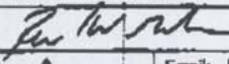


		MORS CONTRACTOR DISCLOSURE FORM		712A		MORS P#: (If known) DEADLINE: 2 MAY 08 Fax to: 703-653-8066	
Principal Author:		Other Author(s):					
Deborah V. Duong							
Principal Author's Organization and complete mailing address:				Principal Author's Signature:			
OSD/PA&E Simulation and Analysis Center				X  Date: May 5, 2008			
1225 South Clark Street Suite 300 Arlington, VA 22202				Phone: 703-698-2341 Fax: 703-604-6400 Email: debbie.duong.ctr@osd.mil			
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The Oz Wargame Integration Toolkit: Supporting Wargames for Analysis



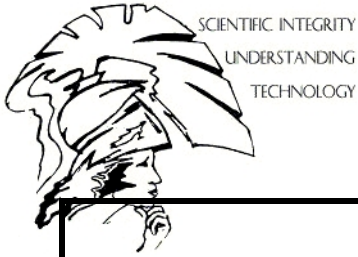
Deborah Duong, Will Ellerbe, Lauren Murphy



Got a Wicked Problem?

- **Irregular Warfare (IW) analysis** is a “Wicked Problem”
 - IW: Battlegrounds of social concepts
 - Legitimacy
 - Popular Will
 - Many perspectives
 - Seems unsolvable
- Two complementary approaches to analysis:
 - **Human:** Wargaming
 - **Machine:** Simulation
- **The Oz Wargame Integration Toolkit**
 - A solution that takes the best of both approaches
 - Integrates wargames, simulations, rule-based systems, and data





Human vs. Machine

Analysis of the Social World

Subject Matter Experts (SMEs)	Computer Simulation
Can understand human contexts	Limited and forced understanding
Can recognize new situations	Newness (emergence) not well developed
Hard to get statistical significance (exception: Massive Multiplayer Online Gaming)	Easy to repeat
Human variance requires more repetitions	Can hold all else the same
Individuals stove-piped	Scalable and crosscutting: incorporates knowledge from many disciplines
Can not connect micro to macro	Can compute micro-macro complexity



"If I only had a
(computer) brain"



"If I only had a
(human) heart"



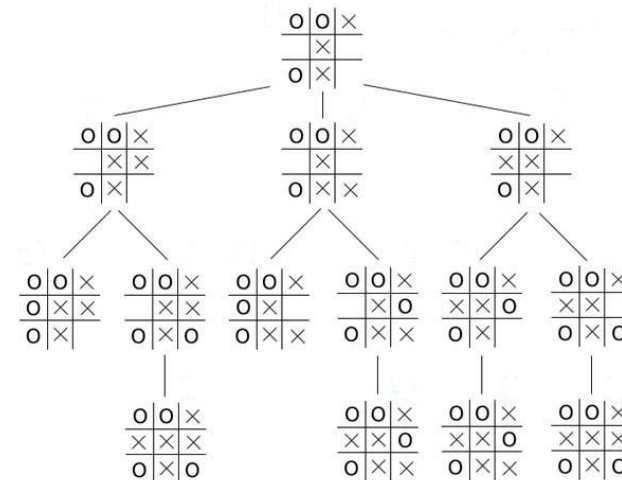
Synergies between Human and Machine in Oz

- Oz supports achieving statistically significant patterns
 - Allows branching and keeps track of the branches
 - Keeps track of hierarchical categorizations of moves in an “ontology”
 - Enables post-game statistical analysis and data-mining
 - Streamlines the move input and adjudication process
 - Players quickly select from available moves in a menu
 - Computer models suggest adjudications that humans may check
 - Rapid entry of ontologies, rules, models, and data
 - Human resources may be applied to more repetitions of the game
- Oz does not limit human creativity
 - Free moves are allowed in the war game
 - Players may suggest a new categories
 - Text descriptions are stored
 - In extended games, computer modelers have time to incorporate new moves into their models
 - New moves are easily expressed in ontology and rules
 - Human adjudicators have the final say over model suggested results



