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.**

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.**

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**

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**

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**

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.**

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**

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.**

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**

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.**

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**

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.**

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**

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.**

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.

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.**