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Southampton

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

The screenshot displays a web-based ontology editor for the Demining Ontology. On the left, a class hierarchy is shown with expandable/collapsible icons (triangles) and class icons (circles with 'C'). The hierarchy is as follows:

- ExplosiveDevice
- Facility
- InformationResource
- InformationSource
- LandMineComponentType
- Location
 - SpatialLocation
 - PointLocation
 - Region
 - AdministrativeRegion
 - GeographicalRegion
 - MineHazardArea
 - ActiveMineHazardArea
 - ActiveOrUnclearedMineHazardArea
 - ClearedMineHazardArea** (highlighted)
 - DDGMineHazardArea
 - HighPriorityMineHazardArea

The right pane shows the details for the selected class, **ClearedMineHazardArea**. It includes an **rdfs:comment** field with the text: "A cleared mine hazard area is a mine hazard area whose clearance status is always 'Cleared'". Below this are tabs for **Asserted** and **Inferred** conditions. The **Asserted Conditions** tab is active, showing a list of conditions:

- NECESSARY & SUFFICIENT**
 - MineHazardArea** \Rightarrow **hasClearanceStatus** \Rightarrow **Cleared** (highlighted)
- NECESSARY**
- INHERITED**
 - \exists isLocatedIn SpatialLocation

Each condition is preceded by a circle containing a 'C' (for class) or an 'E' (for existential quantifier). The interface also features various icons for editing, deleting, and navigating between different views.

