resource
☒	T01	poison_s...	Task	Task
☒	T04	poison_jaf...	Task	Task
☒	T05	create_poi...	Task	Task

In the **Filter Commands** textbox the word **poison** is typed which causes all nodes with **poison** in any attribute to be revealed. Pressing the **[Select All]** button places a check mark in all the nodes. Lastly in the **Visualizer Commands** pressing the **[Show Only Checked Items]** button hides all but the checked items.



The **[Clear All]** button is pressed to clear all the check marks. **poison** is replaced in the **Filter Commands** with the word **sg-1**. Be aware that even though only nodes with **sg-1** are to be added the two nodes with **sg-17** also appear as sg-1 is a sub-string of sg-17. SO instead of using the **[Select All]** button check marks are manually placed in the check boxes desired.

Filter Commands

Find:

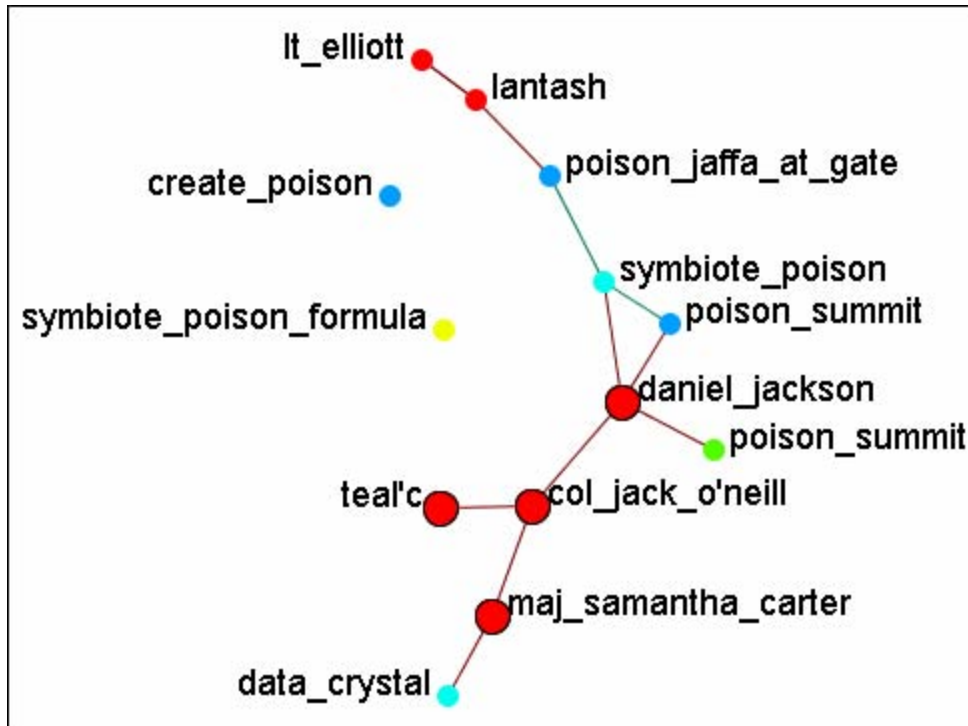
Rule: ☐ Match **at least one** filter ☒ Match **all** filters

ALL Agent Event Knowledge Location Resource Task

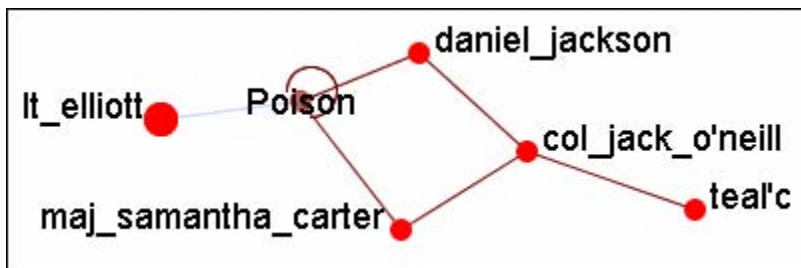
	Node ID	Node Title	position	symbiote
	<set filt...>	<set filt...>	<set filt...>	<set filt...>
☒	A01	col_jack_...	sg-1_leader	
☒	A02	maj_sam...		
☒	A03	daniel_jac...		
☒	A04	teal'c		
☐	A06	lt_elliott		lantash
☐	A10	maj_man...	sg-17_lea...	

5 item(s) selected, 6 visible, 16 total

The **[Add Checked Items]** button is pressed and the four new nodes are added to the Visualizer.



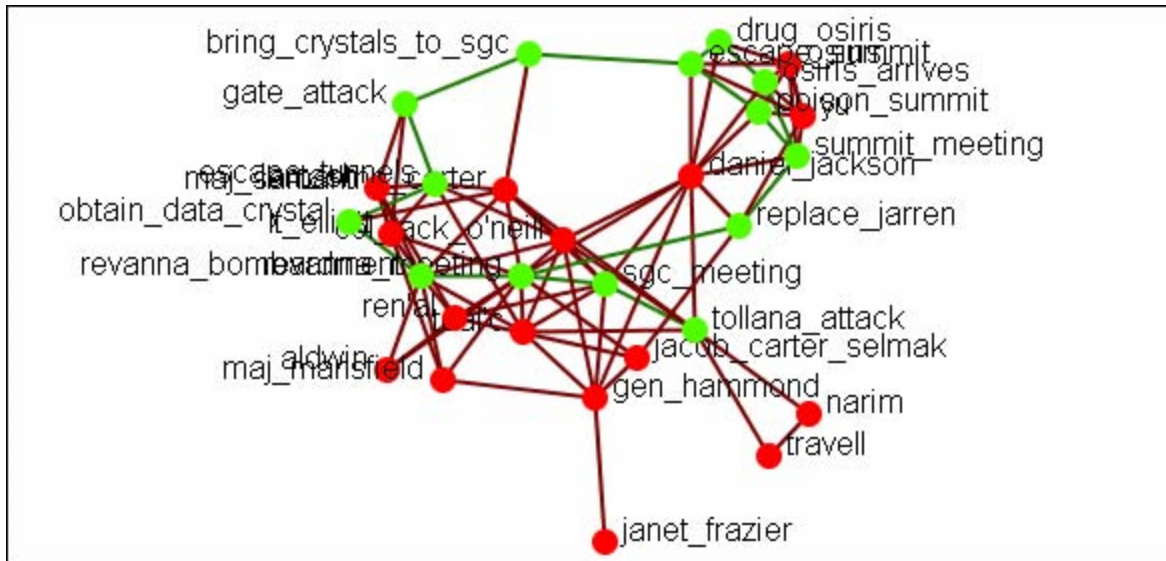
With the four nodes of sg-1 still check marked press the **[Highlight Checked Items]**. The four nodes are now displayed in a larger format.



The last button, **[Create Meta-Node]** will cull nodes into a Meta-Node.

Move Left / Right

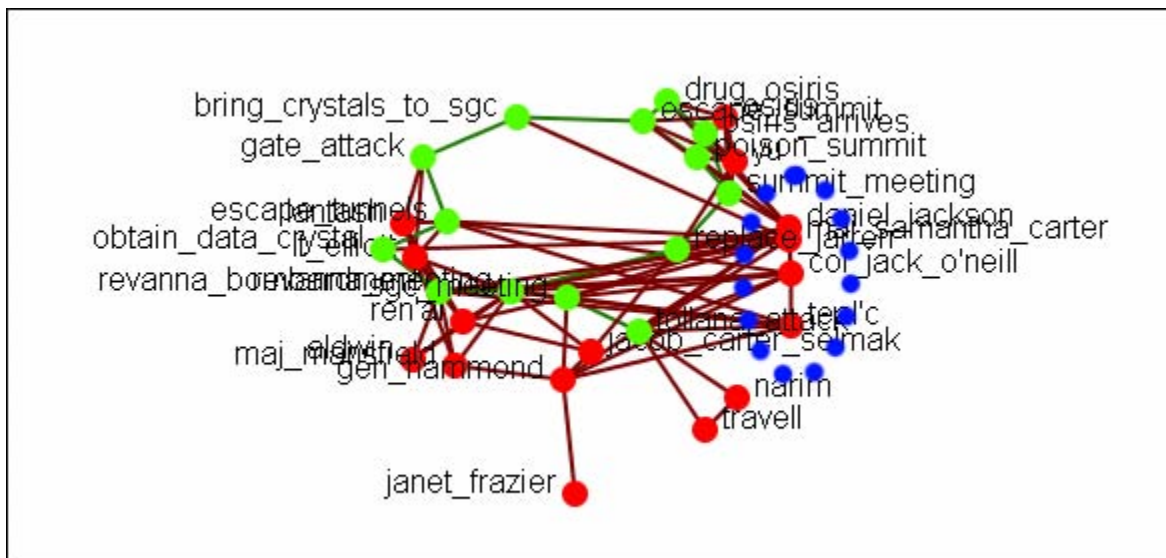
If a set of nodes needs "pulled out" of the display the **Move Left / Move Right** buttons can help. Below is a normal display. The nodes for SG-1 are quite difficult to see.



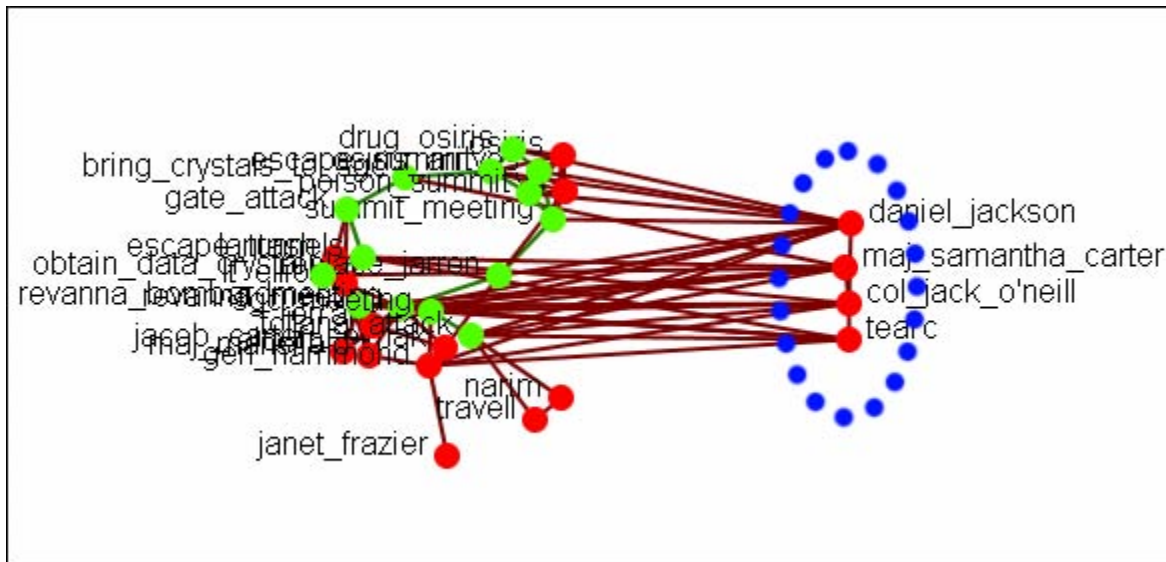
From the Keyset Selector dialog select the nodes to be highlighted and place a check mark in the box.

	Node ID	Node Title	Class ID	Class Type	pos
	<set filt...	<set filt...	<set filt...	<set filt...	<se
☒	A01	col_jack_...	Agent	Agent	sg-
☒	A02	maj_sam...	Agent	Agent	
☒	A03	daniel_jac...	Agent	Agent	
☒	A04	teal'c	Agent	Agent	

Press the **[Move to the Right]** button. This brings the selected items toward that side of the display.

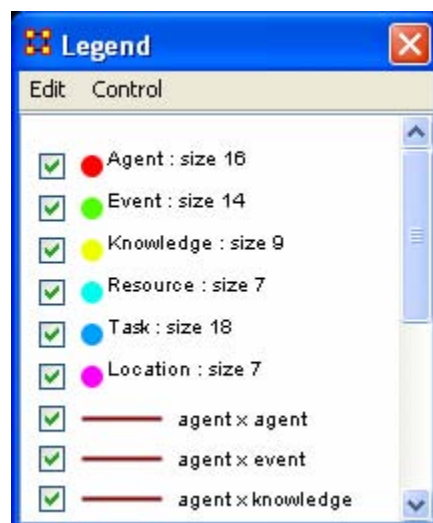


Pressing the button again will move the selected nodes farther in that direction.

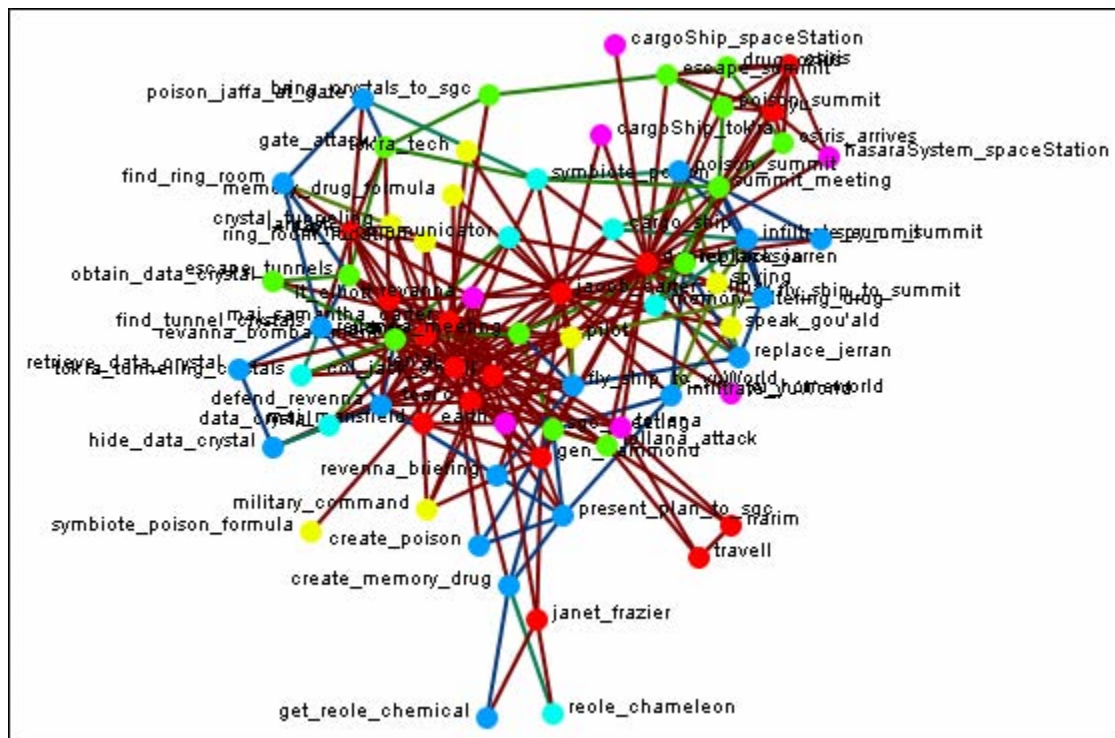


The **Legend** dialog box allows you to quickly hide and reveal nodes and links in the Visualizer.

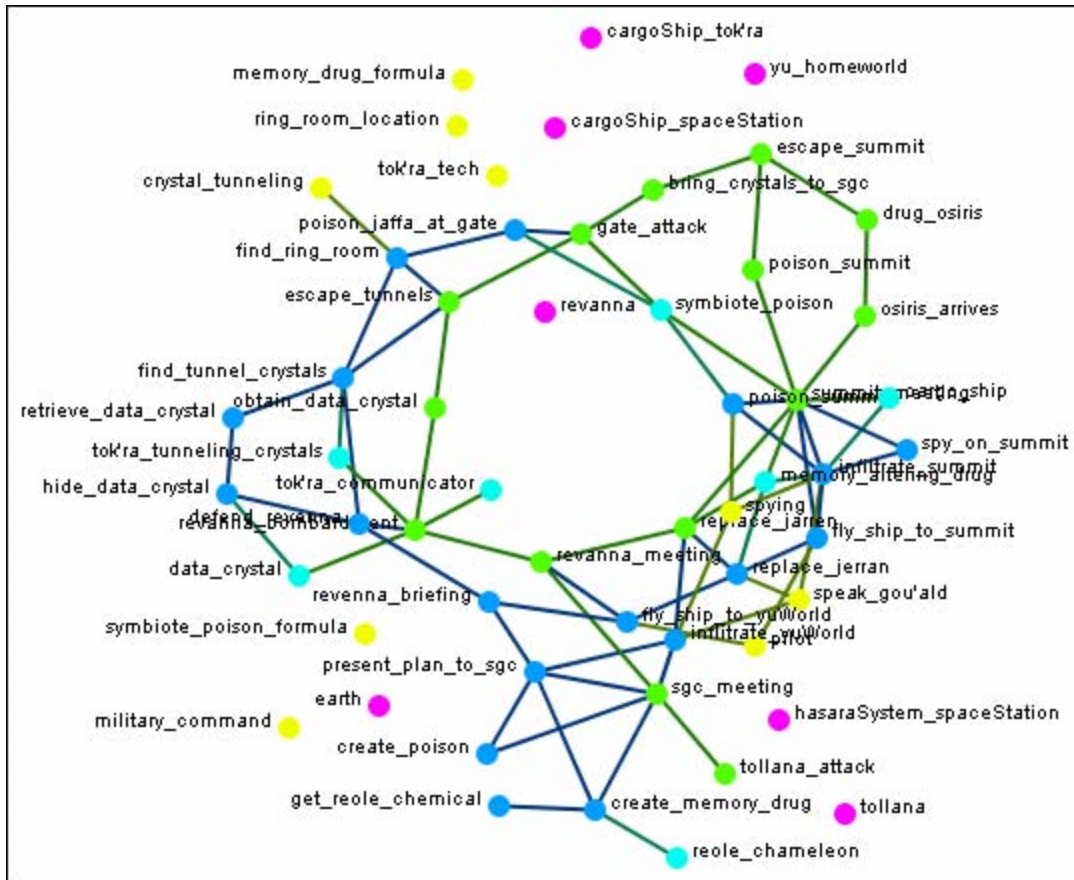
Use the checkboxes to change a NodeSets visibility. When you first call up the Visualizer all the boxes will contain checkboxes...



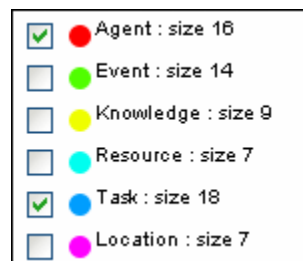
...and in the Visualizer all nodes and links are revealed. A little hard to make heads or tails of something like that.



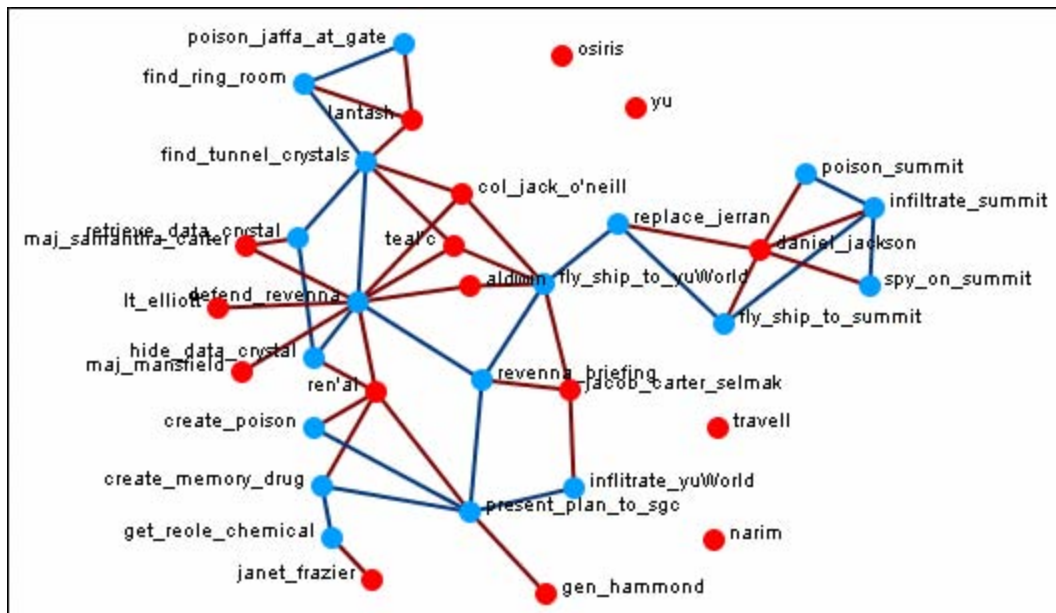
By using the Legend checkboxes you can selectively **show / hide nodes and links**. Deselect the checkbox to the left of **Agent**. Instantly all of the Agent nodes are hidden along with any connections they had with the rest of the nodes. The node structure is a little easier to see now.



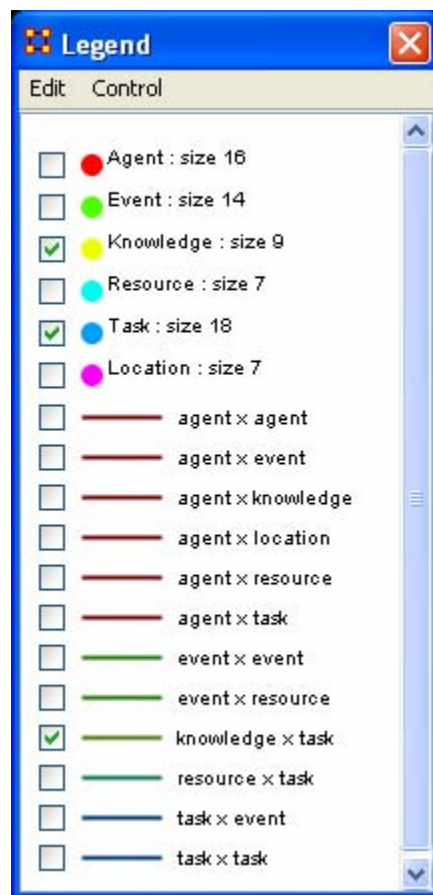
Next think about a particular set of connections you'd like to see, say a **task x task network** and how the agents relate to the tasks.



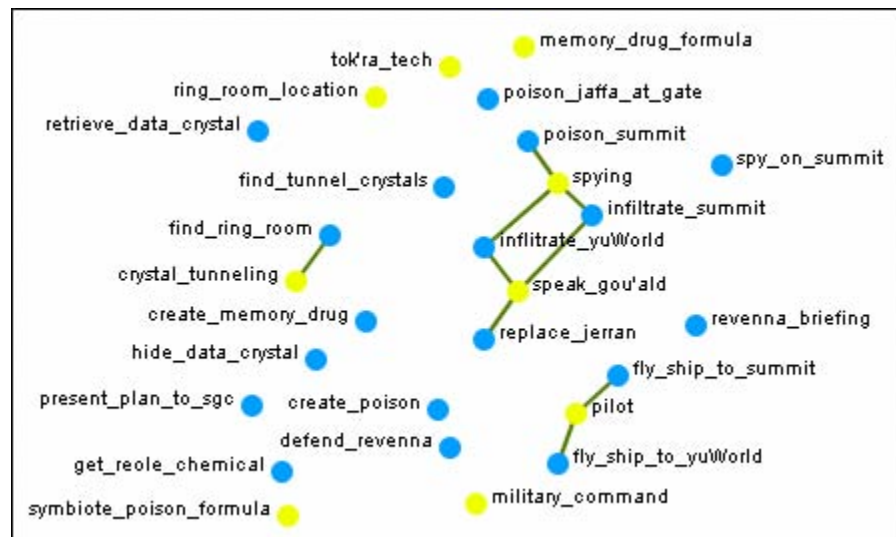
From the Legend box menu select **Control => Hide All nodes** Then again from the menu **Control => Refresh Legend**. Now place checkmarks in the checkboxes for **agent, task, and task x task**. All the tasks will be linked together as per your network and all the agents will have connections to the tasks they are associated with.



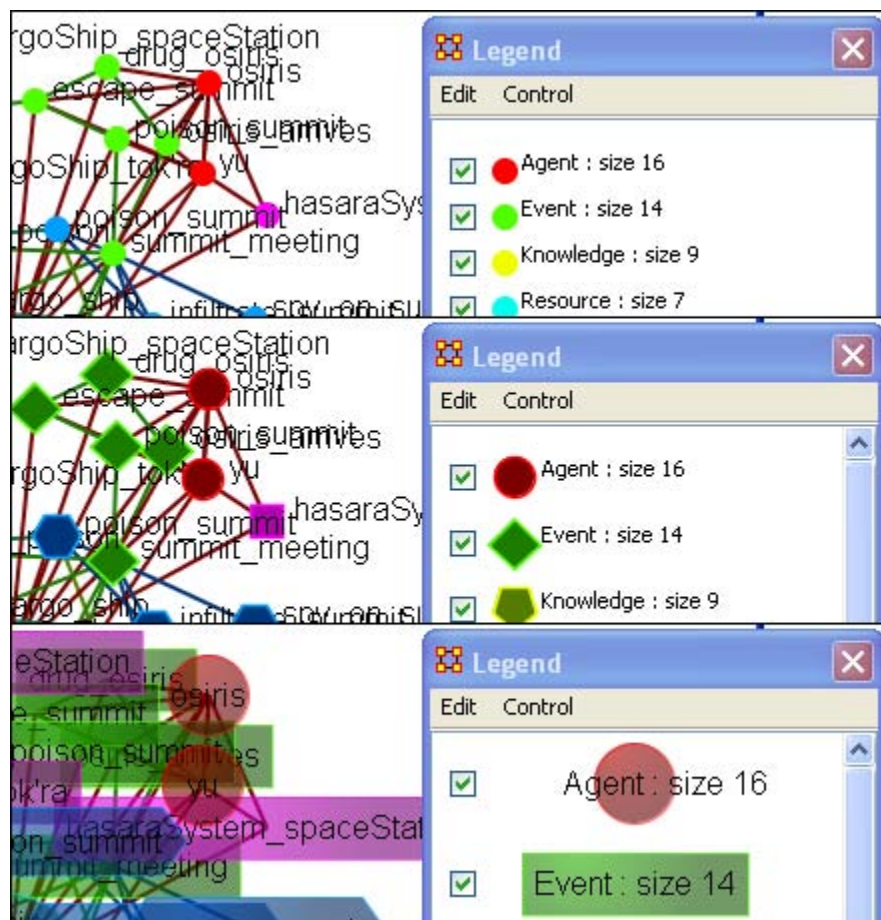
Another example is how **knowledge relates to specific tasks**. From the Legend menu select **Control => Hide All Nodes**. Now place checkmarks next to **knowledge**, **task**, and the **Knowledge x task** network.



Now the Visualizer reveals which knowledge is required for which specific tasks.

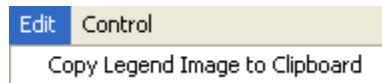


The legend also reflects the size, shape, and color of the nodes in the Visualizer.



Legend Edit Menu

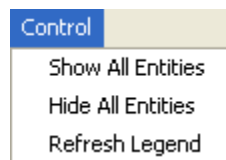
Below is an image of the Legend Edit Menu and a description of this tool:



Copy Legend Image to Clipboard : Copys an image of the **entire** legend that can be pasted into an image-editing program.

Legend Control Menu

Below is an image of the Legend Control window:



Show All Nodes : Will bring into view all entities in the MetaMatrix. Good to use if you need to make a fresh start.

Hide All Nodes: Hides every entity. Good starting point when you only wish to display a small subset of entities.

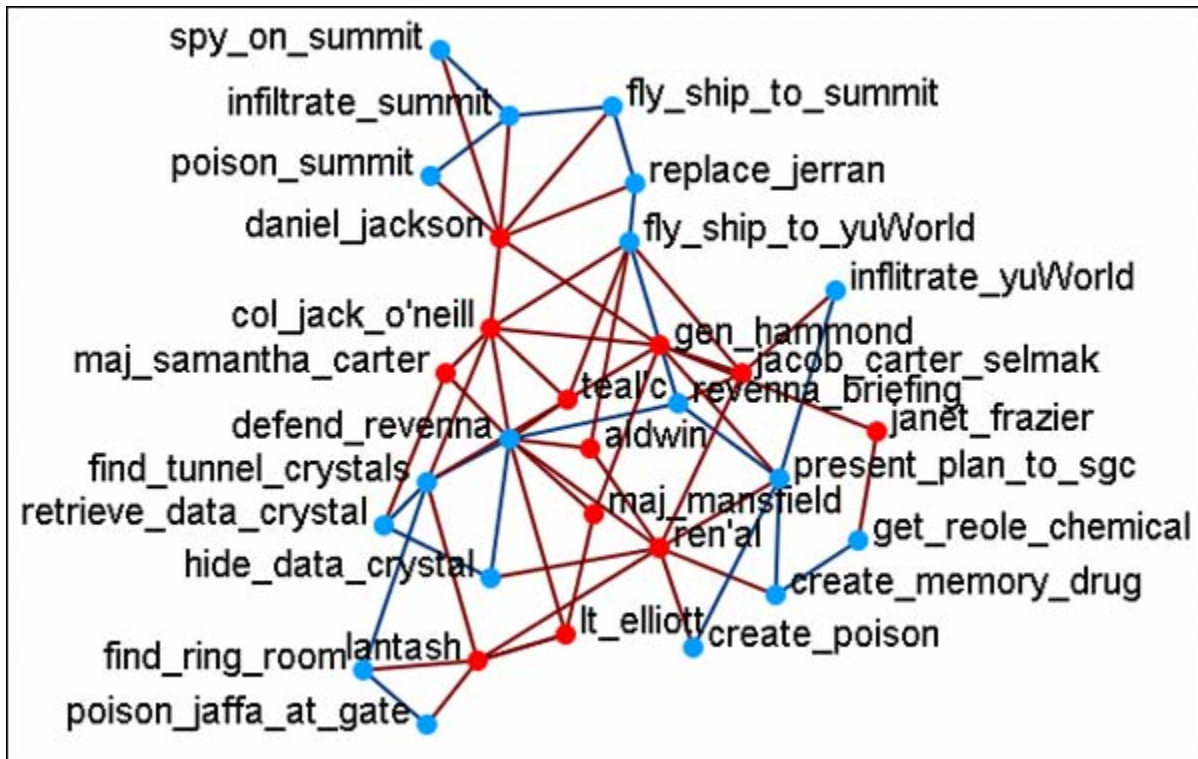
Refresh Legend : After using the menu items above and/or using the checkboxes this item will bring the Visualizer up to date.

Node Color

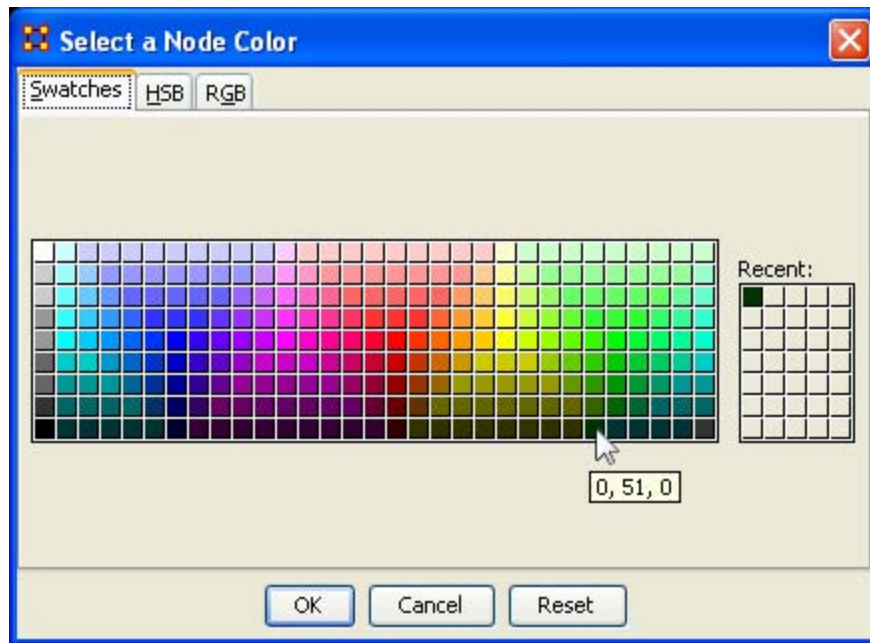
The color of a NodeClass can be changed in the Visualizer. In the Legend window click on the colored node of a NodeClass. This will bring up a color selector box. Select a new color and click **[OK]**. All the nodes of that NodeClass will change colors.

NOTE : This color change is in effect for as long as the Visualizer is open. If you close and re-open the Visualizer the colors will revert to their default colors.

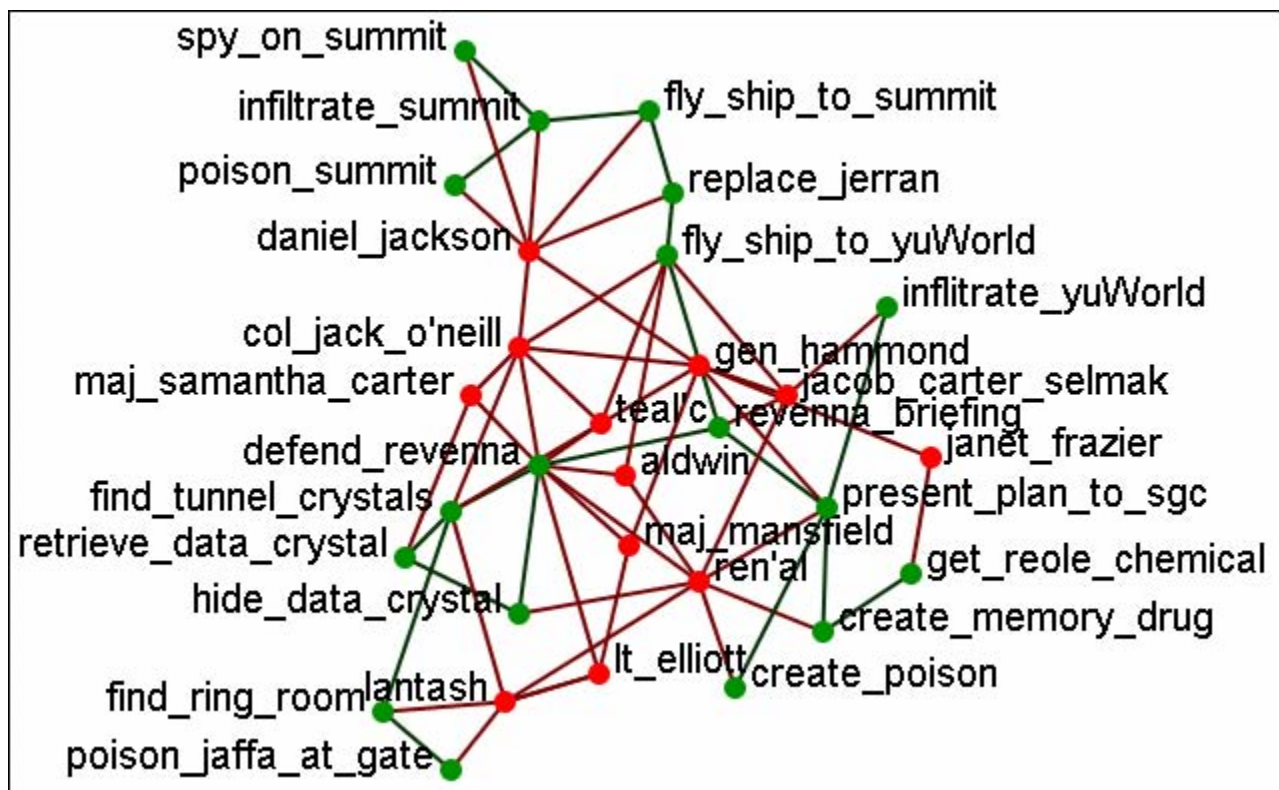
Here is a section with the default colors of **red** for agents and **cyan** for tasks.



Open the Legend window (if it's not open already) and click once on the NodeSet you want to change. This will bring up the **Color Change** dialog window.



Select **[OK]** and the new color will be displayed for the chosen NodeSet.

