Using Semantic Technologies to Improve Information Exploitation in Military and Civilian Application Contexts

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SEMIOTIKS Overview

- Knowledge Discovery
  - resource discovery
  - resource classification
- Knowledge Extraction
  - extraction of knowledge content from textual sources
- Knowledge Retrieval
  - tools to support the retrieval of task-relevant information
- Knowledge Integration
  - integration of disparate knowledge sources
- Knowledge Dissemination
  - knowledge monitoring and alerting capability

- Humanitarian Demining Scenario
  - alignment and integration of military datasets with humanitarian demining ontologies
  - assessment of mine hazard areas
  - scheduling, planning and monitoring of mine clearance operations
Technology Components

- **Domain Ontologies**
  - humanitarian demining, hostile bomb attacks, USAF bombing missions, explosive devices
  - SWRL rules to provide decision support

- **SEMIOTIKS Resource Browser**
  - classifies text resources with respect to ontology elements

- **Knowledge Extraction Tool**
  - semi-automatic knowledge extraction capability

- **Graphical Query Tool**
  - supports information retrieval and data integration

- **Knowledge Monitoring System**
  - provides monitoring and knowledge dissemination capability
Demining Ontology

**ClearedMineHazardArea**

- rdfs:comment
  - A cleared mine hazard area is a mine hazard area whose clearance status is always 'Cleared'.

**Asserted Conditions**

- MineHazardArea
- hasClearanceStatus \(\exists\) Cleared
- hasClearanceStatus \(\exists\) ActiveOrUnclearedMineHazardArea
- isLocatedIn SpatialLocation

**Categories**

- ExplosiveDevice
- Facility
- InformationResource
- InformationSource
- LandMineComponentType
- Location
  - SpatialLocation
    - PointLocation
  - Region
    - AdministrativeRegion
    - GeographicalRegion
    - MineHazardArea
      - ActiveMineHazardArea
      - ActiveOrUnclearedMineHazardArea
      - ClearedMineHazardArea
    - DGDMineHazardArea
    - HighPriorityMineHazardArea
Resource Browser

- **Classification Mode**
  - classifies textual resources with respect to ontology elements
  - uses annotation properties in the source ontology
  - annotation properties represent the lexicalization of ontology elements

- **Discovery Mode**
  - query expansion technique
  - used to browse Web resources
Resource Discovery

Query

?++

Expanded Query

Search Engine

SEMIOTIKS Resource Repository

Resources

Term Extraction

Extracted Terms (10)

“activity” “team” “equipment” “project”
Google Web Search ("terrorist attack")
Documents Discovered: 47, Phrases Expanded: 3

100%

- BBC NEWS | UK | London rocked by terror attacks - (local, remote)
- BBC NEWS | Special Reports | London explosions - (local, remote)
- BBC NEWS | South Asia | Gunmen shoot Sri Lanka cricketers - (local, remote)
- BBC NEWS | South Asia | Mumbai rocked by deadly attacks - (local, remote)
- BBC NEWS | World | Europe | Scores die in Madrid bomb carnage - (local, remote)
- BBC NEWS | Scotland | Airport incident was terrorism - (local, remote)
- BBC NEWS | South Asia | As it happened: Mumbai attacks - 28 Nov - (local, remote)
- BBC NEWS | South Asia | Bombings rock Indian tourist city - (local, remote)
- BBC NEWS | Middle East | Bahrain 'fils terrorist attack' - (local, remote)
- BBC NEWS | UK | London bombings toll rises to 37 - (local, remote)
- BBC NEWS | UK | 'Airlines terror plot' disrupted - (local, remote)
- BBC NEWS | Asia-Pacific | Chinese border assault kills 16 - (local, remote)
- BBC NEWS | Middle East | Jordan 'thwarts terrorist attack' - (local, remote)
- BBC NEWS | South Asia | Deadly blasts hit Indian capital - (local, remote)
- BBC NEWS | Americas | McCain aide regrets terror claim - (local, remote)
- BBC - Test Match Special: Lahore attacks shock England players - (local, remote)
- BBC | Jersey - In Pictures - Simulated Terrorist attack - (local, remote)
- BBC NEWS | INDEPTH | LONDON ATTACKS - (local, remote)
- BBC NEWS | Asia-Pacific | Ball attack 'targeted Australians' - (local, remote)
- BBC NEWS | Europe | 'Major al-Qaeda attack foiled' - (local, remote)
- BBC NEWS | World | Asia-Pacific | Australia foils 'terror attack' - (local, remote)
- BBC NEWS | Europe | Germany foils 'massive bomb plot' - (local, remote)
- BBC NEWS | Programmes | Panorama | Preparing for a crisis - (local, remote)
- BBC NEWS | World | Asia | Berlin - Australia arms export broker - (local, remote)
Knowledge Extraction Tool