Resource Browser

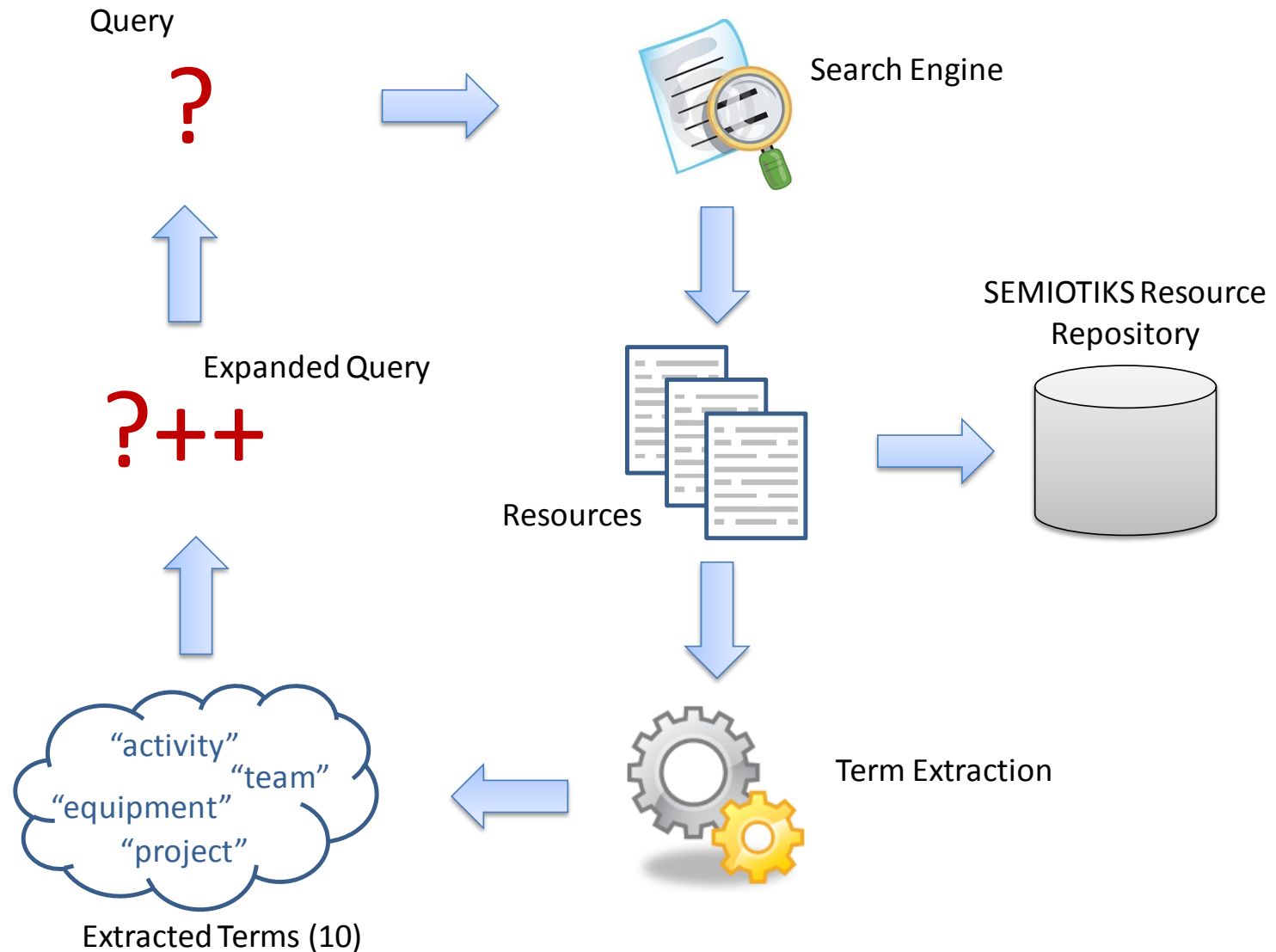
► Classification Mode

- 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



View Process

Google Web Search ("terrorist attack")

Documents Discovered: 47, Phrases Expanded: 3

100%

Phrases Documents

- 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)
- http://news.bbc.co.uk/hi/english/static/in_depth/americas/2001/day_of_terror/ – (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 'foils 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 | Bali 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-Pacific | Australia terror suspects charged – (local, remote)

Root Classes

Home

search:

India

Afghanistan

UnitedStatesOfAmerica

UnitedKingdom

Root

UnitedKingdom

London

BBC NEWS |
Programmes |
Panorama |
Preparing for a
crisis

BBC NEWS |
England | Is the
North East
prepared?

BBC NEWS
| UK |
'Airlines
terror plot'
disrupted

BBC World
Service |
Learning
English |
News
English –
Words in
the News

BBC NEWS |
Special Reports
| London
explosions

BBC NEWS | Europe
| 'Major al-Qaeda
attack fo

The Jawa Report: Amsterdam:
Terrorist Attack Foiled

BBC NEWS
Scotland | A
incident '
terrorist

BBC NEWS | UK |
London rocked
by terror attacks

BBC – Radio
– Today –
Leaky
chemical
suits

BBC NEWS |
England |
London | Is
London
prepared?

BBC NEWS |
World |
Asia-Pacific |
Australia foils
'terror attack'

BBC NEWS
UK | London
bombings toll
rises to 37

Politics |
Terror advice
pamphlet
unveiled

South Asia |
As it
happened:
Mumbai
attacks – 28
Nov

BBC NEWS |
INDEPTH |
LONDON
ATTACKS

BBC NEWS |
England |
Tyne | City is
tested in
terror
exercise

BBC NEWS |
England |
Oxfordshire |
Hundreds
involved in
mock terror
attack

How Likely is
a Nuclear
Terrorist
Attack on the
United States?
– Council on
Forelan

Afghanistan

BBC NEWS |
Asia-Pacific | Bali
attack 'targeted
Australians'

Most Emailed
News Stories

BBC NEWS | World
| Asia-Pacific |
Australia terror
suspects charged

BBC NEWS | World
| Asia-Pacific |
Australia foils
'terror attack'

The Jawa Report:
Amsterdam:
Terrorist Attack
Foiled

BBC NEWS | UK |
London bombings
toll rises to 37

Pakistan: Terrorist
attack targets
international
cricket match

BBC NEWS | Europe
| Germany foils
'massive' bomb
plot

Biological terror
attack likely by
2013, panel says –
CNN.com

Response to
terrorist attack
makes bus driver a
hero – CNN.com

UnitedStatesOfAmerica

BBC NEWS | N
Ireland | NI
trains for
bio-terrorist
attack

BBC NEWS |
Americas | US
terror drill 'so
far successful'

Writing After
Terrorist Attack
Has Positive
Medium Term
Effects

BBC NEWS |
Americas |
McCain aide
regrets terror
claim

Biological
terror attack
likely by 2013,
panel says –
CNN.com

BBC World
Service |
Learning
English | News
English –
Words in the
..