Statistics through Branching

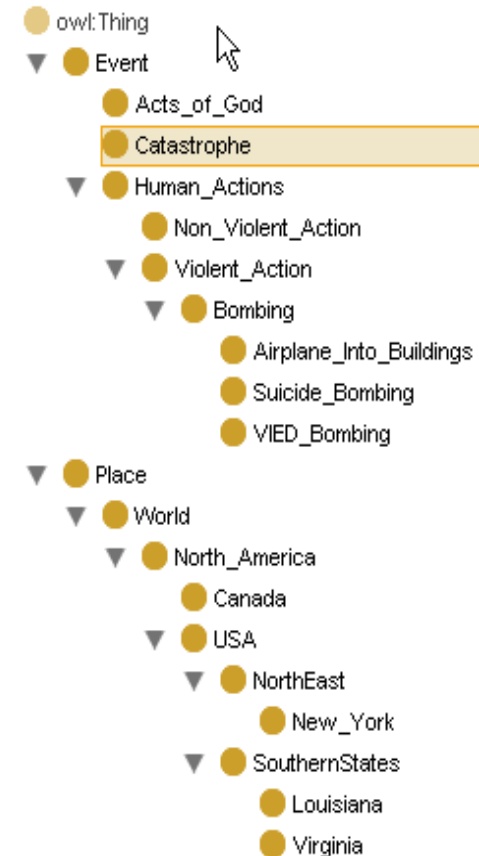
- For example, every time a particular action is done, or a particular player makes a move, give it to another player
 - For pair-wise comparison, or random block design experiments
 - Fewer repetitions needed
 - “Holds all else the same” by giving the same history up to the branching point
- Done behind the scenes
 - Players only see history that they should see
 - Perception is preserved
 - Oz file sent through email
- Necessary part of the Scientific Method
 - Done in the United Kingdom and the Army War College





Statistics through Ontology Technology

- Ontology: A way to categorize data into general and specific categories
 - Intuitive interface for input through Protégé open source software
- Facilitates significant level of aggregation for Statistics and Data Mining
 - There might not be enough data on specific terrorist acts, but it may be significant on a general level
 - Provides gradient for data mining techniques (like MPICE, CAST, ACTOR, FORESITE)





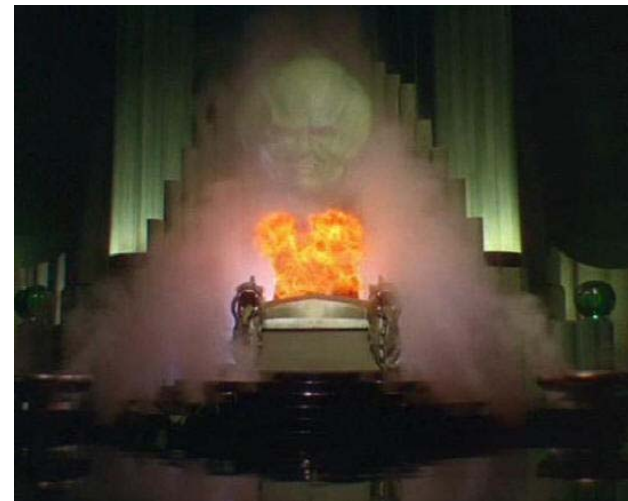
Finding Patterns in Creative Actions

Q. How can we use statistics if Irregular Warfare Analysis is Wicked?

- Doesn't human creativity make actions unique?

A. We aren't studying uniqueness, we are studying patterns

- Unique actions still fall into types
- Statistics measure coerciveness of action
 - Defined by a **lack** of variance in response
- Medical statistics deal with similar levels of variation





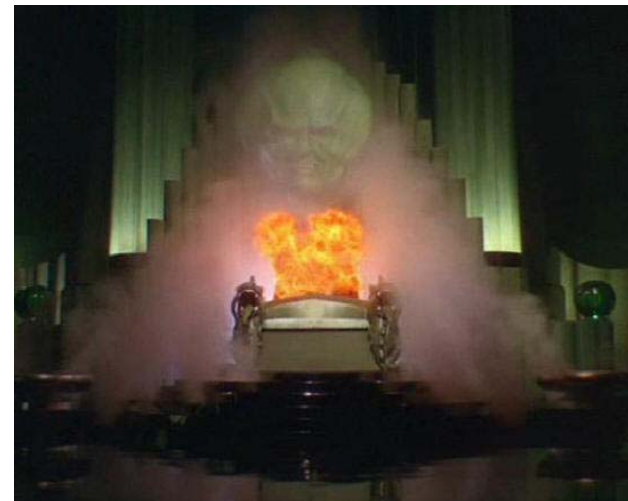
The Game World vs. the Real World

Q. But we aren't using real data!

A. We are finding patterns in our best SME and model estimates

- Strategic role-playing helps players to “be there”
- Statistical comparisons with real data can eliminate “game bias”

Statistics tease out the effects due to the game itself from the effects due to the idiosyncrasies of the players





The Model Composition Problem

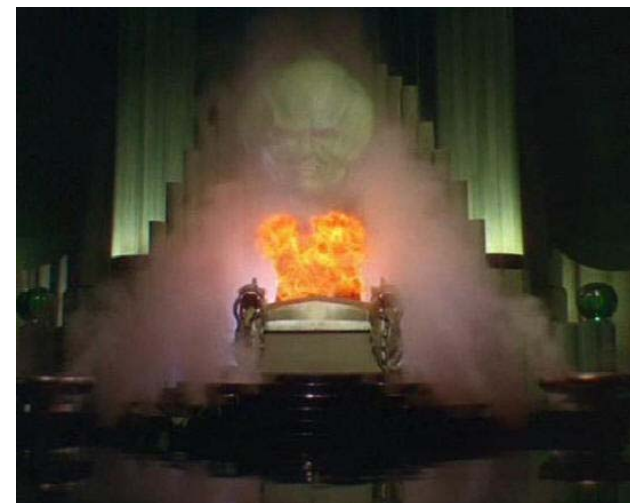
Q. Isn't the social computation in your automated adjudication another wicked problem?

