Human-agent Collaboration Ontology (HACON)™:
Implications for Designing Naturalistic C^2 Decision Systems

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Presentation Overview

- Human-agent Collaboration
- Human-agent Collaboration in C^2
- Understanding Agents
- Human-agent Collaboration Ontology
- Ontology Applications
- Naturalistic Decision-making Example
- Metrics
- Research Program

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Human-agent Collaboration

- Is not one human – one agent
- Is more than human-agent communication language
- Goes well beyond human-agent interaction
- Is especially significant in complex decision-making applications

Emphasis is on capitalizing on the respective strengths of humans and agents during collaborative decision-making

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Human-agent Collaboration in C^2

- Military decision-making applications (e.g., C^2) impose certain unique requirements on human-agent collaboration
  - adaptive human-agent collaboration architectures
  - dynamic function reassignment
  - decision-making under time-stress, uncertainty, risk

Emphasis is on optimally leveraging the human role in the face of ongoing changes

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Understanding Agents

- Agent Roles
- Agent Classification
- Human-agent Collaboration Regimes

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Agent Roles

- Peers
  - develop shared understanding of task, their interdependencies, and contingencies
  - achieve seamless handoffs with shared understanding of context
  - deviate from “best practice” shared role when human is overloaded and/or fatigued, or unavailable
- Associate/Colleague
  - cooperates with human but performs different tasks than humans do
  - different from peer because this agent cannot be used to replace the human
- Assistant/Staff
  - agent performs tasks on behalf of the user
  - agent(s) has a clear notion of a goal and knowledge of the task domain to achieve it
  - shared vocabulary and task domain concepts enables terse, high-level human commands
- Teacher
  - pedagogical agent with domain as well as instructional knowledge
  - goal is transfer of knowledge/skills from domain KB/agent to learner
  - learning consists of getting to know and apply concepts, skills
- Learner
  - agent “learns” to perform tasks on behalf of the user; the information-seeking policy of the user

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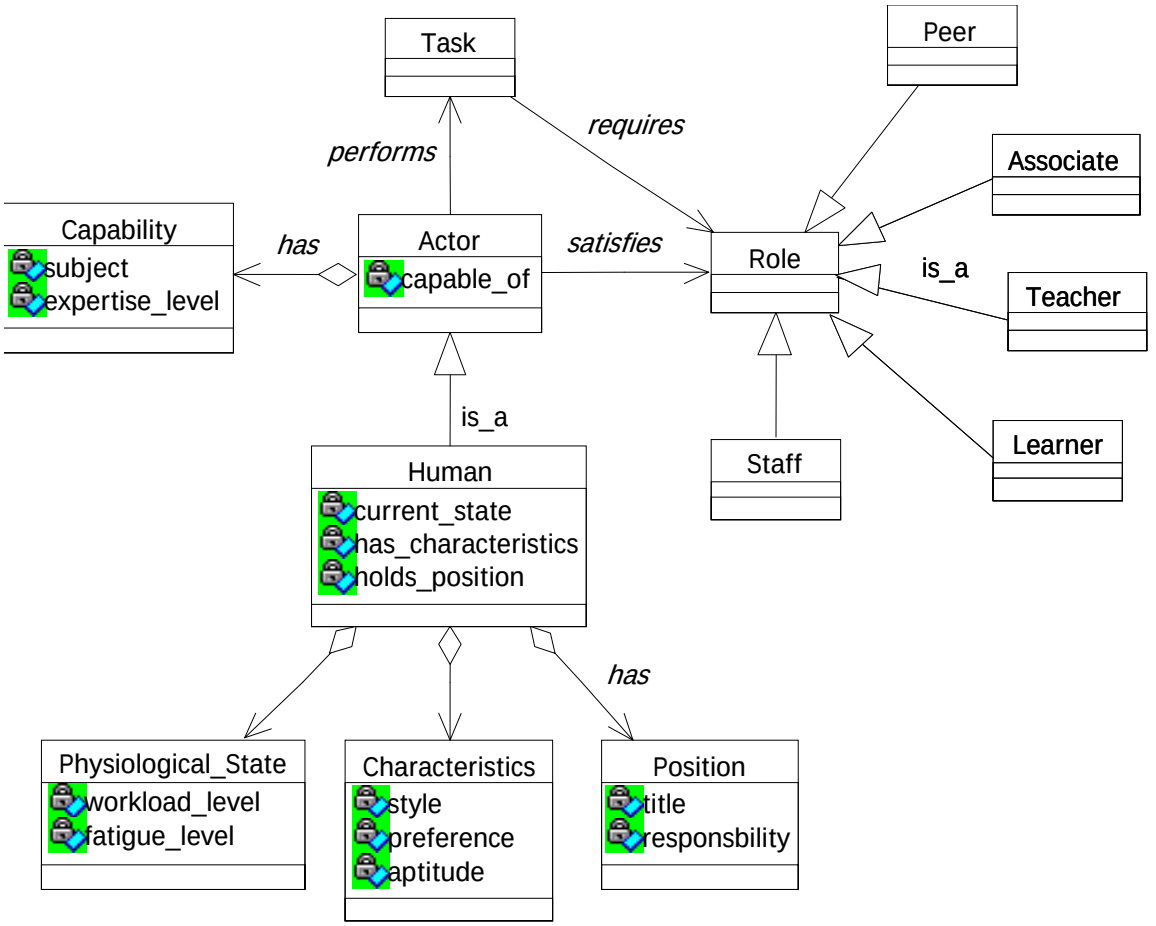
Agent Classification