BBC NEWS | UK
| N Ireland | NI
trains for
bio-terrorist
attack

How Likely is a
Nuclear
Terrorist Attack
on the United
States? –
Council on

Most Emailed
News Stories

BBC NEWS |
Europe | 'Major
al-Qaeda
attack foiled'

Cheney
Predicts
Catastrophic
Terrorist Attack

BBC NEWS | UK
| 'Airlines
terror plot'
disrupted

BBC NEWS |
South Asia | As
it happened:
Mumbai
attacks – 28
Nov

BBC – Test
Match
Special:
Lahore
attacks
shock
England

President
condemns
cowardly
terrorist
attack on
cricketers

Pakistan:
Terrorist
attack
targets
international
cricket
match

Biological
terror attack
likely by
2013, panel
says –
CNN.com

India

Mumbai

Al Jazeera
English –
CENTRAL/S.
ASIA –
Cricketers
wounded in

BBC NEWS | South
Asia | Gunmen
shoot Sri Lanka
cricketers

BBC NEWS
| South
Asia |
Bombin
rock
Indian
tourist
city

TERROR
NON-STOP:
101 killed in
Mumbai
attacks

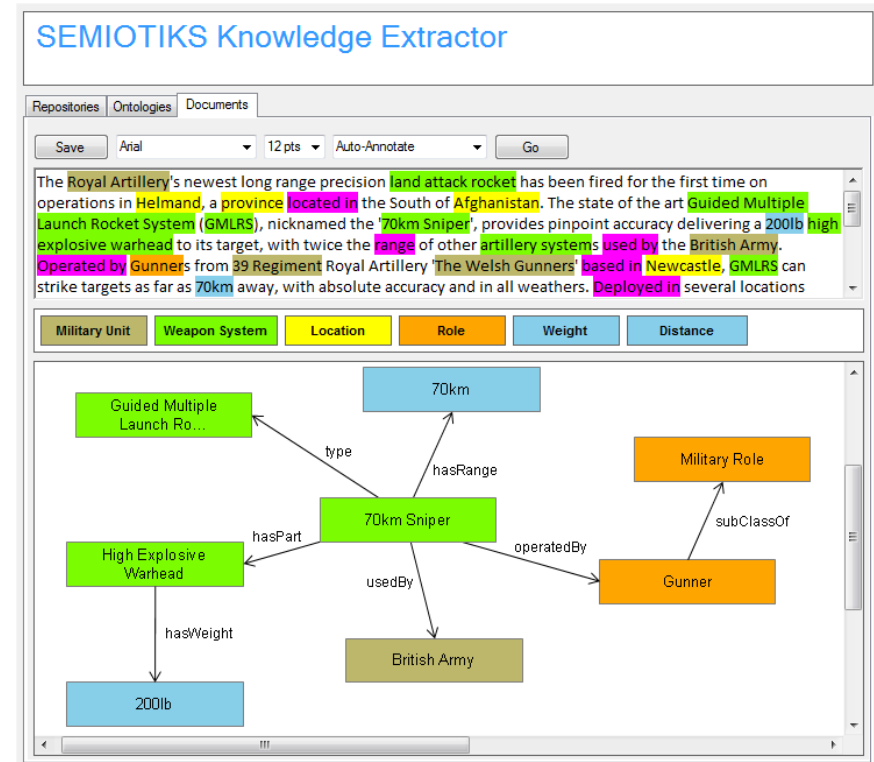
Violence as sport

BBC – Test
Match
Special:
Lahore
attacks
shock
England

President
condemns
cowardly
terrorist
attack on
cricketers

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



SEMIOTIKS Knowledge Extractor

Repositories Ontologies Documents

Save

Arial