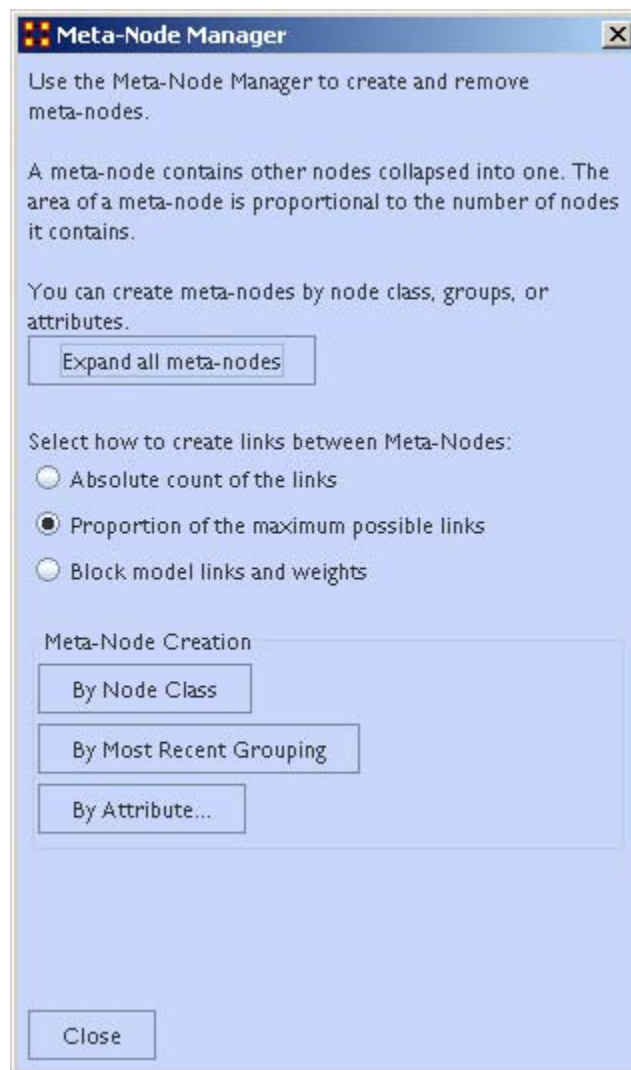


The newly selected color appears in both the Visualizer and Legend windows.



Creating a Meta-Node

 A **Meta-Node** contains multiple nodes collapsed into one. You can create Meta-nodes based on the nodesets in your organization, or you can create MetaNodes based on the attributes of the nodes. From the drop down menu select **Tools > Meta-Nodes** or select the **Meta-Node Manager** button on the toolbar. This brings up the **Meta-Node dialog box**.



1. **Expand all meta-nodes** expands all meta-nodes to their respective single nodes.
2. **Select how to create links between Meta-Nodes:**

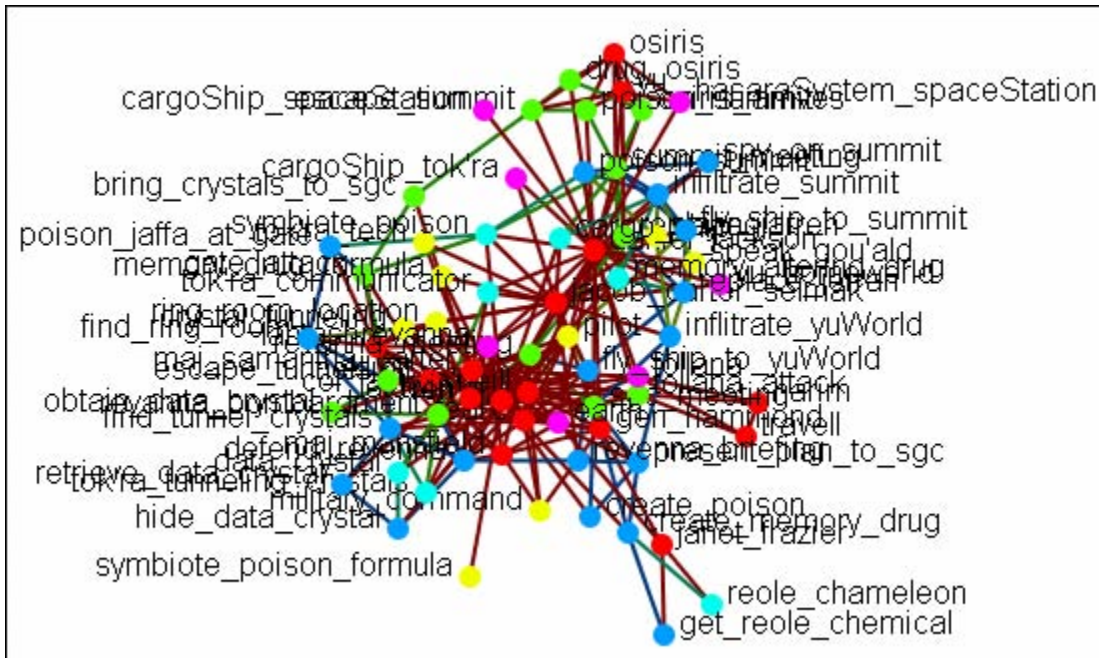
- o **Absolute count of the links :** Counts each link from any node in the Meta-Node to any other node as 1.0.
- o **Proportion of the maximum possible links :**
- o **Block model links and weights :**

3. **Meta-Node Creation** is controlled by three buttons:

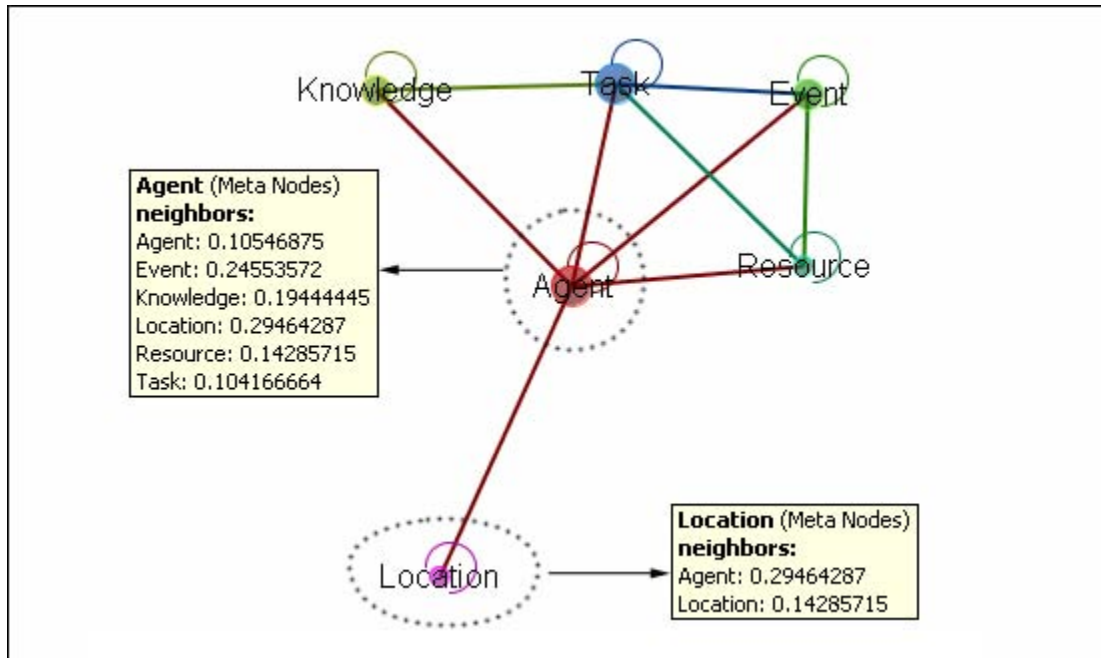
- o **By Node Class :** Creates Meta-Nodes based on current NodeSets.
- o **By Most Recent Grouping :** Creates Meta-Nodes based on the most recent use of the [Group Viewer](#).
- o **By Attribute...** : Creates Meta-Nodes on **one** individual attribute.



Node creation is done via three buttons in the **Meta-Node Creation** section.



This button will create Meta-Nodes for each NodeSet.



Meta-Node Attribute

This button creates Meta-Nodes using a **single** attribute. It's used in conjunction with the **Funnel Nodes** checkbox. Below is an image of the Select an attribute box:

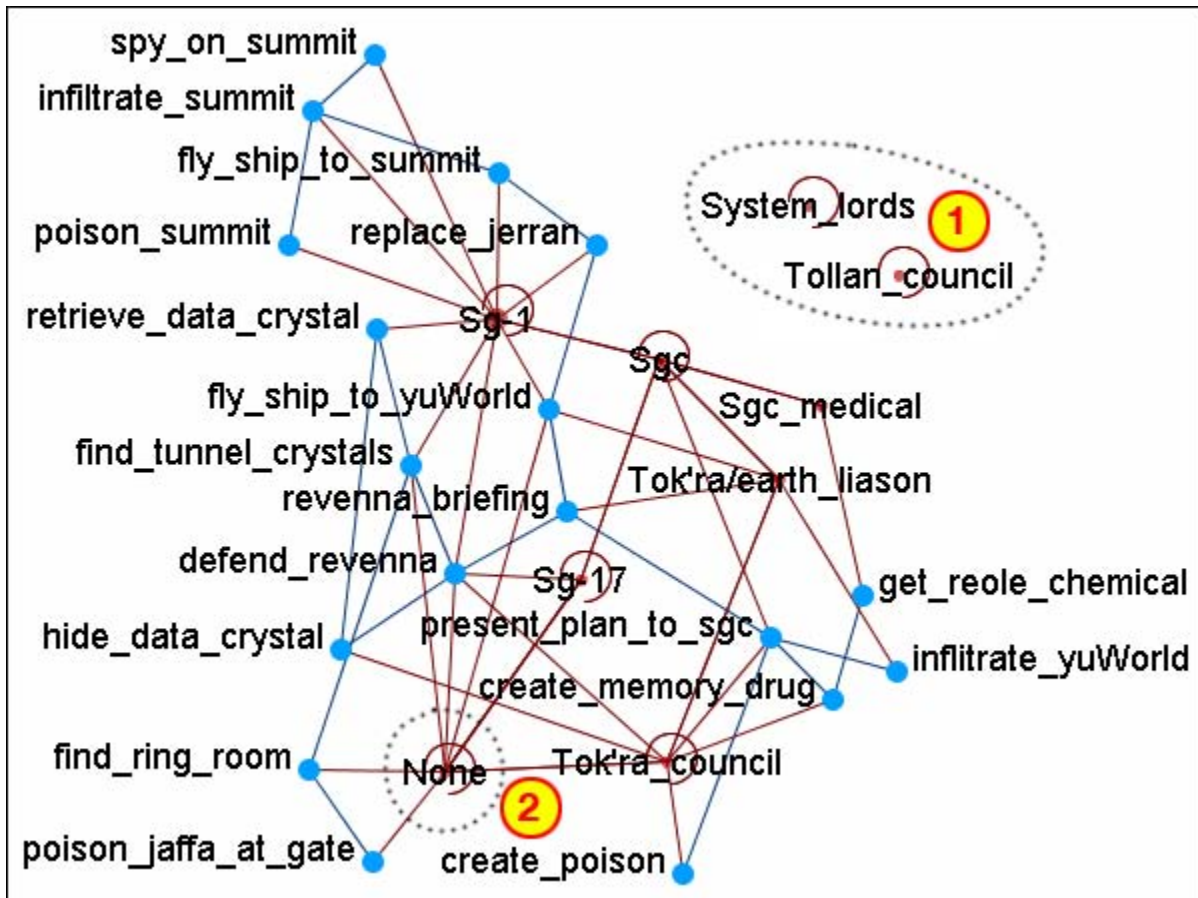
Select an attribute:

group

☐ Funnel nodes without this attribute into a new Metanode

Choosing **group** without the **Funnel Nodes** checked creates a confusing display.

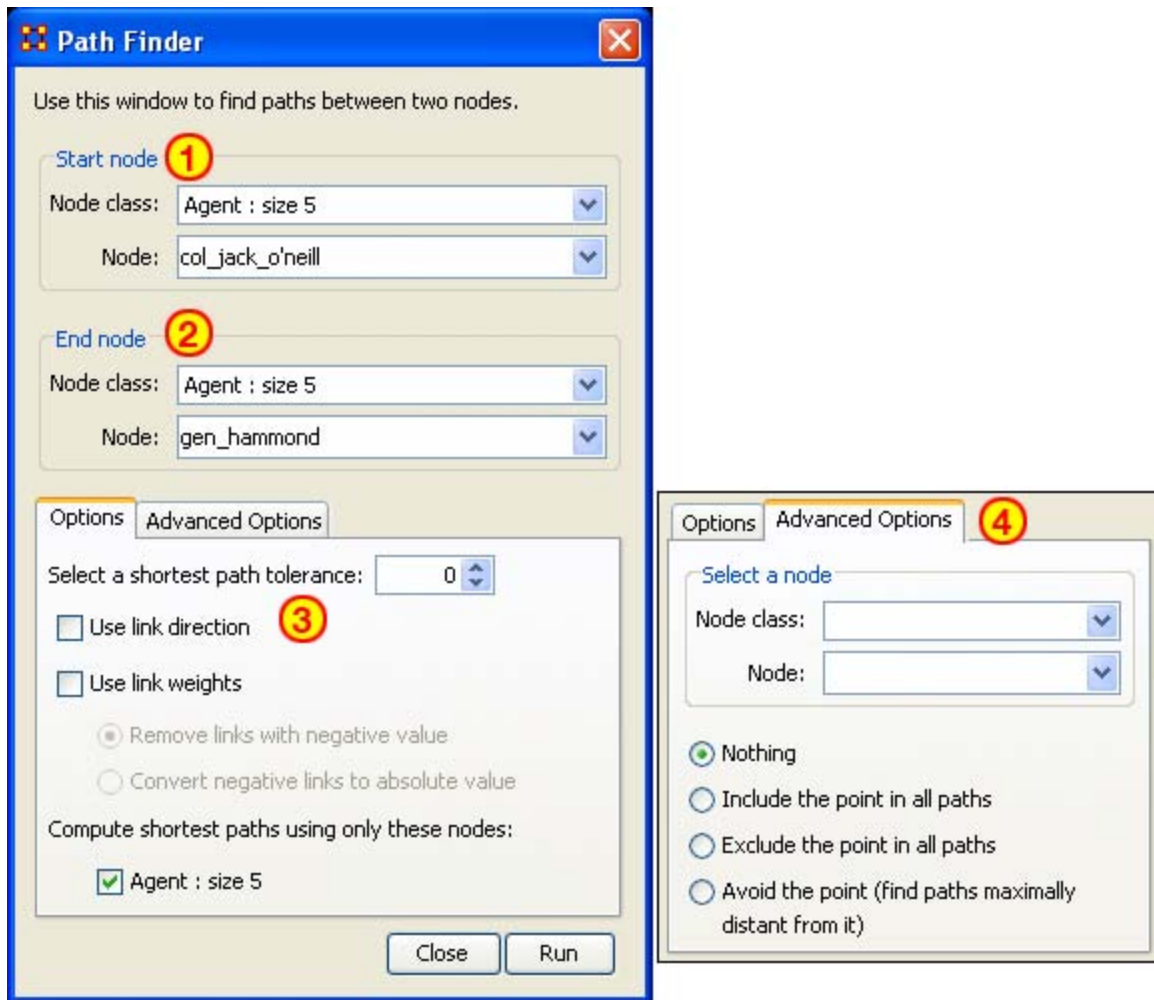
any tasks and that groups in area **2** are all the agent nodes that had no groups affiliation.





Path Finder

The Path Finder is used to find, not only, the shortest path between two nodes but also paths to other nodes when particular situations occur. Below is an image of the Path Finder tool and a description of its various elements.



The interface contains four sections:

Start node : Select the NodeSet/Node to begin the path.

End node : Select the NodeSet/Node to end the path.

Options : Options regarding link parameters and which NodeSets to use.

Advanced Options : Options regarding whether, and how, to use one particular node within the set.

Using only Agent nodes (tolerance = 0)

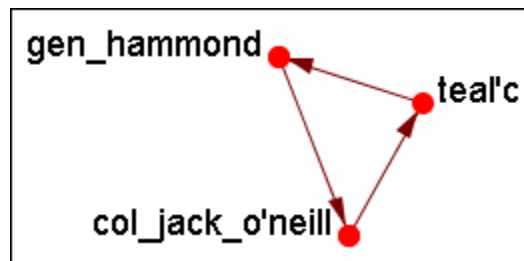
Using only the Agent NodeSet the pathway requires three intervening nodes.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	0.0	0.0	1.0	5.0	0.0
maj_samant...	1.0	0.0	1.0	0.0	0.0
daniel_jackson	-1.0	0.0	0.0	-1.0	0.0
teal'c	0.0	0.0	0.0	0.0	1.0
gen_hammond	-5.0	0.0	0.0	0.0	0.0

NOTE : For this example the values in the Network have been altered from the regular values.

Tolerance of "1", nothing else checked.

Shortest path: 1



There is the direct link from gen_hammond to col_jack_o'neill and the secondary pathway with teal'c in the middle.

Use link direction

Shortest path: 2

The path direction **must** lead **from** the source **to** the target.

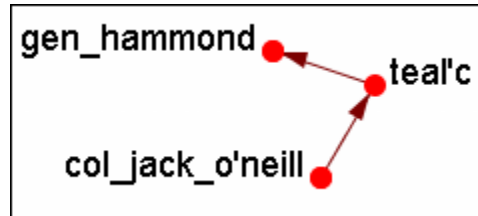


The link from gen_hammond to col-jack-o'neill is removed as it's a directional link in the wrong direction. The shortest link is "2".

Use link weight (Remove links with negative values)

Shortest path: 6

Use link weights finds the shortest path from A to B using minimal weights as opposed to minimal number of links. Also the shortest path is the total of the link weights — not the number of links total.

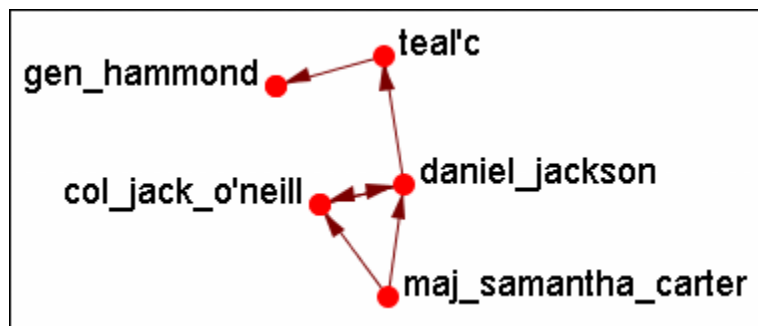


The shortest path is from col_jack_o'neill to teal'c (5) then from teal'c to gen_hammond (1) for a total of "6".

Use link weight (Convert negative links to positive values)

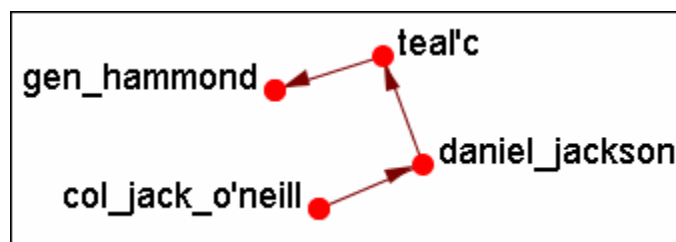
Shortest path: 3

Uses the **absolute** values of numbers. A **negative number** becomes a **positive number**.



Use link direction and link weight with absolute values

Shortest path: 3



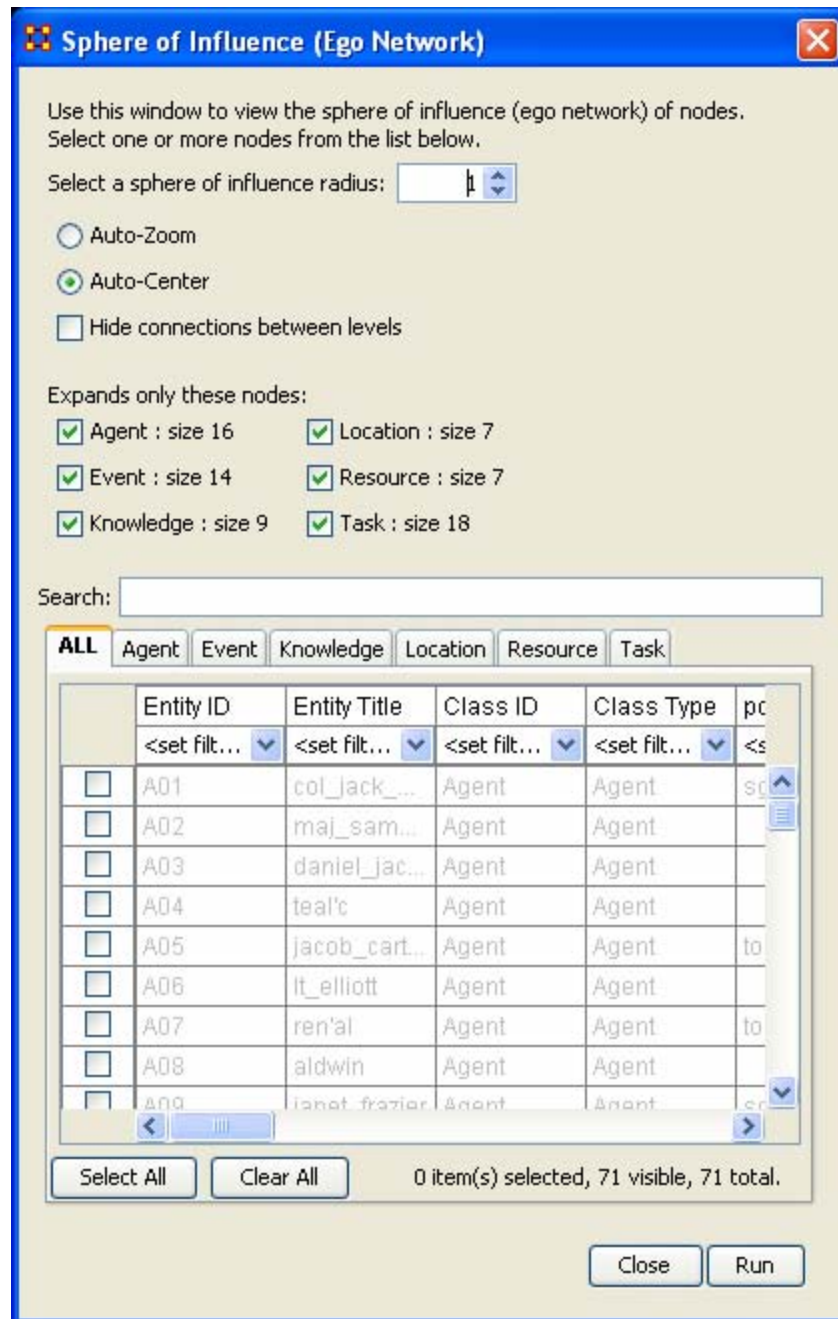


Sphere of Influence

Each node within a network has a unique **Sphere of Influence** or **Ego Network**. Essentially it's a direct relationship with it's neighbors as a function of specified path length. The ORA Visualizer allows you to focus on this relationship by creating an **Ego Map** centered on any particular node you choose.

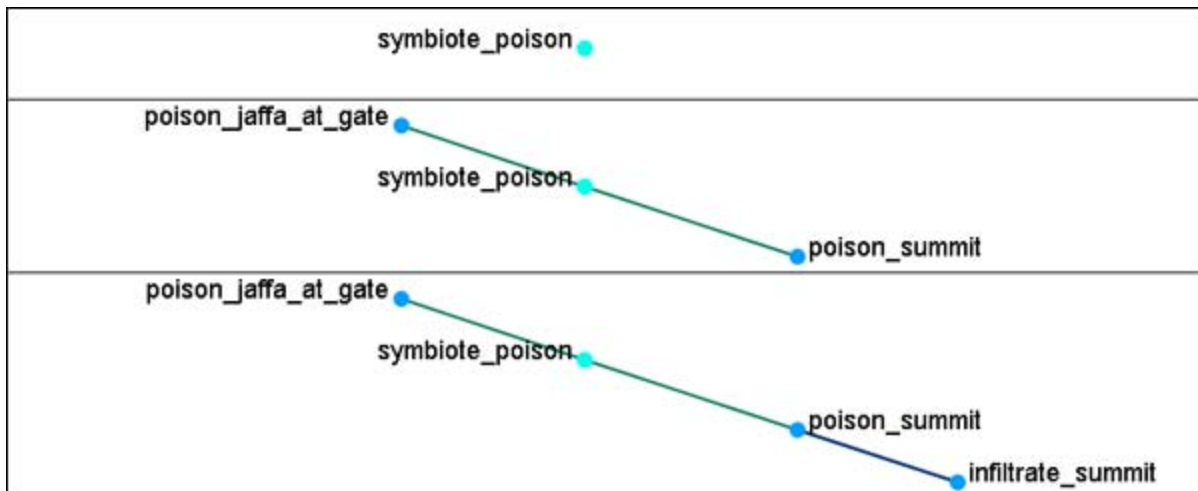
From the Visualizer's Main Menu select **Tools ⇒ Sphere of Influence**.

The following dialog box will then appear. From here you can select the **Size of your sphere's influence, the NodeSets, and Key Sets to use**.



Select a sphere of influence radius

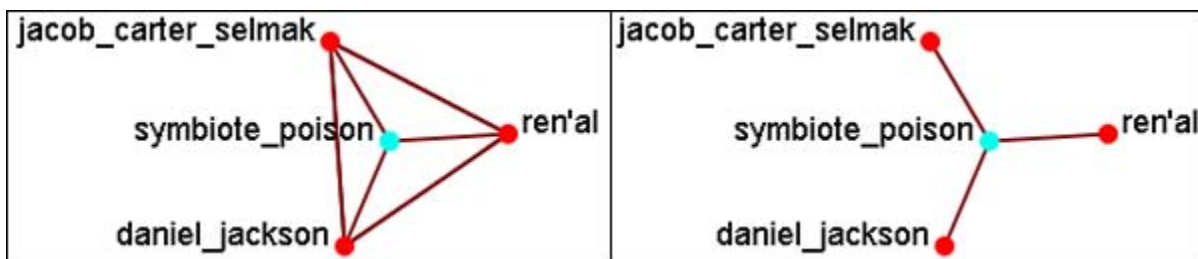
The drop down box allows you to choose the **path length** for a particular node(s). The value starts out at 0. Below is an example of a radius of 0, 1, 2, and 3. In many other cases the links will branch out as you increase the radius.



Auto-Zoom : Maximizes your ego network within the Visualizer.

Auto-Center : Keeps the visualized Ego Network centered within the Visualizer display.

Hide connections between levels : Removes any connections between nodes that do not have a connection to any node in the filter.



Expand only these nodes : Allows you to select the components you wish to have displayed in a node's Sphere of Influence.

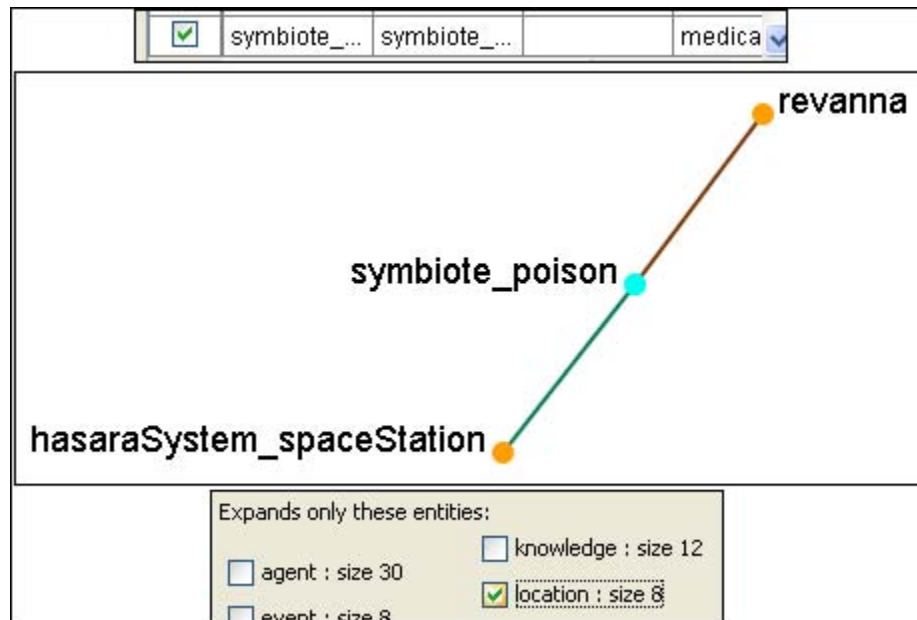
Filter Commands : Used for selecting the filters to use on the current visualization.

Node selection table : Allows the selection of individual nodes for visualization. First selected is **symbiote_poison** in the bottom table. Then the NodeSets **events and locations** were added. Only the nodes that are linked to the original **symbiote_poison** are displayed in the Visualizer.

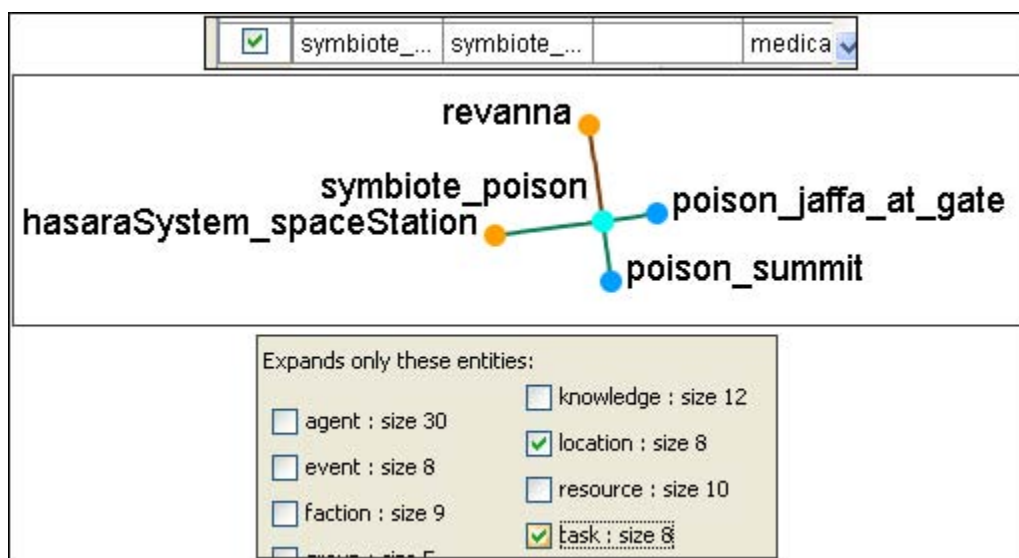
A Sphere of Influence Example

This example will show how to take one node and expand upon it to show how it is related to nodes in other nodesets. First, from the table at the

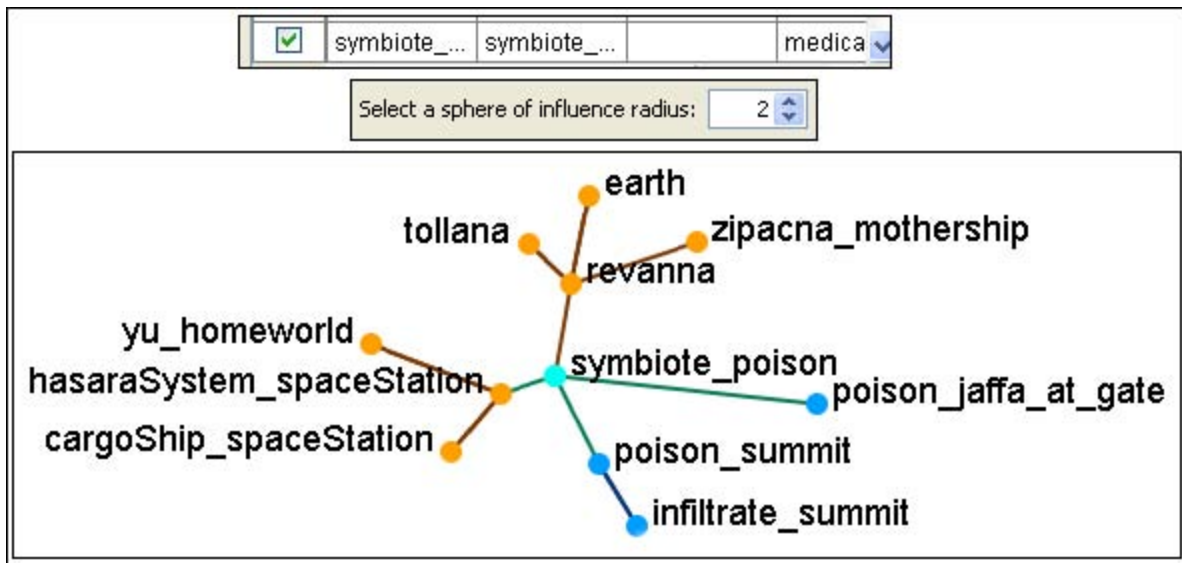
bottom, select a node. Here we select the **symbiote_poison**. From the **Expands only these nodes:** place a checkmark in **location**. It reveals that symbiote_poison is connected to two locations, **Ravenna** and **hasaraSystem_spaceStation**.



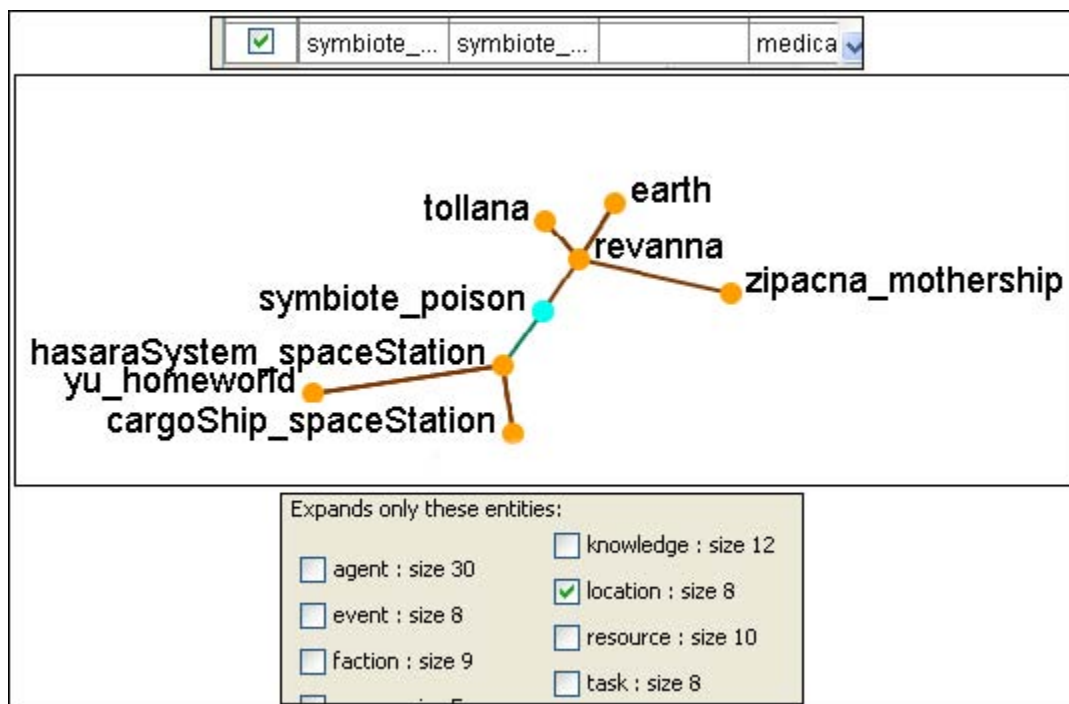
Next we'll place a checkmark next to **tasks**. This reveals that there are two tasks that relate directly to symbiote_poison, **poison_jaffa_at_gate** and **poison_summit**.



Now that we've got a couple of nodes on the screen let's increase the radius of the sphere to 2. The tree will now display all nodes within 2 links of symbiote_poison.



Lastly you can eliminate any nodesets by removing them from the list. Remove the checkmark from **tasks**: to reveal only the locations up to two links away.



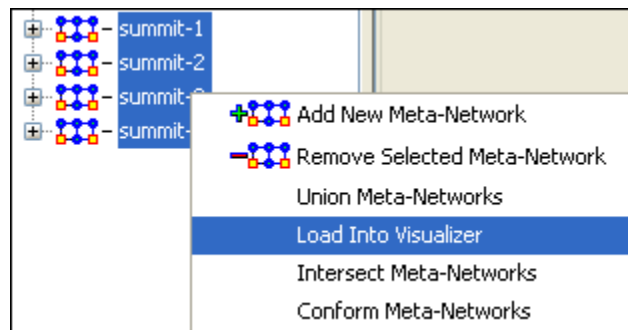
The **Sphere of Influence** allows you to hone your search and show only the nodes you need to see.

View Networks Over Time

The **Networks Over Time** loads multiple Meta-Networks into the Visualizer and displays them as **Time Slices**. What follows are the procedures to do this:

Step 1)

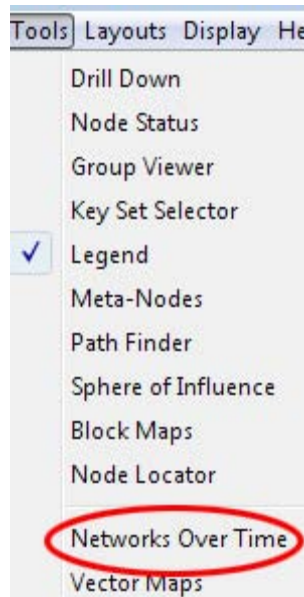
First, highlight the Meta-Networks to load into the Visualizer. For this example I divided the whole Stargate Summit network into four distinct phases. 1) The meetings; 2) What was supposed to happen; 3) What did happen; 4) The attack on the Tok'ra homeworld. These are Summit 1-4.



