



Human Source Characterization & Supporting Sensemaking with Network Visualizations

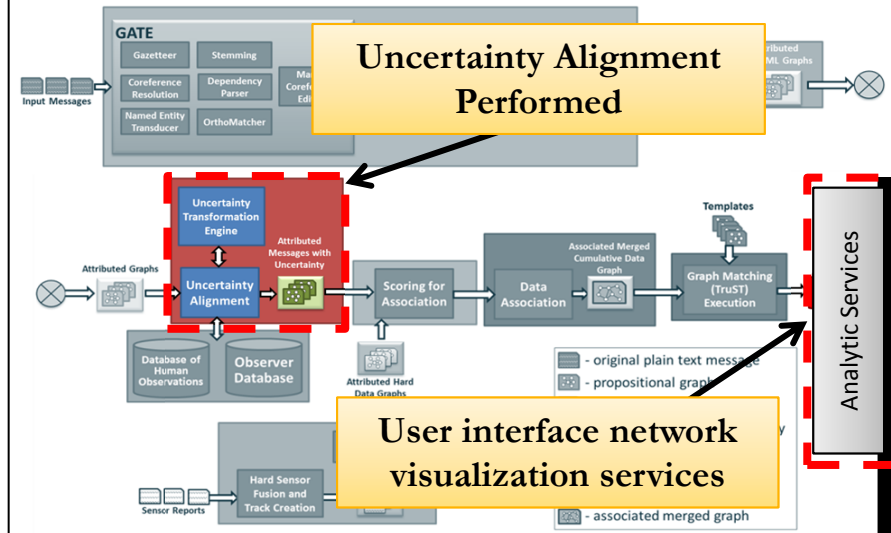
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Objectives

- Validate human source characterization models developed in Y1-2 and assess benefits to data association and situation assessment processes
- Develop and test network visualization techniques to support use of fusion output during intelligence analysis/sensemaking tasks



Scientific/Technical Approach

- Evaluation of uncertainty alignment with/without human error models using
 - Synthetic data approach
 - Observed data approach
- Adaptation of proven HF techniques to identify & characterize common Sensemaking tasks, develop visualization methods
- Controlled empirical testing of different network visualization instantiations

Accomplishments

- Demonstrated 6% improvement in true:observed matching accuracy with synthetic data
- Collected over 10,000 human observations based on simulated insurgency scenario (PSU)
- Isolated & characterized common Sensemaking tasks w.r.t. level of cognitive control
- Planned experiment & acquired/augmented software (NodeXL) to evaluate Sensemaking performance enhancements with network visualization aids

Challenges

- Validation may require access to Analysts or SMEs



Main Scientific/Technical Accomplishments

Human Source Characterization &

Supporting Sensemaking with Network Visualizations



Validated fusion processing benefits resulting from uncertainty alignment

- Context-aware models derived from empirical literature
- Validation via synthetic (200,000+ observations) & human participant observed datasets (10,000+ observations)
- Early results show improvement in situation assessment (true to observed)

Planned experiment to evaluate network visualizations as analytic service component to support analyst tasks

- Identified & characterized common IA Sensemaking tasks
- Experimental tasks intending to evaluate performance with/without visualization
- Custom scenario & message set, analogous to IA, for evaluation of knowledge based tasks by non-analysts



Project Statistics and Summary

Human Source Characterization &

Supporting Sensemaking with Network Visualizations



Personnel supported/Participating:

- Ph.D. Students: Michael Jenkins, Geoff Gross
- M.S. Student: Hiroto Kaku
- Undergraduate: Shanney Lacey
- Faculty: Ann Bisantz, Rakesh Nagi

Publications:

- Journal papers: 1 (in revision)
- Book chapters: 1 (in press)

Graduate Research Honors:

Gross, G., M. P. Jenkins, S. Lacey, A. M. Bisantz, & R. Nagi, Towards context-aware data fusion: Evaluating the benefits of integrating situationally qualified human observations into fusion processes:

- Winner of the 2012 University at Buffalo ISE Graduate Research Competition, March, 2012;
- 2nd place at the 2012 University at Buffalo School of Engineering and Applied Sciences Research Competition, April 26, 2012;
- Invited for presentation to the 2012 University at Buffalo Dean's Advisory Council, April 2012.