12 pts

Auto-Annotate

Go

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

Military Unit

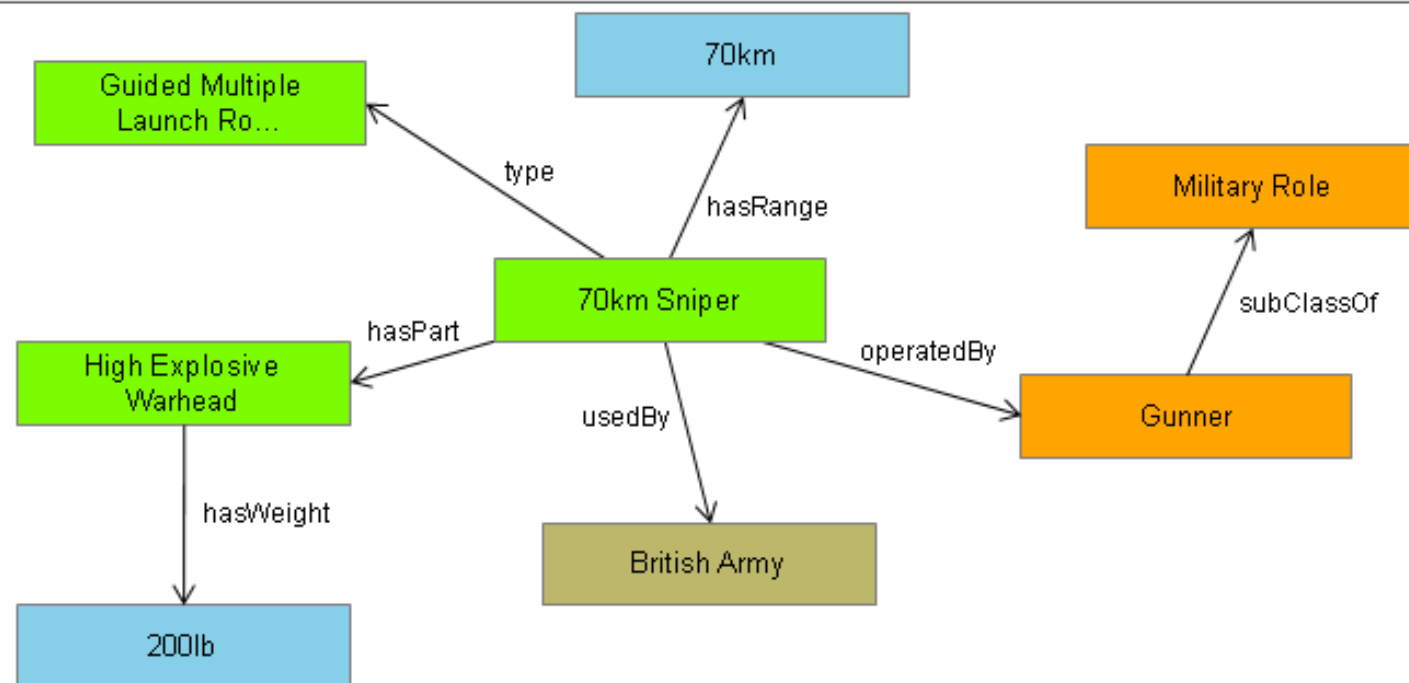
Weapon System

Location

Role

Weight

Distance



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

Nitelight 0.1a

Ontologies

foaf

athlete

terror

terror Root Classes

▶ Event

▶ Person

▶ Location

▶ OwnershipTransfer

Person Sub Classes

▶ Terrorist

Terrorist Sub Classes

▼ TerroristLeader

education

picture

height

used facility

```
graph LR; person((?person)) --- affiliation(terrorOnt:affiliation); affiliation --- organisation((?organisation)); person --- type(rdf:type); type --- terroristLeader(terrorOnt:TerroristLeader)
```

Properties: ?organisation

Type:

Bound Variable

Value:

?organisation

Order:

0

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
}
```


Knowledge Integration

- ▶ 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** **?aaip_ICN** .

?x **owl:sameAs** **_:a**

}

WHERE

{

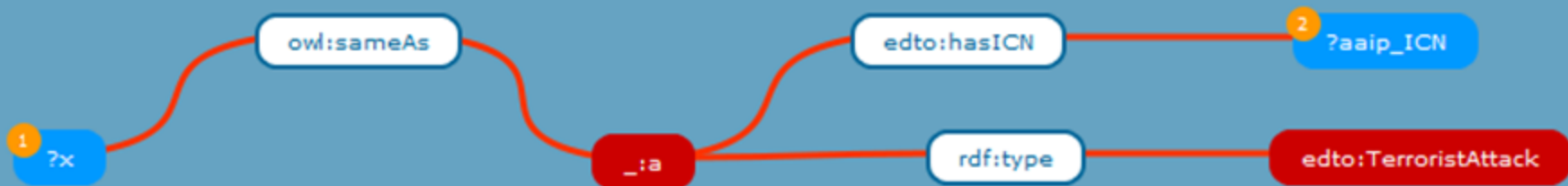
?x **rdf:type** **aaip:TerroristIncident**

?x **aaip:hasICN** **?aaip_ICN**

}



CONSTRUCT



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 .
}
```