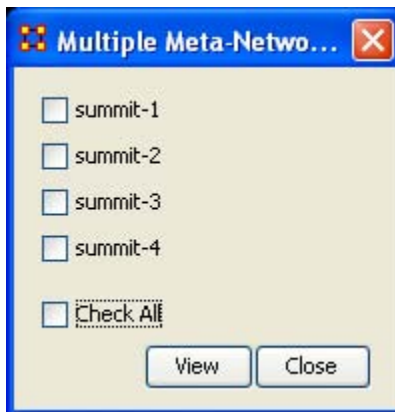
Step 2)

Once you select "Load Into Visualizer", go to the ORA Visualizer.

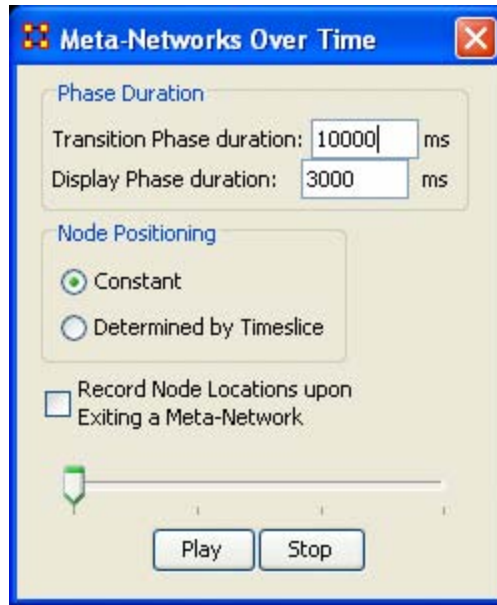
From the ORA Visualizer Main Men Bar select the Networks Over Time Option.



The dialog box appears for you to verify you've chosen the correct Meta-Networks. Place a checkbox in the ones you want or **Check All**. Then select **[View]**.



To control the Over Time function from the main menu, select **Tools ⇒ Networks Over Time**.



The **Phase Duration** has two controls. **Transition Phase duration** sets the amount of time in milliseconds for the fading out of the previous set and the fading in of the new set. The **Display Phase duration** sets the amount of time in milliseconds that a set will be displayed before moving to the next set.

Constant maintains a node's position throughout all Timeslices.

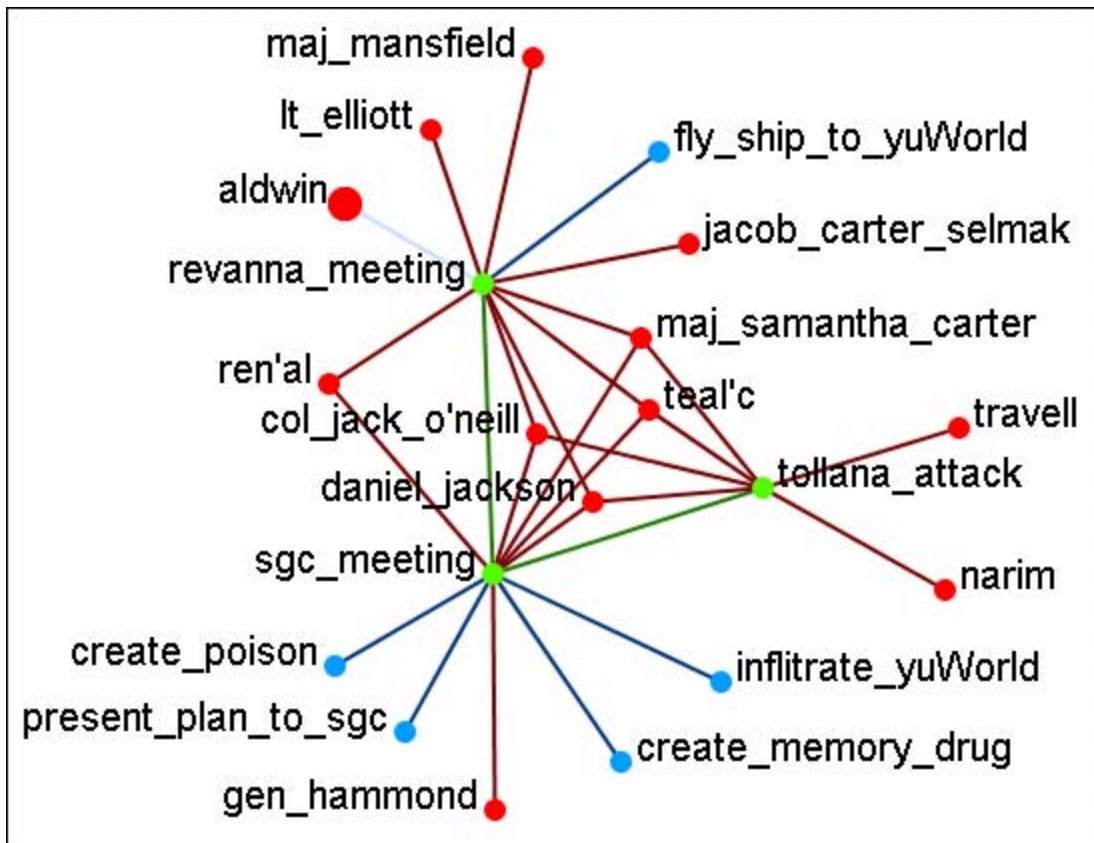
Determined by Timeslice allows you to move a node independently in each Timeslice.

Record Node Locations upon Exiting a Meta-Network maintains a node's position when changing Timeslices. **NOTE:** It does not maintain the node's positions after you exit the Visualizer. Upon returning to the Visualizer all nodes will be in default positions.

The **Slider bar** controls which Timeslice is displayed. The buttons at the bottom, **[Play]** and **[Stop]** control the motion display.

Summit-1

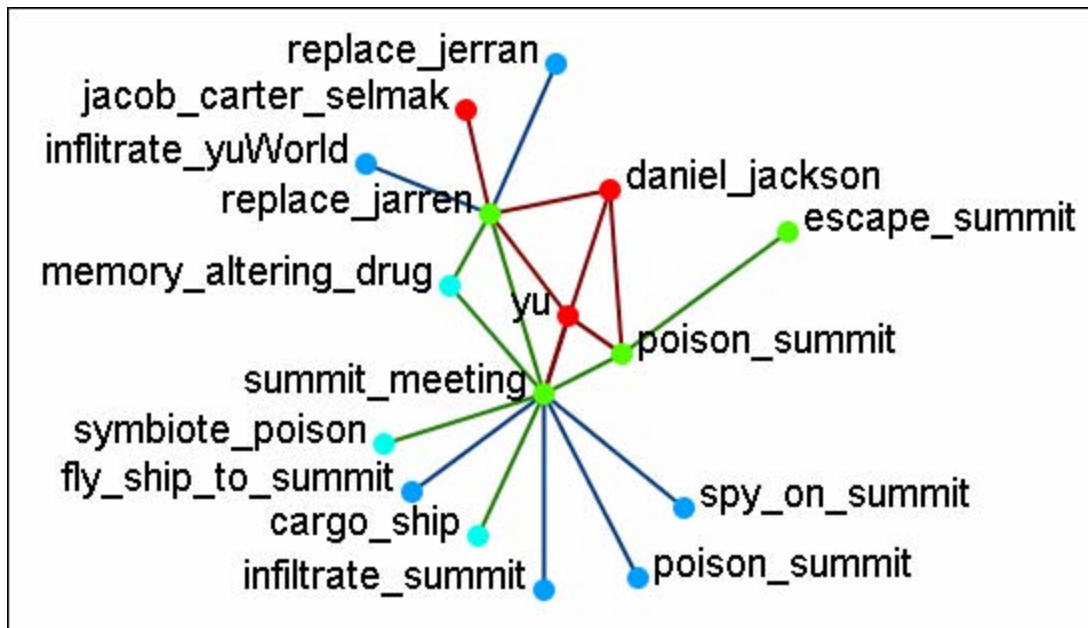
The initial meetings between the SGC and the Tok'ra



Note: You can select multiple nodes by simply clicking on them. You do not need to depress any other keys (i.e., ctrl+shift, etc.).

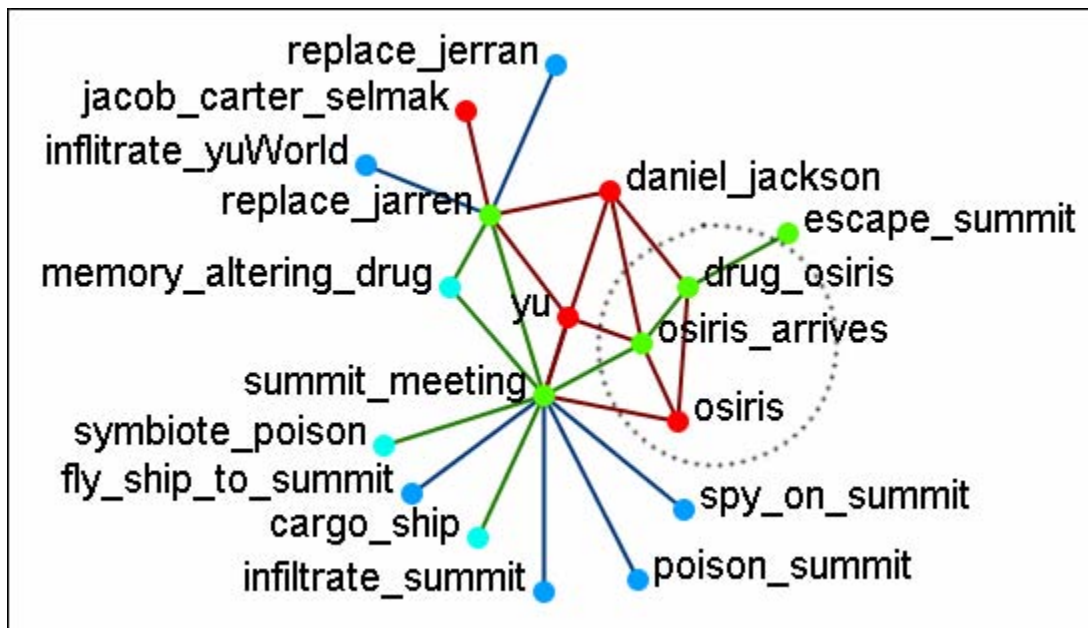
Summit-2

The plan as it was **supposed** to go



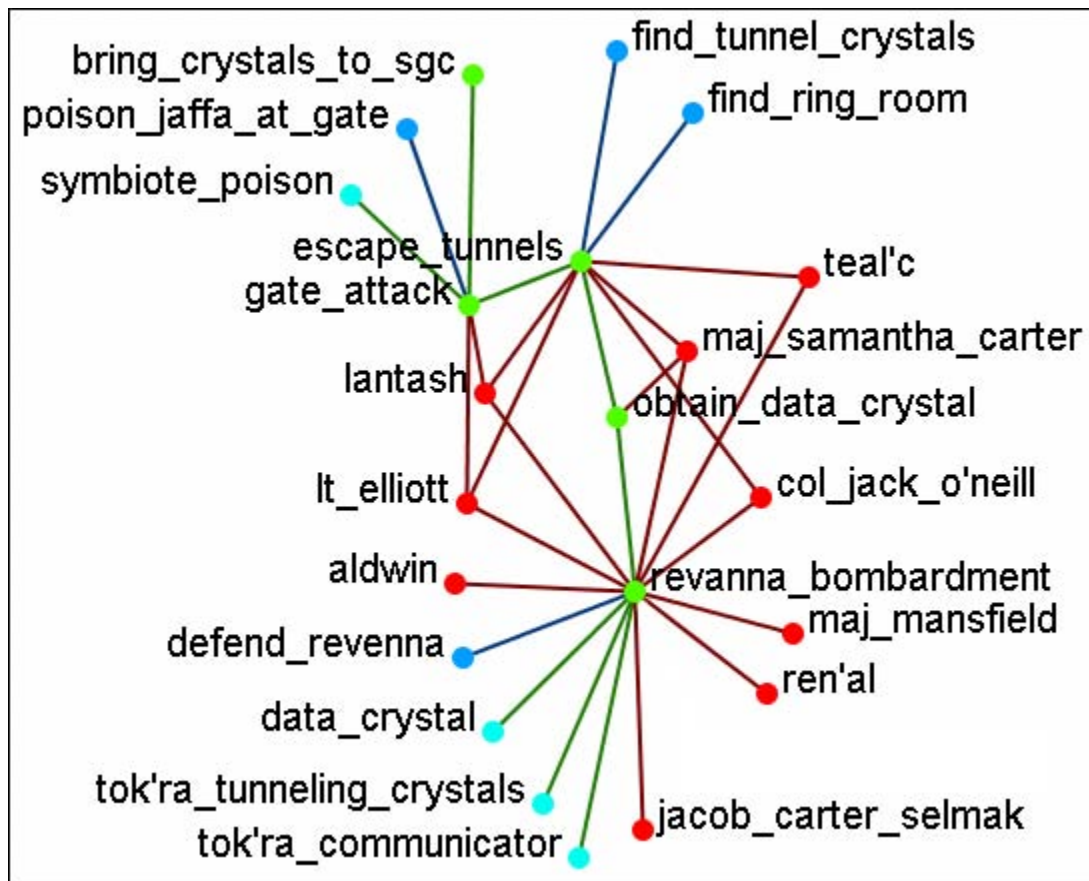
Summit-3

What really happened when Osiris showed up unexpectedly. Instead of poisoning the Summit daniel_jackson decides to forgo that action after hearing the information from Osiris. He's almost found out but still escapes.



Summit-3

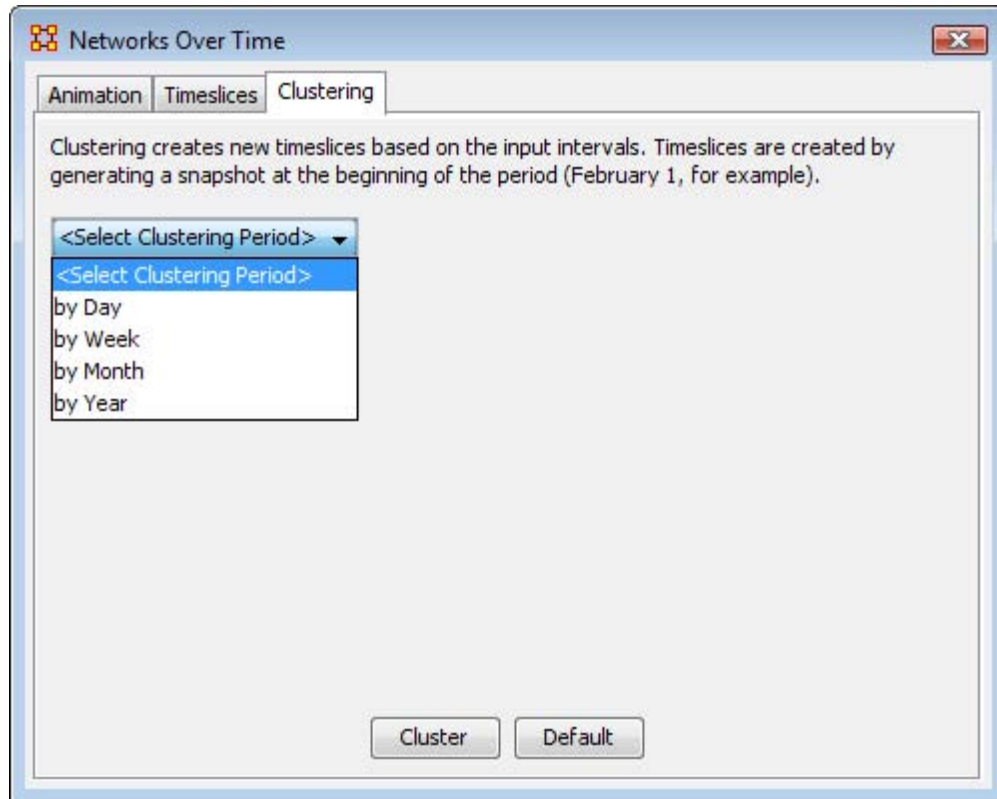
What was happening back on Revanna while daniel_jackson was at the Summit.



NOTE : Measures and reports run on these multi-Meta-Networks are for all connections, not the individual Meta-Networks.

Time Clustering

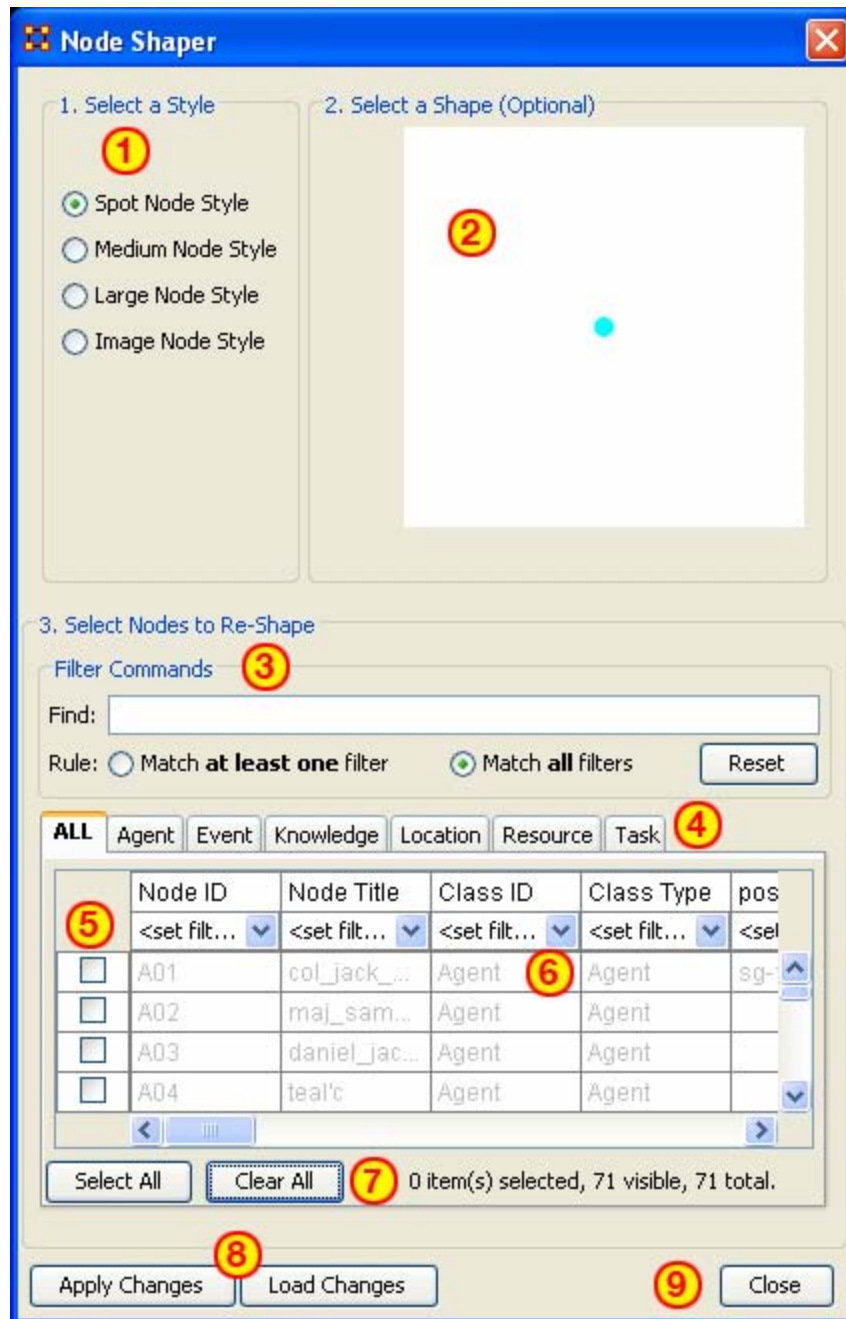
Time clustering is available via the Over Time dialog in the Visualizer. It's a fairly simple panel – there's a ComboBox to select which period you want to cluster by (by Day, by Week, by Month, by Year), and two radio buttons to select what a week begins with (only used when clustering by week). Finally, there's a simple button to cluster.



Clusters are fairly straightforward. It looks at the start date (earliest date available in a set of timeslices) and the end, and grabs snapshots at the given interval, looking at the beginning of that interval. So, if you cluster by month, it'll move through each month, grabbing a snapshot of the 1st day. If no Timeslices exist for that day, it just uses the Timeslice with a date closest to that day without going over.

Node Shaper

The **Node Shaper** allows you to change the size of individual node(s) or assigning pictures. Below is an image of the Node Shaper widow and a description of how to change the shape of the nodes in your model.



1. **Select a Style :** Select from three Node Style Sizes or use an image in its place of the node.
2. **Select a Shape :** An optional shape can be used instead of the NodeSet's default shape. The node will retain its default NodeSet color.

3. **Select Node to Re-Shape** : The bottom section contains the controls for selecting which nodes to work with. Typing anything in the **Find** textbox will automatically filter out non-matching nodes.
4. **NodeSet tabs** : Select which NodeSets to view. **ALL** shows every node or the tabs will show only their individual NodeSets.
5. **Checkboxes** : Place a checkmark in the box next to the nodes you want to change.
6. **Filters** : Use for filtering based on individual attributes. You can filter on more than one attribute at time. An example can be found in [Create a new Meta-Network](#)
7. **Select/Clear All buttons** : Will either **Select or Clear all VISIBLE nodes**. If a check marked node has been filtered out and is currently **NOT** visible when the **Clear All** button is pressed, then that node will retain it's checkmark and be affected by future changes.
8. **Apply/Load Changes** : After any changes have been made to the top portions selecting the **[Apply Changes]** buttons will cause them to be displayed in the Visualizer.
9. **Close** :



What follows are examples of how the **Node Shaper** changes the **NodeSet**.

Whenever the **Node Shaper** is called and a node is assigned something other than it's default shape new attributes will be added to **Every** NodeSet, not just the NodeSet you're working with.

- **Drawing Type** : This will define what type of node is to be drawn, shape of image. There are three options for size (small, medium, and large) and one option for image.
- **Nodes Shape** : There are four large shapes (circle, rectangle, ellipse, and hexagon), eight medium shapes (circle, hexagon, downtriangle, pentagon, diamond, square, uptriangle, and octagon), and one small shape.

- **Image** : Contains the name of the file associated with that node.

Changing one node will **create these three attributes** and place the default value in every node in every NodeSet. Any of these attributes can be manually changed from within the Main Interface Editor.

This is useful if you have changed many nodes and want to restore them all to their defaults quickly and easily. The quickest way is using the [Copy and Paste](#) method.

①	②	③	④
Drawing T...	Drawing T...	Drawing T...	Drawing T...
<set filt... ▾	<set filt... ▾	<set filt... ▾	<set filt... ▾
image	image	medium	medium
image	image	medium	medium
image	image	medium	medium
image	image	image	medium
small	small	small	medium
small	small	small	medium
medium	medium	medium	medium
medium	medium	medium	medium
large	large	large	medium
medium	medium	medium	medium
small	small	small	medium
medium	medium	medium	medium
large	large	large	medium
medium	medium	medium	medium
medium	medium	medium	medium
medium	medium	medium	medium

Column "1" contains the modified values. In column "2" three values of medium are highlighted and copied using **Ctrl-C**. In column "3" the cursor is moved to the top cell and **Ctrl-V** is used to paste those three values in. In column "4" this is repeated until all values are back to their defaults.

If the **Image** attribute contained a filename then changing **Drawing Type** to image will relink that file to the picture. Any of the four **Drawing Type** values can be placed in this column.

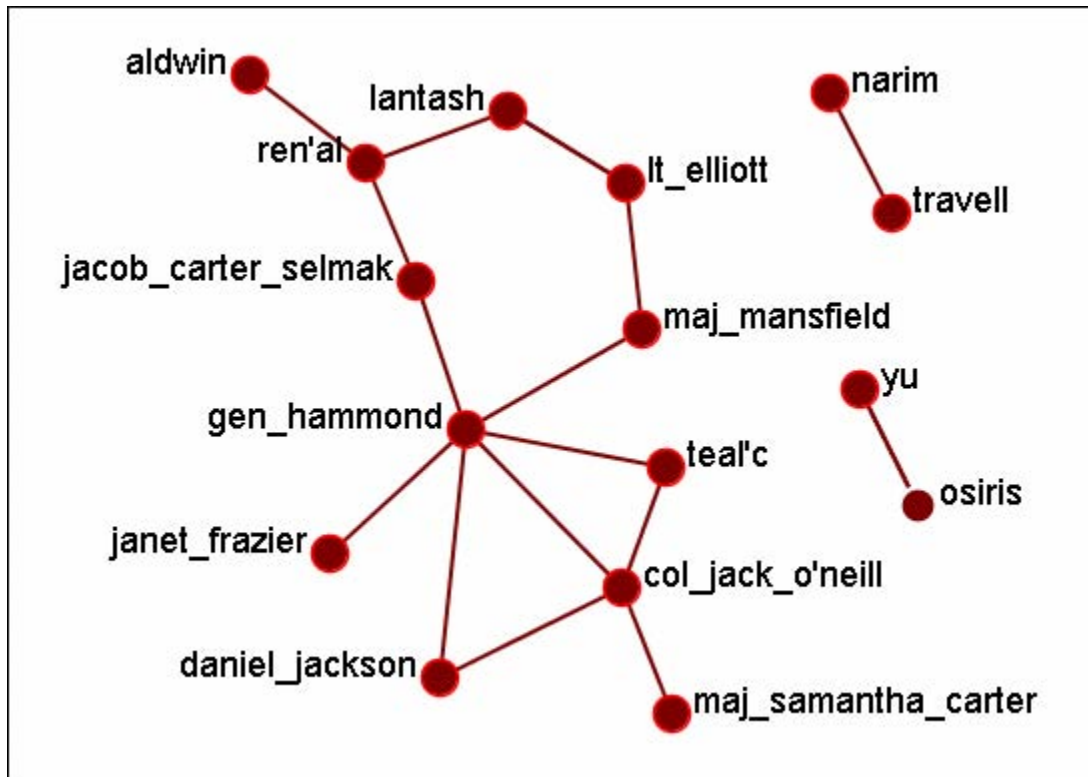


Node Shaper Examples

Original agent x agent Network

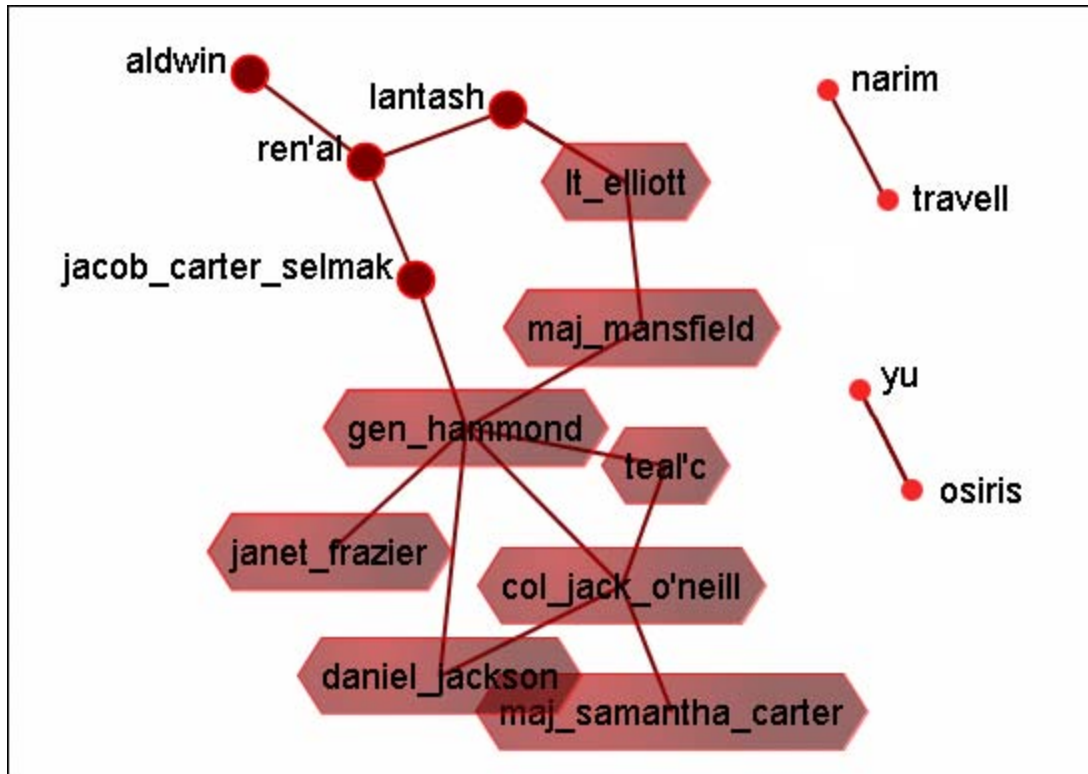
Below is the **agent x agent** network in the normal **medium sized nodes**.

We will proceed to change the shape of the nodes to varying sizes as well as add image and picture icons to the nodes.



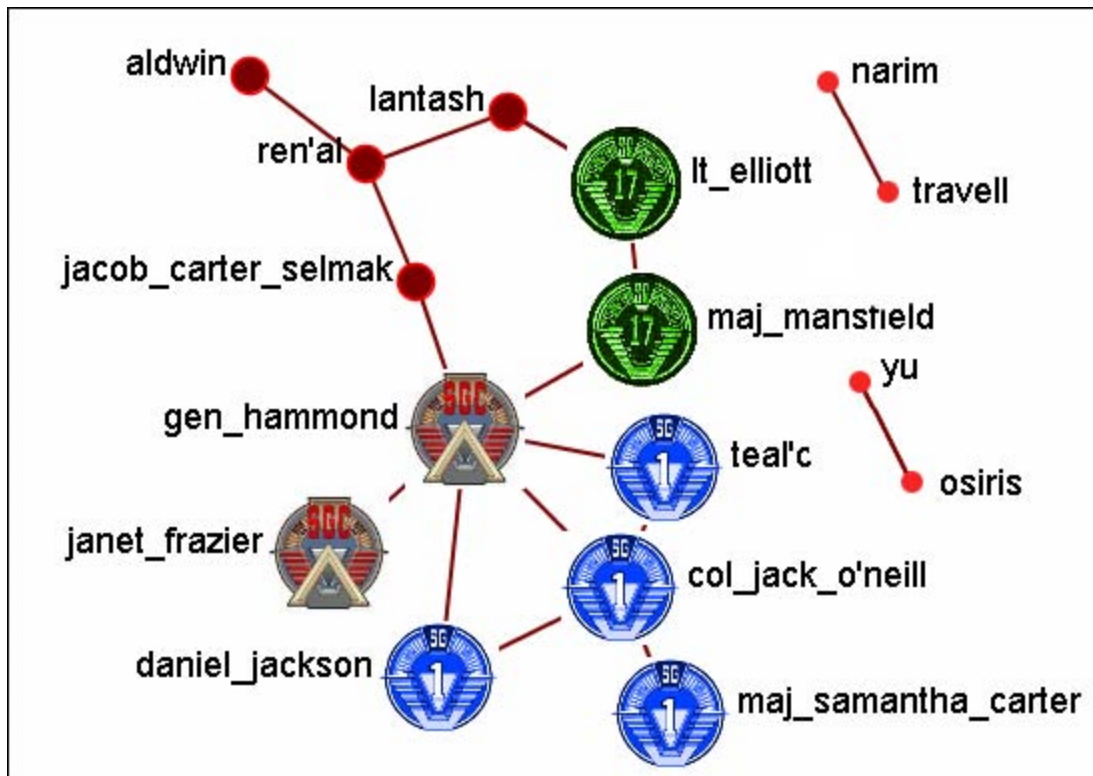
Multiple Sized Nodes

By using the **Find** textbox and the **Filters** I placed checkmarks in all members of the SGC. Then the **Large Node Style** was selected the **[Apply Changes]** button was pressed.



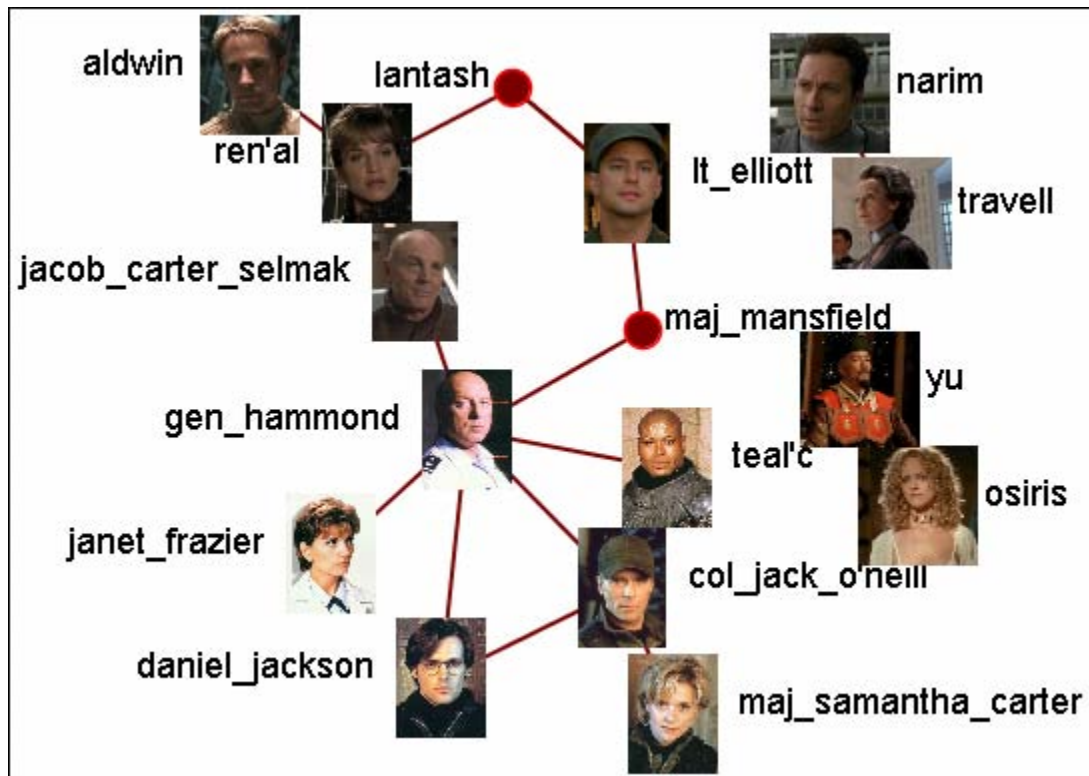
Picture Replacement

Here three different symbols were used to denote 1) the SG-1 team (the blue circles), 2) the SG-17 team (the green circles), and 3) the SGC who are not members of either team. This was accomplished by filtering which group was to be displayed. Then checkmarks were placed and **Image Node Style** was selected. Then for each group an individual picture was applied to all the selected nodes together.



Lastly is the ability to assign a picture of the actual person the node represents (or location, object, etc.).

NOTE : It's suggested that any picture to be used should be reduced to a maximum of 40 x 40 pixels before importing as this is the size ORA will reduce it automatically.



Visualizer Layout Menu



Run Active Layout : Turns on the motion and allows ORA to attempt to sort out the positioning of the nodes.



Stop Active Layout : Turns off the motion and stops all nodes from moving. This allows you to move individual nodes around without disturbing the rest of the Meta-Network.

Spring Embedded Layout : This layout operates fine in datasets of approximately under 500 nodes. Much higher than that and the layout gets sluggish. A single layout iteration could take two minutes or longer. Not really practical.

Spring Embedded (with enhancements for large data) : The enhanced layout with large datasets. It uses the same basic algorithm but has some optimizations built in. With 10k nodes or so, a single layout iteration takes 10 seconds or so.

NOTE : Now you're probably asking *"if this new algorithm is so good, why not keep it on all the time?"* Reason: If you pick up and drag a node, and as such drag an entire meta-network, the display will look jittery and confusing. So, whenever you load in under 500-nodes, the normal version is enabled. More than that, it uses the enhanced version.

Run MDS Layout :



Run Tree Layout :



Run Circle Layout (Pendants to Outside): Takes all pendants and puts them in a circle. All Nodes connected to a pendant are on a circle inside the pendant circle. Repeat until all nodes are in some circle, with the inner most nodes being the farthest from any pendant.



Run Circle Layout (Center is High Betweenness) : Calculate the Centrality-Betweenness for the graph. Take the node(s) with the highest value. Place them in the center. All nodes connected to those nodes get put on a circle surrounding the center. Repeat as necessary.



Run Hierarchical Layout : Tries to layout the network in a pyramid formation so that all arrows either point up or point down.