- What do you do with many perspectives?

A. Yes, we are forced to compose social simulations

- One simulation can't hold the entire social world
- Each social scenario is a unique combination
 - Impractical to simulate from scratch
 - Needed for quick-turnaround analysis
- Since social scientists disagree, all perspectives of every discipline need to be tested

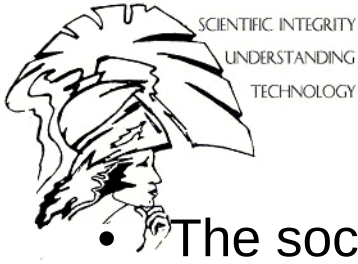
... and we are applying advanced technologies to the problem





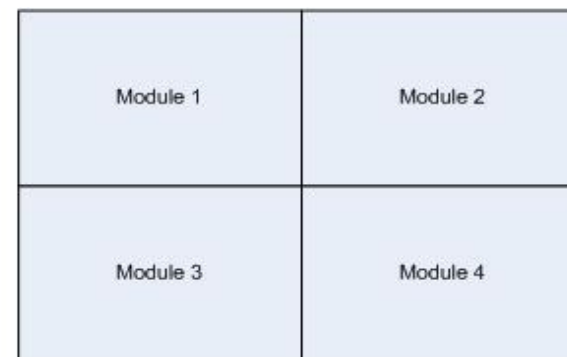
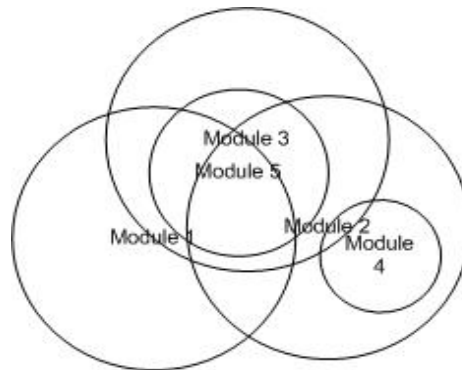
Composition through Ontology Technology

- Ensures Multi-Resolutional models can speak to each other
 - Makes a mapping between simulations possible
 - An action at a lower level for a lower resolutional model is automatically mapped to a higher level for a higher resolutional model
 - Hub and Spoke scheme is used
 - Integrates simulations through the MVC (model view controller) software engineering design pattern
 - Multi resolutional software agrees to a data model, and consistency with that agreement is enforced
 - Data Model is not buried in the control logic of the simulation
- Enables consistent integration with data in databases, of different ontologies
- Facilitates appropriate levels of description for rules
 - A deep ontology allows a rule to be general or specific, as appropriate



Problem: Consensus Among Social Models

- The social disciplines are different views at the same phenomena
 - Overlap: the same ***or highly correlated*** events are covered in two or more simulations
 - Conflicts typically occur in areas of overlap
- In Oz, models may be synchronized at areas of overlap
 - Many conflict resolution/synchronization schemes may be used
 - Human adjudication
 - Weighted voting schemes
 - Weeds out bugs in replicated models
 - Constraint satisfaction
 - Coevolution

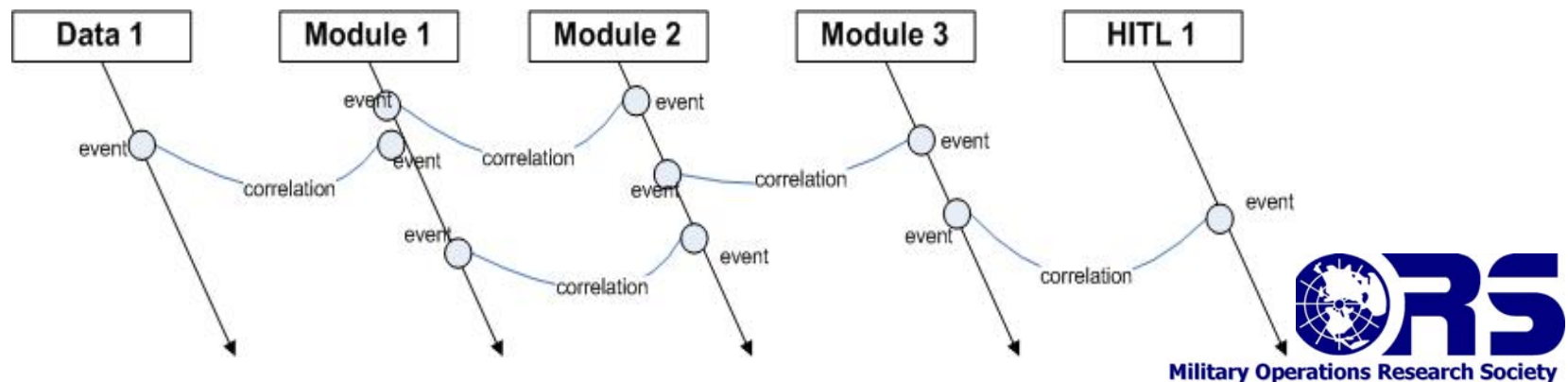


Social models overlap, as on the left, instead of fitting neatly together, as on the right