- supports manual and automatic modes of semantic annotation
- uses concept resolution service to identify concepts in textual resources
- supports graphical modes of knowledge editing
The Royal Artillery's newest long range precision land attack rocket has been fired for the first time on operations in Helmand, a province located in the South of Afghanistan. The state of the art Guided Multiple Launch Rocket System (GMLRS), nicknamed the '70km Sniper', provides pinpoint accuracy delivering a 200lb high explosive warhead to its target, with twice the range of other artillery systems used by the British Army. Operated by Gunners from 39 Regiment Royal Artillery 'The Welsh Gunners' based in Newcastle, GMLRS can strike targets as far as 70km away, with absolute accuracy and in all weathers. Deployed in several locations...
Graphical Query Tool

- Web-based graphical tool for creating and editing SPARQL queries
- Uses HTML 5 functionality
  - `<canvas>` element
- Provides full support for SPARQL, including CONSTRUCT query form
- Uses graphical formalisms to represent semantic query language elements
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX terrorOnt: <http://www.mindswap.org/2004/terrorOnt.owl#>

SELECT ?person ?organisation
WHERE
{
  ?person rdf:type terrorOnt:TerroristLeader
  ?person terrorOnt:affiliation ?organisation
}
Semantic queries can be used for the contingent assertion of information as well as for information retrieval

- allows semantic queries to be used like rules
- can be used to translate or transform information
- SEMIOTIKS graphical query designer can therefore be used as tool for creating data integration and transformation ‘rules’
CONSTRUCT
{
\_a rdf:type edto:TerroristAttack .
\_a edto:hasICN ?aip_ICN .
?x owl:sameAs \_a
}

WHERE
{
?x rdf:type aip:TerroristIncident

?x aip:hasICN ?aip_ICN
}

CONSTRUCT

?x owl:sameAs \_a

\_a edto:hasICN

\_a rdf:type edto:TerroristAttack

?x aip:hasICN ?aip_ICN

aip:TerroristIncident

edto:TerroristAttack
CONSTRUCT
{
_:o rdf:type smao:OrdnanceDrop .
_:l rdf:type smao:GeographicPointLocation .
_:l smao:hasLatitude ?latitude .
_:l smao:hasLongitude ?longitude .
_:o smao:hasSpatialLocation _:l .
_:d rdf:type smao:DateInstant .
_:o smao:hasTemporalLocation _:d .
_:d smao:hasDate ?date .
_:b rdf:type ?smaoOrdnance .
_:o smao:involves _:b .
_:o smao:hasDamageAssessment ?smaoBDA .
_:a rdf:type smao:MineHazardArea .
_:a smao:isCausedBy _:o .
_:a smao:hasSpatialLocation _:l .
_:a smao:hasReportedDate ?date .
_:a smao:mayContain _:b .
_:a smao:hasClearanceStatus smao:Uncleared
}

WHERE
{
?s rdf:type ato:Sortie .
?s ato:hasLatitude ?latitude .
?s ato:hasLongitude ?longitude .
?s ato:hasDate ?date .
?s ato:hasOrdnance ?ordnance .
?smaoOrdnance smao:sameAs ?ordnance .
?smaoOrdnance rdfs:subClassOf smao:Bomb .
?s ato:hasBDA ?bda .
?smaoBDA rdf:type smao:DamageAssessment .
?smaoBDA smao:hasBDAKeywordMapping ?bda .
}
Knowledge Monitoring System

- Allows user to monitor situation events and contingencies
- Provides multiple alerting and notification mechanisms
  - RSS feeds
  - Email
  - GIS Information Display
  - Synthesised Skype Voice Message Alert
  - Skype Text Message Alert
- Allows user to customize alert message
- Uses Zeroconf networking to integrate system components with zero configuration
New Knowledge Monitor

Operation: Semiotiks Default
Interval (mins): 1
Unique Field: ?unique

Query:
PREFIX mindterror: <http://www.mindswap.org/2004/terrorOnt.owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?unique ?affiliation
WHERE {
  ?unique rdf:type mindterror:Terrorist .
  ?affiliation rdf:type mindterror:Terrorist_Group
}

Message:
An event involving a member of the group {?affiliation} has been detected!