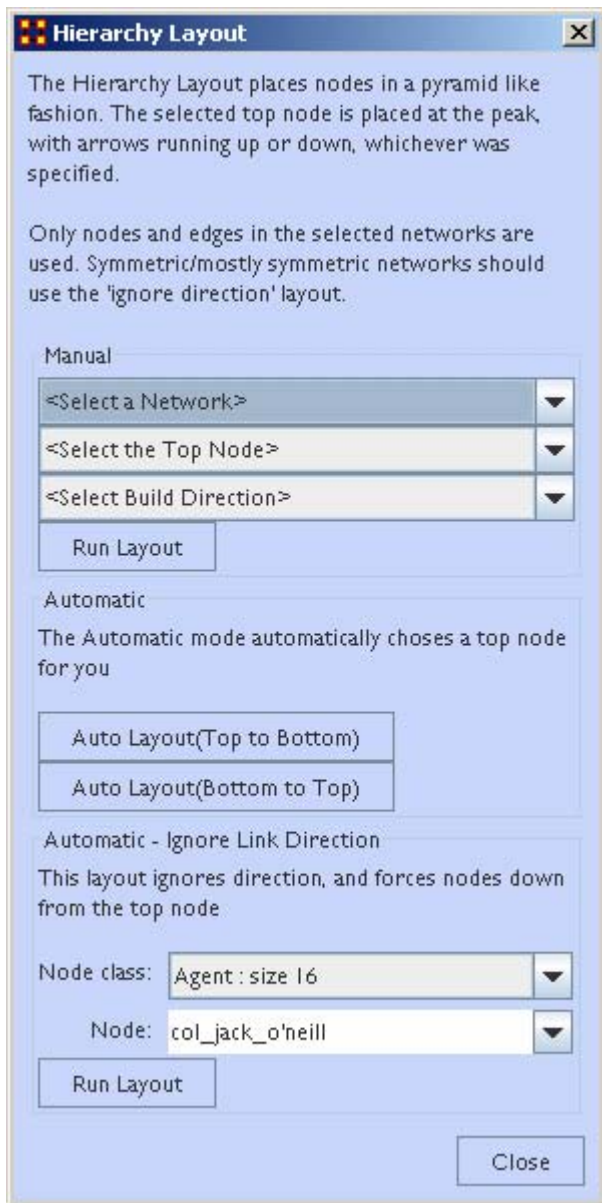
Run Box Layout : More of a Polygon Layout, really. You select 1-4 groups of nodes (either by node type or by node class). Each group is then laid out as one edge of a polygon. 1 Group = circle, 2 Groups = 2 parallel lines. 3 Groups = Triangle, 4 Groups = square



Attribute / Measure Layout : Uses the input attribute and/or measure as the x,y coordinates of the nodes.



Hierarchical Layout



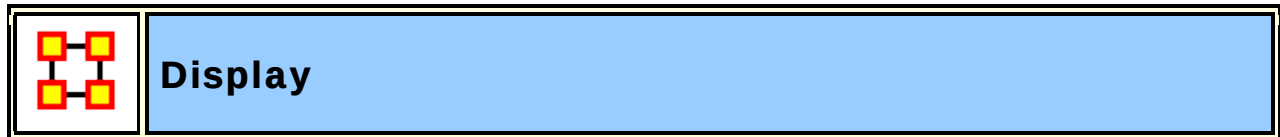
Run Hierarchical Layout :

When selecting the Hierarchical lay out option, you will be prompted for a square network (including the Visible meta-network, since technically its square), and then for a node to use as the **peak** node. Finally, you must choose the desired build direction. This refers to Link direction, since a link could mean **reports to** just as easily as it could mean **commands**.

Arrows always try to maintain their direction meaning, in the event of cycles, for example, we try to minimize the number of arrows that go "against the current", so to speak. It will also will warn you should you try to input a symmetrical network, as those don't really have **bosses** or **subordinates**.

Hierarchy Layout has two buttons, for automatic layout, without having to enter in any data on top nodes. The buttons are to be used depending on what the link between two nodes really constitutes. If it's more of a **Link points to boss** node, building from bottom to

top works best. It links signify who gives commands, top to bottom.



Link Appearance



Link Labels > Show Link Labels : Toggles on/off the display of the labels of the links.



Link Labels > Show Weight Value Labels : Toggles on/off the display of the weight of the links

Link Labels > Show Weight Sign Labels : Sets the label and shows whether their weight is positive or negative.



Link Color > Default : Removes all custom link coloring and resets all links to default.



Link Color > By Link Weight : You can set a range of colors to represent the weight of links. A dialog box allows you to chose the colors for the minimum and maximum weights.



Link Color > Match Source Node : Colors the link the same as the source.



Link Color > Match Target Node : Colors the link to match the target.



Show Multiple Links Between Nodes : For any two (or more) links that link the same two nodes (usually because two nodeclasses have two or more graphs linking them), this causes to not be rendered as a straight line, but rather allow for each link to be curved, making every single link visible.



Retain Bidirectional Links : When two nodes have links to each other only one link will be displayed.



Split Bidirectional Links : When two nodes have links to each other only both links will be displayed. These links will be rendered as curved links between the nodes.



Show Links : Toggles on/off the display of links between nodes.

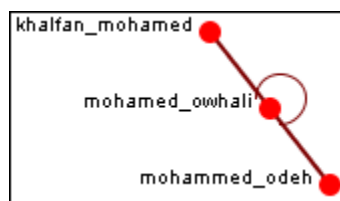
Scale Link Width to Number of Links Between Nodes :
Adjusts the width of the link to represent the weight of the link.



Show Arrows : Toggles on/off the display of the arrows of the links.



Show Self Links (Loops) : Shows whether there is a connection between a node and itself. It is designated with a circle pointing back to itself.



Node Appearance

Label Style > Default : Sets the label to appear to the right of the node. This is the default position for labels.

Label Style > On Right of Node : Sets the label to appear to the right of the node.

Label Style > On Left of Node : Sets the label to appear to the left of the node.

Label Style > On Top of Node : Sets the label to appear on top of the node.

Label Style > On Bottom of Node : Sets the label to appear beneath the node.

Label Style > Centered on Node : Sets the label to appear directly centered on the node.



Node Style > Toggle Node Size : Rotates between the three sizes and styles for the display of the nodes.

Node Style > Spot : Sets the size of all nodes to a small colored circle.

Node Style > Small Shapes : Sets all nodes to a colored shape (circle, square, triangle, pentagon, diamond, hexagon).

Node Style > Large Shapes : Sets shape of nodes to a colored shape only large enough to contain the label.

Comments



Show Comments : Toggles on/off the display of comments



Set Comments Font : Sets the font used in Visualizer comments.



Set Comments Color : Sets the color used in Visualizer comments.

Title

Title Location > Top : Sets the Title to the top of the Visualizer window.

Title Location > Bottom : Sets the Title to the Bottom of the Visualizer window.

Title Location > Left : Sets the Title to the left of the Visualizer window.

Title Location > Right : Sets the Title to the right of the Visualizer window.

Title Location > Center : Sets the Title to the center of the Visualizer window.

Set Title : Create a title for a screen shot. The title will remain a static size and retain its position regardless of the zoom of movement of the display.

Set Title Font : Set the font used in the title of the screen shot

Show Title : Toggle visibility of the title.

Log Scale Nodes :



Show MouseOvers : Toggles the information boxes on and off whenever you hover the mouse over a node or link in the Visualizer.



Autozoom : Zooms the display either In or Out to bring all nodes into view.



Background Color > Black : Sets the Visualizer background to black.



Background Color > White : Sets the Visualizer background to white.



Background Color > Custom : Brings up the color picker which allows you to chose any color for the background.

NOTE : *Some of the possible background colors can make it difficult to view the Visualizer. Your best choice is black (although white is used in the examples for easier printing).*

Background Image > Load : Allows you to chose a **.jpg, .gif, or .png** to use as a background.

NOTE : *Some pictures may make viewing the network somewhat difficult.*



Background Image > Clear Image : Removes the image and returns the background to the last background color used.



Black and White Only : Removes all colors form the Visualizer.



Grayscale : Removes the hue from all nodes and links displaying them as shades of gray. If any of the nodes are difficult to read try changing the background color to a darker or lighter color. A black background works very well for grayscale images.



Reset Node /Link Options : Resets all node and link colors back to default.



Link Color

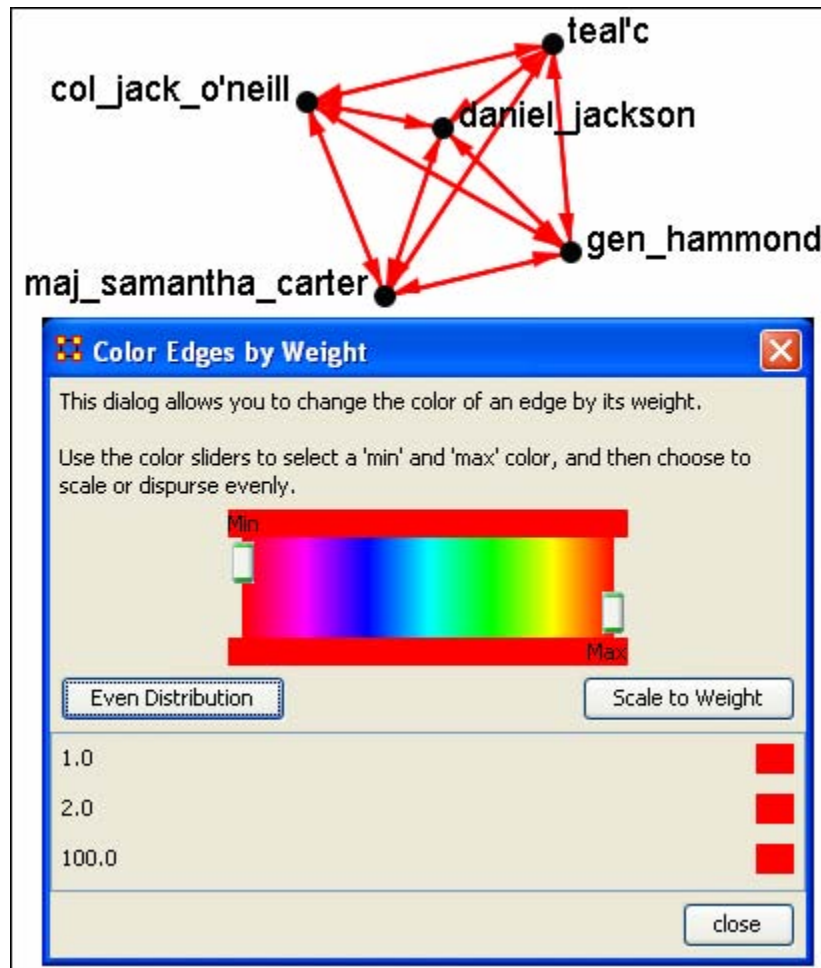
In ORA you can color links according to several preferences. Below are the procedures for doing so.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	0.0	1.0	2.0	1.0	2.0
maj_samant...	2.0	0.0	1.0	2.0	1.0
daniel_jackson	1.0	2.0	0.0	1.0	2.0
teal'c	2.0	1.0	2.0	0.0	1.0
gen_hammond	100.0	100.0	100.0	100.0	0.0

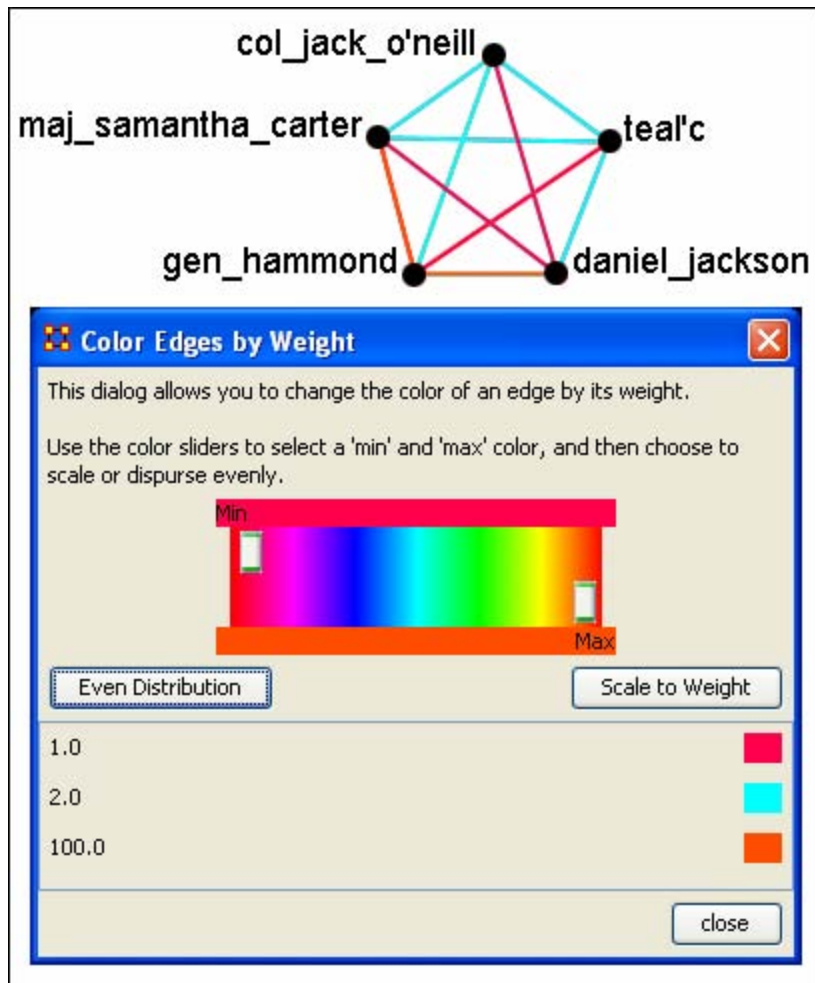
NOTE : For this example all the nodes are colored black so as to decrease the color confusion.

NOTE : For this example the link weights have been drastically altered from the original values to assist in display purposes.

NOTE : Below is a warning for the placement of the **Min** and **Max** sliders. When the sliders are set to the absolute left and right positions this causes all the colors to be set to red. Move the sliders in to prevent this.

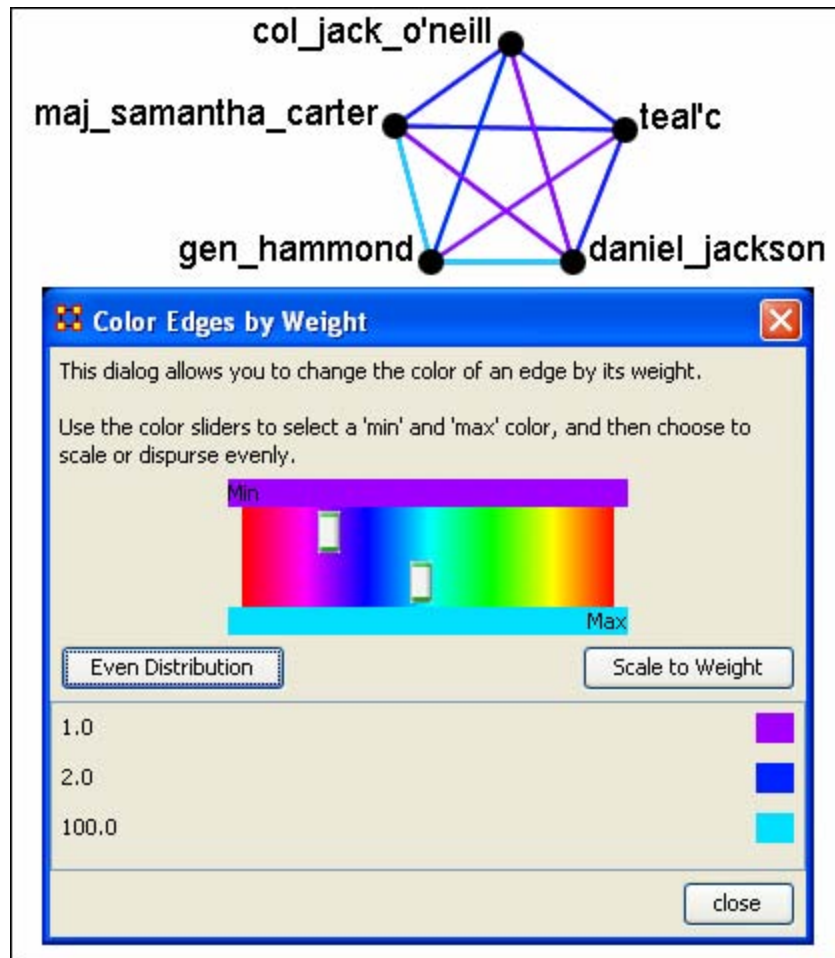


Even Distribution - The Full spectrum



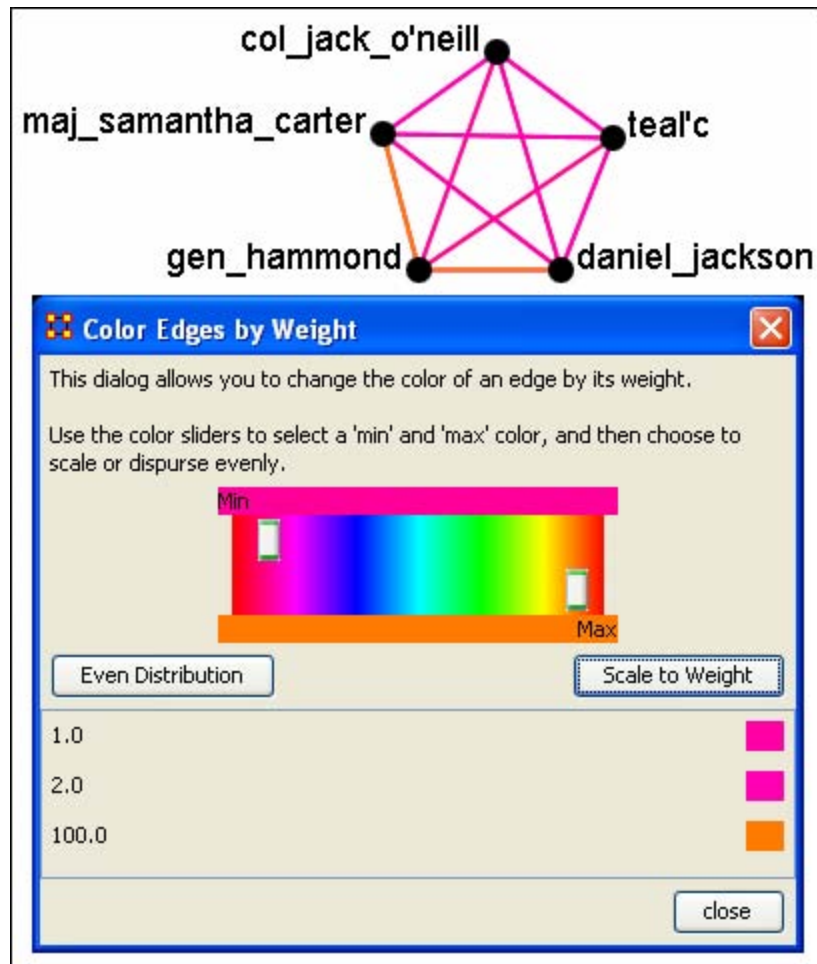
The colors used are evenly distributed across the chosen spectrum. Using a NodeSet with weights of 2, 4, 6, 8, & 10 would have three colors chosen at evenly spaced intervals across the spectrum.

Even Distribution - The Limited spectrum



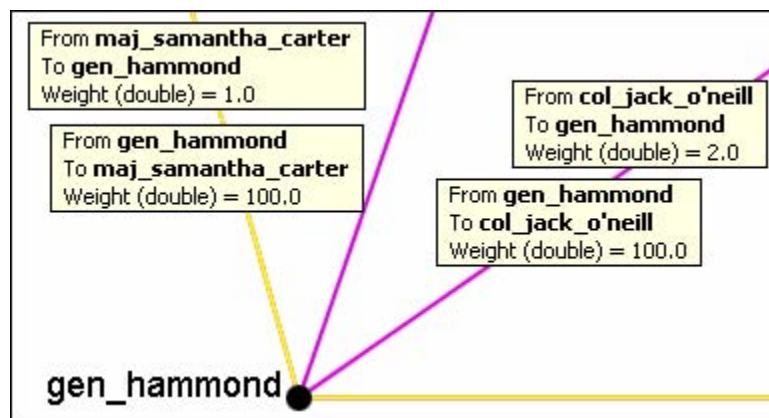
Limiting the spectrum to smaller set will cause some of the numbers to contain very similar colors. This might make it difficult to tell the various shades of blue apart. Use this only when there are a very limited number of values.

Scale to Weight



When scaling to weight the **100** values cause a spread to occur that makes all other values in the same general color area.

Link Values



When a link is bi-directional and the weights of the links are not the same the Visualizer will color the link that was drawn last.

Change link Color

After setting the type **Even Distribution / Scale by Weight** the color of the links can be set manually through the color changer. Click on the color box of any of the links to bring up the color change dialog box. Select a new color and select **[OK]**.

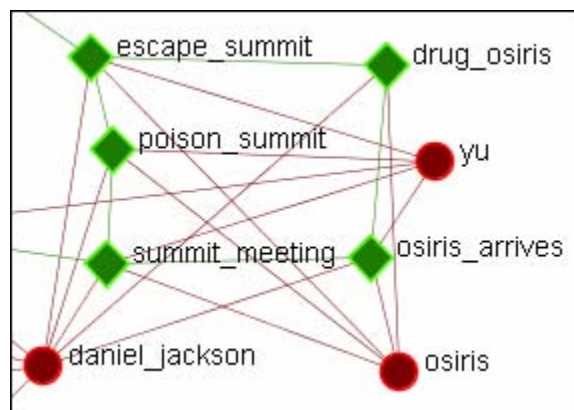


While in the Visualizer **Comments** can be added to the display. Right-click a node and from the contextual menu select **Add Comment**. The comment is placed in a colored box with a dashed arrow connecting them to the original node.

NOTE : These comments are not saved when exiting the Visualizer.

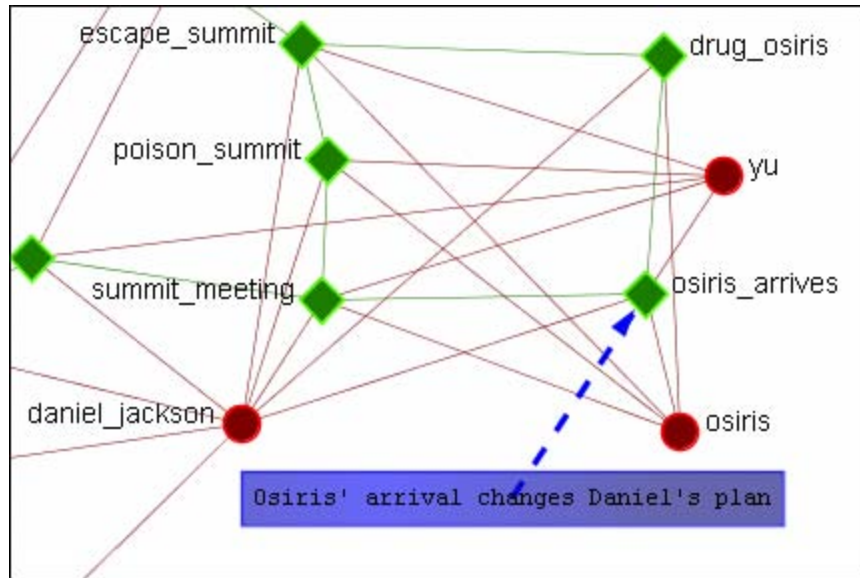
NOTE : The main use of these comments would be in creating screenshots for display in order to add commentary for a report.

Below is a section of the Stargate scenario with the unexpected appearance of Osiris.

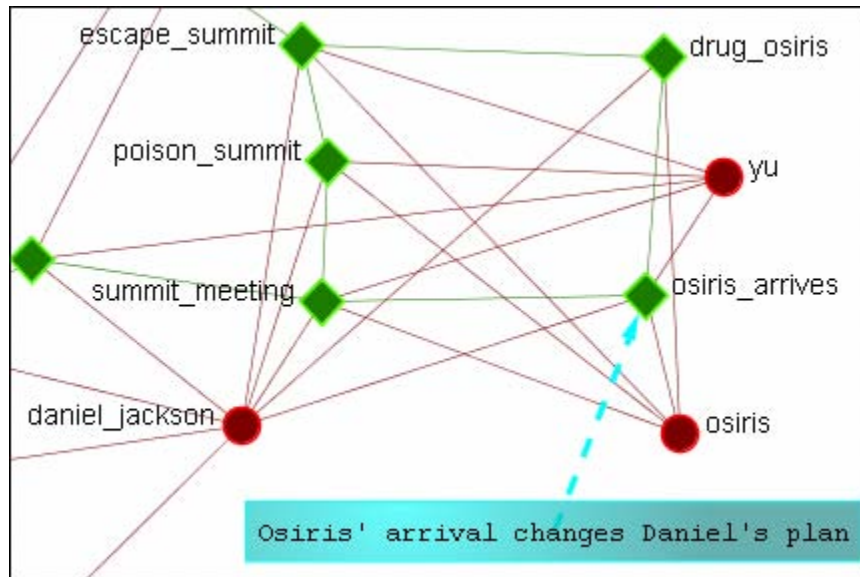


Adding a Comment

A comment is added stating Osiris's arrival changes the plan.

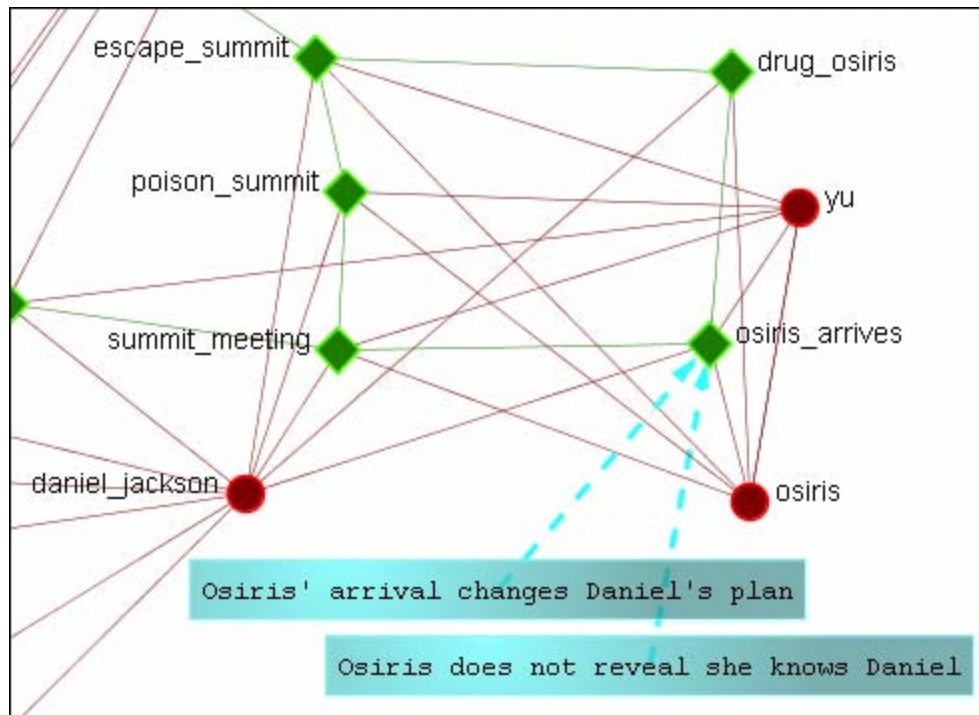


From the main menu, under the Tools item, the font size and color, as well as the color for the box, can be changed.



Adding Multiple Comments

It is also possible to add multiple comments to the same node.



REMEMBER: These comments are not saved when exiting the Visualizer.

Deleting a Comment

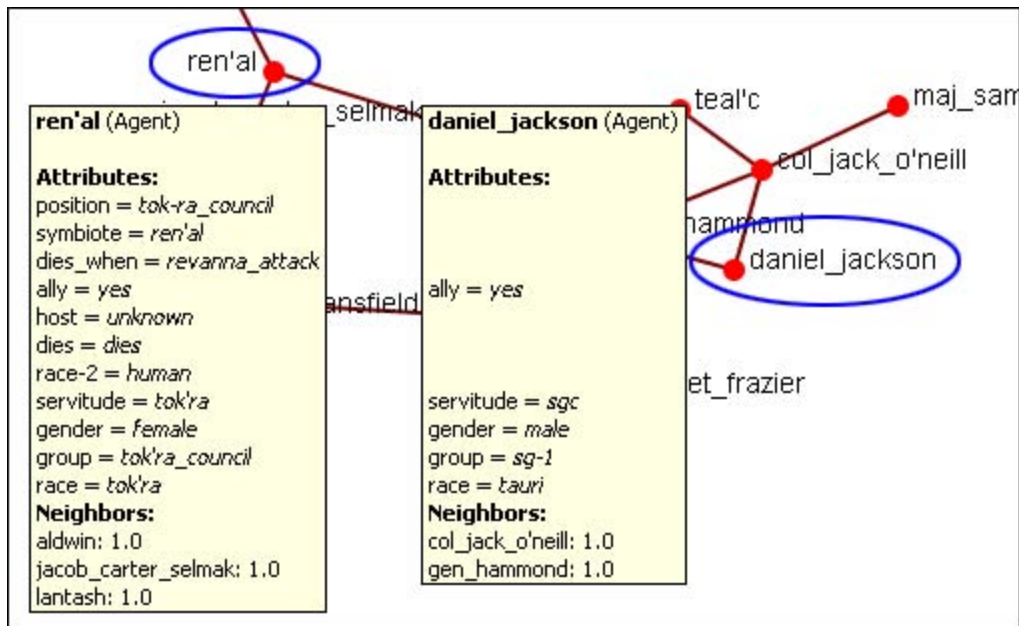
A comment can be deleted by first selecting that comment. A right-click brings up the contextual menu. From this menu select **Delete Selected Node(s)**.



NOTE : To access the contextual menu the option must be checked.

Go to **Display** >  **Show Mouse Overs** and make sure the option is checked.

When the pointer is passed over any Node in the Visualizer a **yellow tooltip box** will appear showing information on links to other nodes as well as values for measures that have been run. Below is a screen shot comparing two MouseOvers.



If an **Attribute** is empty ORA will leave a blank line for that attribute. Only if the attribute has a value will it be displayed. **Neighbors** are all the links to other nodes.



Nodes can be replaced with various symbols or pictures to make it easy to identify individual nodes. There are a few items to note.

All images should be reduced to approximately **50 x 50 pixels** before using in ORA. Bigger images will be reduced in size on the display and the image quality may possibly be degraded.

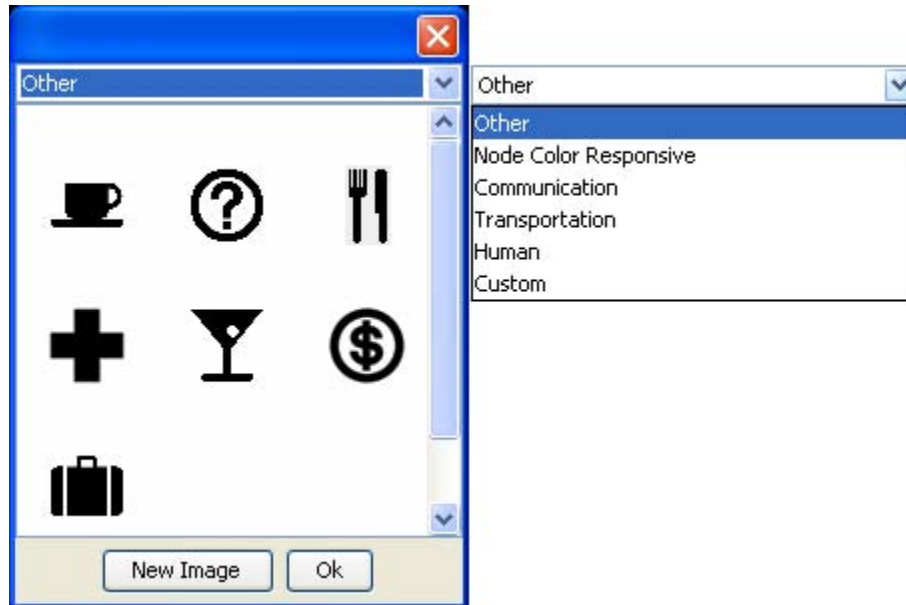
If a picture is placed on a background with the color **R=255, B=0, G-192** the background will be changed to the color of the node.

Setting a Image Folder

The Set Picture option is designed with modularity in mind, with adding new images as easy as putting a folder with images in the **include\OraFiles\images\Visualizer\node** folder. The dialog will automatically read that folder for subfolders, use the subfolder names as categories, and the images inside the subfolders as the images for each category.

Set Picture

Right-click any node and select from the contextual menu **Appearance Submenu > Set Picture**. The Node Selector dialog box will appear. The drop down menu contains various types of node images. With a node selected a custom image can be applied. Nodes with Images will scale.



Custom

The **Custom** option allows for the inclusion of a user's own icons.

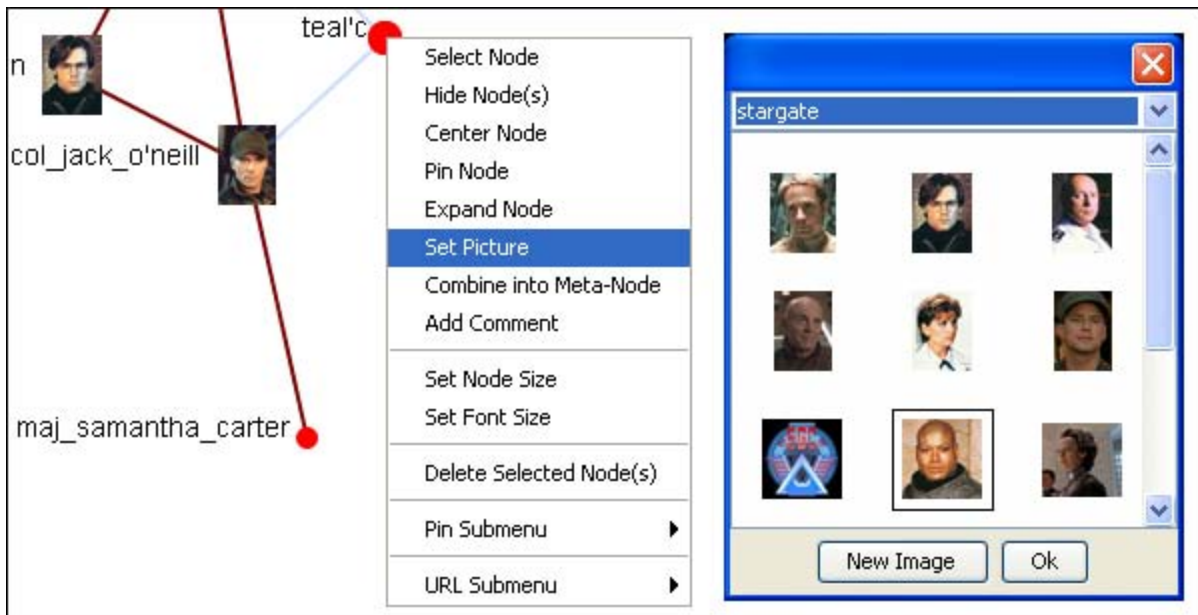
The custom category is used for images that have been previously loaded in the current meta-network. Clicking OK applies the currently selected node's image to all nodes selected in the Visualizer.

Additional information can be found in the [Node Shaper](#) section.

The **[New Image]** button brings up a navigation box from which to navigate any directory and select an image file. The picture types can be **jpg/jpeg, gif, or png**. These will all be collected into the **Custom** section.

NOTE : Remember to reduce the picture size BEFORE importing it into ORA.

To set a new image right-click the node and select **Set Picture**. This brings up the picture dialog box. Locate the appropriate picture and select it. A black border will appear around the image. Select **[OK]** will set the picture to the node.



Visualizer Contextual Menus

The Contextual Menu is displayed by right-clicking on a Node or Link. It contains many standard uses in manipulating nodes and links.

Node Menu

Pin SubMenu :

Pin All Nodes : Globally pins all nodes. Nodes are unaffected by the **[Play]** button or the movement of other nodes.

Unpin all Nodes : Frees all nodes from being pinned.

Pin Selected Node(s) : All selected nodes will become **pinned**

Unpin Selected Node(s) : All selected nodes will become **unpinned**.

URL SubMenu :

Attach URI : You can attach a URI to the selected node.

Go To URI : Activates your browser and goes to the URI associated with this node.

Appearance Submenu :

Picture : You can replace the node shape with a picture.

Node Size : You can numerically set the Node Size of an individual node.

Font Size : You can numerically set the Font Size for an individual node.

Enlarge : Increases the size of the selected node in the Visualizer

Shrink : Decreases the size of the selected node in the Visualizer

Brighten : Lightens the shade of the color of the selected node

Darken : Darkens the shade of the color of the selected node.

Hide Labels : Hides the label of the selected node

Show Labels : Reveals the label of the selected node

Visibility Submenu :

Hide Node(s) : Removes the selected node (along with all links) from view in the Visualizer.

NOTE : *This does not delete the node from the Meta-Network.*

Hide Adjacent Node(s) : Hides all nodes that are linked to the selected node. The selected node remains visible.

Other :

Color Adjacent Edges : Allows you to chose the color for all links associated with the selected node. Only works on one node at a time.