Model Consensus through Rule-Based Systems

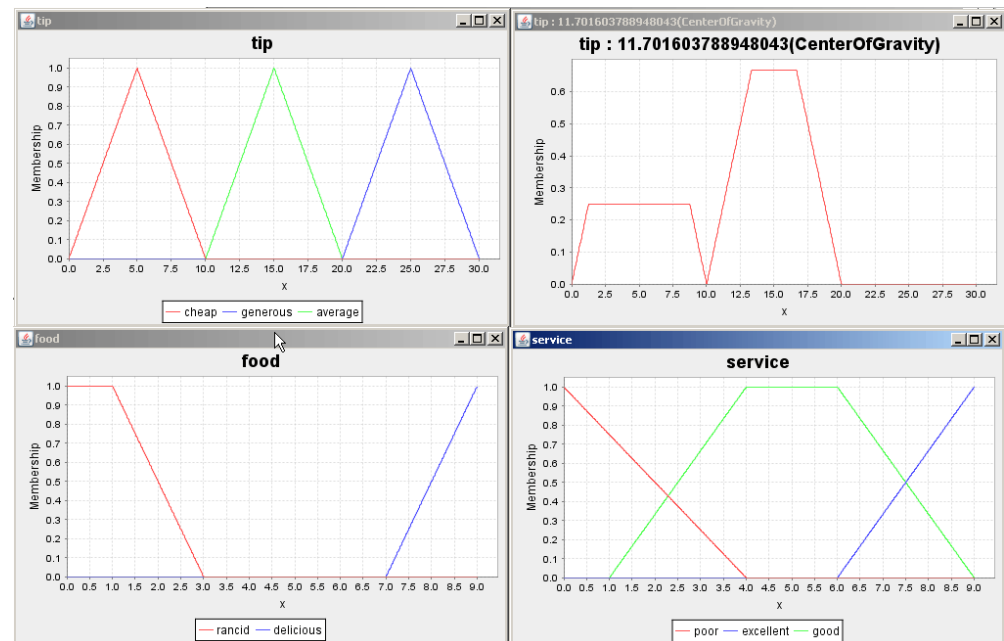
- In Oz, the social literature itself helps achieve consensus
 - Both types of social literature are used
 - Social theory/causal models drive simulation modules
 - Correlative studies designate weighted areas of overlap
- Correlative rules automate integration and validation
 - Models and model combinations that best fit patterns in data are best
 - We can not expect models to predict events, but we can expect them to match patterns
- Fuzzy rulesets model correlative studies
 - Exactly matches the data of correlative studies
 - Weight of rule taken from correlation coefficient
 - Robust with respect to contradictory data
 - Fuzzy Cognitive Maps implement constraint satisfaction conflict resolution





Data Aggregation with Fuzzy Rules

- Combines real-valued model results into PMESII adjudications
 - Correlative Data are Social Indicators
- Scalar: Can determine degrees of change
- Intuitive interface for input with verbal descriptions of phenomena
 - Open source JFuzzyLogic
- A rule from PITF correlative data:
 - If a state's factionalism is high, and its democracy is partial, then its stability is low
 - Calibrated to data



If the food is delicious and the service is excellent, then the tip is generous



Automation of Wargame

- After automated adjudication, consensus is exported to models for them to restart from
 - Humans may also change fuzzy rule adjudications
 - Human modification may be switched off for automation
- Model-Game-Model Process
 - AI in game may generate legal moves and play them
 - Instead of taking every possible move, as in Data Farming, takes moves according to strategy, and in order to win, as in Strategic Data Farming
- If a computer plays COMPOEX or PSOM better than people do, its better to automate
 - Enough runs to explore space of possibilities
 - Talk over the meaning of moves in chess never won the game