Latitude	Longitude	Date	Ordnance	Ordnance Type
30.555214	62.527184	30/08/200	CBU87	Cluster_Munition
31.842669	65.008108	30/05/200	CBU89	Cluster_Munition
31.031679	65.516628	14/02/200	CBU87	Cluster_Munition
33.005480	64.403853	08/11/200	CBU89	Cluster_Munition
31.162229	64.314208	23/05/200	AGM65	Air_to_Surface_Missile
31.221124	63.142128	01/11/200	AGM114	Air_to_Surface_Missile
32.854735	62.172752	03/11/200	AGM114	Air_to_Surface_Missile
32.005924	64.748358	24/02/200	AGM114	Air_to_Surface_Missile
32.276455	63.355941	07/03/200	CBU89	Cluster_Munition
31.686258	62.460980	05/11/200	AGM114	Air_to_Surface_Missile
29.850973	64.595005	10/12/200	AGM65	Air_to_Surface_Missile
30.366595	64.376892	08/10/200	AGM65	Air_to_Surface_Missile
31.048047	62.717375	01/03/200	CBU87	Cluster_Munition
29.877762	64.373919	04/10/200	CBU97	Cluster_Munition



```
- <smao:MineHazardArea>
  <smao:hasReportedDate rdf:datatype="http://www.w3.org/2001/XMLSchema#date">2008-
    12-19</smao:hasReportedDate>
  <smao:hasLength
    rdf:datatype="http://www.w3.org/2001/XMLSchema#int">2348</smao:hasLength>
  <smao:hasSpatialLocation>
    - <smao:GeographicPointLocation>
      <smao:hasLongitude
        rdf:datatype="http://www.w3.org/2001/XMLSchema#string">64.184884</smao:hasLongitude>
      <smao:hasLatitude
        rdf:datatype="http://www.w3.org/2001/XMLSchema#string">33.137629</smao:hasLatitude>
      </smao:GeographicPointLocation>
    </smao:hasSpatialLocation>
    <smao:hasWidth
      rdf:datatype="http://www.w3.org/2001/XMLSchema#int">841</smao:hasWidth>
    <smao:hasClearanceStatus
      rdf:resource="http://www.edefence.org/ontologies/semiotiks/SMAO.owl#Uncleared" />
    <smao:hasSource
      rdf:datatype="http://www.w3.org/2001/XMLSchema#anyURI">http://www.edefence.org/~ps/se
    </smao:hasSource>
  </smao:MineHazardArea>
```