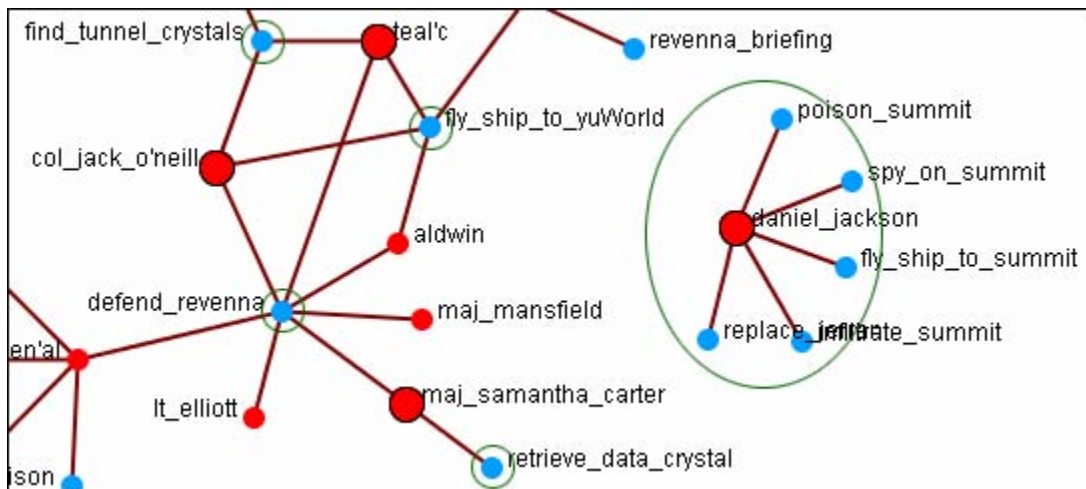
Select Node : Registers the node as **selected** when ORA affects multiple nodes.

Center Node : Brings the selected node to the center of the Visualizer.

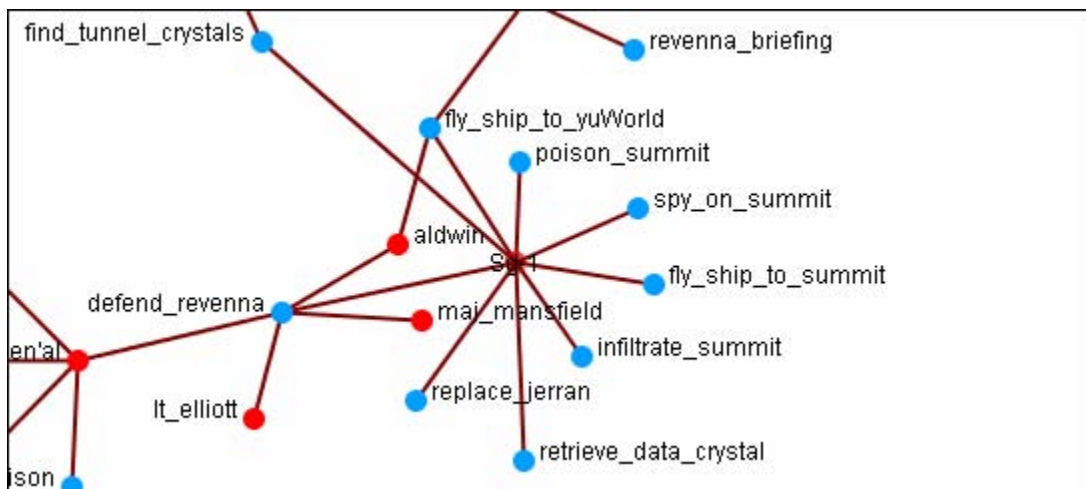
Pin Node : Pins node to background so it is unaffected by the movement of other nodes.

Expand Node : Shows all nodes and links connected to the selected node.

Combine into MetaNode : Multiple nodes can be selected and combined into a **Meta-Node** which will contain links to all the nodes that the individual nodes had. The four large circles of SG-1 are selected. The and green circles show which tasks are associated with these agents. Press, and hold, the Control key while selecting each node for the Meta-Node. Then **without releasing the Control key**, right-click one of the nodes to bring up the contextual menu. Select **Combine into Meta-Node**.



After combining the **task nodes** that were linked to the individual nodes are now linked to the **sg-1 Meta-Node**.



NOTE : If additions or deletions of NodeSets needs done expand the Meta-Node before proceeding.

Add Comment : Attaches a comment to the **currently selected node**. Good for making notes for display purposes. Comments can be toggled to be

shown or hidden from the Display menu. The color and font of the comments are also controlled from the Display menu.

Delete Selected Node(s) : Allows for the deletion of nodes from a Meta-Network from within the Visualizer.

NOTE : *This deletion is permanent once the Meta-Network is saved. If there is any question regarding the deletion then remove the Meta-Network from ORA before saving and reload the Meta-Network.*

Link Menu

Link Status : Brings up the Link Status box with information on its weight, the network, source and target nodes, source and target nodeset.

Hide Link : Hides the link. This does not delete the link.

Set Value : Set a new value for a link.

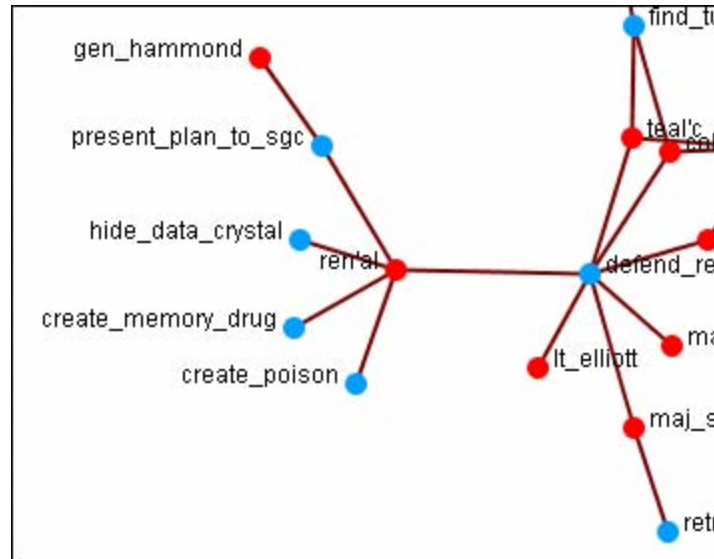
Reverse Direction : Reverses the **Source** and **Target** aspects of the link.

Delete Link : Removed the link from the Network.

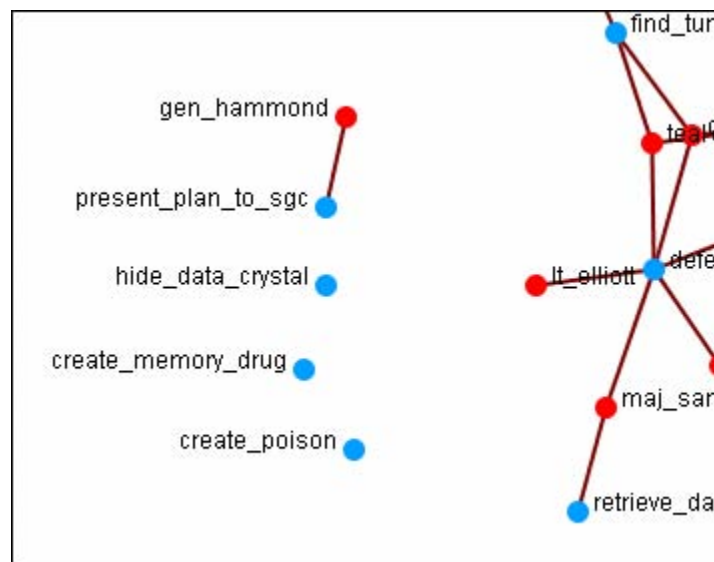


You can remove nodes directly from the ORA Visualizer by right clicking on a node and selecting **Hide Node**. Below is an example of removing a node using the Hide Node tool.

Find the node you want to hide. Here we will hide **ren'al**.



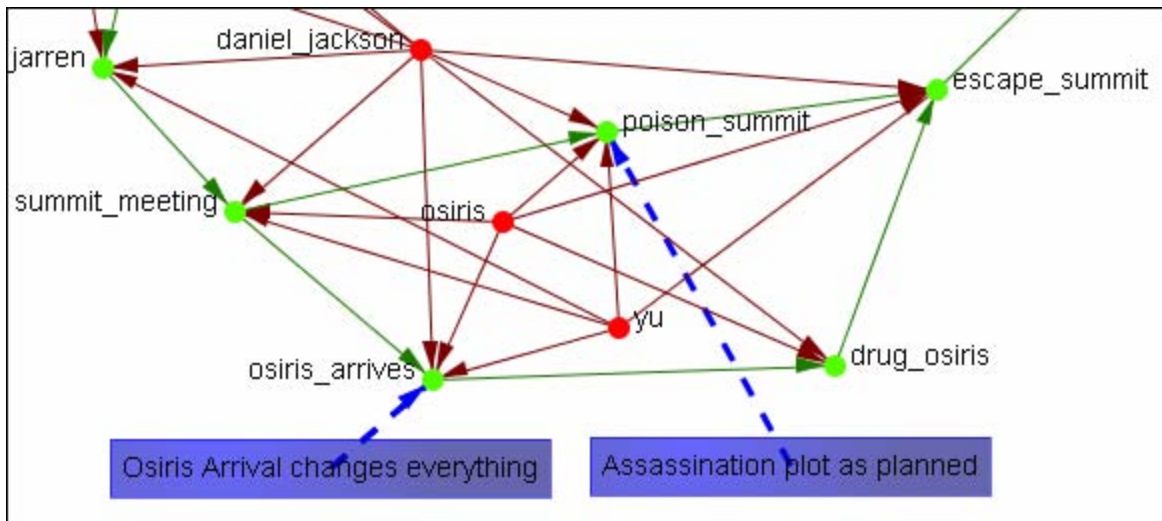
Place the cursor over the node and **right-click** on the node to bring up the contextual menu. Highlight **Hide node**. **gen_hammond** and the four task nodes are now separated from the rest of the network.





Comments

Add Comment : Attaches a comment to the **currently selected node**. Good for making notes for display purposes.



Mouse Menus

Right clicking any node in the Visualizer brings up a menu of the most useful tasks concerning nodes.

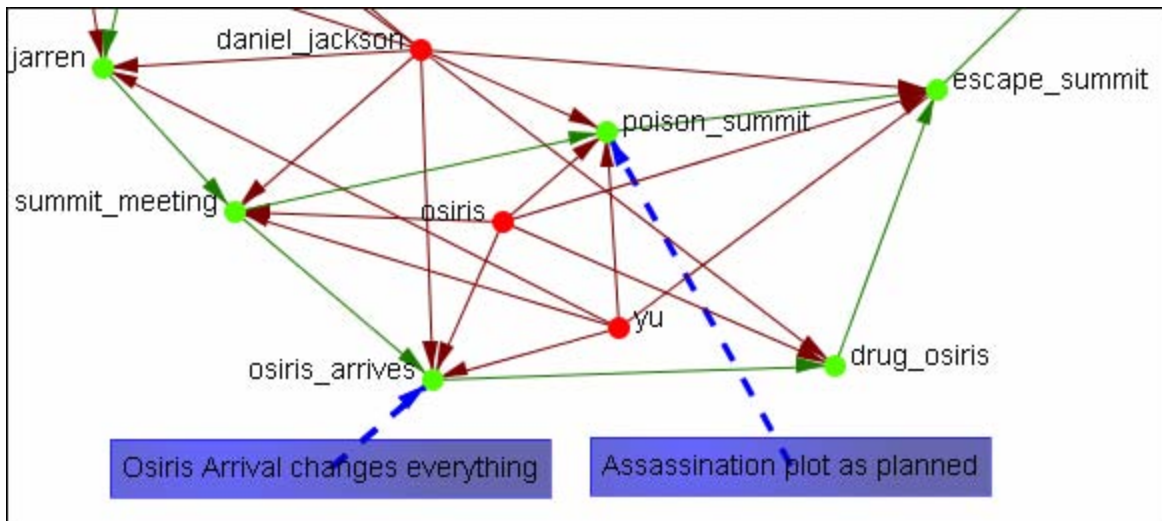
The Pin Node Submenu : Allows you access various function involving **pinning and unpinning** nodes in the Visualizer

The URI Submenu : Allows you to attach a URI to a node or go to a URI already attached to a node.

The Appearance submenu : allows you to control the size of the individual node and font, brighten or darken it's color, or show or hide an individual label. You can even assign an individual picture to a node which is helpful when you are familiar with the agents, locations, or items.

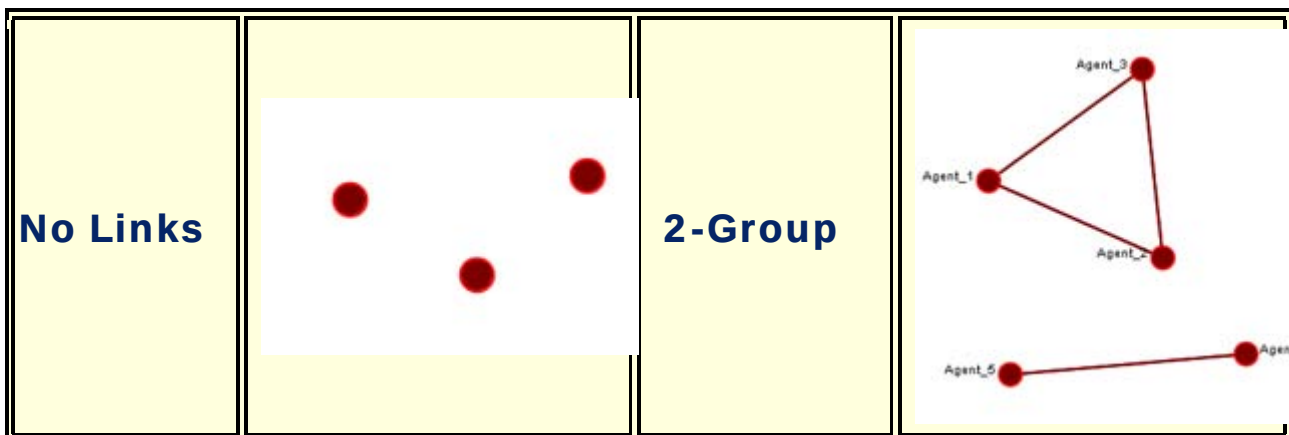
MetaNodes : After selecting two or more nodes you can combine them into a single MetaNode and give that MetaNode a name. If necessary you can also Expand that MetaNode into its individual nodes.

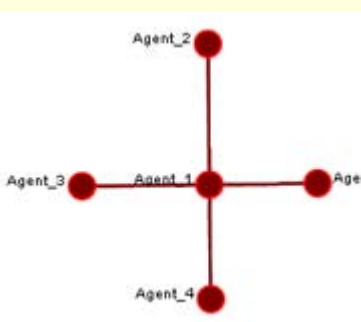
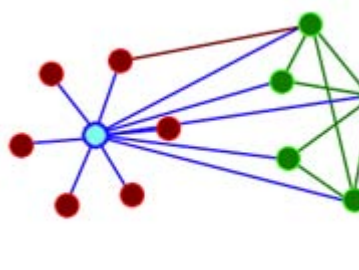
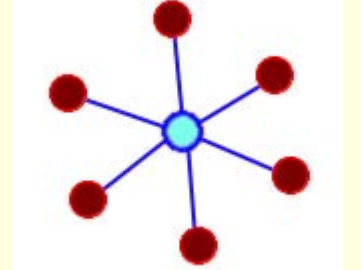
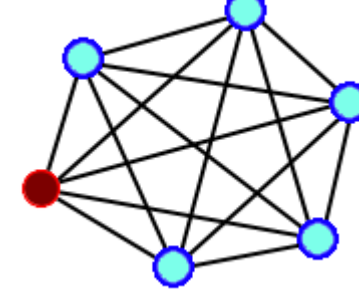
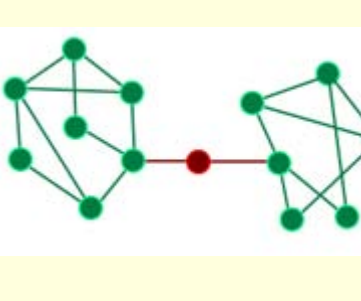
Comments : You can add or delete comments for any node in the Meta-Network.



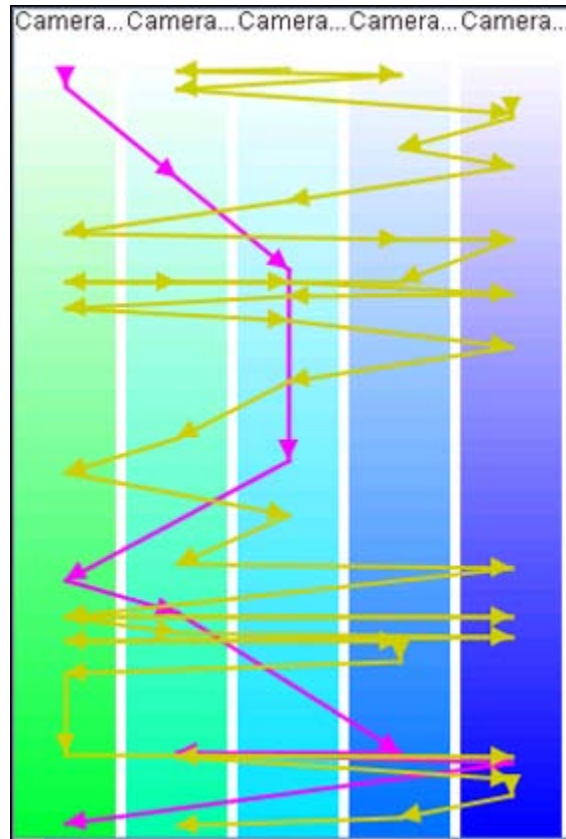
Visualizer Patterns

This is a list of common patterns that can make it easier to find various clusters as the underlying structure of your network.



Bowtie		Chain	
Circle		Star	
Cognitive Demand		Degree Centrality	
Eigenvector or Centrality		High Betweenness and No Degree	

 **Loom** also deals with nodes in locations but is keyed on the timeframes in which nodes appear. There are locations in which two agents appear in but which were there at different times and never met.



GIS

The GeoSpatial Visualizer differs from the 2D Visualizer as it places nodes on a representative map whereas the regular Visualizer allows the nodes to float freely in a **non-space**.

Many **Geospatial information system (GIS)** products apply the term geospatial analysis in a very narrow context. In the case of vector-based GIS this typically means operations such as map overlay (combining two or more maps or layers according to predefined rules), simple buffering (identifying regions of a map within a specified distance of one or more features, such as towns, roads or rivers) and similar basic operations. The Geospatial Network tool in ORA allows for the plotting of a Meta-Network on a map of the globe using **longitude** and **latitude** for placing the nodes.

This **longitude** and **latitude** is associated with a **location** nodeclass. Then other nodeclasses are associated with the location nodeclass. This information is used to place people and items on the map.

Below is the default map included with ORA's GIS tool.



NOTE : Other maps, or layers, can be added and loaded into the GIS Visualizer. The GIS Visualizer generally can load geospatial maps based on the **Shapefile** format.

The ORA Geospatial Visualizer can be accessed from either the main menu bar: **Main Menu Bar > Visualization > Geospatial Networks** or by clicking the triangle on the Visualizer button in the Editor.

Geospatial Networks attributes

The Meta-Network **MUST** contain a **location Node Class** and that Node Set **MUST** contain **longitude** and **latitude** data. Below is an example of a **Location** node class information that contains Longitude and Latitude as attributes.

Location	COUNTRY	POP	CAP	LONGITUDE	LATITUDE

Murmansk	Russia	468000	N	33.0860405	68.96355
Arkhangelsk	Russia	416000	N	40.6461601	64.52067
Saint Petersburg	Russia	5825000	N	30.4533272	59.95189
Magadan	Russia	152000	N	150.780014	59.571
Perm'	Russia	1160000	N	56.2324638	58.00024
Yekaterinburg	Russia	1620000	N	60.6101303	56.84654
Nizhniy Novgorod	Russia	2025000	N	43.94067	56.28968
Glasgow	UK	1800000	N	- 4.26994753	55.86281
Kazan'	Russia	1140000	N	49.1454659	55.73301

NOTE : The columns which are necessary to build a **Location Node Class** are highlighted in Blue. In this example below, COUNTRY, POP, and CAP are not necessary, though they can be added, as additional attributes. Further below this chart, we will display how a location node set will appear in ORA's editor.

Longitude and Latitude Format : The longitude and latitude use the **degree.minute** format. **Longitude** begins at the prime meridian which runs through Greenwich Village and run eastward 360 degrees. You can also denote the longitude values with positive or negative (-) numbers between 0 and 180. **Latitude** uses a 0-point which begins at the equator and runs to 90 to the north and -90 to the south.

	Node ID	Node Title	ethno-reli...	friendship	latitude	longitude	political-le...
	<set filt...	<set filt...	<set filt...	<set filt...	<set filt...	<set filt...	<set filt...
☐	afghanistan	afghanistan			34.28	69.11	
☐	africa	africa					
☐	airport	airport					
☐	britain	britain	christian	friend	51.36	0.05	liberal
☐	cape_town	cape_town					
☐	dar_es_sal...	dar_es_sal...					
☐	darfur	darfur		friend	12	24.45	
☐	egypt	egypt	sunni	friend	30.01	31.14	
☐	europa	europa		friend			liberal
☐	farm	farm		friend			
☐	indonesia	indonesia	sunni	friend	6.09	106.49	liberal
☐	israel	israel	jewish	friend	31.71	35.1	
☐	karachi	karachi					
☐	kenya	kenya		friend	1.17	36.48	
☐	lebanon	lebanon	sunni	friend	33.53	35.31	
☐	liberia	liberia			6.18	10.47	
☐	london	london	christian	friend	51.36	0.05	
☐	manhattan	manhattan	christian	friend	40.47	73.58	liberal



 The GUI contains tools to work with the GIS maps. You can also customize the toolbar with functions from the menu.

Standard Toolbar



Copy Image to Clipboard : Places a copy of the current map in the clipboard which can be pasted into another program.

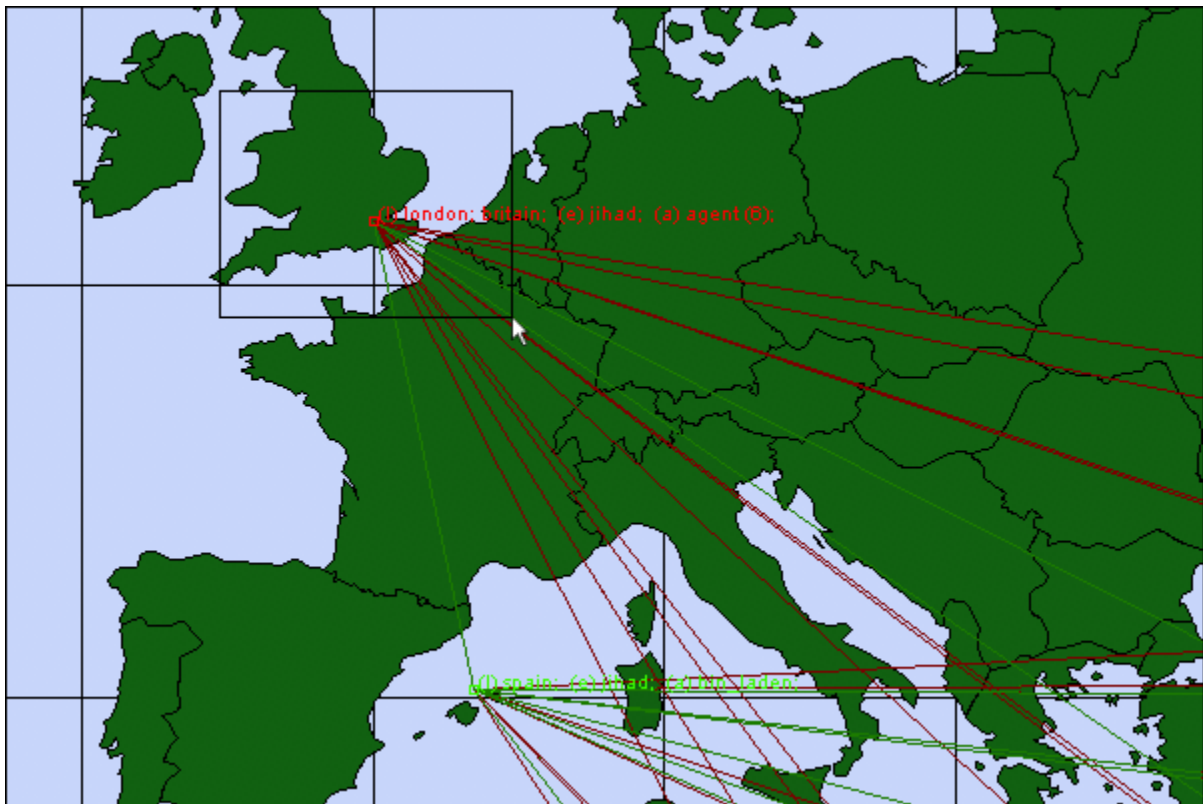


Pan Map : Place the cursor on the map and click the button. The map will re-center on those co-ordinates.

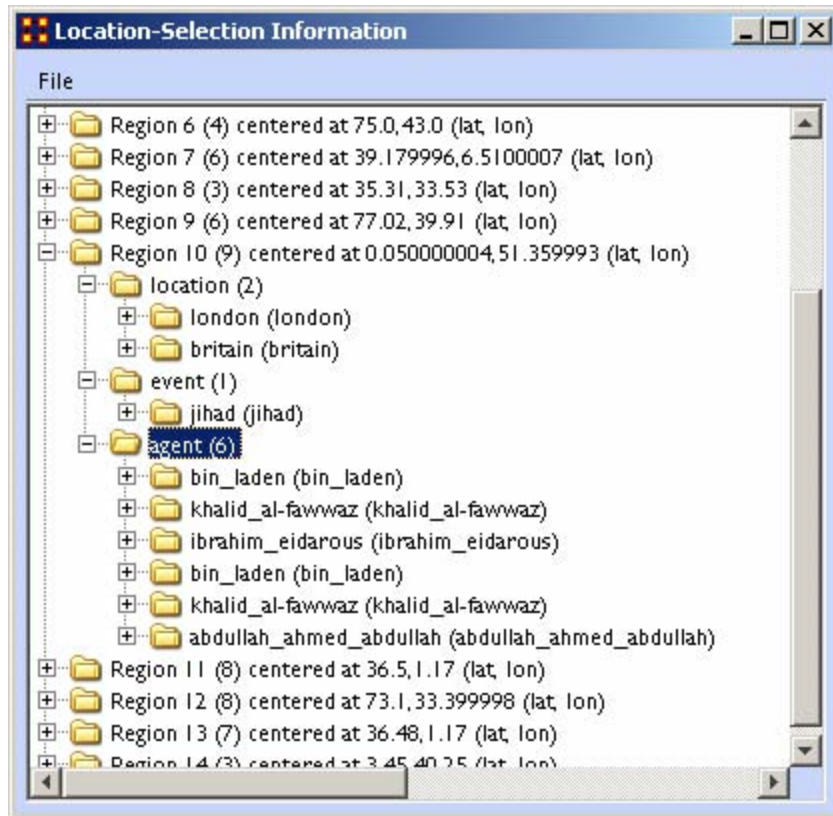


Select Place : Click and drag to capture nodes for information to display in an information window. This information will be displayed in an expanding tree format. Click and drag the cursor

to include the nodes to display.



A pop-up window will display information for all the nodes captured by the cursor.



Zoom In : Zoom In works in two ways. 1) Click and drag to select the area you want to zoom in on. The selected area will fill the GIS window. 2) Click the map once and the view will zoom in centering on the clicked area. This can be repeated until you zoom in as close as needed.



Zoom Out : Place the cursor on the map and click the button. the map will zoom out and re-center on those co-ordinates.



Show Labels : Toggle the labels on & off.



Show Links : Toggle the links on & off.



Show Arrows : Toggle the arrows on & off.

Font Size : Increase or decrease font size using the up & down arrows.

Node Size : Increase or decrease node size using the up & down arrows. The size of the node is proportional to the number of entities in a location.

Link Width : Increase or decrease link width using the up & down arrows.



 The GeoSpatial file menu allows you to open, add, and save map data.



Open Meta-Network... : Opens a **NEW** Meta-Network file into the Geospatial map. REMEMBER: The new file needs to have both **longitude and latitude** data.

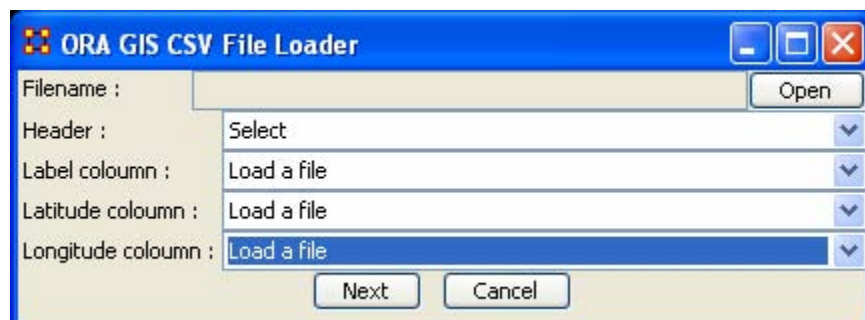


Open Trailset... :

Add GIS Data... :



Add CSV : You can load a **.csv** file and specify which columns contains the longitude/latitude data.





Add KML (Google Earth) : KML is a file format used to display geographic data in an earth browser (e.g. Google Earth). A KML file is processed in much the same way that HTML (and XML) files are processed by web browsers. Like HTML, KML has a tag-based structure with names and attributes used for specific display purposes.



Add e00 : Contains Geographic Information Systems (GIS) mapping data exported by ArcGIS software. ORA can import this style of vector data and convert it for use in the GeoSpatial tool.



Add ERSI Shapefile : An ERSI shapefile is a digital vector storage format for storing geometric location and associated attribute information. Shapefiles spatially describe geometries: points, polylines, and polygons.

NOTE : *This format lacks the capacity to store topological information.*



Add Shapefile (using Openmap) :



Add Shapefile (using Geotools) :

Save Map... :



Save Map To PNG : Saves the currently map to the **.PNG** format.



Save Map To SHP : Saves the currently map to the **.SHP** format.

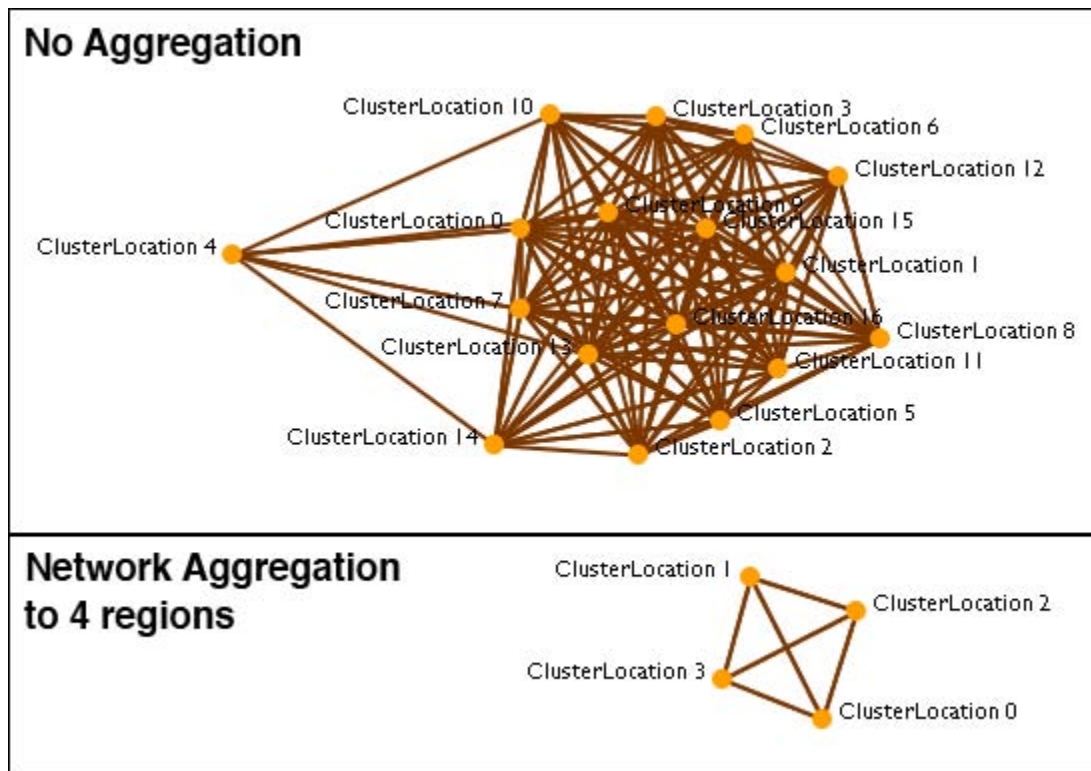


Save Map To KML : Saves the currently map to the **.KML** format.



Save Map To DyNetML : Saves the current map to the **DyNetML** format with the added NodeClass **ClusterLocation--ClusterLocation**. This records changes affected by the Network

Aggregator in grouping locations into regions.



Save Map To Loom Trailset : Saves the currently map to the **Loom** format.

Current GIS Layers



Open From Defaults : Opens what is currently saved as the default Dynamic Network and GIS layers.



Open from a File : Uses the information saved in the choose file to set the Dynamic Network and GIS layers.



Save As Default : Saves the currently selected Dynamic Network and GIS layers as the default.



Save to a File : Saves the currently selected Dynamic Network and GIS layers to a file.

Current Meta-Network Locations Configurations



Open From a File :



Save to a File :



Create Meta-Network From Visible Network...



Copy Image To Clipboard : Saves a picture of the current map to the clipboard which can be pasted into another program for use in demonstration purposes.

Close



GeoSpatial Modify Menu



GeoSpatial Actions Menu.



Replace Current Meta-Network :



Create New Spatial Relation :



Create New Spatial Nodeset :

GeoSpatial Analyze Menu

 GeoSpatial Actions Menu controls color and size of location nodes.

Reset Map Zoom : Reset the display of the map to it's default size.



Reset Nodes Colors and Size : Returns on nodes to their default colors and sizes.

NOTE : *If the colors do not reset, click on the map with Pan tool to force the reset.*

Size Nodes by Attribute or Measure : Sizes nodes using numerical data.

NOTE : *You can not size by an attribute using non-numerical data.*



Size Links by Value : Adjusts the weights of links in proportion to all links.

Color Nodes by Attribute or Measure : Colors the nodes using

Color Nodes by Component :



Color Nodes by Concor Grouping : Colors nodes using [Concor Grouping*](#).

Color Nodes by Newman Grouping : Colors nodes using [Newman Grouping*](#)

GeoSpatial Tools Menu

 Tools is a set of controls for adjusting how nodes and links are displayed.

Layer Manager : Controls the visibility of the NodeClass(es), Network(s), and Shape layers on the map by checking or unchecking the boxes.

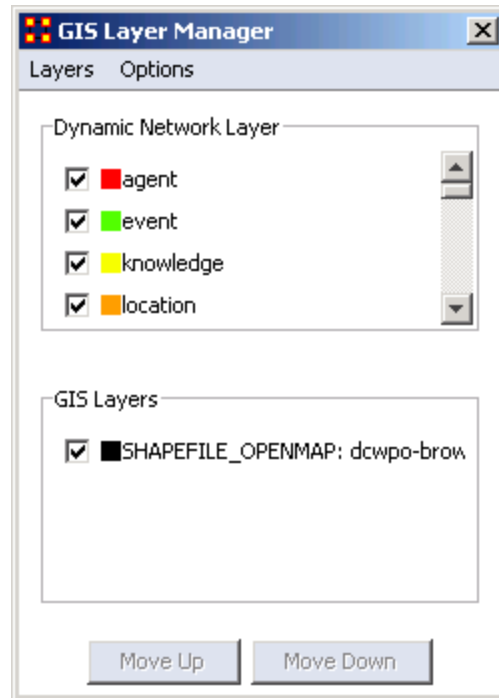
Network Aggregator : Controls the groupings of nodes which are displayed together as separate regions.

Get/Set View :

Configure Meta-Network Locations :

Layer Manager

The **GIS Layer Manager** controls what is displayed in the GeoSpatial Visualizer. This includes all NodeClasses and Shape layers. It is similar to the Legend in the regular Visualizer.



Selecting or Deselecting a NodeClass or GIS Layer will remove it from the display. It does not remove it from the dataset.

The **Move Up** and **Move Down** buttons adjust the display position of the SHAPE files. These buttons have no effect on the Network Layers.

Layer Manager Menus

Layers

Add New Layer : You can add additional map files to the display.

Remove Selected Layer : You can remove selected map layers from the display.

Show All Network Layers : Displays all node information on the map

Hide All Network Layers : Removes all Network information from the map. The Information is still available through the Layer Manager.