Publications

Human Source Characterization & Supporting Sensemaking with Network Visualizations



- M. Jenkins, G. Gross, A. Bisantz, R. Nagi “Towards Context Aware Data Fusion: Modeling and Integration of Situationally Qualified Human Observations into a Fusion Process for Intelligence Analysis,” *Information Fusion*, (In Revision, September 2012), 12 p.
- M. Jenkins, A. Bisantz, J. Pfautz, (In Press). Human Engineering Factors in Distributed and Net Centric Fusion Systems. In Chong, Hall, Liggins and Llinas (eds.) *Distributed data fusion for net-centric operations*. Boca Raton: CRC Press.



Technical Approach

Human Source Characterization



3-phased approach to integrate contextually qualified soft data into fusion stream

- Year 1:** Developed approach using 4 exemplar COIN relevant observational categories with existing to identify contextual influences and create context-aware error characteristic models
- Year 2:** Characterized relevant COIN categories (total of 15) based on available literature & integrate error models into fusion uncertainty alignment process
- Year 3:** Empirically validate the benefits of providing context-aware soft sensor source characterization models for information fusion systems via:
 - Synthetic Data Approach
 - Observed Data Approach



Technical Approach

Human Source Characterization



Synthetic Data Approach:

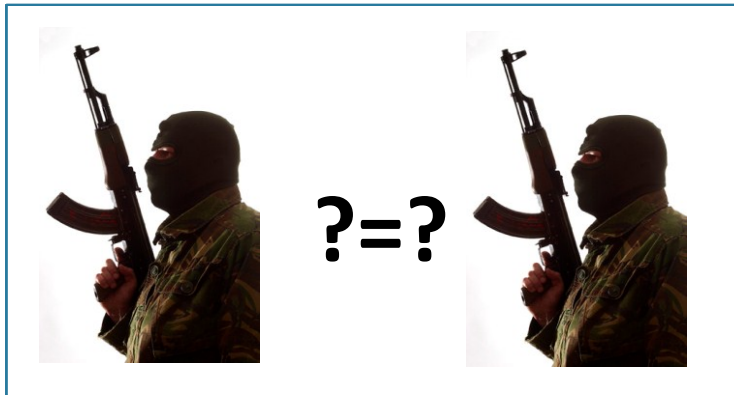
Leverage synthetic dataset to evaluate data association & situation assessment performance

- True Person data generated via US Census data
 - Observers and Targets pulled from this population
- Bias & variance introduced for randomly selected observer-to-target observations, yielding ~200,000 synthetic attribute observations
- Uncertainty representations formed given available metadata combined with relevant context-aware models of human observation

Observed-to-Observed Results

Example:

Determine if 2 observed individuals are the same person



Results (in progress)

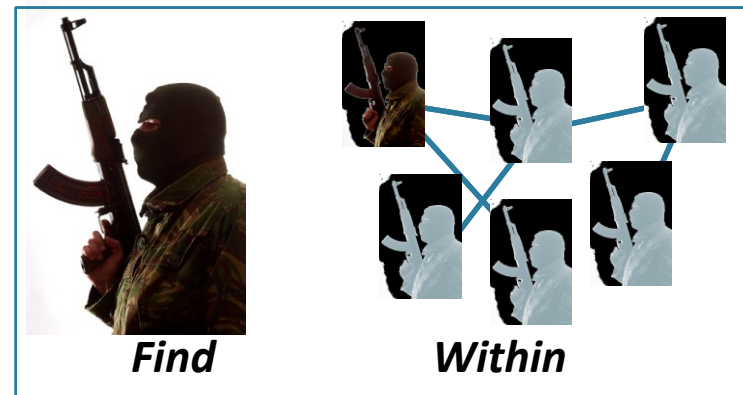
Simulates data association

- Generate multiple observations of common individual
 - Observations from different and/or same observer
- Determine recall/precision of associations

