Actionable Knowledge Guided HTC Visualization

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I. Problem Statement
I. Problem Statement

• Visualize Holistic Target Characterization
  – Focused on Commander’s Objective
  – Provide an meaningful and intuitive visualization of the possibly very large HTC

• Ability to display interdependencies and non-obvious relationships
  – Allow users to navigate & manipulate high order links and nodes
  – Provide multi-modal visualization of links and nodes
II. Introduction
II. Introduction (1)

Project Requirements

• Two & Three Dimensional Depiction of Links/Nodes & Entities/Relationships
  – Must work across multiple data formats
  – Allow for N-dimensional link/nodes analysis

• Rapid Scanning of Documents at Multiple Security Levels for Potential Relevance to Established Objective and Alert User

• Ability to Drill Down Rapidly to Underlying Data/Analytical Products

• Ability to Access Planning Tools via Web Portal
II. Introduction

- JIAPC will “…provide holistic analytical support to combatant commanders” - IO Roadmap.
  - Provide Holistic Target Characterization across the information, cognitive, and physical domains
  - Produce kinetic and non-kinetic options that facilitate the IO planning efforts of combatant command staffs
  - Decision Under Uncertainty
  - Offer all combatant commands connectivity to JIAPC knowledge base
II. INTRODUCTION

Actionable Knowledge Guided Visualization

• What is it?
  – Simply, it’s the maintenance of the commander’s intent WRT the mission objective throughout the visualization process.

• What’s in it for me?
  – Actionable knowledge allows more problems to be solved better, by both human and machine.

• How did you use it?
  – 21CSI used it to create the JIAPC Holistic Target Characterization Visualization; a multi-modal, semantic-based visualization.
III. System Overview
III. SYSTEM OVERVIEW (1)

Major Concepts

1. Visualize Asymmetric Relationships
   - Provide multi-modal semantic based visualization capable of showing relationships from amongst different types in different ways.

2. Facilitate Building Relationships
   - Efficient integration of evidence from multiple disparate domains into the HTC.

3. Tools for Analyzing Non-Obvious High Order Relationships
   - Propagating PMESII, or other weights in a meaningful way to analyze high order possibilistic structures.
IV. TECHNIQUE DESCRIPTION
Key Technical Points

1. Knowledge Visualization

- Knowledge Representation
  - Multi-modal visualization for multiple SME ontologies, knowledge representations
  - Ontological structures used for semantically guided visualization
    - Required for AKGHTC

- Semantic Distances
  - If one can be built for a significant frame of discernment, then the knowledge can have semantic tessellation
    - Semantic tessellation
  - Helps graph visualization
    - Force directed visualization
    - Voronoi clustering
  - Open research problem
    - Chosen according to heuristics
IV. Technique Description (2)

“Up to my knee-pits in data…”

2. Visualization Induced Malapropism

• Making a choice based on properties of the visualization rather than the data the visualization is supposed to represent. Very real danger!

  – Not the same as facile answers
  – What is ‘apropos’?
    • It’s the fitness to the ‘true’ AK representation
  – Chaining based on large datasets may result in waste of resources, or worse, propagate into tasking.

• Malapropos ‘Concept Checker’

  – Determine patterns of malapropisms
  – Requires a ontological changes
  – Very hard for cross-discipline CIE
3. **Actionable Knowledge Representation**

- **Ontology**
  - Basis for actionable knowledge representation
  - Knowledge is Inherently Consensual
    - Open-source ontologies and electronic dictionaries more likely to be vetted.
  - Provide ‘Rosetta’ translations to disparate domains with their own ontology

- **Semantic Distance**
  - Basis for metrics, strengths, clustering, specificity, etc.
  - Creates equivalence partitions for heuristics
    - (although, not sufficient for graph serialization)

- **Actionable Knowledge**
  - Provides additional weightings of utility
  - Utilizes existing ontology and semantic distance
  - Partially derivable risk/value models
V. SYSTEM IMPLEMENTATION
V. SYSTEM IMPLEMENTATION

JIAPC HTCV Application

• Multi-modal display of data
  – Semantically-tagged items equivalent throughout
  – Semantic Iconography
  – GIS correlated with Hyperbolic Graph
  – Integration with Tree Navigation
  – Integrates with Web and Office documents

• Leverages Underlying Expressive Ontology
  – Process driven
  – English-free concept IDs
  – Semantic strengths
V. SYSTEM IMPLEMENTATION (2)

JIAPC HTCV Web Access

• **Web-enabled Access**
  – Supports multiple roles
  – Integrated Rolodex
  – Integrates with other web resources

• **Process Specific Semantic Queries**
  – Concept graphs generate queries to DB, Web, or SME
  – English-free concept IDs
  – Keeps track of query results per node.
V. SYSTEM IMPLEMENTATION (3)

JIAPC HTCV Process Templates

- **Concept Graphs**
  - Canonical pre-built according to known planning processes
  - Nodes represent constraints
  - Drill-down to supporting concept graphs

- **Semantic Queries**
  - Concept graphs represent constraints and can be translated to queries
  - Color-coded for ‘fitness’ of the evidence for that node
  - Process measures according to the supporting evidence
VI. CONCLUSION
Benefits of the Technology and Extended Applications

- **Actionable Knowledge Improves Visualization of Massive Amounts of Data**
  - AK-based utility provides a basic design pattern for preference ordering and partitioning information, which reduces cognitive load
  - AKR structures can represent multiple translations of intent, which can be interpreted as context for the recruitment of appropriate visualization heuristics.

- **Rigorously Representing Mission Intent as a First Class Property of the CIE Improves Metrics of Effectiveness and Performance**
  - Higher resolution translation of the AK in multiple disparate domains improves compliance with the mission objective, and thus effectiveness.
  - Algorithmic translations of the AK allows for better leveraging of heuristics and more accurate preference ordering, reducing work for both human and machine, and thus improving performance.

- **Actionable Knowledge Provides a Bridge to Better Understanding Cognitive Modeling in C2 Applications**
  - AKR ontologies forms the basis for studying reusable actions WRT utility
  - Partitionable utility functions provide a better representation of the problem space than embodying cognitive artifacts within information architectures by fiat.
ABOUT 21CSI

- 21st Century Systems, Inc.® (21CSI®) is a pioneer in agent-based decision support systems for time- and mission-critical military applications
  - Woman-owned, founded in 1996
- Decision support tools across the spectrum of missions
  - Individual Soldier Situational Awareness
  - Distributed Warship Command and Control
  - Decision Under Uncertainty
  - Homeland Security/Force Protection Situational Awareness
  - Secure R&D Collaboration…*and others*
- Our applications run on all types of hardware…
  - Wireless PDAs
  - Laptops, desktops, to massive parallel computers
    …*and are Operating System independent*
- Military Small Business Contractor Success Story
  - 100% Commercialization Achievement Index
- Offices in: NE, MO, HI, WA, RI
  - Top Secret Facility Clearance