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

Home

Resource Discovery

Knowledge Extraction

Knowledge Monitors

Resource Browser

Knowledge Base

All Monitors

New Monitor

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 .
    ?unique mindterror:affiliation ?affiliation .
    ?affiliation rdf:type mindterror:Terrorist_Group
}
```

Open Query Editor

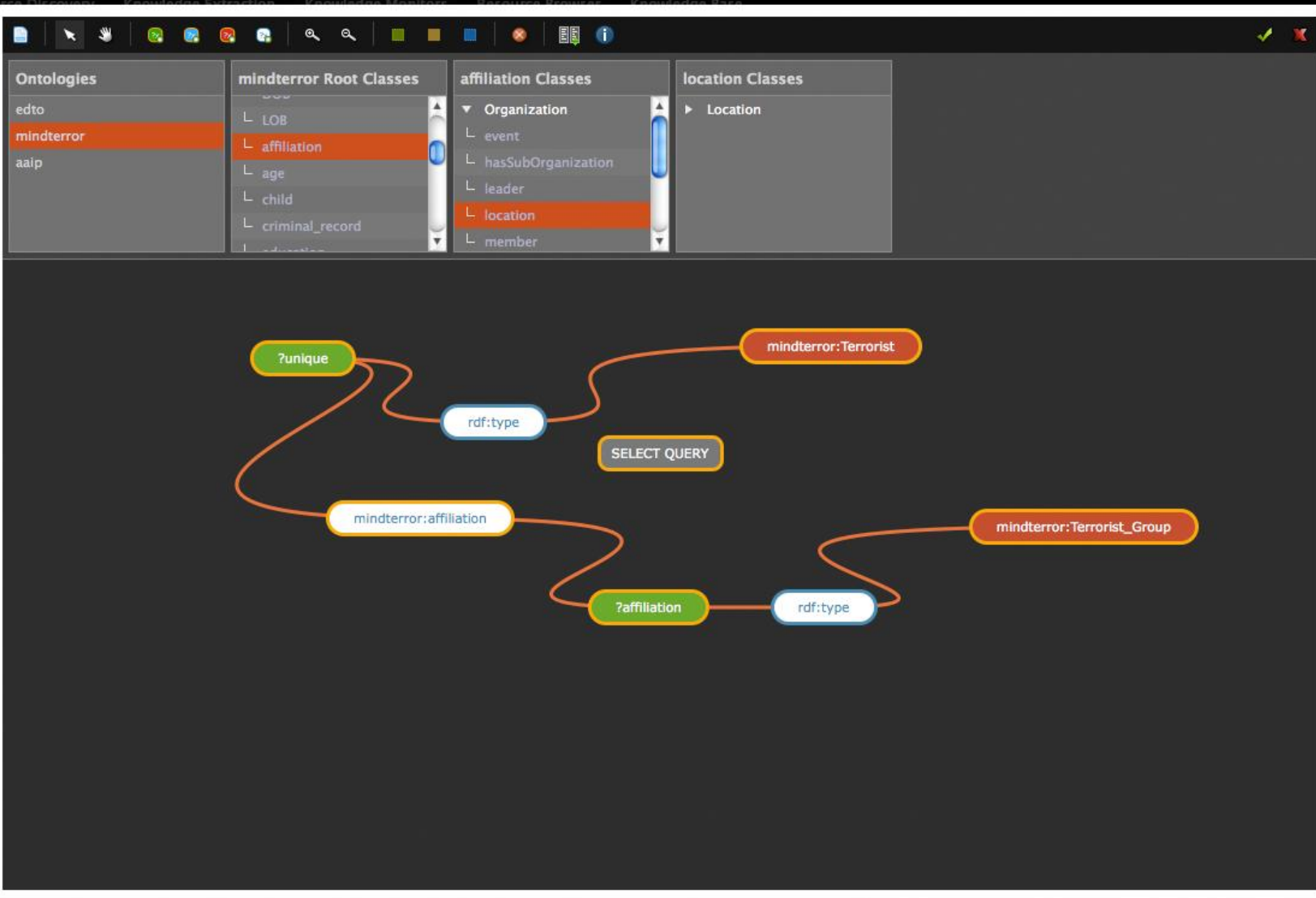
Message:

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

Outputs:

Type	Recipients	Operations
SMS	+4477344555123	DELETE

New Output



Latitude: 51.7483021667772°
Longitude: 0.302989651837776°
Heading: 11.35°
Tilt: 84.012141726208°
Altitude: 9.2 km