True-to-Observed Results

Example:

Search if a known terrorist is in a network of observed persons



Results

Simulates situation assessment

- 6.7% increase in similarity comparisons ≤ 0.01 away from top similarity score
- 5.9% increase in similarity comparisons that are the top ranked similarity score



Technical Approach

Human Source Characterization



Observed Data Approach:

Leverage human subjects' estimations of simulated COIN video scenario to further assess fusion system performance

- Simulated COIN scenario (PSU) with 24 target persons across two videos
- Observations of 14 target attributes (numeric & linguistic) collected from 30 participants, yielding ~10,000 estimations
- Population & context-specific performance models generated
- Linguistic-to-numeric estimation mappings generated

Next Steps:

For both linguistic & numeric population & context-specific error models:

1. Calculate Truth:Observed similarities to simulate situation assessment
2. Observed:Observed similarities calculated to simulate data association
3. Populate random cumulative data graphs with actual person observations
 - Evaluate precision/recall of graph matching for existent/non-existent situation of interest
4. Populate random message graphs with actual person observations
 - Evaluate precision/recall of data association on cross message associations



Technical Approach

Supporting Sensemaking with Network Visualizations



Motivation:

Fusion systems provide massive volume of complex information

- Information availability increasing
- Cognitive resources fixed
- Entities & Relationship driven
- Network (Graph) Visualization format assumed without evidence of its benefits

State of the Art:

Visualizations employed to increase quantity of information displayed, however challenges to effective use exist

- Common tendency to display everything possible
- Lack of empirical research on appropriateness of visualizations



Technical Approach

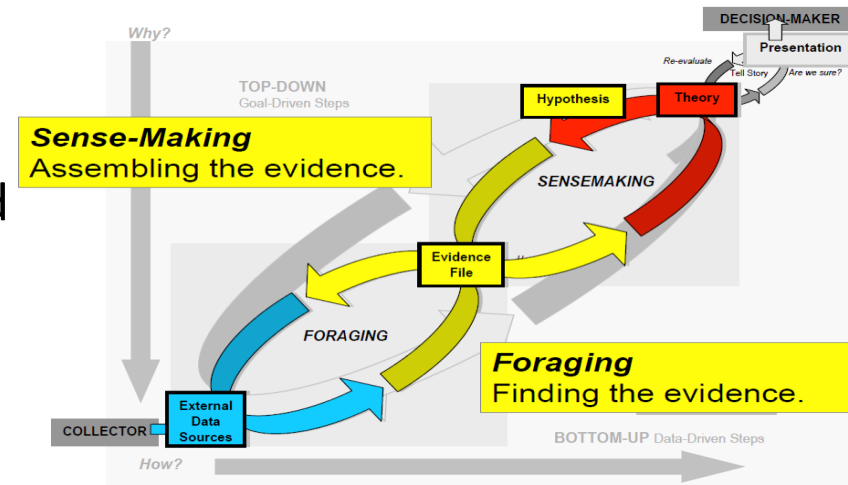
Supporting Sensemaking with Network Visualizations



Approach:

Empirically evaluate Network (Graph) Visualization effect on IA tasks

- Sensemaking framework adopted
- Key IA tasks isolated & characterized
 - *Foraging*
 - *Sensemaking*
- Analogous IA scenario developed



Output of empirical testing will provide evidence & guidance on...

- Graphically enhanced NetViz's vs. NetViz's vs. Non-Visualizations
- Recommendations for enhancements to MURI system data graph interface

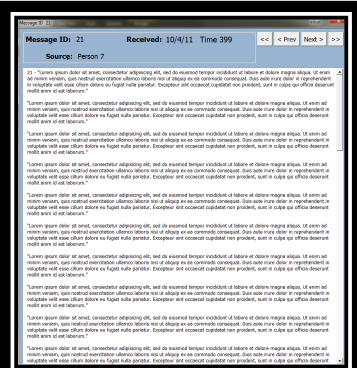


Technical Approach Supporting Sensemaking with Network Visualizations

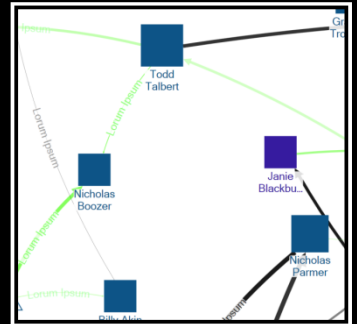


Examples:

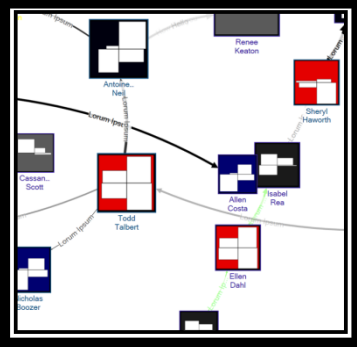
Non-Visualization Display



Traditional Network Visualization Display



Graphically Enhanced Network Visualization Display





Technical Approach Supporting Sensemaking with Network Visualizations



Examples:



Message ID: 21 Received: 10/4/11 Time 399 << Prev Next > >>

Source: Person 7

21 - "Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum."

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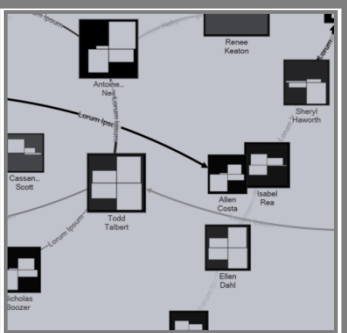
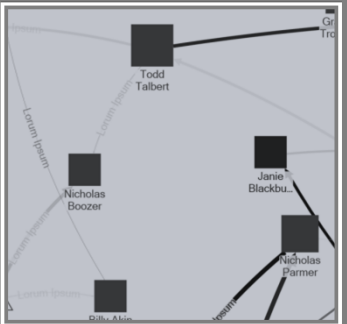
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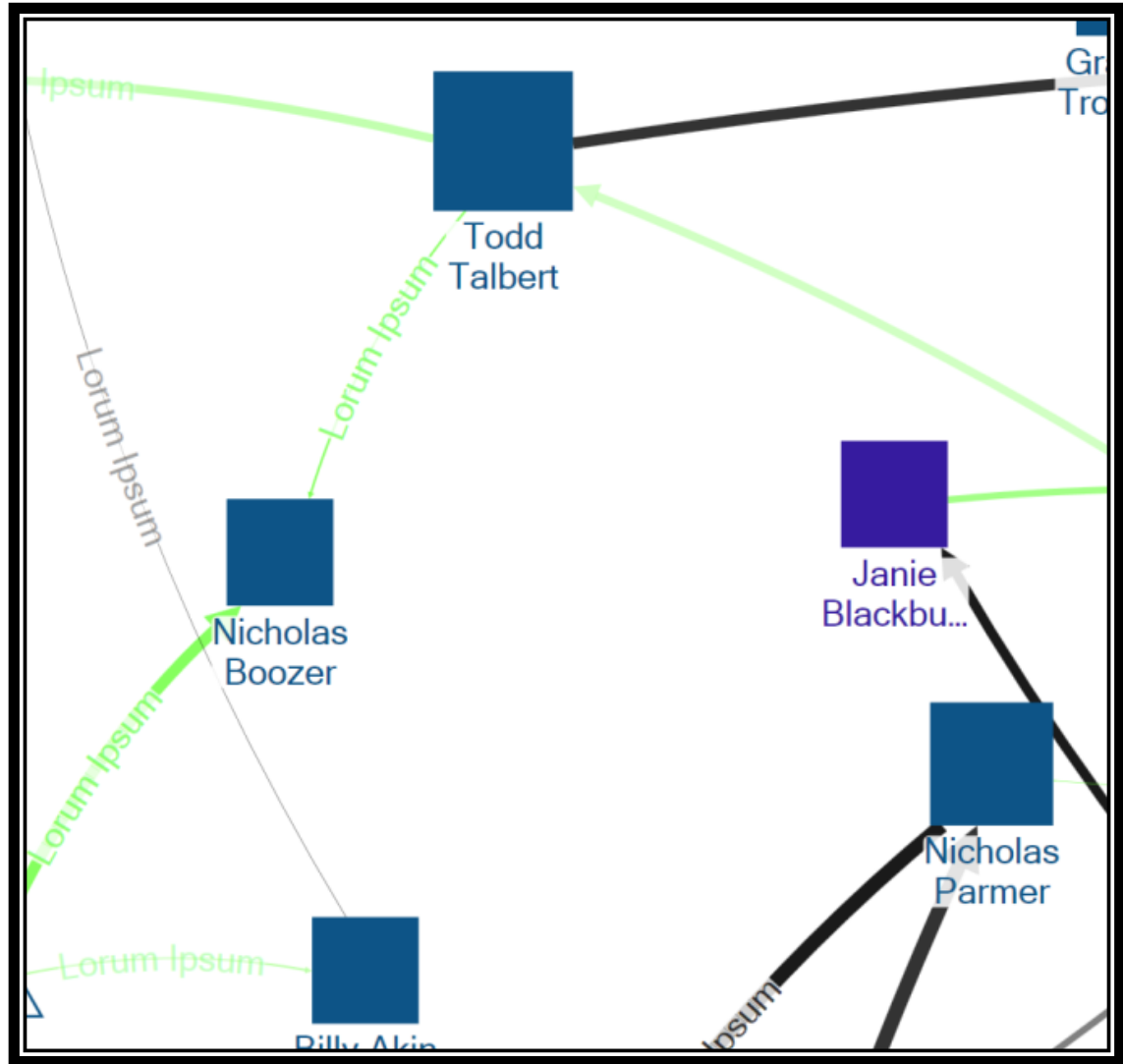
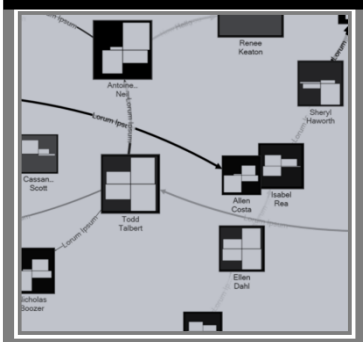
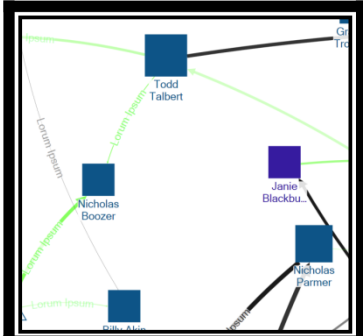
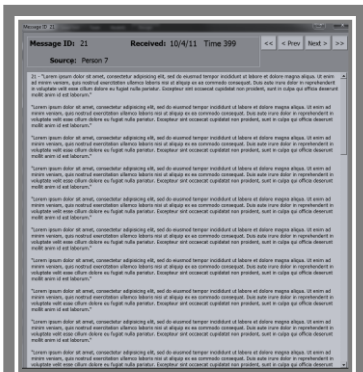




Technical Approach Supporting Sensemaking with Network Visualizations



Examples:

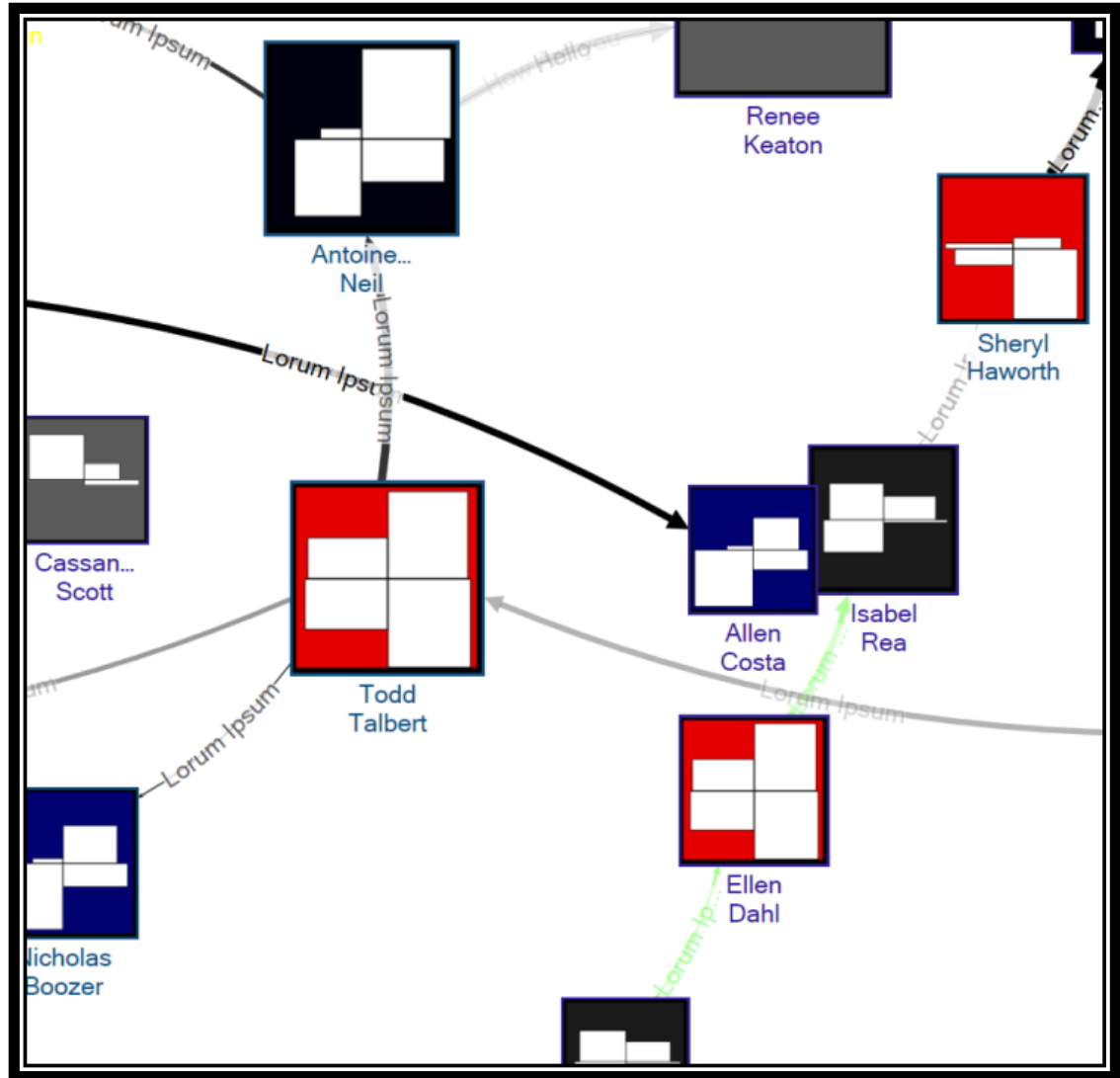
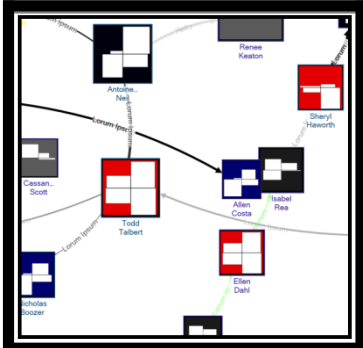
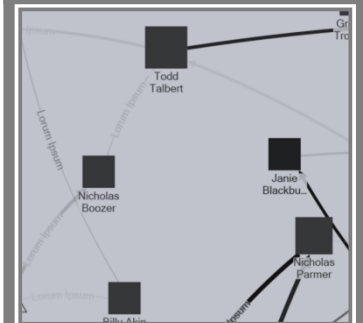
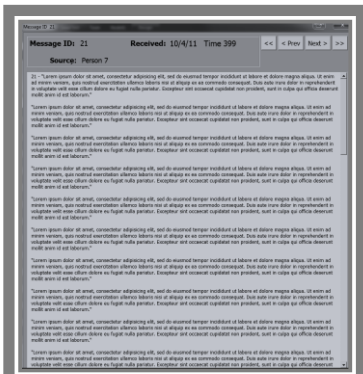