Change Layer Position > Move Layer Forward :

Change Layer Position > Move Layer Backward :

Change Layer Position > Move Layer To Front :

Change Layer Position > Move Layer To Back :

Add Layer As Nodeset :

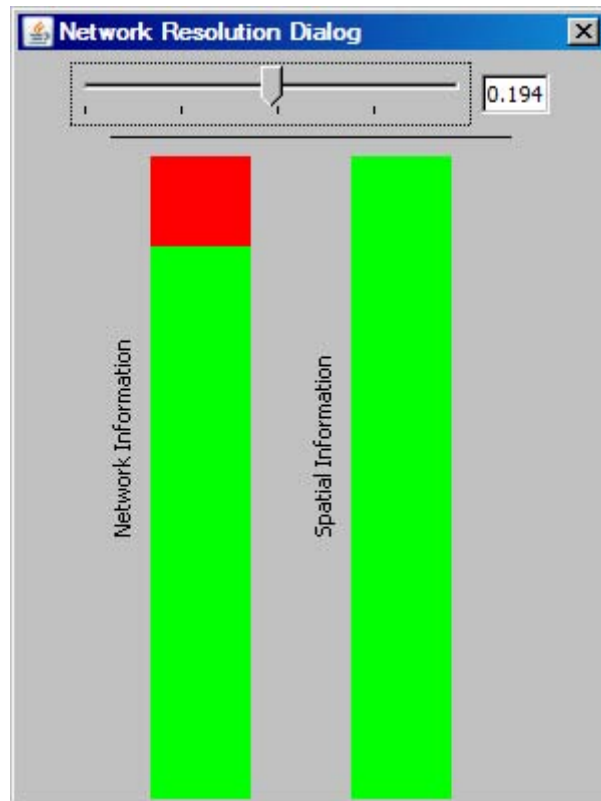
Options

Set Current Map Data As Default :

Reset Map With Default Data :



The Network Aggregator looks at regions instead of individual locations. Using the slider you can control how dense each region will be. Increasing the density groups more locations into a region.



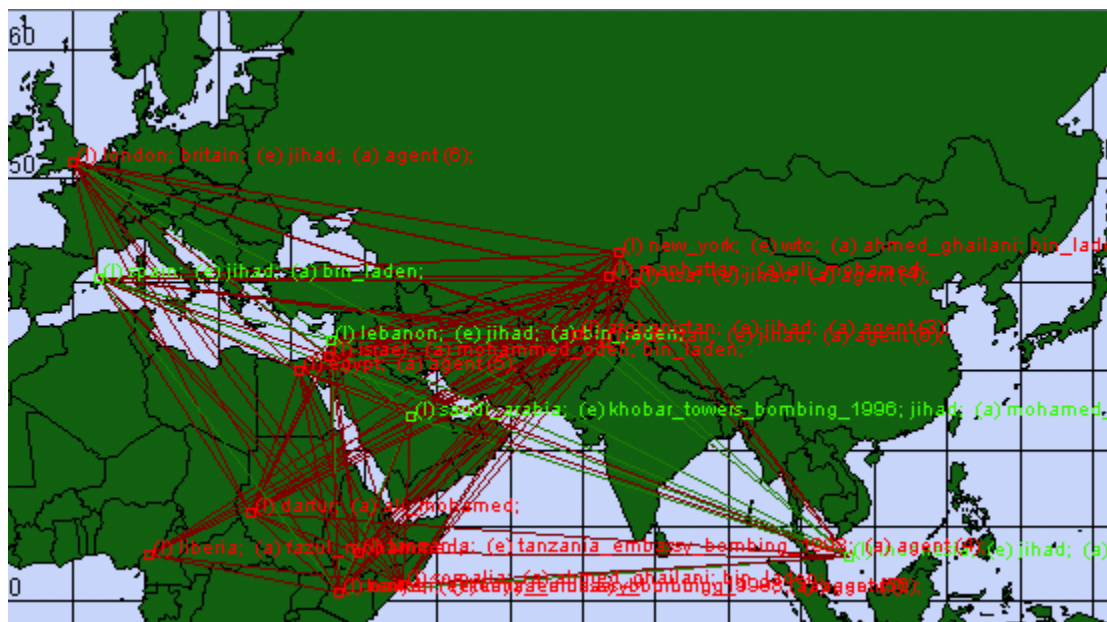
Using a sliding scale, which in turn represents network information retention (or loss) depending on the level of the adjusted slider. A value can also be entered manually in the numeric field box.

When the network bar is fully **red** it indicates full network resolution and therefore network information is preserved and displayed in the GIS Visualizer. Conversely, when lower network resolution figures are entered network detail can be sacrificed. This bar graph is intended to show the level of such loss.

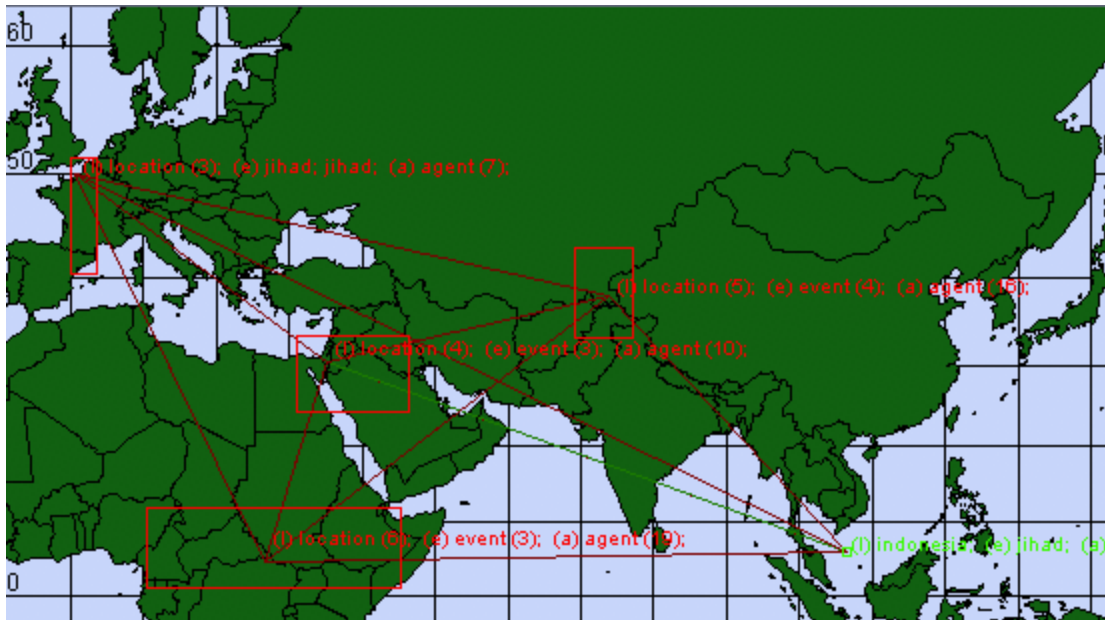
It is best to experiment with the slider at varying values and observing GIS visualization for optimum balance of data resolution and visual relevancy.

This is a useful tool when you have many noisy or cluttered locations. The grouping assists you in seeing the connections easier.

GeoSpatial with no aggregation



GeoSpatial using Network Aggregation



GeoSpatial Options Menu

 These options control various display options of the Visualizer.

 **Show Links** : Toggles the visibility of the Links.

 **Show Labels** : Toggles the visibility of the Node Labels.

 **Show Arrows** : Toggles the visibility of the link Arrows.

Use 2D Visualization (Openmap)

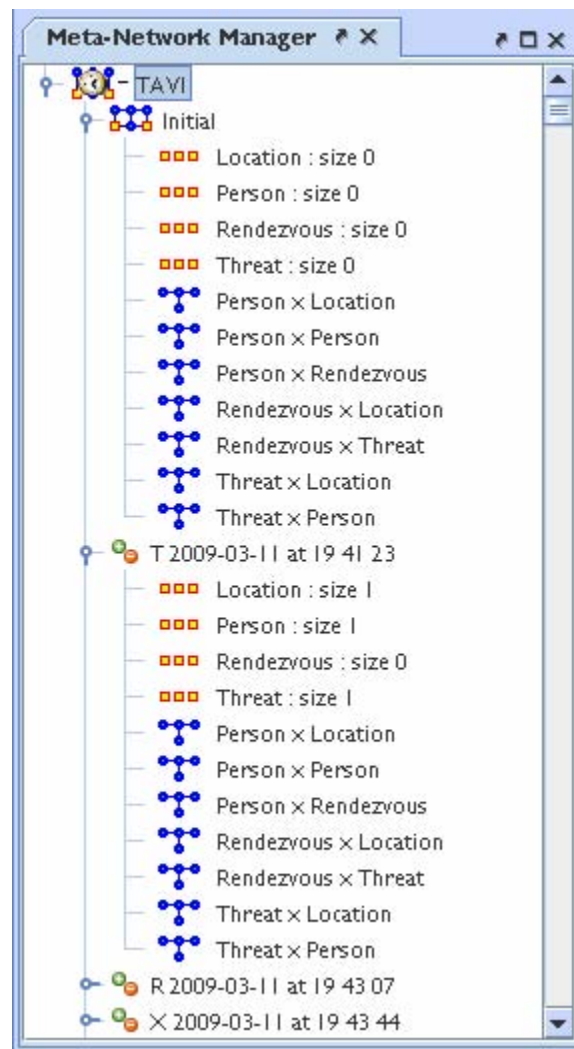
Use 3D Visualization (NASA Worldwind)

Loom / View Trails

Before starting you need a dataset that can be used within the Loom. One such dataset is the TAVI dataset.

Use **File > Open Meta Network** to open TAVI.xml

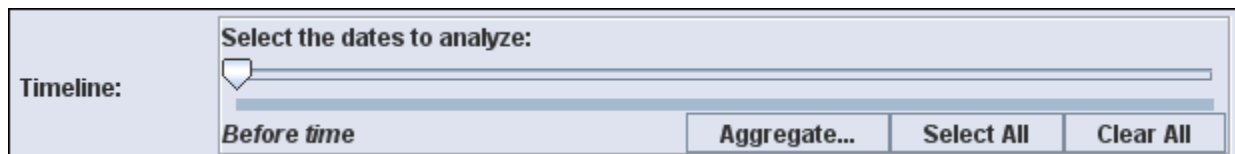
The clock icon in the Meta-Network Panel means that it is a dynamic meta network and that there are continuous-time updates (**deltas, which are listed below the top-level network**) indicating how the network changes over time.



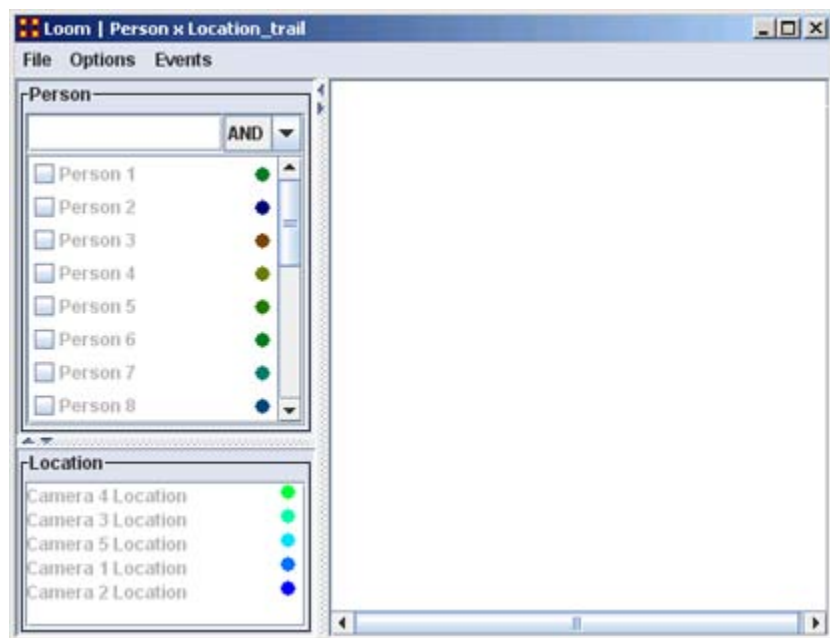
To analyze the data you must have a relation that **A)** changes over time and **B)** stays many:one (e.g., a person must have only one location at any given time). Usually this is Agent x Location, but in theory you can select other relations.

In the main ORA screen, open the **Visualizer > View Trails**. Select the **Person x Location** input network.

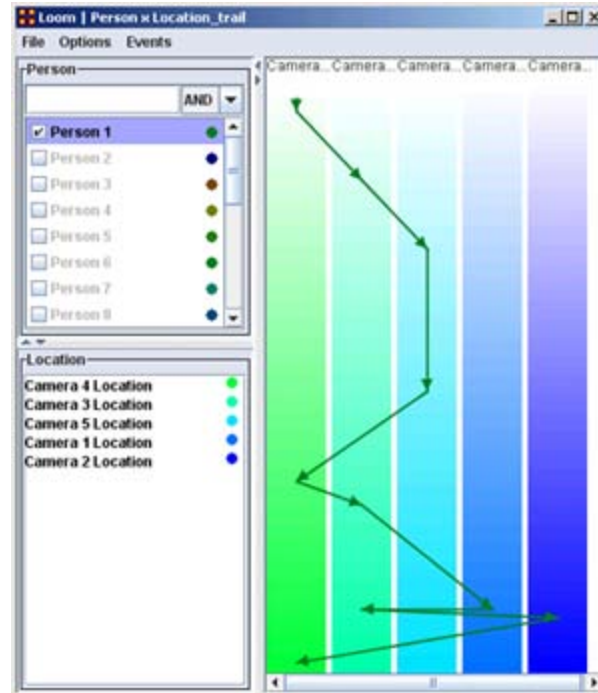
At the top left is a list of Agents; the bottom left is a list of locations. Activating the check-box next to an agent will cause its trail to appear in the right hand panel. The large vertical strips correspond to locations, and the path moving between them is the trail indicating the agent's location at each point in time.



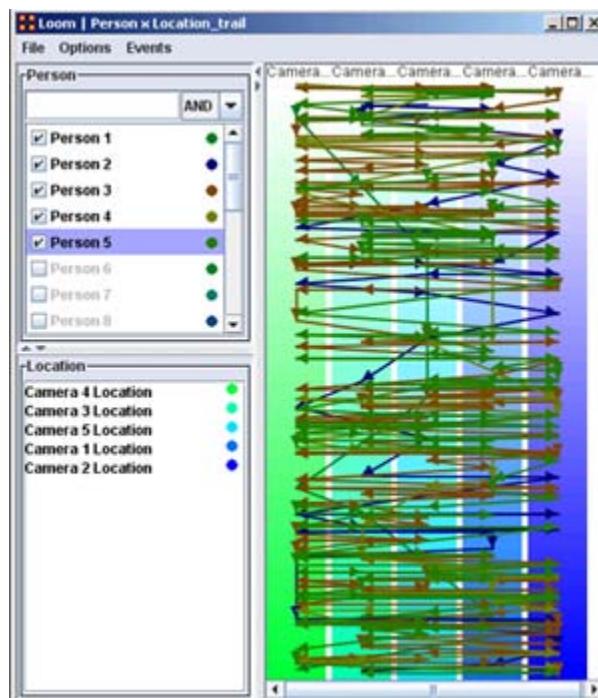
Open Loom : Highlight the TAVI dataset in the Meta-Network pane. From the drop down menu select **Visualizations > View Trailsets**. In the dialog box select **Persons x Locations**. The Loom window will appear with the chosen Network.



Selecting one person you can easily see where they've been (**Left window**). But when you select multiple people, it can quickly get impossible to view the trails (**right window**).



Making the Display more Readable : can be done in several ways. Clicking the color circle representing the individual node brings up the color changer. You can then select a color which stands out better for viewing.





Loom File Menu

Open ... : Opens up DyNetML file which contains location and time data.

Save as... : Saves currently open DyNetML file under a new filename.

Export > DyNetML : Saves the Loom data as a DyNetML file.

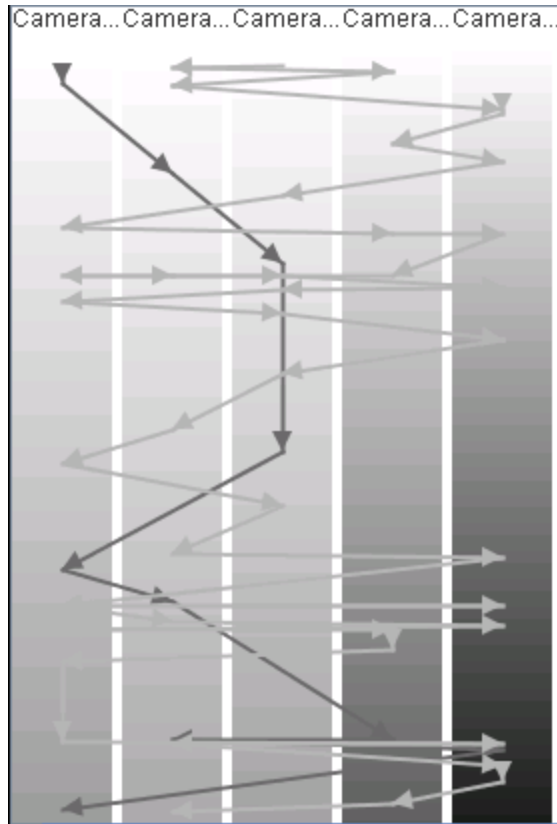
Save Image as... : Saves an image of the current Loom state. Can be saved as a **png, jpeg, pdf, svg, or tiff** file.



Loom Options Menu

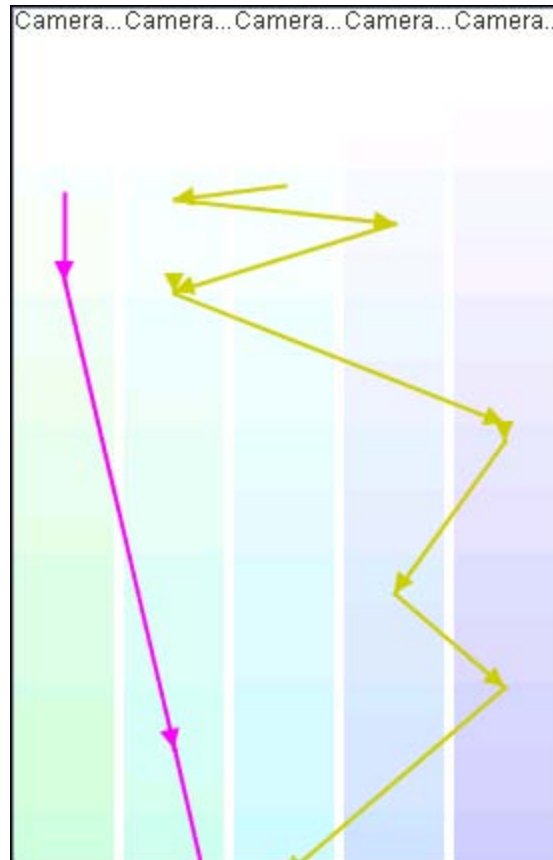
Anti-Aliasing : Used to smooth out rough edged lines.

Grayscale : Removes all colors from image and is good when printing black and white images.

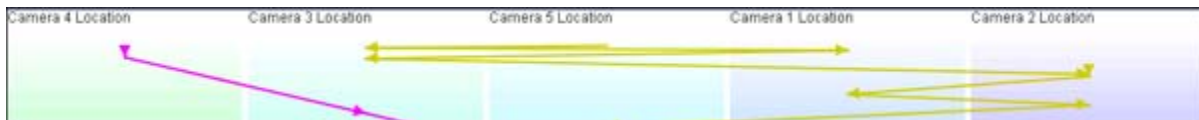


Show Timeline : Displays the timeline markers on the left of the Loom.

Stretch Vertical : You can select a percentage to enlarge the height of the Loom. Good when many nodes are situated in a small area.



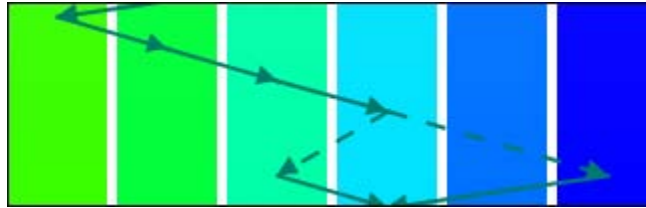
Bar Width : Widens the individual locations. Good when many nodes are situated in a small area.



Allow Multiple Waypoints per Period : If unchecked a node will appear **only** in the most weighted position. If checked then the node will be placed in all locations.

Example : A main location also contains three separate rooms. An agent can be listed to be in the main location but can also be listed as moving between the individual rooms. If this option is checked, the agent will be shown to be in all locations which can lead to it appearing an agent is in two places at once.

NOTE : The dotted line denotes a node which disappeared from all locations then reappeared later on.



ORA contains over **100 measures**.

What is a Measure

A measure is a function that takes as input a Meta-Network and outputs a single value or a vector of values. Consider the measure **Density**. The output for this measure is a single number used to analyze an organization. By default, all measures are run on a Meta-Network. To view which measures are available, go to the Tools menu and select the **Measures Manager**.

ORA Measures Manager

The Measures Manager categorizes measures in the following ways:
Entity Level, Graph Level, and Risk Category.

Entity Level Measure is one that is defined for, and gives a value for, each entity in a network. If there are x nodes in a network, then the metric is calculated x once each for each node.

Examples are Degree Centrality, Betweenness, and Cognitive Demand.

Graph Level Measure is one that is defined for, and gives a value for, the network as a whole. The metric is calculated once for the network.

Examples are Centralization, Graph Hierarchy, and the maximum or average Betweenness

Some reports use a predefined set of measures, and these are not affected by the Measure Manager selections (**for example, the Intel, Context, Located SubGroups, Sphere of Influence, and Immediate Impact** reports). The **Risk Report**, however, uses only the measures selected in the Measure Manager.

The following sets of entities (with their abbreviated symbol) are used throughout the document: Agent (**A**), Knowledge (**K**), Resource (**R**), and Task (**T**). The following networks defined on these entity sets are used throughout the documentation.

Symbol	Entity Sets		Name
	U	V	
AA	Agent	Agent	Communication Network
AK	Agent	Knowledge	Knowledge Network
AR	Agent	Resource	Capabilities Network
AT	Agent	Task	Assignment Network
KK	Knowledge	Knowledge	Information Network
KR	Knowledge	Resource	Training Network
KT	Knowledge	Task	Knowledge Requirement Network
RR	Resource	Resource	Resource Substitute Network
RT	Resource	Task	Resource Requirement Network
TT	Task	Task	Precedence Network

Input:

This lists each of the Networks that are required as input to the measure. If a measure takes as input a specific network from the Meta-Network, such as the **Agent x Knowledge (AK) matrix**, then it is

listed. If the measure runs on any **square (unimodal) network then N is given**. A measure can require more than one input matrix.

1. Each input matrix can have one or more of the following requirements:

- a. **square**: the matrix must have the same number of rows as columns
- b. **binary**: it must be binary data (i.e. any links in the network are assumed to have a weight of one)
- c. **symmetric**: the network must be undirected

2. ORA does the following when a network does not meet one or more of the above requirements:

- a. **square**: measure is not computed
- b. **binary**: measure is computed, and edge weights are ignored (all edges are given value one)
- c. **symmetric**: measure is computed, and the matrix is first symmetrized using the union method

A complete list of all measures available in ORA, along with references, input and output specifications, can be found in the following ORA Measures sections.

	Access Redundancy

Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : $\mathbb{R} \in [0, (|A| - 1 * |R|)]$.

Computational Time

Fast

Description

Average number of redundant agents per resource. An agent is redundant if there is already an agent that has access to the resource.

Input : Agent by Resource matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The knowledge and resources an agent uses to perform the tasks to which it is assigned. Individuals or organizations that are high in workload are those that are doing more complex tasks and have the resources and knowledge or expertise to do those tasks. Tasks are more complex if they require more expertise and/or more resources. This measure is only calculated if all of the following matrices are available: agent x knowledge, agent x resource, agent x task, knowledge x task, resource x task.

Example : In a given organization, employees have access to certain knowledge (e.g., fix computers) and resources (e.g., computer parts). This measure would compute a value to reflect the overall level of organizational access within the network.

Actual Workload

Input :

Agent by Knowledge matrix with DataType=binary

Agent by Resource matrix with DataType=binary

Agent by Task matrix with DataType=binary

Knowledge by Task matrix with DataType=binary

Resource by Task matrix with DataType=binary

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The number of knowledge that an agent lacks to complete its assigned tasks expressed as a percentage of the total knowledge required for the assigned tasks.

Input :

Agent by Knowledge matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The number of knowledge that an agent has that are not needed by any of its tasks expressed as a percentage of the total knowledge of the agent.

Input :

Agent by Knowledge matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The number of resources that an agent lacks to complete its assigned tasks expressed as a percentage of the total resources required for the assigned tasks.

Input :

Agent by Resource matrix with DataType= binary.

Agent by Task matrix with DataType= binary.

Resource by Task matrix with DataType= binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The number of resources that an agent has that are not needed by any of its tasks expressed as a percentage of the total resources of the agent.

Input :

Agent by Resource matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Kathleen M. Carley, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

A measure of actor power based on access to knowledge, resources, and tasks in the organization.

Example : An individual within an organization that has the most connections, hence access, to knowledge (special skills), resources (unlimited funding) and tasks (has the most important tasks). Such an agent would rank high in the SocioEconomic Power measure.

Input :

Agent by Knowledge matrix with DataType=binary.

Agent by Resource matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Carley, Kathleen M. 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : $\mathbb{R} \in [0, (|A| - 1 * |T|)]$

Computational Time

Fast

Description

Average number of redundant agents assigned to tasks. An agent is redundant if there is already an agent assigned to the task.

Input : Agent by Task matrix with dataType=binary

Output : Graph Level with DataType=real



Informal Name

None

Citation

Kleinberg J.M, 1998

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

A node is authority-central to the extent that its in-links are from nodes that have many out-links. Individuals or organizations that act as authorities are receiving information from a wide range of others each of whom sends information to a large number of others. Technically, an agent is authority-central if its in-links are from agents that have are sending links to many others. The scientific name of this measure is authority centrality and it is calculated on agent by agent matrices.

Input : Square matrix with DataType=real.

Output : Node Level with DataType=real.



Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The average shortest path length between nodes, excluding infinite distances.

Example : In a given organization, this measure computes the average amount of connections between any two members in the organization.

Input : Square matrices.

Agent by Knowledge matrix with DataType= binary

Agent by Task matrix with DataType= binary

Knowledge by Task with DataType= binary

Output : Graph Level with DataType= real.



Informal Name

None

Citation

Carley, Kathleen M. 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The average speed with which any two nodes can interact. This is based on the inverse of the shortest path lengths between node pairs.

Example : In an organization that any two individuals have an average of 3.4 connections between them would approximate the average speed at which a communication might spread throughout the organization. Naturally, the lower the average links, the higher the organizational speed.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Freeman, 1979

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Network centralization based on the betweenness score for each node in a square network. This measure is defined for directed and undirected networks.

The Betweenness Centrality of node v in a network is defined as: across all node pairs that have a shortest path containing v , the percentage that pass through v . Individuals or organizations that are potentially influential are positioned to broker connections between groups and to bring to bear the influence of one group on another or serve as a **gatekeeper between groups**. This agent occurs on many of the shortest paths between other agents. The scientific name of this measure is betweenness centrality and it is calculated on agent by agent matrices.

Example : This measure indicates the extent that an individual is a broker of indirect connections among all others in a network. Someone with high Betweenness could be thought of as a gatekeeper of information flow. People that occur on many shortest paths among other People have highest Betweenness value. Betweenness is one of the key measures used by those interested in networks.

Input : Square Node Level Matrix with DataType= binary

Output : Node Level and dataType="real"



Informal Name

None

Citation

Bonacich P., 1987 "Factoring and weighing approaches to clique identification" Journal of Mathematical Sociology, 2 (January, 1972), 113-120.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The Bonacich Power Centrality computes the centrality of each entity based on the centrality of its neighbors. Beta should be chosen such that its absolute value is less than the reciprocal of the largest eigenvalue of N.

Example : In a given organization, this measure can tell us who is connected to the most powerful (e.g., other highly connected agents) people.

Input : Square Node Level matrix with DataType=real.

Output : Node Level and DataType=real.



Informal Name

None

Citation

Cormen, Leiserson, Rivest, Stein 2001. "Introduction to Algorithms" Second Edition. Cambridge, MA: MIT Press, 2001.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Description

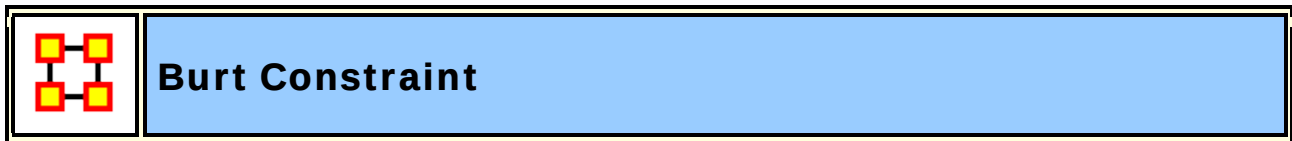
An node which, if removed from a network, creates a new component.

This is often called a **Gate Keeper** node. It consists of **High Betweenness and Low Centrality**. A Boundary Spanner is **an articulation point of N**, as defined in the referenced book.

Example : An employee with few direct connections, but if removed from the network will result in an unconnected sub-group.

Input : Square Node Level Agent by Agent matrix with
DataType=binary, Direction=No.

OutputNode Level with DataType=Binary.



Informal Name

None

Citation

Burt, Ronald. Structural Holes: The Social Structures of Competition. Cambridge, MA: Harvard University Press, 1992.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The degree to which each node in a square network is constrained from acting because of its existing links to other nodes.

Example : Bob is given a certain task, but that task requires certain links, which Bob does not have. Bob is constrained in the sense he does not have the links to complete the task. This measure computes a value for such relationships as they distributed across the whole network.

Input : Square matrix with dataType=real.

Output : Node Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2007

Minimum and Maximum Values

Minimum :

Maximum :

Computational Time

Fast

Description

Detects entities with high or low degree relative to other entities. The formula discounts for the fact that most agents have some connections and assumes that there is a general discount to having large numbers of connections.

Input : Square matrix with dataType=real.

Output : Node Level with DataType=real and type=row.



Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

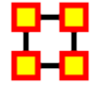
Slow

Description

The number of distinct cliques to which each node belongs. Individuals or organizations who are high in number of cliques are those that belong to a large number of distinct cliques. A clique is defined as a group of three or more actors that have many connections to each other and relatively fewer connections to those in other groups. The scientific name of this measure is clique count and it is calculated on the agent by agent matrices.

Input : Square matrix with dataType=binary.

Output : Node Level with DataType=integer.

	Classic SNA Density

Informal Name

None

Citation

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

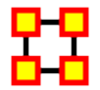
Fast

Description

The ratio of the number of links versus the maximum possible links for a square network. Self-loops are ignored.

Input : Square matrix with dataType=binary.

Output : Graph Level with DataType=real.

	Closeness Centrality

Informal Name

None

Citation

Freeman, L.C. (1979). "Centrality in Social Networks I: Conceptual Clarification." Social Networks, 1, 215-239.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

The average closeness of a node to the other nodes in a network. Closeness is the inverse of the average distance in the network between the node and all other nodes.

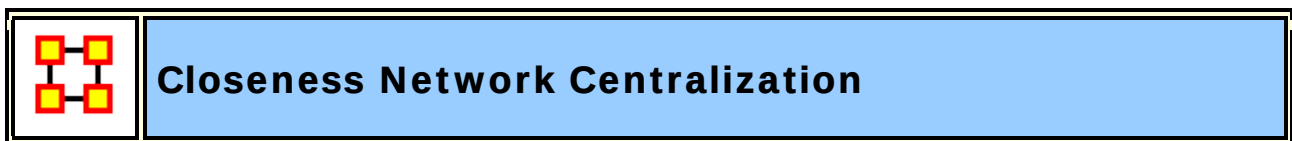
Closeness reveals how long it takes information to spread from one individual to others in the network. High scoring individuals in Closeness have the shortest paths to all others in the network. It would follow such individuals could monitor the information flow in an organization better than most others that have a lesser Closeness value. The ones with the highest value in this measure will often times have the best picture of what is happening in the network as a whole.

In short, Closeness is the inverse of the average distance in the network between any given node and all other nodes.

Example : Closeness reveals so-called people in the know. Closeness measures the path length from one person to another in a network. It tells us which person is central to an organization.

Input : Square matrix with DataType=binary.

Output : Node Level with DataType=real.



Informal Name

None

Citation

Freeman, L.C. (1979). Centrality in Social Networks I: Conceptual Clarification. Social Networks, 1, 215-239.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Network centralization based on the closeness centrality of each node in a square network. This is defined only for connected, undirected networks.

Example : An organization has employees, computers, benchmarks, and products. How central these entities exist within the connections of the network, which is defined by the connections they have throughout the network, is loosely what is network centralization. This measure computes a value for the centrality of these entities.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

Emergent Leader

Citation

Carley, Kathleen M. & Yuqing Ren, 2001, "Tradeoffs Between Performance and Adaptability for C3I Architectures." In Proceedings of the 2001

Command and Control Research and Technology Symposium, Annapolis, Maryland, June, 2001.

Carley, 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Measures the total amount of cognitive effort expended by each agent to do its tasks, need to move, connecting others, and so on. Such individuals may never become the formal leader of a group. Emergent leaders are identified in terms of the amount of cognitive effort that is inferred to be expended based on the individual's position in the meta-network. Individuals who are strong emergent leaders are likely to be not just connected to many people, organizations, tasks, events, areas of expertise, and resources; but also, are engaged in complex tasks where they may not have all the needed resources or knowledge and so have to coordinate with others, or have other reasons why they need to coordinate or share data or resources.

Input : Agent by Agent matrix with dataType= binary.

Output : Node Level Agent with DataType=real.



Informal Name

None

Citation

Carley, Kathleen 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Measures the degree to which each pair of agents has complementary knowledge, expressed as the percent of total knowledge.

Input : Matrix with Type=Agent (Source) and Type=Knowledge (Target) and DataType=binary.

Output :

Node Level : Node Level with Type=agent and DataType=real.

Dyad Level : Dyad Level with SourceType=agent, TargetType=agent, and DataType=real.



Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Measures the degree to which each pair of agents has complementary knowledge, expressed as a percentage of the knowledge of the first agent.

Example : If one person in an organization knows how do perform X but can't do Y. Whereas another individual can do Y but not X, such individuals would rank highly in this measure.

Input : Agent (source) by Knowledge (knowledge) matrix with DataType=binary."

Output :

Node Level with Type=agent and DataType=real.

Dyad Level with Type=agent, Target=agent, and DataType=real.



Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

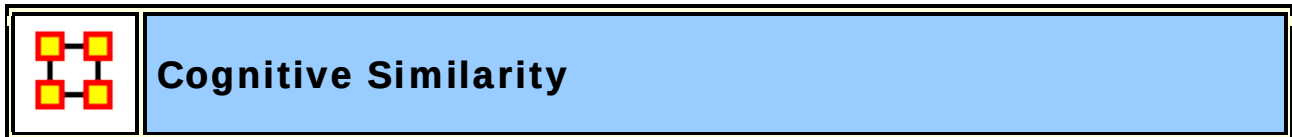
Description

Measures the degree to which each pair of agents has the exact same knowledge. Each value is normalized by the row sum.

Example : In an given organizational network, let us say that Bob has the knowledge to perform X, Y, and Z. Whereas Sally also has the knowledge to perform X, Y and Z. This measure would rank this pair (i.e., dyad) high in Cognitive Resemblance.

Input : Agent by Knowledge matrix with DataType=binary.

Output : Dyad Level with an Agent by Knowledge matrix with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Measures the degree to which each pair of agents have overlapping knowledge.

Example : With an organization where Bob has the knowledge of X, Y and Z and Sally has the knowledge of Q, R and Z. The Cognitive Similarity measure would compute a value for Bob and Sally's overlapping knowledge of Z.

Input : Agent (source) by Knowledge (target) matrix with dataType=binary.

Output :

Node Level with Type=agent and DataType=real.

Dyad Level with Agent by Agent matrix with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

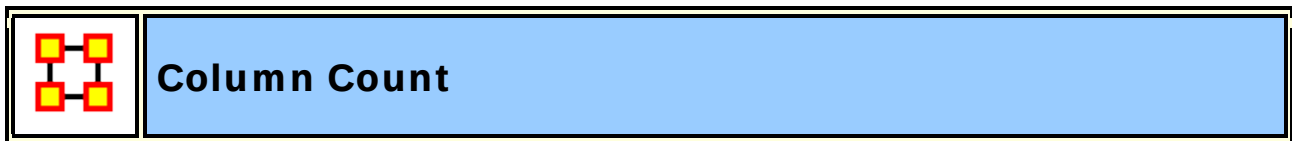
Description

The fraction of entities with column nodes with degree greater than one.

Example : In a given organization, we have the following entities: employees (agents), computers (resources), benchmarks (tasks). This measure tells us on how many links greater than one exist within these entity types.

Input : Matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : Number of Columns

Computational Time

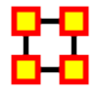
Fast

Description

The number of column nodes in a network.

Input : Matrix with DataType=binary.

Output : Graph Level with DataType=integer.

	Column Degree Centrality

Informal Name

None

Citation

Wasserman and Faust, 1994

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

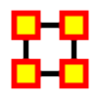
Fast

Description

A centralization based on the degree of the column nodes of a network.

Input : Matrix with DataType=real

Output : Node Level with dataType=real and Type=column.

	Column Degree Network Centralization

Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum :

Maximum :

Computational Time

Fast

Description

A centralization based on the degree of the column nodes of a network.

Input : Matrix with DataType=real

Output : Node Level with dataType=real and Type=column.



Informal Name

None

Citation

Carley, Kathleen M. 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : $\mathbb{R} \in [0, (m-1) * n]$

Computational Time

Fast

Description

The mean number of column node links in excess of one.