- User agents
  - collect relevant information from user to initiate a task
  - interpret user commands/decompose user commands
  - assign work to task agents
- Task agents
  - have knowledge of the task domain as well as other task agents or information agents
  - coordinate with other task agents and information agents
  - form plans to achieve goals
  - executes plans
- Information agents
  - provide intelligence access to collection assets
  - are initiated either top down (by user or task agent) or bottom up by occurrence of particular information patterns
  - notify other interested agents when a particular condition of interest occurs
  - actively monitor information sources

Human-agent Collaboration Ontology (HACON™)

- Human Representation Schema
- Software Agent Representation Schema
- Human-agent Collaboration Schema

Human Representation Schema



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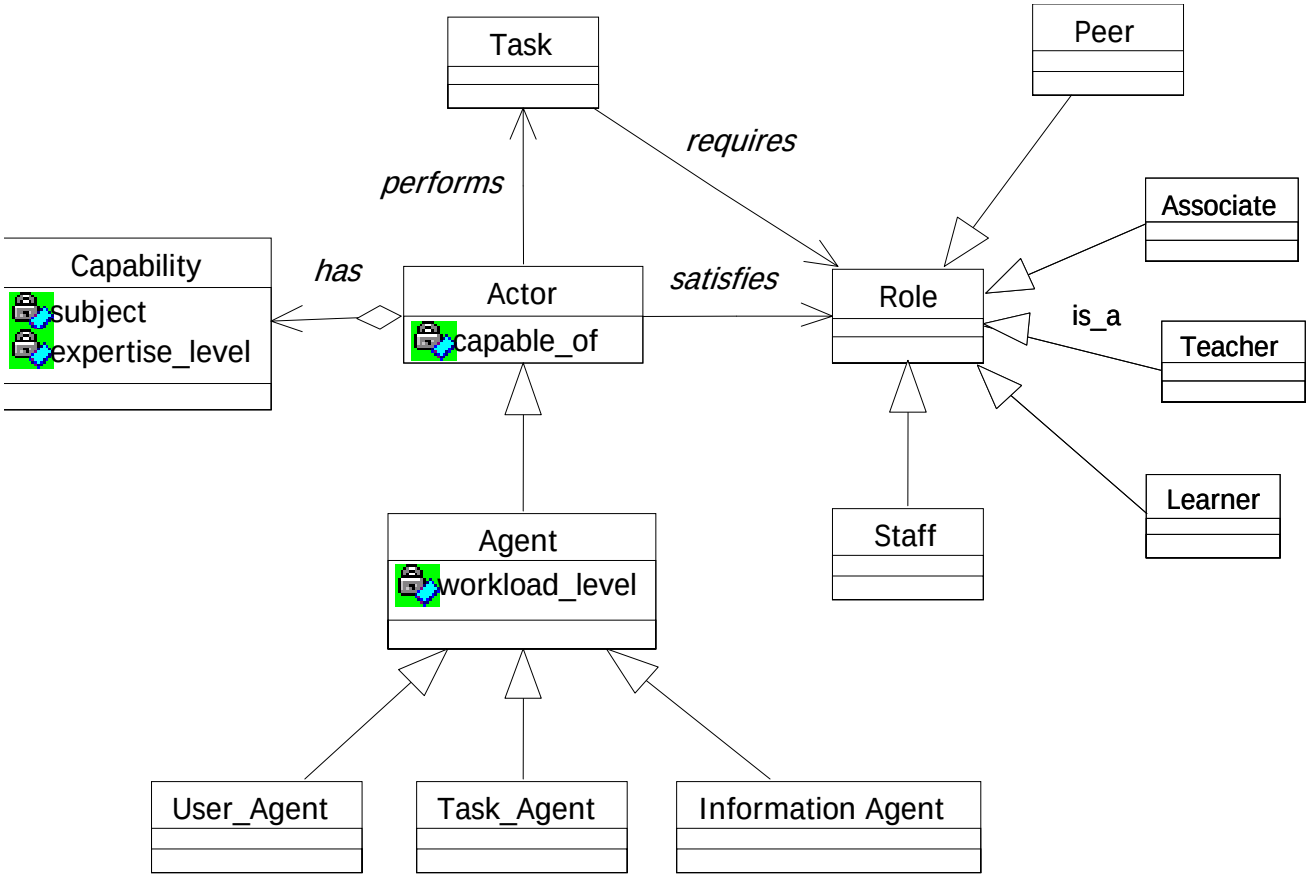
Software Agent Representation Schema