Distance: 83.1 km
FOV: 45°
Terrain Elevation: 0.00 meters

London

Decision Support

- ▶ 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

Ⓢ MineIncidentIn2008

MineIncident(?x) \wedge
hasTemporalLocation(?x, ?y) \wedge
DateInstant(?y) \wedge
hasDate(?y, ?date) \wedge
swrlb:lessThan(?date, "2009-01-01") \wedge
swrlb:greaterThan(?date, "2007-12-31")
 \rightarrow
MineIncidentIn2008(?x)

Ⓢ DeminingOrganizationSuitedForHighPriorityMineHazardAreas

Ⓢ HighPriorityMineHazardArea

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

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

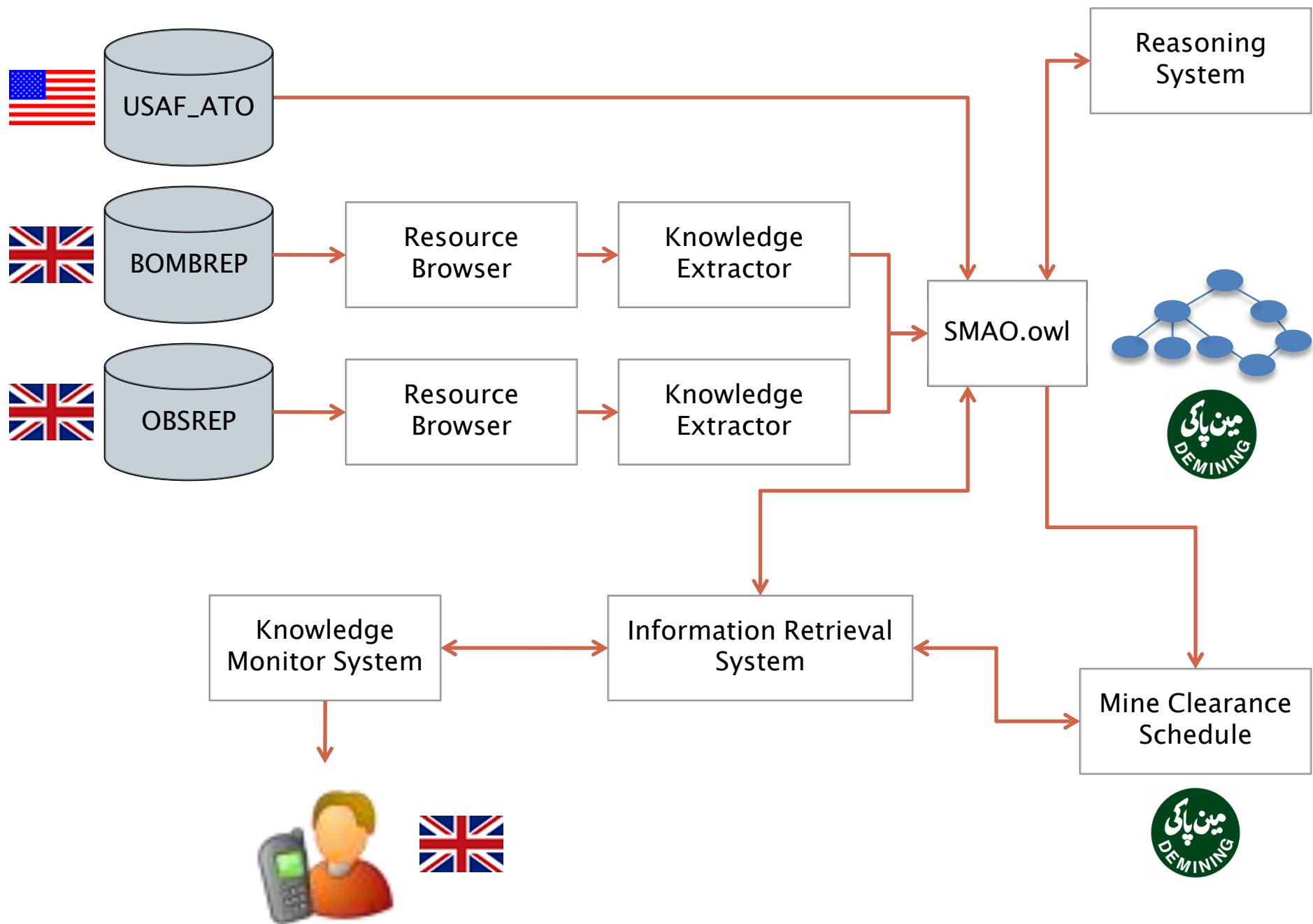
Demonstration Scenario