Outputs:
<table>
<thead>
<tr>
<th>Type</th>
<th>Recipients</th>
<th>Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMS</td>
<td>+4477344555123</td>
<td>DELETE</td>
</tr>
</tbody>
</table>
Ontology-mediated decision support capability
  ◦ support mine hazard area assessment
  ◦ support assignment of mine clearance tasks to demining organization
  ◦ support planning and scheduling of mine clearance activities

Relies on a combination of DL reasoning and SWRL rules

Uses Pellet reasoner and JESS rule engine
MineIncident(?x) \land 
hasTemporalLocation(?x, ?y) \land 
DateInstant(?y) \land 
hasDate(?y, ?date) \land 
swrlb:lessThan(?date, "2009–01–01") \land 
swrlb:greaterThan(?date, "2007–12–31") 
\rightarrow 
MineIncidentIn2008(?x)

HumanitarianDeminingOrganization(?x) \land 
hasSpecialistExpertiseWith(?x, ?device) \land 
HighPriorityMineHazardArea(?area) \land 
contains(?area, ?device2) \land 
abox:hasClass(?device, ?deviceClass) \land 
abox:hasClass(?device2, ?deviceClass) 
\rightarrow 
DeminingOrganizationSuitedForHighPriorityMineHazardAreas(?x)

(\exists \text{hasAssociatedMineIncident (MineIncidentIn2007} \sqcup \text{MineIncidentIn2008)}) \sqcap (\exists \text{hasAssociatedMineIncident MineIncidentWithBetween2And5Fatalities})
Demonstration Scenario

- Humanitarian demining
- Afghanistan
  - 16 year demining programme
  - one of the worst affected areas for mines/UXO
  - 9000 demining personnel (ex military)
- Multiple agencies
- UNMACA
  - coordinating agency

“What we found in Kosovo was that we had a lot of demining organizations on the ground and no one had a clue as to what was going on...who was demining where. So you had multiple agencies turning up on the same worksite...whereas other areas had no one turning up.”

Danish Demining Group
UK Army OBSREP Proforma - Modified

On 25 May 2004 evidence of a minefield was reported at 30.336637 degrees latitude and 62.703302 degrees longitude. Further investigation of the area revealed the presence of PMN and MON-100 mines. The minefield was reported to cover an area of approximately 4382 meters by 4642 meters. The mines are assumed to be active and entry to the area is prohibited. At the present time the minefield is believed to be uncleared.

<table>
<thead>
<tr>
<th>C</th>
<th>Obstacle location</th>
<th>Lat: 30.336637</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lon: 62.703302</td>
</tr>
<tr>
<td>D</td>
<td>Obstacle data:</td>
<td>True</td>
</tr>
<tr>
<td></td>
<td>Mines present indicator</td>
<td>Anti-Personnel</td>
</tr>
<tr>
<td></td>
<td>Generic mine type</td>
<td>Minefield</td>
</tr>
<tr>
<td>E</td>
<td>Obstacle area size</td>
<td>Length: 4642</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Width: 4382</td>
</tr>
</tbody>
</table>
| UXO type| Specific mine characteristics                                                       | PMN: This is a delay-armed, pressure-fired, high explosive (blast) antipersonnel (apers) landmine.
Issues for Future Work

- Ontology-mediated text classification
  - use ontologies to enhance classification performance
- Relational knowledge extraction
  - what are the limits of automated capabilities
- Scalability of reasoning systems
  - Pellet and JESS reasoners did not perform well with large datasets
- Better methods for implementing semantically-mediated decision support systems
  - control over rule execution
  - task templates, problem-solving methods, rule types
Research focus areas
- knowledge extraction
- resource classification
- retrieval
- reasoning

Technological outcomes
- graphical query designer tool
- knowledge extractor tool
- resource browser / classification system
- knowledge monitor system

Technical demonstration
- available during lunch!