Semantic Fusion of Multi-INT Data

14 November 2011

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SPEEDING THE DISCOVERY, INTEGRATION AND FUSION OF INFORMATION
Extracting Knowledge and Semantically Fusing Multi-INT Data

A persistent problem for ISR data analysis is in how to identify, extract and fuse essential elements of information (EEIs) from multi-INT, multi-source data in an automated fashion.

We will present a government-funded framework being developed and used by the US military that addresses this problem for a wide range of military and border protection applications.
Overview

- We will briefly discuss several GOTS tools to process structured and unstructured data to extract knowledge and perform semantic fusion.
- We will describe how we perform extraction of knowledge from multi-INT data sources (e.g. Human Intelligence, Signals and Imagery).
- We will demonstrate how the tools and technologies are used to combine information from structured and unstructured data to “connect the dots”.
How you will benefit

- Learn how semantic tools can:
  - **Greatly reduce the time** to perform multi-INT intelligence analysis through increased automation
  - **Improve the quality** of the resulting intelligence products by fusing data from many sources

- Begin to understand the operational value of semantic technologies
Session Topics

- Essential Elements of Information (EEIs)
- WebTAS and CIDNE
- Wave Exploitation Framework (Wave-EF)
- Extracting EEIs from Multi-INT data
- Semantics
- Ontology-based Fusion
- Fusion Demonstration
Essential Elements of Information

- EEIs are **knowledge or information** users want to extract from data sources.
- EEIs are the building blocks of information and intelligence requirements.
- They reflect the **important objects and relationships** necessary for **situational awareness and intelligence analysis**.
- Examples:
  - Entities (e.g. people, organizations, locations, facilities, weapons)
  - Relationships between entities
  - Events (e.g. disease outbreak)
  - Activities (e.g. attacks, precursor events, movements)
  - Conditions of interest (e.g., imagery change detection)
How are EEIs embedded within multi-INT data?

- Human Intelligence (HUMINT) – EEIs described in text
- Imagery Intelligence (IMINT) – EEIs depicted in the images, image metadata and the free text remarks and comments in IMINT intelligence messages
- Signals Intelligence (SIGINT) – EEIs depicted in collected signals, signals metadata and the free text remarks and comments in SIGINT intelligence messages
- MASINT, GEOINT, OSINT, etc. are similar
EEIs in CIDNE

Snapshot reports and multimedia from multiple disciplines feed Human Terrain Analysis: People, Tribes, Organizations, Facilities, Geospatial Areas and Relationships.
CIDNE Cultural & Social Analysis

- Civil Affairs Projects and PRT Reporting
- Tactical Atmospheric Observations
- Population Assessment
- Social Networks Relationships and Interest
- Key Leader Engagements
- Bios of Leaders and Influencers
- Tribal Operating Areas
- Cultural References and Demographics

Understand the Culture & Social Networks - Protect and Rebuild Society
WebTAS Information Fusion & Product Generation

WebTAS data access and analytics
- GOTRS software in operational use world-wide
- Provides cross-data set access and analytics

CAWS product creation layer
- Creates PowerPoint briefs using integrated data
- Links products to data sources
- Provides package storage and retrieval supporting product evolution/update
We leverage Wave-EF technology components to develop custom applications.
If EEIs can be recognized and automatically extracted from unstructured data, computers can automate much more of the intelligence analysis process.

Extracting EEIs typically involves a ‘pipeline’ of these four steps:

- Data source selection, access and ingest
- Format normalization and parsing
- Annotating entities, relationships and events
- Transformation and export

SOAP
JMS
DDS
AMQP
REST
RSS
Files

Data Ingest
Format Parsing
Entity, Relationship, Event Annotation
Export (optional)

XML
RDF
CSV
BY The Associated Press (November 2, 2011)

WASHINGTON — Three confirmed cases of human infection with avian influenza (H5N1) virus have been reported in the regions surrounding Goytapa Azerbaijan and Bileh Savar Iran. All three were reportedly on a religious pilgrimage to Baku when they fell ill.