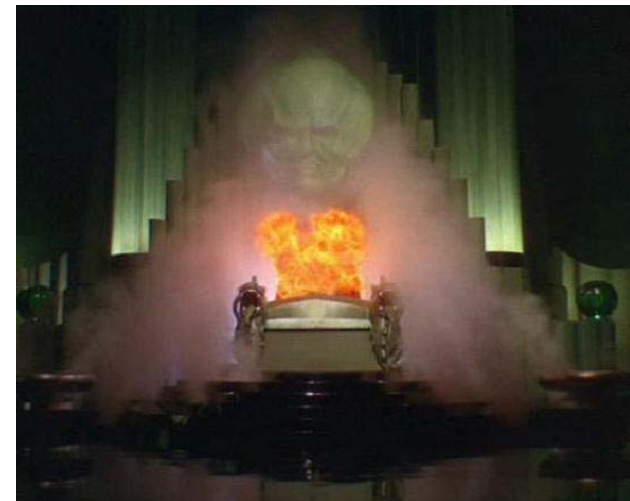


The Oz User Interface

Q. Isn't it hard to both smooth the process and let players be creative at the same time?

A. Lets look at the interface...

- There are two forms
 - The Move Form
 - The PmESII Adjudication Form





The Move Form

- The Main Page is the Move Form, containing information on individual moves
- Players enter overall strategies from the menu
- Players enter free text moves
- White cell can enter free text “screening” adjudication
- Moves are categorized so they may be entered into models, rules, and stored for statistical analysis
 - Players enter Actor, Resource, Time, Location, Target, Intended Effects, and Strategy
 - White cell enters visibility of the action
 - If there is no appropriate category, a new one may be entered into the existing ontology
- Historical forms are filtered according to what is visible to the player
 - A Timeline shows historical moves
 - They may be further filtered based on the categorizations
- Game may be branched on particular moves for comparison



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The Move Form

Oz

File Edit View Control Help

New Move **Validation** ☐ Automatic **Filter** ☐ On/Off

Timeline

Need Time	Jan2014	Feb2014	Mar2014	Apr2014	May2014	Jun2014

< >

Branch

No Moves Present

Move

Description	Players	Time	Actor	Action	Location	Intended Effect	Resource	Target



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Describe Strategies and Enter New Categories Through Control Menu

Oz Demo

File Edit View **Control** Help

New Move
Create

Describe Strategy ...
Suggest New Category ...
PMESII Adjudication ...
Branch on Each Instance of Action ...

Report ☐ Automatic

Timeline By Month

Need Time Jan2014 Jan2014 Feb2014 Mar2014

Branch
Onotology file: \Africa.rdf-xml.owl

No Moves Present

Properties Screening

Move

Description

Players	Time	Actor	Action

Strategy Description

Please Enter Strategy Description

Player

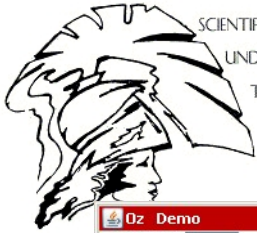
Known Strategy

OK Cancel

Please Suggest a New Category:

Parent Category

OK Cancel



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Navigate History with Timeline and Filter

Oz Demo

File Edit View Control Help

New Move ... Go To Time Period ... Validation Filter

Filter Move History ... Check Report Automatic On/Off Setup

Switch Player ...

Timeline By Month Refresh Setup

Need Time Jan2014 Jan2014 Feb2014 Mar2014 Apr2014 May2014 Jun2014

Branch Onotology file:.\Africa.rdf-xmlLowl Strategy

No Moves Present

Properties Screening

Move Description

Filter Move History

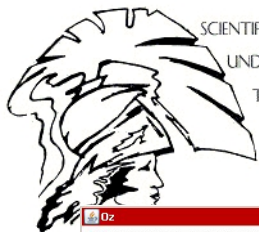
Please Select Filter Criteria (to be ANDed Together)

Players	Time	Action	Resource
Actor	Location	Effects	Strategy
Target	Result	Screeners	Visibility

OK Cancel Clear

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Categorization Buttons Bring Up Categorization Tree

02

File Edit View Control Help

New Move: Create Empty Validation: Check Report Automatic Filter: On/Off Setup

Timeline: By Month Refresh Setup

Need Time	Jan2014	Feb2014	Mar2014	Apr2014	May2014	Jun2014
	Jan2014					

Branch: Onotology file://Africa.rdf.xml.owl Strategy

No Moves Present

Properties Screening

Move	Description	Players	Time	Actor	Action	Location	Intended Effect	R

Please Suggest a New Category:

Parent Category

OK Cancel

Filter Move History

Please Select Filter Criteria (to be ANDed Together)

Players	Time	Action	Resource
Actor	Location	Effects	Strategy
Target	Result	Screeners	Visibility

OK Cancel Clear

Please Select Time Period:

Time Period

- Turn1
 - Jan2014
 - Week01
 - Week02
 - Week03
 - Week04
 - Feb2014
 - Week05
 - Week06
 - Week07
 - Week08
 - Mar2014
 - Apr2014