- ▶ 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.”

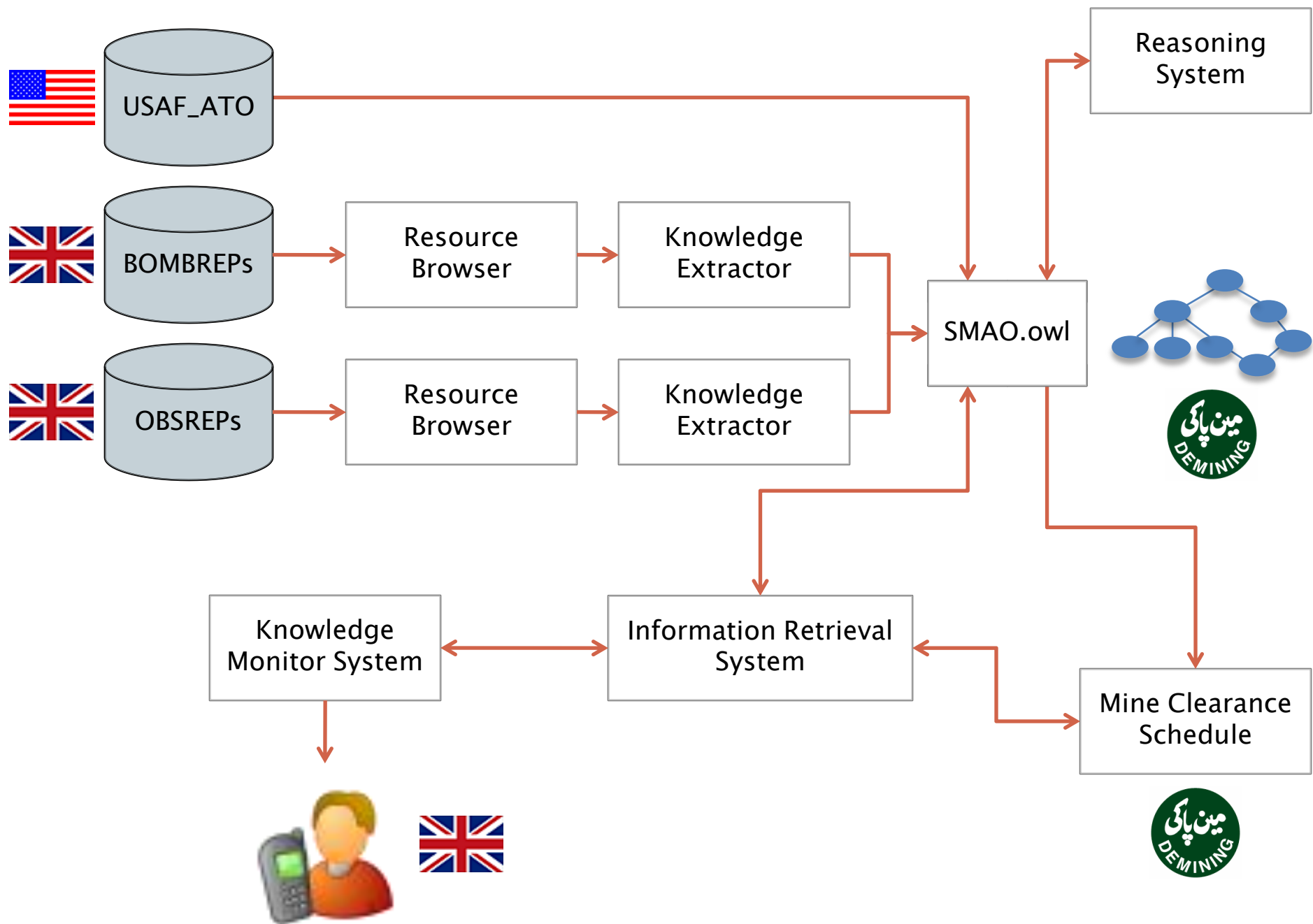
– Stephen Robinson (2006)
Danish Demining Group



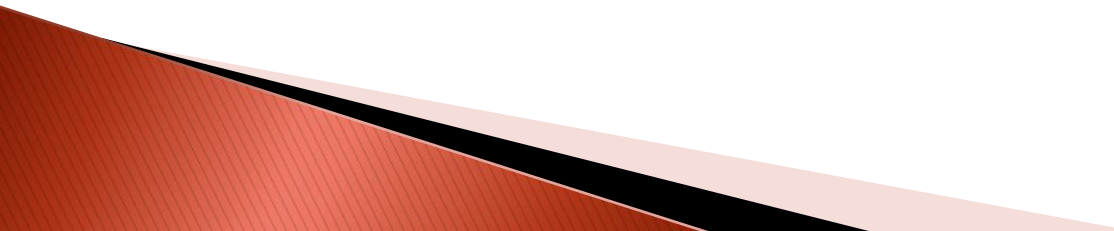
UK Army OBSREP Proforma - Modified

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.

To	CLASSIFIED	Report No: 301
From	CLASSIFIED	
Title	OBSREP	
As at/DTG	25 May 2004	
C	Obstacle location	Lat: 30.336637 Lon: 62.703302
D	Obstacle data: Mines present indicator Generic mine type Obstacle type	True Anti-Personnel Minefield
E	Obstacle area size	Length: 4642 Width: 4382
	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
- 

Summary

- ▶ **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!