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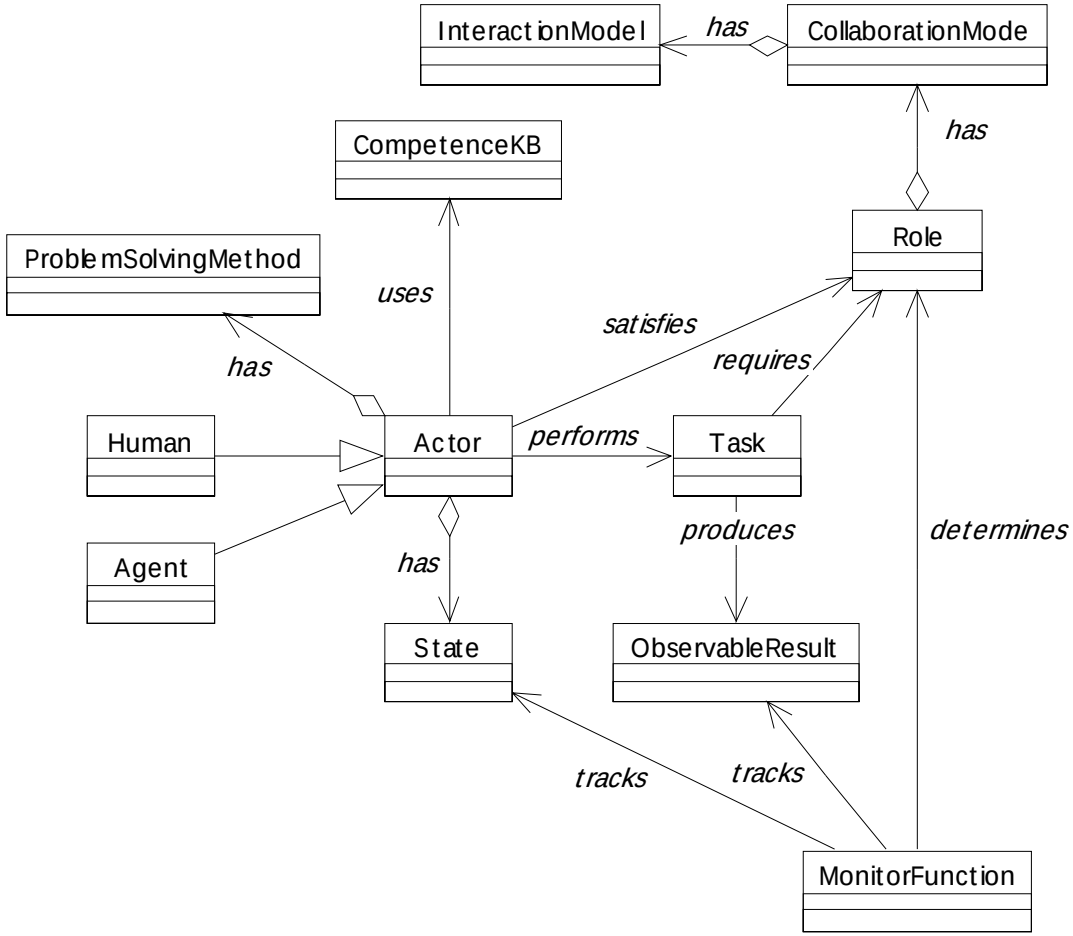
Human-agent Collaboration Schema



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Ontology Applications

- Decision-making
- Planning
- Decision support
- Design

For example, HACON can be extended for naturalistic decision-making

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Naturalistic Decision-making

- Simply described as "*the way people use their experience to make decisions in field settings*"
- Emerged from the study of how real people make real decisions in real situations
- Well-suited to describing how decisions are made under time-stress, uncertainty, and risk

NDM has yet to be exploited within Decision Support Systems!