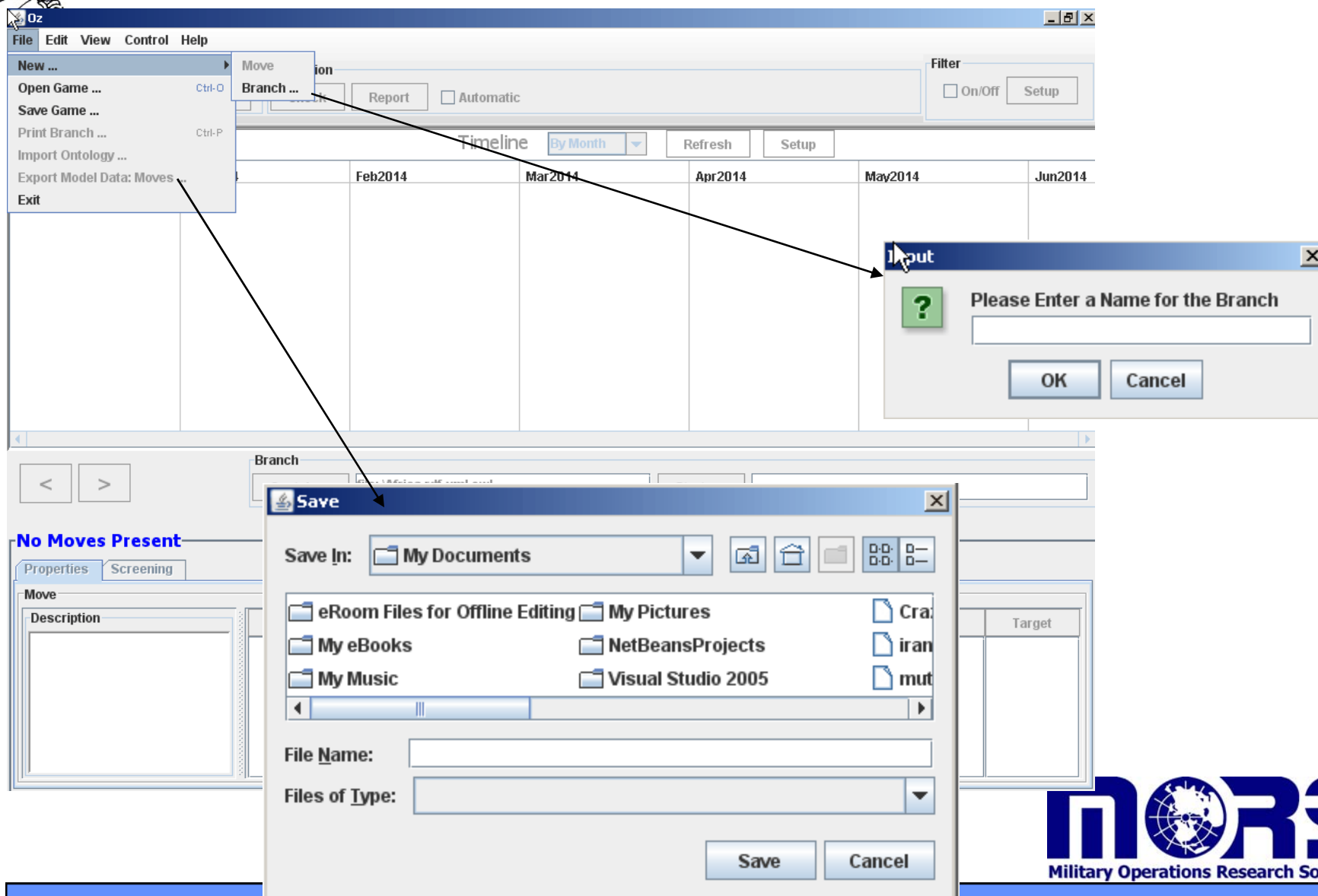
OK Cancel



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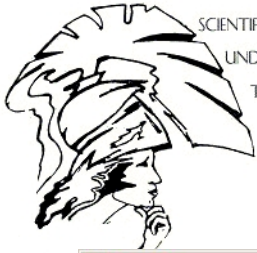
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Game Branched and Moves Exported to Models through File Menu



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Checklists Help Players Keep Track of the Process

The screenshot displays the 'Oz Demo' application interface. The main window has a menu bar with 'File', 'Edit', 'View', 'Control', and 'Help'. Below the menu bar, there are buttons for 'New Move', 'Create', and 'Empty'. A 'Help' menu is open, showing options: 'Player Checklist', 'Move Checklist', and 'User Manual'. Two help windows are shown, both titled 'Help'.

Player Checklist

- ☐ Identify Yourself (View Menu : Switch Player ...)
- ☐ Import Ontologies (File Menu : Import Ontology ...)
- ☐ New or Open Branch To Be Adjudicated (File Menu : Open Branch ...) OR (File Menu: New : Branch ...)
- ☐ Create a Blank Move Form (File Menu : New : Move)
- ☐ Describe Overall Strategy (Control Menu : Describe Strategy ...)
- ☐ Enter Text and Classifications of Move (Move Panel)
- ☐ Save Branch (File Menu: Save Branch ...)