Input : Matrix with dataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2003

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Measures the communication need of agents to complete their assigned tasks.

Example : In a given organization **Bob** is assigned a task which is dependant upon his social links to other individuals in the network. The measure would compute a value for how dependent Bob is on the links to the other individuals to complete the task. A higher value would indicate Bob must possess a greater number of connections to complete

any given task he is assigned. Conversely, a low value would indicate relatively few linkages are necessary to complete certain tasks.

Input :

Agent by Agent matrix with dataType=binary.

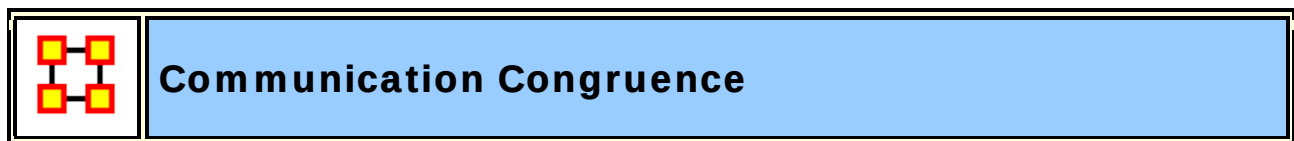
Agent by Task matrix with dataType=binary.

Agent by Resource matrix with dataType=binary.

Resource by Task matrix with dataType=binary.

Task by Task matrix with dataType=binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Measures to what extent the agents communicate when and only when it is needful to complete tasks. Perfect congruence requires a symmetric Agent x Agent network.

One of the following pairs of matrices must exist: **AK/KT, AR/RT**. If both exist, then the measure first concatenates them into **[AK AR], [KT RT]** and uses them.

Communication Congruence = 1 iif agents communicate when and only when it is needful to complete their tasks. There are three task related reasons when agents i and j need to communicate:

(a) **Handoff**: if i is assigned to a task s and j is assigned to a task t and s directly precedes task t.

(b) **Co-Assignment**: if i is assigned to a task s and j is also assigned to s.

(c) **Negotiation**: if i is assigned to a task s and j is not, and there is a resource r to which agents assigned to s have no access but j does.

The three cases are computed as follows:

(a) let $H = AT \cdot TT \cdot AT'$

(b) let $C = AT \cdot AT'$

(c) let $N = AT \cdot Z \cdot AR'$, where $Z(t,r) = [AT' \cdot AR - RT'](t,r) < 0$

Note that C is always symmetric, but not necessarily H and N.

let $Q(i,j) = [(H+H') + C + (N+N')](i,j) > 0$.

Communication Congruence requires reciprocal communication, explaining the transposes of H and N to make them symmetric.

let d = hamming distance between Q and AA, which measures the degree to which communication differs from that which is needed to do tasks.

The maximum value for d is $d_{\max} = |A| \cdot (|A| - 1)$

Then Communication Congruence = $1 - (d / d_{\max})$, which is in $[0,1]$.

Input :

Agent by Agent matrix with dataType=binary.

Agent by Task matrix with dataType=binary.

Agent by Resource matrix with dataType=binary.

Resource by Task matrix with dataType=binary.

Task by Task matrix with dataType=binary.

Output :

Graph Level with DataType=real.



Informal Name

None

Citation

Carley Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Measures the percentage of reciprocal links in a network. This is also called Reciprocity.

Input : Square matrix with DataType=binary

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Ashworth, M. and Kathleen M. Carley, 2003 "Critical Human Capital" Working Paper, CASOS, Carnegie Mellon, Pittsburgh PA.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

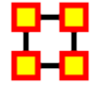
Description

Detects entities that have ties that no other entity has. Individuals or organizations that are high in complete exclusivity for events are those that attend or are supposed to attend an event that no one else does. The scientific name of this measure is complete exclusivity and it is calculated on agent by event matrices.

Example : Individuals or organizations that are high in complete exclusivity for events are those that attend or are supposed to attend an event that no one else does.

Input : Matrix with DataType=binary.

Output : Node Level with DataType=real and Type=row.

	Complexity

Informal Name

None

Citation

Wasserman and Faust, 1994

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

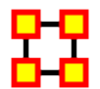
Fast

Description

The density of the meta-network as a whole.

Input : MetaMatrix with DataType=binary.

Output : Graph Level with dataType=real.

	Connectedness

Informal Name

None

Citation

Krackhardt, D. 1994. Graph Theoretical Dimensions of Informal Organizations. In Computational Organization Theory, edited by Carley,

Kathleen M. and M.J. Prietula. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Measures the degree to which a square network's underlying (symmetrized) network is connected. Individuals or organizations that connect groups are those that are connecting disconnected groups. The individual or organization may be connected to only one or a few members of each groups. This is a composite measure that is high when the agent is potentially influential but is not in the know. This is calculated as the ration of betweenness centrality to total degree centrality and is calculated on agent by agent matrices.

Input : Square matrix with dataType= binary.

Output : Graph Level with DataType= real.



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Description

Measures the degree to which each pair of rows has complementary data, expressed as the percent of total data.

Input : Matrix with dataType=binary.

Output :

Node Level with Type=row and DataType=real.

Dyad Level with SourceType=row, TargetType=row, and
DataType=real.



Informal Name

None

Citation

Carley, Kathleen, M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Measures the degree to which each pair of rows has complementary data, expressed as a percentage of the data of the first row.

Input : Matrix with dataType=binary.

Output :

Node Level with Type=row and DataType=real.

Dyad Level with SourceType=row, TargetType=row, and
DataType=real.



Informal Name

None

Citation

Carley, Kathleen, M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

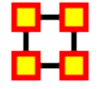
Measures the degree to which each pair of rows has the exact same data.

Input : Matrix with dataType=binary.

Output :

Node Level with Type=row and DataType=real.

Dyad Level with SourceType=row, TargetType=row, and
DataType=real.

	Similarity Correlation

Informal Name

None

Citation

Carley, Kathleen, M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

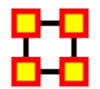
Measures the degree to which each pair of rows have overlapping data.

Input : Matrix with dataType=binary.

Output :

Node Level with Type=row and DataType=real.

Dyad Level with SourceType=row, TargetType=row, and
DataType=real.

	Density

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. Social Network Analysis: Methods and Applications. Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The ratio of the number of links versus the maximum possible links for a network.

Density compares existing links to all possible links in the employee communication network. It reflects the social level of organizational cohesion. This measure must be interpreted in relation to the size of the group and the type of work performed.

Input : Unimodel matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. Social Network Analysis: Methods and Applications. Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The maximum shortest path length between any two nodes in a unimodal network $G=(V,E)$. If there exist i,j in V such that j is not reachable from i , then $|V|$ is returned.

Input : Square matrix with dataType=binary.

Output : Graph Level with DataType=integer.



Informal Name

None

Citation

Carley, Kathleen M.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Computes the degree to which something could be easily diffused (spread) throughout the network. This is based on the distance between nodes. A large diffusion value means that nodes are close to each other, and a smaller diffusion value means that nodes are farther apart.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Burt, Ronald. Structural Holes: The Social Structures of Competition. Cambridge, MA: Harvard University Press, 1992.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The effective size of a node's ego network based on redundancy of links.

Example : In a given organization, let us say Bob has ties to many others in the organization, who in turn have redundant ties to other people. The point at which this no longer applies tends to define effective network size.

Input : Square matrix with DataType=real.

Output : Node Level with DataType=real.



Informal Name

None

Citation

Krackhardt, D. 1994. Graph Theoretical Dimensions of Informal Organizations. In Computational Organization Theory, edited by Carley, Kathleen M. and M.J. Prietula. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The degree to which each component in a network contains the minimum links possible to keep it connected.

Example : In an organization, let us say Bob has a connection to the computer, Sales, Event, and Goal. This measure computes a value for the minimum number of links entities such as Bob must have for the network to maintain its network status. Therefore, this is a network level measure. In other words, if Bob had one less link, then the entities would cease to constitute the original network.

Input : Square matrix with DataType=binary and Directed=No.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Bonacich P, 1972

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Calculates the principal eigenvector of the network. A node is central to the extent that its neighbors are central. Leaders of strong cliques are individuals or organizations who are connected to others that are themselves highly connected to each other. In other words, if you have a clique then the individual most connected to others in the clique and other cliques, is the leader of the clique. Individuals or organizations who are connected to many otherwise isolated individuals or organizations will have a much lower score in this measure than those that are connected to groups that have many connections themselves. This would be true even if such a **WHO** might have a high amount of actual connections (**i.e. high degree centrality**).

It calculates the eigenvector of the largest positive eigenvalue of the adjacency matrix representation of a square network. A Jacobi method is used to compute the eigenvalues and vectors.

Hub-Centrality and Authority-Centrality measures are generalizations of the Eigenvector Centrality measure and take into account directed links.

Example : It follows that a person well-connected to well-connected people can spread information much more quickly than one who only has connections to lesser important people in a network. People with higher scores of Eigenvector Centrality could be critical when rapid communication is needed.

Furthermore, individuals or organizations that are connected to many other otherwise isolated groups will have a much lower score in this measure than those that are connected to groups that have many connections themselves.

Input : Square Agent by Agent Node Level matrix with DataType=real and directed=No.

Output : Node Level and DataType=real.



Informal Name

None

Citation

Ashworth, 2002

Minimum and Maximum Values

Minimum :

Maximum :

Computational Time

Fast

Description

Detects entities that have ties that comparatively few other entities have. Individuals or organizations that are high in complete exclusivity for knowledge are those that have expertise or are connected to types of

knowledge that no one else has. The scientific name of this measure is complete exclusivity and it is calculated on agent by knowledge matrices.

- Individuals or organizations that are high in complete exclusivity for location are those that have frequented locations that no one else has.
- Individuals or organizations that are high in complete exclusivity for resources are those that have resources or are connected to types of resources that few others have.
- Individuals or organizations that are high in complete exclusivity for tasks are those that are engaged in or assigned to tasks or activities for which no one else is engaged in or assigned to.

Input : Matrix with DataType=binary.

Output : Node Level with DataType=real and Type=row.



Informal Name

None

Citation

Borgatti, S.P. 2003. The Key Player Problem. Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers, R.

Breiger, K. Carley, & P. Pattison (Eds.) Committee on Human Factors, National Research Council, 241-252.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

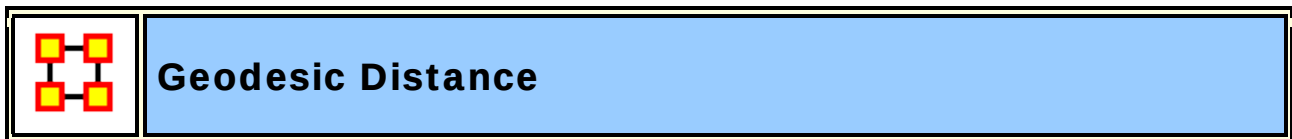
Description

The proportion of nodes in a network that are disconnected.

Example : In a given organization 25 out of 400 sales agents are disconnected from the resources and knowledge that exists at the company headquarters because they travel more frequently and are thus disconnected from the rest of the network. The attribute of this disconnection expressed as a property of the entire organization is its computed disconnected measure.

Input : Square matrix with DataType=binary and Directed=No.

Output : Graph Level with dataType=real.



Informal Name

None

Citation

Wasserman and Faust, 1994

Minimum and Maximum Values

Minimum : 0

Maximum : Number of columns - 1

Computational Time

Medium

Description

Computes the length of the shortest path between all node pairs, where length is the number of links, ignoring link weights. If no path exists between two nodes, then a distance of zero is given. The distance from a node to itself is also zero.

Input : Square matrix with DataType=binary.

Output : Dyad Level with DataType=integer.



Informal Name

None

Citation

Latria and Marchiori, 2001

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Global Efficiency is the normalized sum of the inverse geodesic distances between all entity pairs.

Example : In an organization certain resources are closer to each other in terms of links. If both resources are located closer to each other than it would follow an organization where such resources tend to be more closely distributed across a network would be a more efficient network.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Krackhardt, D. 1994. Graph Theoretical Dimensions of Informal Organizations. In Computational Organization Theory, edited by Carley, Kathleen M. and M.J. Prietula. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

The degree to which a unimodal network exhibits a pure hierarchical structure.

Example : Let us say in an organization Sue is the president. Under Sue, we have 4 vice presidents, whom all in turn have 5 or 10 direct reports, who all have 2 or 3 managers working for them. To such a degree that this architecture is present in the organization is its computed Krackhardt Hierarchy value.

Input : Square matrix with DataType=binary.

Output : Graph Level with dataType=real.

	Hub Centrality

Informal Name

None

Citation

Kleinberg J.M, 1998

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

A node is hub-central to the extent that its out-links are to nodes that have many in-links. Individuals or organizations that act as hubs are sending information to a wide range of others each of whom has many others reporting to them. Technically, an agent is hub-central if its out-links are to agents that have many other agents sending links to them. The scientific name of this measure is hub centrality and it is calculated on agent by agent matrices.

Input : Square matrix with DataType=real.

Output : Node Level with DataType=real.

	In Degree Centrality

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

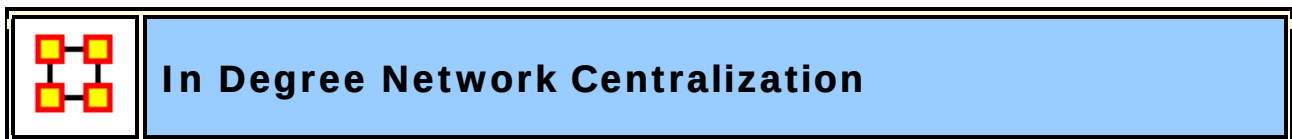
Description

For any node, e.g. an individual or a resource, the in-links are the connections that the node of interest receives from other nodes.

Example : An agent by knowledge matrix with a number of in-links. A piece of knowledge has is the number of agents that are connected to.

Input : Square Agent by Agent matrix with DataType=real.

Output : Node Level with DataType=real and Type=Column.



Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

A centralization of a square network based on the In-Degree Centrality of each node.

Example : In a given organization, all employees have many incoming links to other employees. This is their **In degree** connections. This measure computes a value for the entire organization as a whole as to how central these connections are within the organization.

Input : Square matrix with DataType=real.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow, with High Space requirements

Description

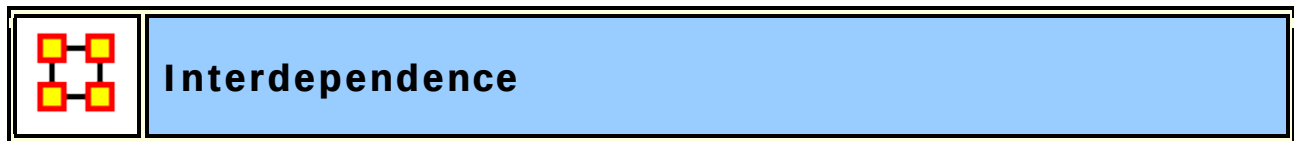
Information centrality is a network metric that accounts for indirect as well as shortest (geodesic) paths among entities. Information centrality is similar to betweenness, except that betweenness considers only shortest paths **geodesics**, whereas information centrality also considers more circuitous paths weighted by the inverse of the path length **(the number of links along the path)**.

Calculates the Stephenson and Zelen information centrality measure for each entity.

Example : Entities high in information centrality are more likely to get more information and to get information faster.

Input : Square matrix with DataType=real and Directed=No.

Output : Node Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The percentage of links in a unimodal network that are Pooled or Reciprocal.

Example : A reciprocal link is one that is bidirectional. Let us say Bob has a link to Sue and Sue has a link back to Bob This is a reciprocal link. However, if Bob had a lot of links to Sue and others, which were not reciprocated, that is bidirectional, than Bob would be said to rank higher in radial links, which linked in one direction. The extent that a network exhibits these relationships is computed as the Interdependence and Radial value for the network.

Let **$G = (V, E)$** be the graph representation of a square network.

Let **a = Pooled Edge Count** and **b = Reciprocal Edge Count** of the network.

Then **$Interdependence = (a + b) / |E|$**

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

Interlocker nodes have a triad count greater than one standard deviation above the mean node triad count.

Example : A typical corporate board of directors is a good example of an interlocking architecture. Whereas a predominant amount of board members—perhaps close to 70-percent—might serve on one board only, it is often common that the remaining 30-percent may serve on 3 or more other boards. These directors that serve on the other boards constitute the interlocking agents that connect all these typical boards together. The Interlockers and radial measures compute a value for such relationships as they exist in the network at the entity, that is agent (e.g., "board member"), level.

Input : Square matrix with DataType=binary.

Output : Node Level with DataType=binary.



Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. Social Network Analysis: Methods and Applications. Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

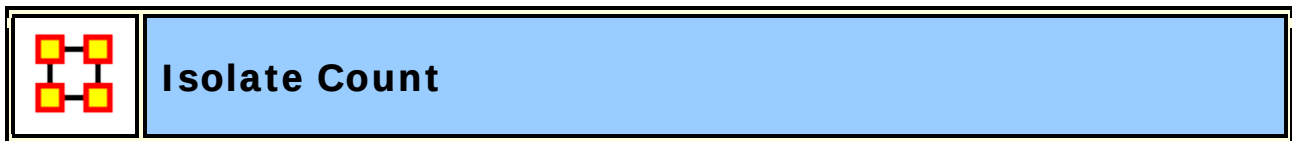
Slow

Description

The average closeness of a node to the other nodes in a network. Inverse Closeness is the sum of the inverse distances between a node and all other nodes. Nodes high in closeness centrality are more likely to communicate faster and operate more efficiently.

Input : Square matrix with DataType=binary.

Output : Node Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen, M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : Number of nodes in the network

Computational Time

Fast

Description

The number of isolate nodes in a unimodal network.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=integer.



Informal Name

None

Citation

Ashworth, M. and Carley, Kathleen M., 2003, "Critical Human Capital", Working Paper, CASOS, Carnegie Mellon, Pittsburgh PA.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

Boolean value which is true if an agent is the only agent who knows a piece of knowledge and who is known by exactly one other agent. The one agent known also has its KAI set to one.

An node level measure that computes the average shortest path length between entities, excluding infinite distances. This is known as the Knowledge Access Index (KAI) value.

Example : Let us imagine a social network where 50 employees have many connections to each other. The average number of connections per employee is the Access Index.

Input : Agent by Agent matrix with DataType=binary

Output : Output is nodeLevel with Type=agent and DataType=binary.

	Knowledge Actual Workload

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The knowledge an agent uses to perform the tasks to which it is assigned.

Input :

Agent by Knowledge matrix withDataType=binary

Knowledge by Task matrix with DataType=binary

Agent by Task matrix with DataType=binary

Output : Node Level with Type=agent and DataType=real.

	Knowledge Congruence

Informal Name

None

Citation

Carley, Kathleen M. 2002

Minimum and Maximum Values

Minimum :

Maximum :

Computational Time

Medium

Description

Measures the similarity between what knowledge are assigned to tasks via agents, and what knowledge are required to do tasks. Perfect congruence occurs when agents have access to knowledge when and only when it is needful to complete tasks.

Input : Agent by Knowledge, Agent by Task, and Knowledge by Task matrices with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Borgatti, S.P. 2003. The Key Player Problem. Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers, R.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The distribution of difference in idea sharing. This is the Herfindahl-Hirshman index applied to column sums of AK.

Example : Characterizes the network in terms of how the items in a knowledge network (**who knows what**) are non-uniformly distributed across employees

Input : Agent by Knowledge matrix with DataType=binary.

Output : Graph Level with dataType=real



Informal Name

None

Citation

Ashworth, 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

Detects agents who have singular knowledge.

Example : A key piece of knowledge that supports an entire organization is only accessible through one person.

Input : Agent by Knowledge matrix with DataType=binary.

Output : Node Level with DataType=real and Type=agent.



Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

Average number of knowledge per agent.

Input : Agent by Knowledge matrix with DataType=binary

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The extent to which agents need to negotiate with each other because they lack the knowledge to complete their assigned tasks.

Example : In a given organization, Bob does not have knowledge needed to complete a certain task but Sue does have it. Bob must negotiate with Sue to gain that knowledge to complete the task. The extent to which others in the organization must negotiate for knowledge that others have is the organization's knowledge negotiation value.

Input :

Agent by Tasks matrix with DataType=binary.

Agent by Knowledge matrix with DataType=binary.

Knowledge by Tasks matrix with DataType= binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, K, Dekker, D., Krackhardt, D (2000). How Do Social Networks Affect Organizational Knowledge Utilization.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The degree to which agents reuse knowledge while doing their tasks.

Example : Sue has X amount of tasks within her company. How many of those tasks that require a knowledge that can be used for one or more of her other tasks is omega knowledge. This measure computes a value for such relations to knowledge sets at the network level.

Input :

Agent by Task matrix with DataType= binary.

Knowledge by Task matrix with DataType= binary.

Task by Task matrix with DataType= binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum :

Maximum :

Computational Time

Medium

Description

Maximum knowledge an agent could use to do tasks if it were assigned to all tasks.

Example : In a given organization, let us say Bob is assigned all task that exist in the organization. This measure would compute a value expressing Bob's potential to carry out all the tasks based on his connections to the resources and knowledge needed for the tasks.

Input :

Agent by Knowledge matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Output : Node Level with Type=agent and DataType=real.

	Knowledge Redundancy

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : $\mathbb{R} \in [0, (|A|-1) * |K|]$

Computational Time

Fast

Description

Average number of redundant agents per knowledge. An agent is redundant if there is already an agent that has the knowledge.

Input : Agent by Knowledge with dataType=binary.

Output : Graph Level with dataType=real.

	Knowledge Task Completion

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The percentage of tasks that can be completed by the agents assigned to them, based solely on whether the agents have the requisite knowledge to do the tasks.

Example : Bob is assigned 10 Tasks to complete which require a certain amount of knowledge to finish. However, on average only 10-percent of this knowledge will be available to Bob for him to complete the tasks given. This measure would compute a value for the likelihood that Bob would be able to complete any given task.

NOTE : *Task Completion Overall is a combination of the Task Completion Knowledge and the Task Completion Resource.*

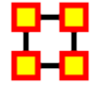
Input :

Agent by Knowledge matrix with dataType=binary.

Agent by Task matrix with dataType=binary.

Knowledge by Task matrix with dataType=binary.

Output : Graph Level with DataType=real

	Knowledge Under Supply

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The extent to which the knowledge needed to do tasks are unavailable in the entire organization.

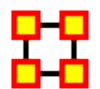
Input :

Agent by Task matrix with dataType=binary.

Agent by Knowledge matrix with dataType=binary.

Knowledge by Task matrix with dataType=binary.

Output : Graph Level with DataType=real

	Lateral Link Count

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The percentage of lateral links in a unimodal network. Fixing a root node x , a lateral link (i,j) is one in which the distance from x to i is the same as the distance from x to j .

Let $G=(V,E)$ be the graph representation of a network. And fix an entity $x \in V$ to be the root entity.

Example : Fixing a root entity x , a lateral edge (i,j) is one in which the distance from x to i is the same as the distance from x to j .

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : Number of links in the network

Computational Time

Fast

Description

The number of links in the network.

Input : Matrix with DataType=binary.

Output : Graph Level with DataType=integer.



Informal Name

None

Citation

Latora and Marchiori, 2001 (Full reference forthcoming)

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Normalized sum of the Global Efficiency of each node's ego network (here, the ego network for entity i does not include entity i).

Example : In an organization, Bob has a connection to the computers, Sales Data, Events, Goals. This measure computes a value for the minimum number of links to entities such as Bob must have for the network to maintain its network status. Therefore, this is a network level measure. If Bob had one less link, then the entities would cease to constitute the original network.

Input : Square matrix with dataType=binary.

Output : Graph Type with DataType=real.



Informal Name

None

Citation

Olson, Malloy

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

The extent to which location influences a particular persons connections.

Input :

Agent by Agent matrix with DataType=real.

Agent by Location matrix with DataType=real.

Output : Node Level with Type=location with dataType=real.

**Informal Name**

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

NOTE : *Minimum Speed = 1 / (Levels for the Network)*

Computational Time

Medium

Description

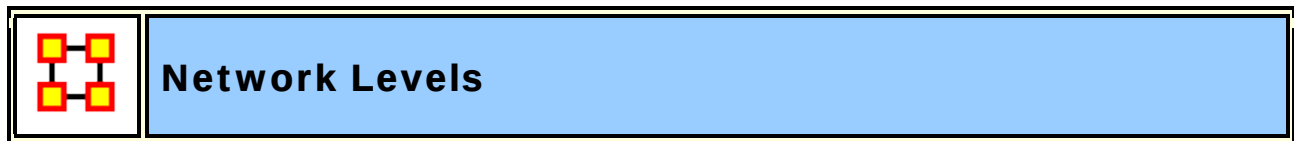
The maximum shortest path length between node pairs (i,j) where there is a path in the network from i to j. If there are no such pairs, then Minimum Speed is zero.

Example : In an organization, we have Bob and Sue with numerous paths between them. The shortest path between this entity pair would be Bob and Sues (Bob/Sue) minimum speed. One might also say that if

there were numerous links between Bob and Sue and that the average linkage was in the neighborhood of 5 paths (e.g., links) when every person in the organization is taken as a whole, the shortest linkage between them would be the minimum speed at which Bob and Sue might communicate. If Bob and Sue had direct links, minimum speed would be 0.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : $Z \in [0, |V| - 1]$

Computational Time

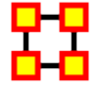
Medium

Description

The Network Level of a square network is the maximum Node Level of its nodes.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=integer.

	Node Count

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : Number of nodes in the network

Computational Time

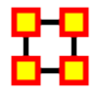
Fast

Description

The number of nodes in a unimodal network.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=integer.

	Node Levels

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : Number of nodes in the network - 1

Computational Time

Medium

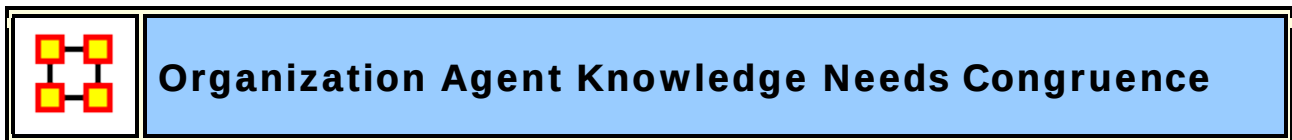
Description

The Node Level for a node v in a square network is the longest shortest path from v to every node v can reach. If v cannot reach any node, then its level is 0.

The Network Level of a square network is the maximum Node Level of its nodes.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=integer.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Across all agents, the knowledge that agents lack to do their assigned tasks expressed as a percentage of the total knowledge needed by all agents.

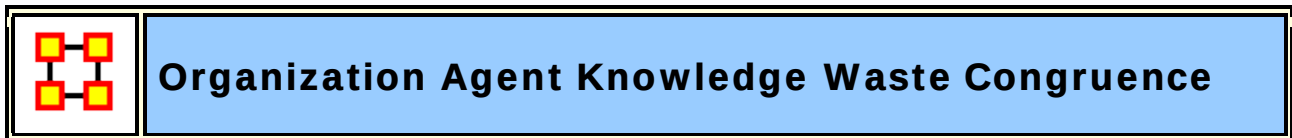
Input :

Agent by Knowledge matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Across all agents, the knowledge that agents have that are not required to do their assigned tasks.

Input :

Agent by Knowledge matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Output : Graph Level with DataType=real.

**Informal Name**

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Across all agents, the resource that agents lack to do their assigned tasks expressed as a percentage of the total resources needed by all agents.

Input :

Agent by Resource matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Across all agents, the resources that agents have that are not required to do their assigned tasks.

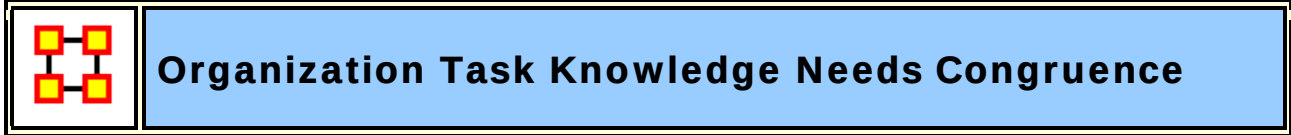
Input :

Agent by Resource matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Across all tasks, the knowledge that tasks lack expressed as a percentage of the total knowledge needed by all tasks.

Example : An organization needs many skills to meet it's organizational objectives. However, not all of the skills are present within the organizational network. This measure computes a value for this lack of skills as it is distributed across the organization as a whole.

Input :

Agent by Knowledge matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Output : Graph Level with dataType=real

	Organization Task Knowledge Waste Congruence

Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Across all agents, the knowledge that agents have that are not required to do their assigned tasks.

Input :

Agent by Knowledge matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Output : Graph Level with dataType=real

	Organization Task Resource Needs Congruence

Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

MediumFast

Description

Across all tasks, the resources that tasks lack expressed as a percentage of the total resource needed by all tasks.

Example : An organization needs many resources to meet it's organizational objectives. However, not all of the resources are present within the organizational network. This measure computes a value for this lack of resources as it is distributed across the organization as a whole.

Input :

Agent by Resource matrix with DataType= binary.

Agent by Task matrix with DataType= binary.

Resource by Task matrix with DataType= binary.

Output : Graph Level with dataType=real



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Across all agents, the resources that agents have that are not required to do their assigned tasks.

Input :

Agent by Resource matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Output : Graph Level with dataType=real



Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

For any node, (e.g. an individual or a resource), the out-links are the connections that the node of interest sends to other nodes. For example, imagine an agent by knowledge matrix then the number of out-links an agent would have is the number of pieces of knowledge it is connected to.

The scientific name of this measure is out-degree and it is calculated on the agent by agent matrices. Individuals or organizations who are high in most knowledge have more expertise or are associated with more types of knowledge than are others. If no sub-network connecting agents to knowledge exists, then this measure will not be calculated. The scientific name of this measure is out degree centrality and it is calculated on agent by knowledge matrices. Individuals or organizations who are high in "most resources" have more resources or are associated with more types of resources than are others. If no sub-network connecting agents to resources exists, then this measure will not be calculated. The scientific name of this measure is out degree centrality and it is calculated on agent by resource matrices.

Input : Square Agent by Agent matrix with dataType=real.

Output : Node Level with DataType=real and Type=row.



Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

A centralization of a square network based on the Out-Degree Centrality of each node.

Example : In a given organization, all employees have so many links to other employees. This is their out degree connections. This measure computes a value for the entire organization as a whole as to how central these connections are within the organization.

Input : Square matrix with DataType=real.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The percentage of tasks that can be completed by the agents assigned to them, based solely on whether the agents have the requisite knowledge and resources to do the tasks.

NOTE : *Task Completion Overall is a combination of the Task Completion Knowledge and the Task Completion Resource.*

Input :

Agent by Knowledge matrix with dataType=binary.

Agent by Resource matrix with dataType=binary.

Agent by Task matrix with dataType=binary.

Knowledge by Task matrix with dataType=binary.

Resource by Task matrix with dataType=binary.

Output : Graph Level with DataType=real



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Measures how accurately agents can perform their assigned tasks based on their access to knowledge and resources.

Input :

Agent by Knowledge matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Agent by Resource matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Output : Graph Level with DataType=real



Informal Name

None

Citation

Ashworth, M. and Carley, Kathleen, M., 2003, "Critical Human Capital, Working Paper, CASOS" Carnegie Mellon, Pittsburgh PA.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

Total number of people reporting to an agent, plus its total knowledge, resources, and tasks.

Personnel Cost is the sum of the in-degree centrality of all AA matrices in the graph (this computes the number of agents reporting to each agent), plus the out-degree centrality of any AK, AR, and AT graphs.

Example : In a given organization, five employees report to Sue. All of the knowledge, resource and tasks connections attributed all the employees and Sue constitute Personnel Cost. This measure then computes a value for Sue based on all these connections of her employees.

Input :

Agent by Agent matrix with dataType=binary.

Agent by Knowledge matrix with dataType=binary.

Agent by Resource matrix with dataType=binary.

Agent by Task matrix with dataType=binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The percentage of pooled links in a unimodal network. A pooled is an link (i,j) such that there exists at least one other link (i,k) in the network, and $k \neq j$.

Let M be the adjacency matrix representation of a unimodal network.

Let $S = \{ (i,j) \mid M(i,j)=1 \wedge \text{sum}(M(:,j)) > 1 \}$

In other words: edge (i,j) is a pooled edge iff the in-degree of entity $j > 1$.

Then **Pooled Edge Count** = $|S| / |E|$.

Example : A pooled edge in a network $N=(V,E)$ is an edge $(i,j) \in E$ such that there exists at least one other edge $(i,k) \in E$, and $k \neq j$.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Cormen, Leiserson, Rivest, Stein 2001. "Introduction to Algorithms" Second Edition. Cambridge, MA: MIT Press, 2001.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Individuals or organizations that connect groups are those that are connecting disconnected groups. The individual or organization may be connected to only one or a few members of each group. This is a composite measure that is high when the agent is potentially influential but is not in the know. This is calculated as the ration of betweenness centrality to total degree centrality and is calculated on agent by agent networks.

Locates nodes that are **high in betweenness centrality, but low in total degree centrality**, and therefore potentially act as links between groups of entities.

Example : This measures finds an individual who could likely have great potential to interact with other parts of an organization based on their existing connections.

Input : Square matrix with DataType=binary and Directed=No.

Output : Node Level and DataType=real



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum :

Maximum :

Computational Time

Medium

Description

Maximum knowledge and resources an agent could use to do tasks if it were assigned to all tasks.

Input :

Example : In a given organization, Bob is assigned all task that exist in the organization. This measure would compute a value expressing Bob's potential to carry out all the tasks based on his connections to the resources and knowledge needed for the tasks.

Agent by Knowledge matrix with DataType=binary.

Agent by Resource matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Output : Node Level with DataType=real



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

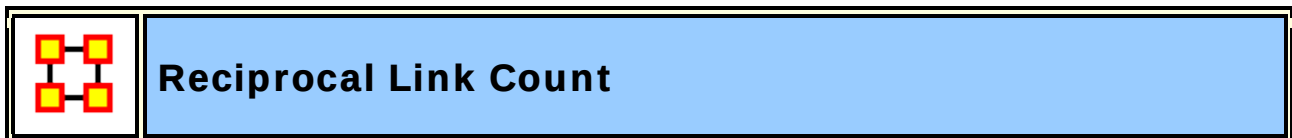
Fast

Description

Radial nodes have a triad count less than one standard deviation below the mean node triad count.

Input : Square matrix with DataType=binary.

Output : Node Level with DataType=binary.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The percentage of links in a unimodal network that are reciprocated. A link (i,j) in the network is reciprocated if link (j,i) is also in the network.

Let $G=(V,E)$ be the graph representation of a network.

Let $S=\text{card} \{ (i,j) \in E \mid i < j, (j,i) \in E \}$

Then **Reciprocal Edge Count** = $|S| / |E|$

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Measures the degree to which each pair of agents has complementary knowledge, expressed as the percent of total knowledge. Each value is normalized by the row sum.

Input : Agent by Knowledge matrix with DataType=binary.

Output : Dyad Level with Type=agent and DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

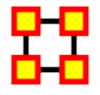
Slow

Description

Measures the degree to which each pair of agents has complementary knowledge, expressed as a percentage of the knowledge of the first agent. Each value is normalized by the row sum. Individuals or organizations that are high in specialized knowledge are those that have expertise or are connected to types of knowledge that few others have.

Input : Agent by Knowledge matrix with DataType=binary.

Output : Dyad Level with Type=agent and DataType=real.

	Relative Cognitive Resemblance

Informal Name

None

Citation

Carley, 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

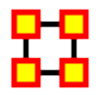
Slow

Description

Measures the degree to which each pair of agents has the exact same knowledge. Each value is normalized by the row sum.

Input : Agent by Knowledge matrix with DataType=binary.

Output : Dyad Level with Type=agent and DataType=real.

	Relative Cognitive Similarity

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Measures the degree to which each pair of agents have overlapping knowledge. Each value is normalized by the row sum.

Input : Agent by Knowledge matrix with DataType=binary.

Output : Dyad Level with Type=agent and DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The degree of dissimilarity between agents based on shared knowledge. Each agent computes to what degree the other agents know what they do not know. Individuals or organizations that are high in specialized knowledge are those that have expertise or are connected to types of knowledge that few others have. The scientific name of this measure is relatively unique and it is calculated on agent by knowledge matrices.

Input : Agent by Knowledge matrix with DataType=binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The degree of similarity between two agents based on shared knowledge. Each agent computes to what degree the other agents know what they know.

Input : Agent by Knowledge matrix with DataType=binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Ashworth, M. and Carley, Kathleen M., 2003, "Critical Human Capital", Working Paper, CASOS, Carnegie Mellon, Pittsburgh PA.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

Boolean value which is true if an agent has exclusive access to a resource and who is known by exactly one other agent. The one agent known also has its KAI set to one.

An node level measure that computes the average shortest path length between entities, excluding infinite distances. This is known as the Resource Access Index (RAI) value.

Example : Let us imagine a social network where 50 employees have many connections to each other. The average number of connections per employee is the Access Index.

Input :

Agent by Agent matrix with DataType=binary

Agent by Resource with DataType=binary.

Output : Node Level with Type=agent and DataType=binary.



Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The resources an agent uses to perform the tasks to which it is assigned.

Input :

Agent by Resource matrix withDataType=binary

Resource by Task matrix with DataType=binary

Agent by Task matrix with DataType=binary

Output : Node Level with Type=agent and DataType=real.

	Resource Congruence

Informal Name

None

Citation

Carley, Kathleen M. 2002

Minimum and Maximum Values

Minimum :

Maximum :

Computational Time

Medium

Description

Measures the similarity between resources assigned to tasks via agents, and what resources are required to do tasks. Perfect congruence occurs when agents have resources when and only when it is needful to complete tasks.

Input : Agent by Resource, Agent by Task, and Resource by Task matrices with DataType= binary.

Output : Graph Level with DataType= real.

	Resource Diversity

Informal Name

Who Has What

Citation

Borgatti, S.P. 2003. The Key Player Problem. Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers, R.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The distribution of difference in resource sharing. This is the Herfindahl-Hirshman index applied to column sums of AR.

Example : Characterizes the network in terms of how the items in a resource network (**who has what**) are non-uniformly distributed across employees

Input : Agent by Resource matrix with DataType=binary.

Output : Graph Level with dataType=real



Informal Name

None

Citation

Ashworth, 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

Detects agents who have singular resource access.

Example : A key resource that supports an entire organization is only accessible through one person.

Input : Agent by Resource matrix with DataType=binary.

Output : Node Level with DataType=real and Type=agent.



Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

Average number of resources per agent.

Input : Agent by Resource matrix with DataType=binary

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The extent to which agents need to negotiate with each other because they lack the resources to complete their assigned tasks.

Example : In a given organization, Bob does not have access to the resources needed to complete a certain task but Sue does have it. Bob must negotiate with Sue to gain those resources. The extent to which others in the organization must negotiate for resources that others have is the organization's resource negotiation value.

Input :

Agent by Tasks matrix with DataType=binary.

Agent by Resource matrix with DataType=binary.

Resource by Tasks matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., Dekker, D., Krackhardt, D (2000). How Do Social Networks Affect Organizational Knowledge Utilization.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The degree to which agents reuse resources while doing their tasks.

Example : Sue has X amount of tasks within her company. How many of those tasks that require a resource that can be used for one or more of her other tasks is omega knowledge. This measure computes a value for such relations to the resources at the network level.

Input :

Agent by Task matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Task by Task matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Maximum resources an agent could use to do tasks if it were assigned to all tasks.

Example : In a given organization, let us say Bob is assigned all task that exist in the organization. This measure would compute a value expressing Bob's potential to carry out all the tasks based on his connections to the resources and knowledge needed for the tasks.

Input :

Agent by Resource matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Output : Node Level with Type=agent and DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : $[(|R|-1)*|T|]$

Computational Time

Fast

Description

Average number of redundant agents per resource. An agent is redundant if there is already an agent that has the resource.

Input : Agent by Resource with dataType=binary.

Output : Graph Level with dataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The percentage of tasks that can be completed by the agents assigned to them, based solely on whether the agents have the requisite resources to do the tasks.

Example : Bob is assigned 10 Tasks to complete which require a certain amount of resources to finish. However, on average only 10-percent of those resources will be available to Bob for him to complete the tasks given. This measure would compute a value for the likelihood that Bob would be able to complete any given task.

NOTE : *Task Completion Overall is a combination of the Task Completion Knowledge and the Task Completion Resource.*

Input :

Agent by Resource matrix with dataType=binary.

Agent by Task matrix with dataType=binary.

Resource by Task matrix with dataType=binary.

Output : Graph Level with DataType=real



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The extent to which the resources needed to do tasks are unavailable in the entire organization.

Example : In an organization where Bob needs to complete Task A, he needs access to Resource B, which in this case might be a computer. However, what would happen if Resource B were simply unavailable? Say the computer was offline 50-percent of the time. This computer would likely under supply the task of completing Task A. This measure would compute a value to the effect that this under supply factor affected the ability to perform the task at hand.

Input :

Agent by Task matrix with dataType=binary.

Agent by Resource matrix with dataType=binary.

Resource by Task matrix with dataType=binary.

Output : Graph Level with DataType=real



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The fraction of entities with row nodes with degree greater than one.

Example : In a given organization, we have the following entities: employees (agents), computers (resources), benchmarks (tasks). This measure tells us on how many links greater than one exist within these entity types.

Input : Matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum : 0

Maximum : Number of rows in the network

Computational Time

Fast

Description

The number of row nodes in a network.

Input : Matrix with DataType=binary.

Output : Graph Level with DataType=integer.



Informal Name

None

Citation

Wasserman and Faust, 1994

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

A centralization based on the degree of the row nodes of a network.

Input : Matrix with DataType=real

Output : Node Level with dataType=real and Type=row.



Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum :

Maximum :

Computational Time

Fast

Description

A centralization based on the degree of the row nodes of a network.

Input : Matrix with DataType=real

Output : Graph Level with dataType=real and Type=row.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : $[(N-1)*M]$

Computational Time

Fast

Description

The mean number of row node links in excess of one.

Example : Let us say in our organizational matrix, we have Bob who multiple links to Sue. Let us say this is multiple linkages has an average of 2.5 per employee to the same manager Sue or another. The measure computes a value for this average which is considering row redundancy.

Input : Matrix with DataType=binary.

Output : Graph Level with dataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

The percentage of links in a network that are neither Reciprocal Links nor Pooled Links. Note that an link can be both a Pooled and a Reciprocal link.

Let **G=(V,E)** be the graph representation of a network, and let **X = set of Pooled edges of G**, and let **Y = set of Reciprocal edges of G**.

Then **Sequential Edge Count = $|E - X - Y| / |E|$**

Example : The percentage of edges in a network that are neither Reciprocal Edges nor Pooled Edges. Note that an edge can be both a Pooled and a Reciprocal edge. Self-loops are ignored.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Graham, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : Unscaled real number

Computational Time

Medium

Description

Individuals or organizations that are high in group awareness are those that by virtue of their connections to others, what resources they use, what knowledge there is, what tasks there are - have a better understanding of what others are doing.

Example : If we take any given pair of actors in an organization, this measure computes a value for how similar they are to each other based on their relationships (i.e., links) to others in the same organization.

Input : Agent by Agent matrix with dataType=binary.

Agent by Agent matrix with dataType="binary" - label="Select an Interaction Matrix"

Agent by Agent matrix with dataType="binary" - label="Select a Physical Proximity Matrix"

Agent by Agent matrix with dataType="binary" - label="Select a Background Similarity Matrix"

Output :

Node Level with Type=agent and DataType=real.

Dyad Level with TargetType=agent and DataType=real.

Formula :

Let alpha, beta, delta, gamma, mu be Real numbers.

Let A = Agent x Agent interaction/communication network.

Let P = Agent x Agent physical proximity network.

Let S = Agent x Agent social demographic similarity network.

Let e = eigenvector centrality measure computed on A.

Let G = geodesics between agents computed on A.

Then the SSA measure between agents i and j is:

$$SSA(i,j) = \alpha * e[i] * e[j] + \beta * P(i,j) + \delta * S(i,j) / (\gamma * G(i,j)) + \mu * A(i,j) * A(j,i)$$



Informal Name

None

Citation

Krackhardt, David. 1998. "Simmelian Tie: Super Strong and Sticky." In Power and Influence in Organizations., edited by Roderick M. Kramer and Margaret Neale, pp. 21/38. Thousand Oaks, CA: Sage.

Simmel, Georg. 1950. "The Sociology of Georg Simmel." New York: Free Press, 1st free press paperback edition.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

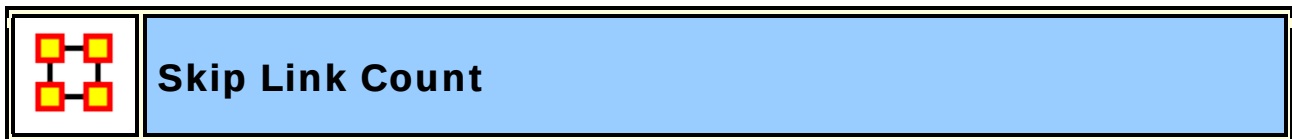
Description

The normalized number of Simmelian ties of each node.

Example : Described informally as ties embedded in cliques and are often associated with **brokers** inside such cliques such that if **Bob** and **Susan** only know of each other because of **Chan** and now all of them, Bob, Susan and Chan, now know each other. Chan, Bob, Susan now have **simmelian ties** to each other.

Input : Square matrix with DataType=binary.

Output : Node Level with dataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

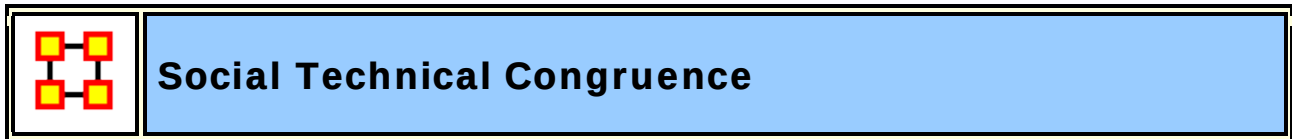
The fraction of links in a unimodal network that skip levels. An link (i,j) is a skip link if there is a path from node i to node j even after the link (i,j) is removed.

A skip edge in a network $G = (V, E)$ is an edge $(i,j) \in E$ such that j is reachable from i in the **graph** $G' = (V, E \setminus (i,j))$, that is, the graph G with edge (i,j) removed. Skip Count is simply the number of such edges in G normalized to be in $[0,1]$ by dividing by $|E|$.

Example : The fraction of edges in a unimodal network that skip levels. An edge (i,j) is a skip edge if there is a path from entity i to entity j even after the edge (i,j) is removed.

Input : Square matrix with DataType= binary.

Output : Graph Level with DataType= real.



Informal Name

None

Citation

Cataldo et al, 2006

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Social technical congruence represents the proportion of coordination requirements that were satisfied through some type of actual coordination activity carried out through some means of communication.

A representation of the coordination requirements among the different workers is obtained by multiplying AT, TT and transpose of AT matrices. This product results in a people by people matrix where a cell ij indicates the extent to which person i works on tasks that share dependencies with the tasks worked on by person j . In other words, the resulting matrix represents the Coordination Requirements or the extent to which each pair of people needs to coordinate their work.

Formally, the Coordination Requirements (CR) matrix is determined by the following product:

Let, **CR = AT * TT * transpose(AT)**

Given a particular CR matrix constructed from relating product dependencies to work dependencies, we can compare it to an Actual Coordination (CA) matrix that represents the interactions workers engaged in through different means of coordination.

$$\text{Diff (CR, CA)} = \text{card} \{ \text{diff}_{ij} \mid \text{cr}_{ij} > 0 \ \& \ \text{ca}_{ij} > 0 \}$$

$$|\text{CR}| = \text{card} \{ \text{cr}_{ij} > 0 \}$$

We have,

$$\text{Congruence(CR, CA)} = \text{Diff (CR, CA)} / |\text{CR}|$$

Input :

Agent by Agent matrix with DataType=binary

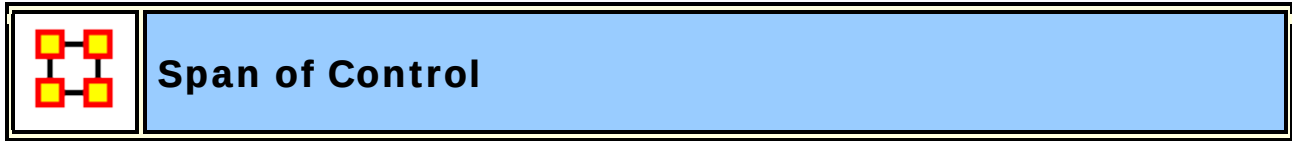
Agent by Task matrix with DataType=binary

Task by Task matrix with DataType=binary

Output :

Graph Level with dataType=real.

Dyad Level with Agent (source) by Agent (target) with
DataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum : 0

Maximum : $\in \mathbb{R} [0, |V|-1]$

Computational Time

Fast

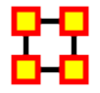
Description

The average number of out links per node with non-zero out degrees.

Example : Bob has 5 out degree links to 5 other personnel in his company and of those 5 personnel, the average non-zero (i.e., people that make up that personnel that have out-degree links of there own) is 4. Whereas Sue might have 5 personnel out degree links, but those personnel have 3 out-degree links themselves on average. It would figure that Sue might have a greater span of control, since the people she connects do, don't have as many connections as those that Bob connects to does. This measure would compute a value for such relationships called Span of Control.

Input : Square matrix with DataType=binary.

Output : Graph Level with dataType=real.

	Spatial Betweenness Centrality

Informal Name

None

Citation

Olson, Mallory

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

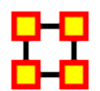
The extent to which a node lies between other nodes that are far from each other.

Input :

Agent by Agent matrix with DataType=real.

Agent by Location matrix with DataType=real.

Output : Node Level with Type=agent and DataType=real

	Spatial Closeness Centrality

Informal Name

None

Citation

Olson, Mallory

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

The extent to which a node is close to the other nodes both in the network and in space

Input :

Agent by Agent matrix with DataType=real.

Agent by Location matrix with DataType=real.

Output : Node Level with Type=agent and DataType=real



Informal Name

None

Citation

Olson, Mallory

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

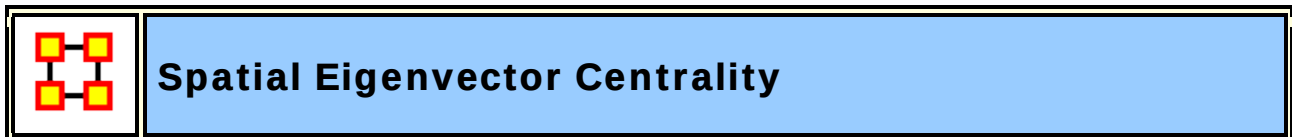
The total distance from a node to its neighbors

Input :

Agent by Agent matrix with DataType=real.

Agent by Location matrix with DataType=real.

Output : Node Level with Type=agent and DataType=real



Informal Name

None

Citation

Olson, Mallory

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

The sum of the eigenvector centralities of all nodes located at a place. Intuitively, the likelihood of arriving at a node at a particular location in a random walk.

Input :

Agent by Agent matrix with DataType=real.

Agent by Location matrix with DataType=real.

Output : Node Level with Type=location and DataType=real



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Measures the similarity between what knowledge are assigned to tasks via agents, and what knowledge are required to do tasks. Perfect congruence occurs when agents have access to knowledge when and only when it is needful to complete tasks.

Knowledge Congruence = 1 iff agents have knowledge when and only when it is needful to complete their tasks. Thus, we compute the knowledge assigned to tasks via agents, and compare it with the knowledge needed for tasks.

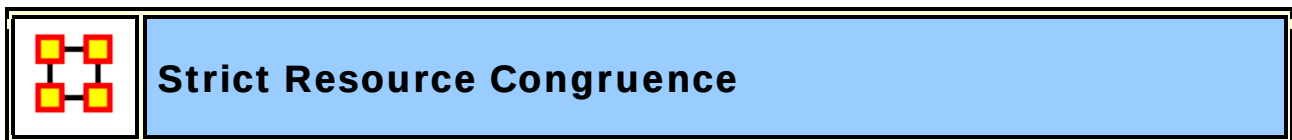
Input :

Agent by Knowledge matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Knowledge by Task matrix with DataType=binary.

Output : Graph Level with dataType=real.



Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

Measures the similarity between resources assigned to tasks via agents, and what resources are required to do tasks. Perfect congruence occurs when agents have resources when and only when it is needful to complete tasks.

Knowledge Congruence = 1 iff agents have knowledge when and only when it is needful to complete their tasks. Thus, we compute the knowledge assigned to tasks via agents, and compare it with the knowledge needed for tasks.

Input :

Agent by Resource matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Output : Graph Level with dataType=real.



Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The number of strongly connected components in a network. The network can be directed or undirected.

Given a square network $G=(V,E)$, the Strong Component Count is the number of strongly connected components in G . This is computed directly on G , whether or not G is directed.

Input : Square matrix with DataType=binary.

Output : Graph Level with dataType=integer.



Informal Name

None

Citation

Ashworth, 2002

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Description

Detects agents who exclusively perform tasks. Individuals or organizations that are high in complete exclusivity for tasks are those that are engaged in or assigned to tasks or activities for which no one else is engaged in or assigned to. The scientific name of this measure is complete exclusivity and it is calculated on agent by task matrices.

Input : Agent by Task matrix with DataType=binary.

Output : Node Level with DataType=real and Type=agent.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The number of knowledge not supplied to a task, but required to do the task, expressed as a percentage of the total knowledge required for the task.

Task Knowledge Needs compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the under supply of knowledge to tasks.

Input :

Agent by Knowledge matrix with dataType=binary.

Agent by Task matrix with dataType=binary.

Knowledge by Task matrix with dataType=binary.

Output : Node Level with Type=Task and dataType=real



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The number of knowledge supplied to a task via agents that are not required by it expressed as a percentage of the total knowledge required for the task.

Task Knowledge Waste compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the over supply of knowledge to tasks.

Input :

Agent by Knowledge matrix with dataType=binary.

Agent by Task matrix with dataType=binary.

Knowledge by Task matrix with dataType=binary.

Output : Node Level with Type=task and DataType=real.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The number of resources not supplied to a task, but required to do the task, expressed as a percentage of the total resources required for the task.

Task Knowledge Needs compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the under supply of knowledge to tasks.

Input :

Agent by Resource matrix with dataType=binary.

Agent by Task matrix with dataType=binary.

Resource by Task matrix with dataType=binary.

Output : Node Level with Type=task DataType=real.



Informal Name

None

Citation

Lee, 2004

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The number of resources supplied to a task via agents that are not required by it expressed as a percentage of the total resources required for the task.

Task Knowledge Waste compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the over supply of knowledge to tasks.

Input :

Agent by Resource matrix with DataType=binary.

Agent by Task matrix with DataType=binary.

Resource by Task matrix with DataType=binary.

Output : Node Level with Type=task and DataType=real.



Informal Name

In The Know

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

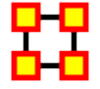
Description

The Total Degree Centrality of a node is the normalized sum of its row and column degrees. Individuals or organizations who are "in the know" are those who are linked to many others and so, by virtue of their position have access to the ideas, thoughts, beliefs of many others. Individuals who are "in the know" are identified by degree centrality in the relevant social network. Those who are ranked high on this metrics have more connections to others in the same network. The scientific name of this measure is total degree centrality and it is calculated on the agent by agent matrices.

Individuals or organizations who are "in the know" are those who are linked to many others and so, by virtue of their position have access to the ideas, thoughts, beliefs of many others. Individuals who are "in the know" are identified by degree centrality in the relevant social network.

Input : Square Agent by Agent Matrix with dataType=real.

Output : Node Level with dataType=real.

	Total Degree Centralization

Informal Name

None

Citation

Freeman, L.C. (1979). Centrality in Social Networks I: Conceptual Clarification. Social Networks, 1, 215-239.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

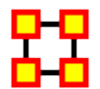
Description

A centralization of a square network based on the Total-Degree Centrality of each node.

Example : An organization has a sales team, computers, sales data and a marketing team. How central all of these entities are within the organization is its total degree network centralization value.

Input : Square matrix with DataType=real.

Output : Graph Level with DataType=real.

	Transitivity

Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Description

The percentage of link pairs $\{(i,j), (j,k)\}$ in the network such that (i,k) is also an link in the network.

Example : The percentage of pairs in the employee communication network where employee **A** is linked to **B** and **B** is linked to **C** and **C** is also linked to **A**

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real



Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum : 0

Maximum : Integer (N-1) (N-2)

Computational Time

Medium

Description

The number of triads centered at each node in a square network. A triad is a relationship amongst three nodes such that they constitute a distinct and important relationship which is deemed relevant to network architecture.

Input : Square matrix with DataType=binary.

Output : Node Level with DataType=integer.



Informal Name

None

Citation

Krackhardt, D. 1994. Graph Theoretical Dimensions of Informal Organizations. In Computational Organization Theory, edited by Carley, Kathleen M. and M.J. Prietula. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

The degree to which pairs of agents have a common ancestor.

Example : In a given organization, if Bob and Ahmed were both hired by Pedro this measure would compute a value correlating to this shared ancestry or linkage that both have to Pedro.

Input : Square matrix with DataType=binary.

Output : Graph Level with DataType=real.



Informal Name

None

Citation

Watts DJ, Strogatz SH "Collective dynamics of 'small-world' networks"
NATURE 393 (6684): 440-442 JUN 4 1998.

Minimum and Maximum Values

Values for both Graph Level and Node Level

Minimum : 0

Maximum : 1

Computational Time

Slow

Description

Measures the degree of clustering in a network by averaging the clustering coefficient of each node, which is defined as the density of the node's ego network.

Example : The average of the proportion of links between each employee and his or her direct neighbors divided by the number of links that could possibly exist between them.

The clustering coefficient gives a sense of the local characteristics of the network--how information spreads by means of employee groups. A higher clustering coefficient supports local information diffusion as well as a decentralized infrastructure because employees are likely to share information and know what is happening in their work group.

Input : Square matrix with DataType=binary.

Output : Both Graph Level and Node Level use produce DataType=real.



Informal Name

None

Citation

Cormen, Leiserson, Riverest, Stein, 2001

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

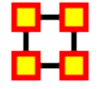
Medium

Description

A node which if removed from a network creates a new component.

Input : Square matrix with DataType=binary and Directed=No.

Output : Node Level with dataType=binary.

	Weak Component Count

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : Integer Value

Computational Time

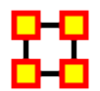
Medium

Description

The number of weakly connected components in an undirected (symmetric) network.

Input : Square matrix with DataType=binary and Directed=No.

Output : Graph Level with dataType=integer.

	Weak Component Members

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : Any Integer Value

Computational Time

Medium

Description

Computes the component to which each node belongs in the underlying, undirected network.

Example : Given a square, **symmetric network $G=(V,E)$** , the Weak Component Member for a entity is the weak component to which the entity belongs. The components are numbered from 1 to the number of weak components (Weak Component Count).

Input : Square matrix with DataType=binary.

Output : Node Level with DataType=integer.



Description

Reports are one of ORA's core functions and comprise a very powerful feature in ORA. There are two ways to access the reports. 1) From the main menu **Analysis > Generate Reports** and 2) The Reports button in the main window.

Categories

ORA reports are divided into groups.

Knowledge Networks & Network Text Analysis : Communications Network Assessment, Communicative Power, Group Talk, Hot Topics, Large Scale, Parts of Speech, Semantic Network.

Statistical Procedures and Diagnostics : Context, Missing Links, Potential Errors, QAP, Statistical Change Detection, Statistical Distribution.

Geospatial : Geospatial Assessment, Key Entity, Trails, Unique Trails Report.

Groups : Core Network, Local Patterns, Locate SubGroups.

Dynamics : Belief Propagation, Change in Key Entities, Immediate Impact, QAP, Statistical Change Detection.

Specialty : Capabilities, Drill Down, Influence Net, Merchant Marine, Optimizer, Public Health, Tactical Insight, Trails Analysis.

Locate Key Entities : Change in Key Entities, Communicators, Critical Sets, Key Entity, Management, Simmelian Ties Analysis.

Locate Key Relations : Shortest Path

All Measures :



Description :

Computes a collection of measures and generates output in categories. Each category analyzes a particular aspect of the meta-network structure.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

	Belief Propagation

Description :

Estimates belief propagation through social networks. This report contains the most common beliefs shared by most people, the beliefs with the highest GINI coefficient, the most strongly held beliefs, the most likely to change beliefs, the most neutral individuals, and the most opinionated individuals.

Why Use This Report :**What networks are in the meta-network :****When are needed to run report :****Using the "don't run the time consuming measures" :****Output :**

Single Meta-Network, multiple Meta-Network comparison.

	Capabilities

Description :

Analyzes the knowledge, resource, and task capabilities of agents and organizations in the network.

Why Use This Report :

To assess an individuals' or organizations' capability to perform tasks.

What networks are in the meta-network :**When are needed to run report :****Using the "don't run the time consuming measures" :**

Output :

Single Meta-Network, side-by-side comparison, multiple Meta-Network comparison.



Description :

Analyzes the changes over time of the agents that score highest in measure values.

Why Use This Report :

This report provides information on the overall structure of a complex network and identifies, for each type of node, which nodes stand out. A complex network typically is a meta-network with multiple types of entities such as people, expertise, resources and locations. Overall structure is defined using meta-network metrics such as Overall Complexity, Social Density, Social Fragmentation, Communication Congruence, Knowledge Congruence, Performance as Accuracy, and Average Communication Speed. Key entities within each of the component networks are identified in terms of metrics such as Degree Centrality, Cognitive Demand, Specialization, and Redundancy. Separate key-entity pages are produced for each type of entity. For example, if there are people and resources - then key people and key resources are both identified. If the user selects two or more networks, this report will compare the results.

What networks are in the meta-network :

When are needed to run report :

At least two networks.

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network.

	Communications Network Assessment

Description :

This report assesses a communications network. As information on speed of information transmittal becomes available it will be updated. This report takes a resource by resource network (preferably one where the nodes are communications devices and the links are the speed of reliability of the link).

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

	Communicative Power

Description :

Analyzes one or more semantic networks to classify concepts by measure values.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, side-by-side comparison, multiple Meta-Network comparison.



Description :

Analyzes the communication network (agent by agent) and gives high level statistics on its structure.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, side-by-side comparison.



Description :

Compares measured values against various stylized forms of networks in an effort to characterize network topology.

Why Use This Report :

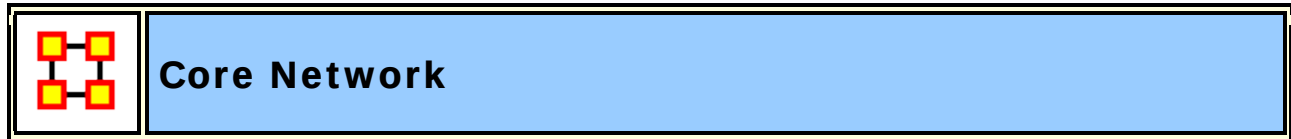
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network.



Description :

Computes the core network and reports general statistics.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, side-by-side comparison.



Description :

Finds critical sets of nodes in a network that best reach all other nodes, or whose removal maximally disrupts a network.

Why Use This Report :

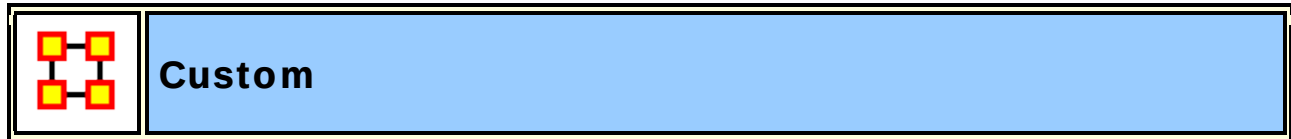
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network.



Description :

Computes a custom report with user selected measures and output tables, pictures, and figures.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Computes the drill down from a selected organization and then to a selected agent.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Finds nodes that are co-located based, and counts the number of nodes that appear at location points.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Analyzes the relationship between agents and knowledge.

Why Use This Report :

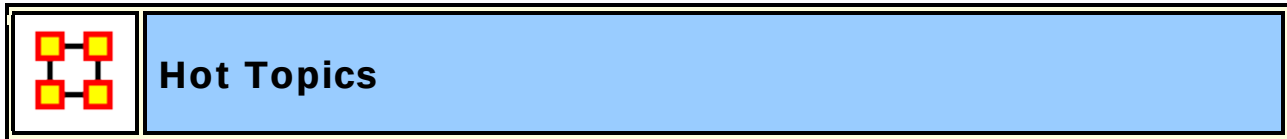
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Analyzes semantic network output from AutoMap.

Why Use This Report :

When you have semantic network data or lists of concepts, networks derived from email content, or texts or documents of any sort.

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, multiple Meta-Network comparison.



Description :

Computes the key actors of the network, and then isolates them individually to determine the effect on measure values.

Why Use This Report :

This report allows the user to engage in **what if** analysis about the immediate impact of removing one or more nodes. Comparative statistic

techniques are used to assess the network with and without the nodes in question.

The user identifies a network, identifies which node or nodes to remove, and then ORA computes the consequent changes in the network by removing those nodes in terms of overall network structure and key entities. A feature of this report is that the user can save the meta-network with the removed nodes and then assess the modified network with any of the other reports.

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network.



Description :

Displays the influence network and gives high level statistics on its structure.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.

	Key Entity

Description :

Identifies key entities and groups who by virtue of their position in the network are critical to its operation.

Why Use This Report :

This report performs a network-level report to find Overall Complexity, Social Density, Social Fragmentation, Communication Congruence, Knowledge Congruence, Performance as Accuracy, and Avg Communication Speed. (Replaces the Event Analysis, Intelligence, and Location Analysis Reports).

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, side-by-side comparison, multiple Meta-Network comparison.

	Large Scale

Description :

Computes all network analysis measures.

Why Use This Report :

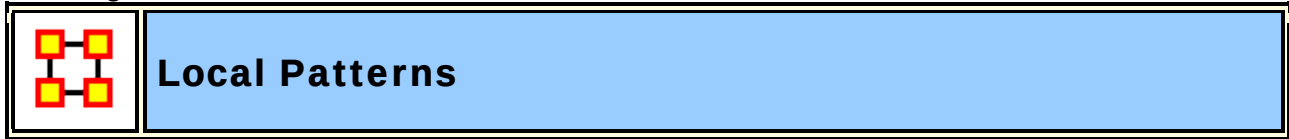
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Find link patterns in a network, such as Star, Checkerboard, and Clique.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Identifies the subgroups present in the network using various grouping algorithms. Most algorithms only work on a single network at a time

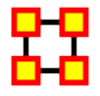
Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

	Management

Description :

Identifies over- and under- performing individuals and assesses the state of the network as a functioning organization.

Why Use This Report :

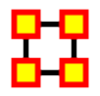
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network, multiple Meta-Network comparison.

	Merchant Marine

Description :

Analyzes the relationship between crew members, owners, vessels, and locations of the Merchant Marine Vessel data.

Why Use This Report :

Used with a special data-set developed by CASOS.

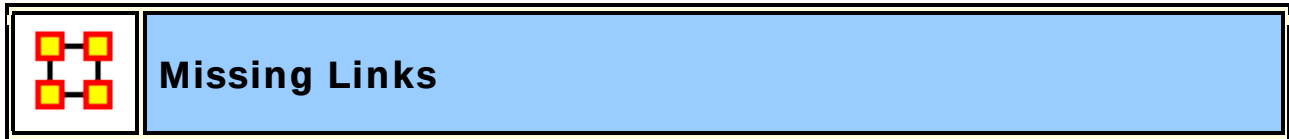
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Compute possible missing links in a network.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Adapt the link structure of a Meta-Network to maximize or minimize selected measure values.

Why Use This Report :

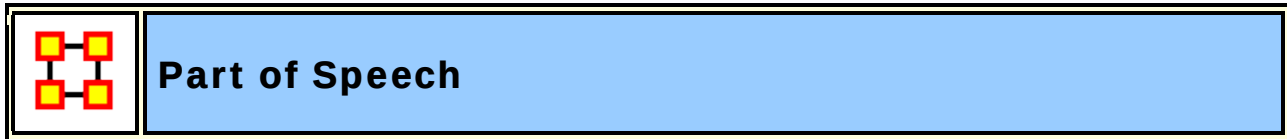
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Describe the distribution of concepts by part of speech in one or more networks.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, multiple Meta-Network comparison.



Description :

Detects potential errors in agent to agent interactions based on the expected interactions from cognitive similarity and expertise.

Why Use This Report :

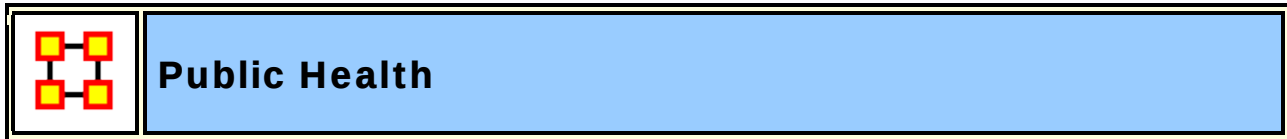
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-work.



Description :

Analyzes health department data to find potential problems.

Why Use This Report :

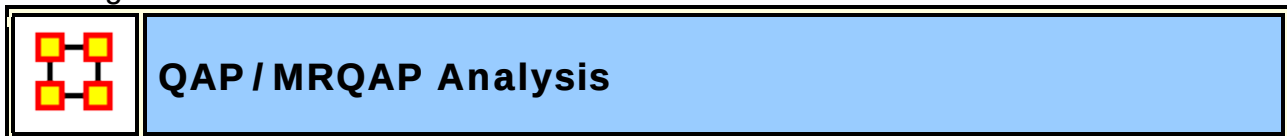
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Computes QAP and MRQAP Correlation and Regression (Dekker and Y-Permutation methods) on input networks.

MRQAP : Used for multivariate cases if your dependent variable is continuous or count data (like in a negative binomial case), you should use MRQAP. If your dependent variable is binary, you should use ERGM (P*) which is forthcoming in ORA. One can perform MRQAP on data that have a dichotomous dependent variable (basically, this is equivalent to using a linear probability model). You do need to interpret your results accordingly.

QAP Analysis : Computes QAP Correlation and Regression (Dekker and Y-Permutation methods) on input matrices. QAP is designed as a bivariate test

(only two variables). Generally, QAP is perfectly fine for almost any bivariate network problem.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Analyzes one or more semantic networks, computing central networks and key concepts and links.

Why Use This Report :

Assesses the connection among concepts. Will derive networks from email content, texts, or documents of any sort.

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, side-by-side comparison.

	Shortest Path

Description :

Computes the shortest path between two entities and general statistics on the paths. The sphere of influence of each entity is also computed.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.

	Simmelian Ties Analysis

Description :

Calculates the number of Asymmetric, Sole-Symmetric, and Simmelian Ties in unimodal networks computes standard measures on them.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

A single agent by agent or actor by actor network.

Using the "don't run the time consuming measures" :

Output :

	Sphere of Influence

Description :

For each individual, identifies the set of actors, groups, knowledge, resources, etc. that influence, and are influenced, by that actor.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Any network. But it's most interpretable if you have an agent by agent and also have another network such as agent by knowledge or agent by resources or agent by location.

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network.

	Standard Network Analysis

Description :

Calculates the standard network analysis measures (Degree Centrality, Betweenness, etc).

This report calculates the standard network analysis measures such as Degree Centrality, Betweenness Centrality, etc. This report can be used on any "square network" where all the nodes are of one type; e.g., a people x people or resource x resource network. The standard network analysis measures typically provide an analyst with a broad overall picture of the structure of the network. If the user selects two or more networks, this report will compare the results.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, side-by-side comparison.



Description :

Analyzes the changes in network-level measures over time using a Statistical Process Monitoring (SPM) control chart. Control limits are determined based on a user defined level of risk.

Why Use This Report :

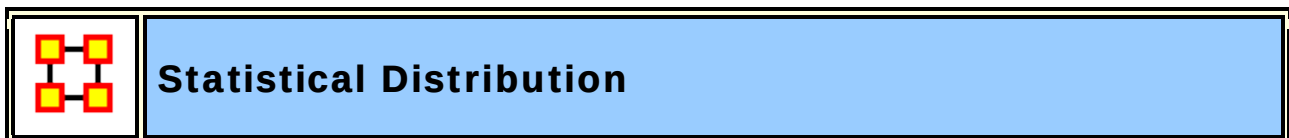
What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, multiple Meta-Networks.



Description :

Fits statistical distributions to a network based on measure values.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Analyzes the top agent nodes across time periods, tracking locations and measure values.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

At least three networks.

Using the "don't run the time consuming measures" :

Output :

Single Meta-Network, Multiple Meta-Network comparison.



Description :

Analyzes the trails that an entity class makes through another entity class, for example, how vessels pass through ports.

Why Use This Report :

What networks are in the meta-network :

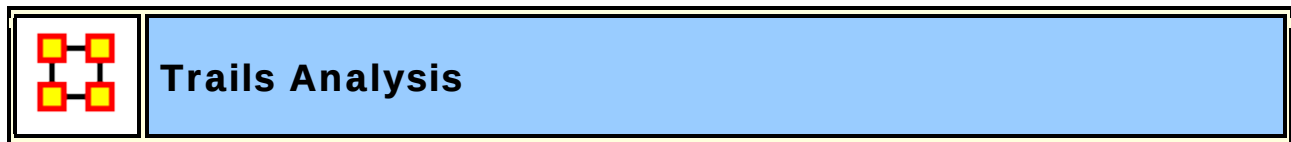
When are needed to run report :

At least two networks. Also requires data in trails format so who/what was where when. Could also be who/what interacted with who/what when.

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.



Description :

Analyzes the trails that are found in the Trails Viewer. It does this by analyzing the trails of one nodeclass as it makes its way through another nodeclass (e.g. how vessels pass through ports).

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network with multiple Meta-Network comparison.

	Unique Trails Report

Description :

Analyzes the path of an entity class through locations over time.

Why Use This Report :

What networks are in the meta-network :

When are needed to run report :

Using the "don't run the time consuming measures" :

Output :

A single Meta-Network.

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