

# **Decision Science Challenges for C2 Agility**

19<sup>th</sup> ICCRTS:

C2 Agility: Lessons Learned from  
Research and Operations

**Elizabeth Bowman** <sub>1</sub>

**Jeffrey M. Bradshaw** <sub>2</sub>

**Robert R. Hoffman** <sub>2</sub>

**Niranjan Suri** <sub>2</sub>

**<sub>1</sub> Army Research Lab**

**<sub>2</sub> Institute for Human Machine Collaboration**

# Acknowledgements

The authors wish to acknowledge Mr. David Jakubek and Ms. Heather McCreary for their sponsorship of this research and their continued interest and support of science and technology applications to enhance human decision making. This research was conducted in support of the Data to Decisions Program and was intended to explore how advances in data science and data analytics might impact decision making , specifically by reducing risks traditionally associated with collecting timely and accurate information.

# Outline

- The decision context for this research
- Research Challenges
  - #1: Human-Machine Collaborative Sensemaking
  - #2: Task Relevant Valuation and Selection of Information
  - #3: Performance Metrics at a Genuine Systems Level
- Promising Science and Technology Development Efforts
  - Fusing Socio-Cultural Data for Discovery
  - Information Processing for Tactical Intelligence
- Recommendations

# Decision Context

- Big data has overloaded systems, networks, and, most importantly, human operators. These factors not only jeopardize decision-making effectiveness, but also the adaptive capacities needed to assure the resilience of the decision-making process itself.
- Effective human decision processes involve significant cognitive, evaluative, and affective activities that are parallel and interactive.
- Decisions are often expressions of contingencies and anticipations of events yet to unfold and might be surprising

# Research Challenge #1:

## Human-Machine Collaborative Sensemaking

- Prescriptive guidelines for the design of visualizations that are informed by principles of human perception and cognition.
- The use of software agents as an adjunct to human sensemaking.
- Incorporating displays and analytics that assist with some of the neglected aspects of deciding.
- Enhancing consequential elements of the entire decision process.

# Research Challenge #2:

## Task Relevant Valuation and Selection of Information

How to manage attentional resources of a decision maker with computational mechanisms to filter all available information to a verified, validated, and task-goal relevant subset?

- *Perceptual Salience*: Ways to capture attention (e.g., by color coding alerts, etc.).
- *Information Salience*: The ability of information to capture the attention of the decision-maker, through either bottom-up (feature- or pattern-driven) aspects of the information, or through top-down (knowledge-driven) aspects of the information.
- *Information Relevance*: The pertinence and utility of the information in actually making a decision; that is, information that should actually shape or determine the course of decision-making. Such information is usually task- or goal-specific, and relates to the context or situation as much as the aims of the consumer of the informational analysis.

## Research Challenge #3:

### Performance Metrics at a Genuine Systems Level

- Conjoint or derived measurement: using multiple measures to form meaningful measurement scales
- How to forge a meaningful set of measures and a measurement structure for meaningful construct scales?
- How can we evaluate the extent to which new technology accelerates achievement of proficiency, or the ability of workers to cope with rare or tough cases?

# S&T Applications:

## Fusing Socio-Cultural Data for Discovery

- In irregular warfare environments, it is critical to incorporate both hard and soft data to gain an understanding of the delicate balance between individuals and groups in society and the environments upon which they depend.
- Technology challenges:
  - Data collection, correlation, and exploitation
  - Extraction of semantic meaning
  - Weighting scales for inferring meaning across various measures
  - Visual representations that are intuitive and easy to learn
  - Performance measures that capture quantitative and qualitative features of the mission environment



# S&T Applications:

## Information Processing for Tactical Intelligence

- Automated generation of social networks, underlying relationships, and changes in network structure as nodes are removed
- Fusion of multi-source data for
  - Discourse and Sentiment Analysis for Prediction of Social Action
  - Summarization for Rapid Situation Understanding and Analysis Product Generation
  - Foreign Language Translation and Summarization
  - Statistical graph algorithms to process extremely large datasets for extraction of topics, networks, and content

# Recommendations

- Decision aid research applying H-M collaborative sensemaking theories and approaches
- Computational approaches for determining the value of information in the context of users, tasks, and biases
- Software agent technologies to bridge the gap between display salience and task relevance
- Useful measurement techniques that address system-level analysis for effectiveness and resilience of complex cognitive work systems

Questions?