Reset

Move Adjudication Checklist

- ☐ Identify Yourself (View Menu : Switch Player ...)
- ☐ Import Ontologies (File Menu : Import Ontology ...)
- ☐ Open Branch To Be Adjudicated (File Menu : Open Branch ...)
- ☐ Export Data for Model Adjudication (File Menu: Export Model Data: Moves ...)
- ☐ Adjudicate Individual Moves, in Text and Categorizations (Adjudication Panel)
- ☐ If necessary, Print Branch for separate SME Adjudication (File Menu: Print Branch ...)
- ☐ Save Branch (File Menu: Save Branch ...)

Reset

The main application window also shows a table with the following data:

Need Time	Jan2014

Below the table, there are navigation buttons '<' and '>'. A status bar at the bottom left says 'No Moves Present'. A 'Properties' panel is visible on the left, showing 'Move' and 'Description' fields.

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White Cell Screens Moves

Oz Demo File Edit View Control Help

New Move Create Empty Validation Check Report Automatic Filter On/Off Setup

Timeline By Month Refresh Setup

Need Time	Jan2014	Feb2014	Mar2014	Apr2014	May2014	Jun2014
	Negotiate Favorable Trade Agreements Cyber Strike	Financial				

Branch: Onotology file: Africa.rdf-xml.owl Strategy

Move: 3 of 3 (Financial)

Properties Screening

Screening Description	Screening	Properties Summary
Result	Sreeners	Visibility
		Blue Cell

time: Week05
player: Blue Cell
location:
effect:
target:
resource:
action: Financial
strategy:
actor: U S Air Force

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The PMESII Adjudication Form

- Accessible from the Control Menu, so that Historical PMESII Adjudications may be examined
 - History is navigated using back and forward buttons
- Adjudicators import model results, rule sets, and answer questions that aren't covered by models and rule sets
- PMESII adjudications are for a particular Time, Location, and Actor
- Rule sets based on Social Indicators roll up the results to PMESII values
- Adjudicators may modify both specific indicator results and general PMESII results
- Adjudicators may export final adjudications back to models so that they all restart from the consensus state



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The PMESII Adjudication Form

Oz File Edit View Help

Scope

Time Location Actor Adjudicator Automate

Imports

Rulesets: Models:

Questions and Answers

Question	Answer	Comment

Data Resources

Method	State	Affected Method	Affected State	Value	Final Value	Reason

Group

Metric	Automated Value	Automated Effectiveness	Final Value	Reason
Defection Rates				
Financing				
IO				
Recruitment				

Population

PMESII Dimension	Automated Adjudication	Automated PMESII Result	Final PMESII Result	Reason
Political				
Military				
Economic				
Social				
Infrastructure				
Information				

OK Cancel



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A Checklist Guides Adjudication as on Move Form

This Presentation

Oz

File Edit View Help

Scope

Imports

Rulesets:

Models:

Data Resources

Method	State	Affect

Group

Metric	Automated Val
Defection Rates	
Financing	
IO	
Recruitment	

Population

PMESII Dimension	Automated Adjudi
Political	
Military	
Economic	
Social	
Infrastructure	
Information	

Help

PMESII Adjudication Checklist

- ☐ Identify Yourself (Menu Form: View Menu : Switch Player ...)
- ☐ Import Ontologies (Menu Form: File Menu : Import Ontology ...)
- ☐ Open Branch To Be Adjudicated (Menu Form: File Menu : Open Branch ...)
- ☐ Open PMESII Adjudicator (This Form) (Menu Form: Control Menu: PMESII Adjudication)
- ☐ Create a Blank PMESII Adjudicator Form (File Menu: New Adjudication)
- ☐ Enter Time, Location, and Actor to be Adjudicated (Scope Panel)
- ☐ Import Model Data (File Menu: Import Model Data ...)
- ☐ Review Model Data and if necessary, modify indicator values and give a reason. (Data Resources Panel)
- ☐ Revisit Move Adjudications and if necessary, modify move adjudications. (Move Form: Adjudication Panel)
- ☐ Import PMESII Ruleset (File Menu: Import PMESII Ruleset...)
- ☐ Answer Questions (Questions and Answers Panel)
- ☐ Run PMESII Ruleset (Automate Button)
- ☐ Review Group Results, and if necessary, Modify Final Group Result and give Reason (Group Panel)
- ☐ Review Population Results, and if necessary, Modify Final Population Result and give Reason (Population Panel)
- ☐ Save Adjudications (File Menu: Save Adjudications ...)
- ☐ Export Data so Models may conform to consensus state (File Menu: Export Model Data: Final Adjudication...)

Reset



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Results Are Rolled Up with PMESII Ruleset, Edited and Exported Back to Models

02

File Edit View Help

New Adjudication
Save Adjudications ...
Print Adjudications ...
Import Model Data ...
Import PMESII Ruleset ...
Export Model Data: Final Adjudication ...