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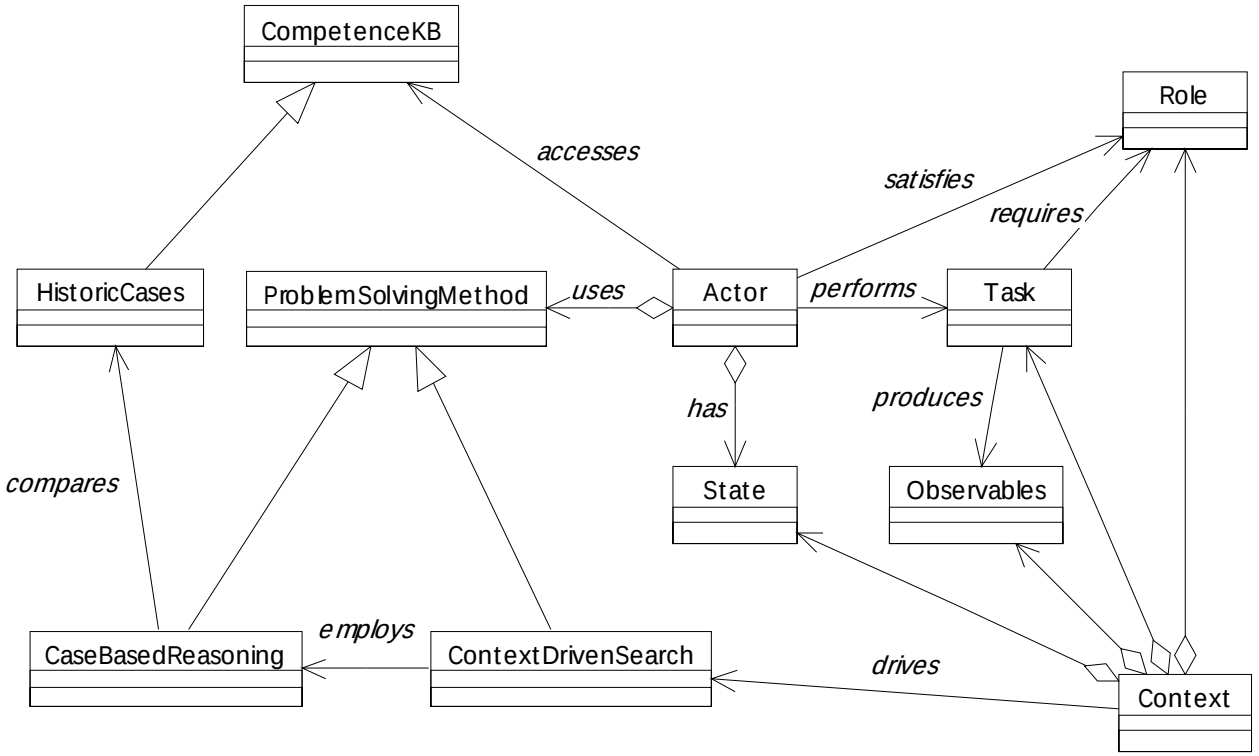
NDM Schema...



… is the first step to operationalizing naturalistic decision-making within DSS

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Case-based Reasoning...

- Exploits heuristics and knowledge of previous cases to find a solution to a current problem
- Solution typically takes the form of an adaptation of a solution to a previous case

… is the second key component for operationalizing NDM within DSS

NDM Implementation in DSS

NDM Concepts	Implementation
Familiar Situations	– Similar cases (based on ontology)
Situation Familiarity Assessment	– Based on reachback for relevant cases using case-based reasoning
Activation of Information from Memory	– Agent tasking (user agent) – Context-driven search of historical cases (information agent)
Evaluation of Suitability of Contemplated Action	– Case-based reasoning; similarity metrics
Implementation of Action	– Execution of plan/workflow associated with "best-fit" case (task agent)

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Sample Metrics

- Human cognitive load
- Agent utilization statistics
- Task completion times for various human-agent function assignments
- Execution delay due to function reassignment
- Execution delay due to resource unavailability
- Multi-agent synchronization delay due to function reassignment

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Research Program

- Create "cognitively-inspired" software testbed based on HACON to investigate performance impacts of:
  - adaptive human-agent collaboration architecture
  - dynamic function reassignment options
  - context switching between human and agents
  - agent learning

We need to understand these issues before we can effectively exploit the human role in shared human-agent C^2 decision-making systems.

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