Knowledge Management for Command and Control

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Presentation Outline

- Introduction – Trends in knowledge management (KM)
- Clustering and partitioning technologies and tools
- Knowledge-authoring technologies
- KM by intelligent agents
- Intelligent agents and KM in C2 to support FORCEnet
- Future research and transition applications

Introduction to Knowledge Management

- **Knowledge – An evolving mix of framed experience, values, contextual information & expert insight that provides a framework for evaluating & incorporating new ideas & information.**
- **Knowledge management (KM) – The process of creating value through organizational integration of the knowledge in the organization.**
- **KM includes expert systems, intelligent agents, collaboration, mixed-initiative paradigms and machine learning.**
- **KM – wave of the future for C4ISR to enhance the SIP/COP.**

Current Trends in KM - 1

- **Exploit and reuse existing knowledge, capture new knowledge as much as possible.**
- **Mixed-initiative paradigm**
- **Expert systems become more user friendly to SMEs who are not Kes.**
- **Growing need for management support and awareness of new trends.**

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Current Trends in KM - 2

- **Loose vs. tight system control/coupling.**
- **Managers need to design a KM policy.**
- **Growing need for management support and awareness of new trends.**
- **Loose coupling – Centralized database administrator does not control component administrators.**
- **Tight coupling – Centralized database administrator controls components.**

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Monitoring Success in KM

- **Importance of metrics – how to define success? May have conflicting goals.**
- **First define success then select metrics.**
- **Consider user requirements & preferences, ease of system usage.**
- **Ex: number of new axioms entered or validated per unit time, rate of error detection, rate of knowledge reuse.**
- **Variables that influence success – external political, economic & internal technical factors**

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Knowledge-Authoring Technologies

DARPA RKF program products:

- **SHAKEN & KRAKEN knowledge authoring systems**
- **nuSketch – Allows user to draw objects on screen and annotate them in KB.**
- **Multi ViewPoint Clustering Analysis tool**
- **Case Mapper – analogy server**
- **Concept maps – users can input ideas and their relationships**

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SHAKEN & KRAKEN

- **Both knowledge-authoring systems have integrated novel KB-access technologies – nuSketch, concept maps, etc.**
- **KB analysis & structure improvement using MVP-CA clustering techniques.**
- **Automation of logical explanation of query results.**
- **Distributed KB connectivity for group collaboration. Ex: command center aps**

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nuSketch Qualitative Reasoning Tool

- **Multimodal interface – sketching input of spatial objects. Users input K about their sketches & system deduces other K from it**
- **Designed for military personnel to learn.**
- **Front-end input tools for both SHAKEN & KRAKEN.**
- **Useful for spatial representation of COEs & construction of battle-space hypotheses via mixed visual & conceptual analogies.**

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Analogical Processing

- **Case Mapper uses qualitative reasoning – novel interface for K entry via analogy.**
- **Architecture enables tight integration of analogical reasoning & multiple kinds of visual spatial reasoning.**
- **Federated reasoning system common to both Case Mapper and nuSketch**

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Clustering and Partitioning in Knowledge Bases

- **Knowledge can be grouped into models, domains, subject areas or microtheories.**
- **Sometimes, an axiom that is true in one domain is false in another.**
- **Domains need internal self-consistency.**
- **Microtheory examples: Zoos, children's stories**
- **Clustering promotes error detection, resolution of semantic heterogeneity, and collaboration among SMEs and intelligent agents.**

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Multi ViewPoint Clustering Analysis Tool - 1

- Groups rules of a KB that share significant common properties from multiple perspectives.
- Facilitates structuring, validation, error correction & inconsistency resolution in the KB.
- MVP-CA – a semantic mediation tool that enables KEs, SMEs to learn terms & concepts in the KB; exploit, reuse & integrate knowledge.
- Contributes to 3 major activities in the KB: development, maintenance & interoperation

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Multi ViewPoint Clustering Analysis Tool - 2

- **Development – Highlights overlapping contexts across clusters of axiom & concept placement in the hierarchy.**
- **Maintenance – Helps expose syntactic and semantic, typographical errors, redundancies and inconsistencies across multi-authored axioms.**
- **Interoperation – Discovery of similarities across different ontologies. Ex: lexically and semantically, close and distant terms.**

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The DARPA Agent Integration Facility (DAIF)

- **Purpose – to collect DARPA-funded technology onto one system to test, validate, utilize and transfer the technology to other programs.**
- **Examples from DARPA's Rapid Knowledge Formation program in the are: SHAKEN, KRAKEN, nuSketch, Java Theorem Prover, MVP-CA tool, Concept Maps, Case Mapper**

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KM by Intelligent Agents

- **No standard definition of intelligent agent. “a persistent computation that can perceive its environment, reason & act alone & with other agents.” Singh ‘98**
- **Intelligent agents can do the following tasks: monitor battle space, summarize observations, process alerts, collaborate.**
- **Process data locally – reduce network bandwidth requirements.**

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Intelligent Agents in Network-Centric C2 Environments

- **Increase network dependability.**
- **Improve joint-task-force capabilities – monitor events continuously & generate alerts**
- **Provide information to staff planners**
  - **Analysis of threats and terrain**
  - **Scheduling and tracking of assets**
  - **Planning of logistics, fires coordination, communications, and force protection**

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Intelligent Agents for KM in C2 for FORCEnet

- **FORCEnet – the operational construct and architectural framwork for Naval warfare in the information age**
- **FORCEnet integrates all assets (sensors, platforms…) to provide a common, integrated operating picture & interoperable forces.**
- **Agents can support human-computer collaboration in dynamic, uncertain, non-deterministic C2 environments.**

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Sensible Agents Program 1

- Architecture was designed specifically for use in complex decision-making environments.
- Sensible agents reside in multi-agent systems.
- Agents react and respond to changing and unpredictable events.
- Agents use their autonomy & independence to determine how goals should be pursued. Ex: Battlefield situation changes, goals change.
- Agents can modify their level of autonomy – a very important and essential property.

Sensible Agents Program 2

Implementation examples of some past and future application domains:

- **Joint Force Air Component Commander.**
- **Naval C2 – Call for Fire.**
- **Naval Radar Frequency Management – Agents managed radar frequencies autonomously without human intervention during an experiment to minimize interference across multiple ships.**
- **Agents could issue alerts in white ship tracking.**

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Future Research and Transition Applications

- **Integrate the knowledge-entry capability via analogy into SHAKEN & KRAKEN for C2 and INTEL KB applications.**
- **Case Mapper needs enhancements of natural language, and concept-map interfaces for statement editing and predicate specification.**
- **Explore more ways that analogy could be used in war game simulation and training.**