Ctrl-P

Location Actor Adjudicator

Questions and Answers

Question	Answer	Comment

Models:

Data Resources

Method	State	Affected Method	Affected State	Value	Final Value	Reason

Group

Metric	Automated Value	Automated Effectiveness	Final Value	Reason
Defection Rates				
Financing				
IO				
Recruitment				

Population

PMESII Dimension	Automated Adjudication	Automated PMESII Result	Final PMESII Result	Reason
Political				
Military				
Economic				
Social				
Infrastructure				
Information				

OK Cancel

Export Data

Player
Input
Fields



Summary

- Wargaming is a useful tool for analyzing Wicked Problems
- Technology can assist wargaming adjudication
- Oz is unique because it
 - Integrates data, rules, and models in the wargaming environment
 - Incorporates Social Science theory
 - Integrates the results of multiple, multi-resolution models
 - Preserves unique perspective of each wargame participant
 - Allows branching of the wargame
 - Preserves a record of the wargame for subsequent statistical analysis
- Can be easily adapted to a variety of wargames



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Questions?





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Back Ups



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Timeline Moves Color Coded By Category

Oz Demo
File Edit View Control Help

New Move: Create Empty Validation: Check Report Automatic Filter: On/Off Setup

Timeline By Month Refresh Setup

Need Time	Jan2014	Feb2014	Mar2014	Apr2014	May2014	Jun2014
	Negotiate Favorable Trade Agreements	Financial				
	Cyber Strike					

Branch: Onotology file: Africa.rdf-xml.owl Strateg

Move: 3 of 3 (Financial)

Properties Screening

Screening Description

Result	Screeners	Visibility
		Blue Cell

Properties Summary

time: Week05
player: Blue Cell
location:
effect:
target:
resource:
action: Financial
strategy:
actor: U S Air Force

Timeline Display Properties

Fill Color Property for Move: Action

Property to Show for Move: Action

Choose Display Color For Property

Swatches HSB RGB

Recent:

Preview

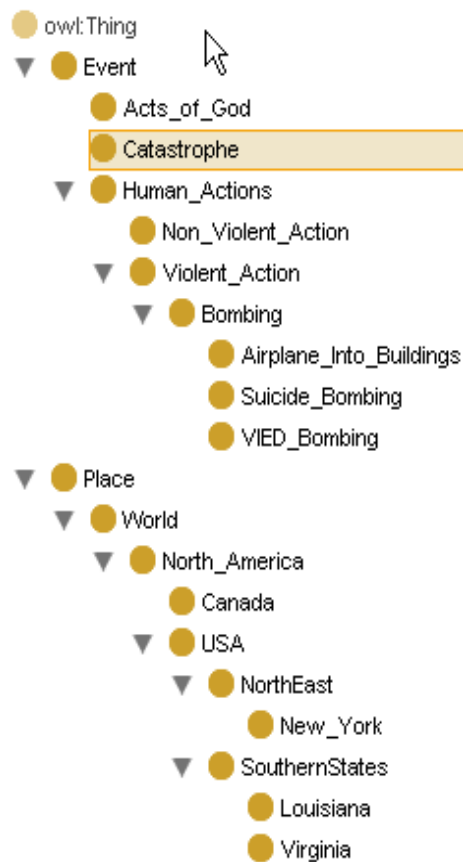
Update Close

Military Operations Research Society

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Categorization Trees are Imported from Protégé Ontology Software





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Moves may be Reused and Reordered through the Edit Menu or the Timeline

Oz Demo

File Edit View Control Help

Validation
empty ☐ Automatic

Filter
☐ On/Off

Timeline

Jan2014 Feb2014 Mar2014 Apr2014 May2014 Jun2014

Select and set time below

Branch
 file:\Africa.rdf-xml.owl

No Moves Present

Properties Screening

Move

Description	Players	Time	Actor	Action	Location	Intended Effect	Resource	Target



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History is filtered by Player Visibility and Categories as on the Move Form

Oz File Edit View Help

Scope: Go To Time Period ... Filter Adjudication History ... Switch Player ...

Location: [] Actor: [] Adjudicator: [] Automate: []

Imports: Rulesets: [] Models: []

Questions and Answers

Question	Answer	Comment

Data Resources

Method	State	Affected Method	Affected State	Value	Final Value	Reason

Group

Metric	Automated Value	Automated Effectiveness	Final Value
Defection Rates			
Financing			
IO			
Recruitment			

Population

PMESII Dimension	Automated Adjudication	Automated PMESII Result	Final PMESII
Political			
Military			
Economic			
Social			
Infrastructure			
Information			

Filter Adjudication History

Please Select Filter Criteria (to be ANDed Together)

[] Time

[] Location

[] Actor

[] Adjudicators

OK Cancel



Example Game Turn Cycle

- First two turns will be 4 weeks 
- Last three turns will be 3 weeks 