Two cases are from Goytapa, one involving a 16 year-old male and the other a 38 year-old female. The male developed symptoms on 17 September and was hospitalized on 21 September. The female developed symptoms on 19 September and was hospitalized on 22 September. Both completed a course of oseltamivir, recovered and were discharged from the hospital. Investigations into the source of infection revealed that both had contact with poultry raised in area.

The third case involved a 12 year-old female who developed symptoms on 23 September near Bileh Savar, Iran while on pilgrimage to Baku. She was hospitalized on 29 September. She passed away on 30 September before completing a course of oseltamivir. The source of her infection is at this time unknown.

All three cases were confirmed by the Azerbaijani Central Public Health Laboratories in Baku, a National Influenza Center of the WHO Global Influenza Surveillance Network and the Centers for Disease Control.
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Three confirmed cases of human infection with avian influenza (H5N1) virus have been reported in the regions surrounding Goytapa Azerbaijan and Bileh Savar Iran.

<ObservationEvent>
    <Actor>Unknown</Actor>
    <Theme>
        <InfectionEvent>Three confirmed cases of human infection...
            <Patient>Three humans</Patient>
            <InfectiousAgent>H5N1 virus</InfectiousAgent>
        </InfectionEvent>
    </Theme>
    <LocationSet>
        <Location>Goytapa Azerbaijan</Location>
        <Location>Bileh Savar Iran</Location>
    </LocationSet>
    <Time>2011-11-02T09:00Z</Time>
</ObservationEvent>
Entity, relationship and event annotations are transformed into Semantic Web standard RDF (Resource Description Framework) statements.

RDF statements, often called RDF ‘triples’, are simple facts that can be linked together to form complex graphs.

Triples have the form “subject verb object”.

RDF graphs can be queried using languages such as SPARQL, the Semantic Web analogue to the query language for relational databases, SQL.

SPARQL allows the content AND the structure of the graph to be queried.
Below is the Infection Event described in the AP report depicted as a graph.
Later discourse shows at least two different events and refines information on the patients.

**Event #1**
- **Time:** 2011-11-02T09:00Z
- **Patient:** 16 year-old male
- **Pathogen:** H5N1 Virus
- **Location:** Goytapa, Azerbaijan

**Event #2**
- **Time:** 2011-11-02T09:00Z
- **Patient:** 12 year-old female
- **Pathogen:** H5N1 Virus
- **Location:** Bileh Savar, Iran
Fusing data from multiple sources

- Data sources typically have only those data relevant to the owners or providers of that data
- Often need to combine data from multiple sources to get the “big picture”, but how do you determine if they are talking about the same entity?

Entity disambiguation

- Within data source:
  - Coreference (e.g., “all three”, “the male”, “two cases”, “both”)
  - Pronoun dereferencing (e.g., “she”, “they”)
  - Nominalization (e.g., “infection”)
- Across data sources:
  - Two or more data sources may have information about the same entity or event
  - Problematic as sources may use different attributes, different modalities, or different units and resolutions
Question: To what degree are two entities the same?

- If different sources are referring to the same entity, we can combine the information from each source for that entity.
Model-Based Disambiguation

Users vet discovered relationships
- Only those matches scoring above a user-set threshold value are presented
- User can override or confirm fusion

SEER model checks for matches across data sources
- Alerts user when potential matches are found
- Confidence can increase or decrease based on attribute value match
- Fuzzy matching can be used

Active area of research
A Doctors without Borders medical clinic has been set up and is in operation in the Caspian Sea region. The clinic services both the local community and religious pilgrims transiting the region.

Several cases of Avian influenza have been reported among the pilgrims. The World Health Organization has issued a Global Alert and Response (GAR) that reads in part “Three confirmed cases of human infection with avian influenza (H5N1) virus have been reported in the regions surrounding Goytapa and Bileh Savar. All three were reportedly on a religious pilgrimage to Baku when they fell ill.”
Essential Elements of Information can be extracted from multi-INT data.

Semantic representations of EEIs makes disambiguation and fusion possible.

Tools such as WebTAS, CIDNE and Wave-EF can be used to fuse EEIs extracted from structured and unstructured data.

While the demonstration showed a humanitarian scenario, this can be used for military and border protection applications.
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