Technical Approach Supporting Sensemaking with Network Visualizations



Examples:





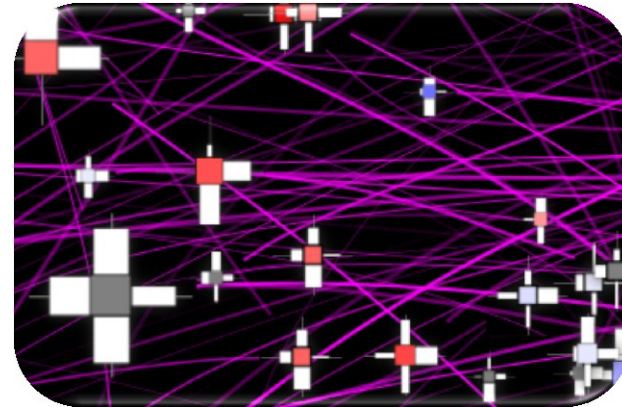
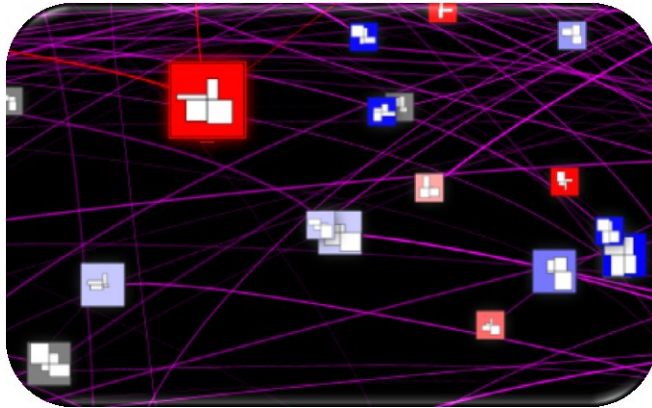
Technical Approach

Supporting Sensemaking with Network Visualizations



Progress:

- Sensemaking tasks identified & characterized
- Two enhanced NetViz designs generated



- Analogous IA scenario & dataset generated (Murder Mystery)
- NetViz software (NodeXL) being augmented for testing

Next Steps (through January 2013):

- Data collection
- Analysis & Recommendations



Summary



- 1. Evaluated performance effects of integrating human source characterization models for uncertainty alignment**
 - Human observer dataset collected and in process of further evaluation of uncertainty alignment, attribute scoring, and linguistics processing
- 2. Experiment underway to provide empirically grounded recommendation on MURI data graph visualization interface**
 - Focus on supporting Sensemaking framed tasks

Challenges:

- MURI system user interface not yet prioritized for user testing & evaluation
- Direct access to Intelligence Analysts (or other SMEs) may be required for validation of tasks and experimental findings



2013-2015 Plans



Human Source Characterization

Research Goals: *Validate Human Source Characterization Performance Benefits*

Determine the degree of fusion system improvement gained from leveraging the source characterization models for both:

- Truthed to Observed References & Associations
- Observed to Observed References & Associations

Capability Goal: *Attribute salience system*

Given that certain characteristics of an entity may have larger bearing on their identity, effort will be given to distinguishing feature attribute weightings to support the possibility of better entity resolution

Human in the Fusion Loop

Research Goals: *Concept-of-Employment*

- Determine effectiveness of network visualizations at supporting analyst Sensemaking tasks
- Explore the benefits (and potentially drawbacks) of graphically enhanced network visualizations

Capability Goal: *Human-in-the-Loop*

Leverage results of experimental & theoretical studies to design prototype front-end user interface to support common Sensemaking tasks