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Supporting Evacuation Missions with Ontology-based SPARQL Federation

Audun Stolpe and Jonas Halvorsen

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The NNEC Concept

- Official policy for Command and Control in NATO forces
- Goal: Achieve better mission effectiveness
- Builds upon extensive information sharing
- Shift from “Need to know” to “Responsibiliy to share”

NNEC objectives

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  - to support decision making during operations

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- Points to ontology based data access + rewriting

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"Find all medical evacuation missions and friendly units such that a) the mission can be classified as being threatened; and b) that the friendly unit can handle the specific type of threat that the enemy poses."

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1. `JOCWatch`: a log of events reported from the field
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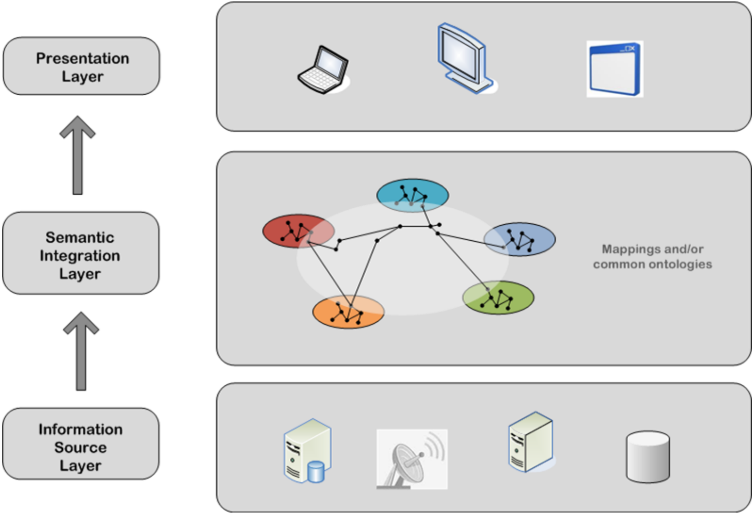
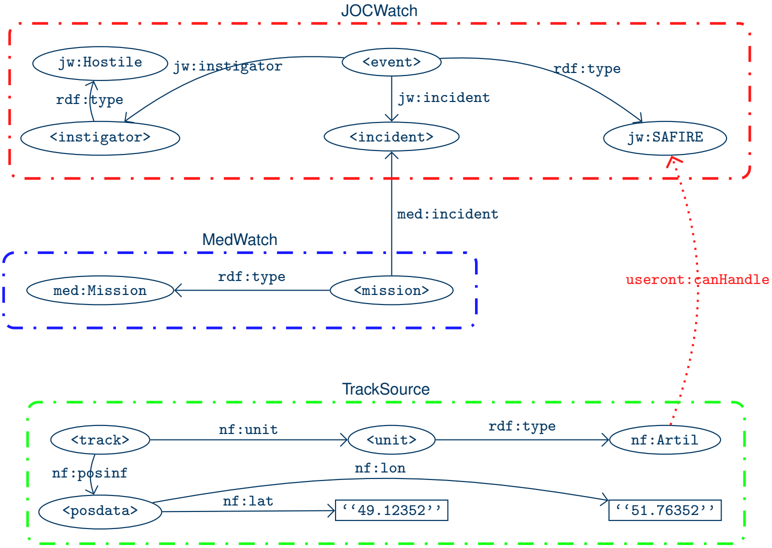
3. `Track Source`: friendly units: capabilities, location.

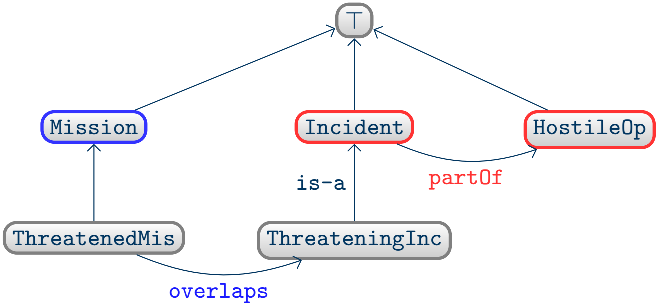
Ontology-based data integration



Conceptual relationship between data sources



Rewriting: A simple example



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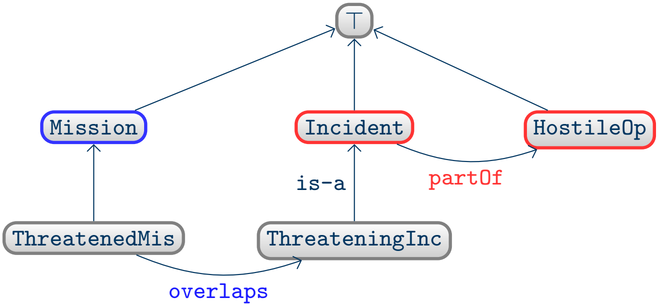

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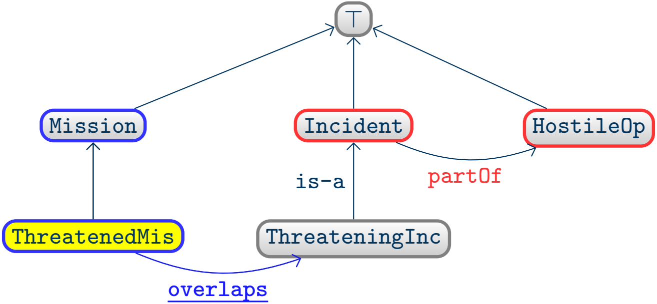

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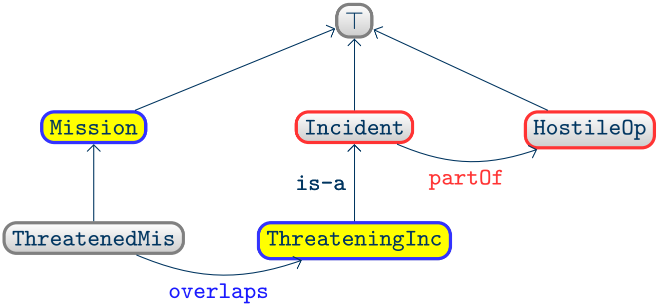

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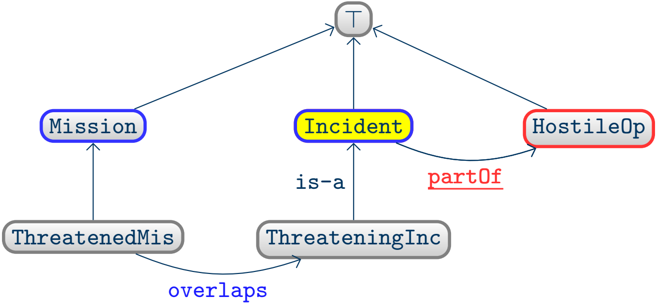

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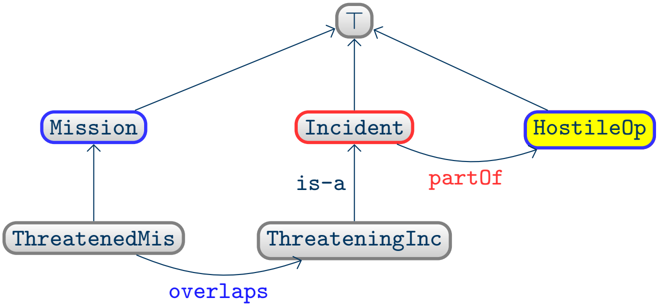

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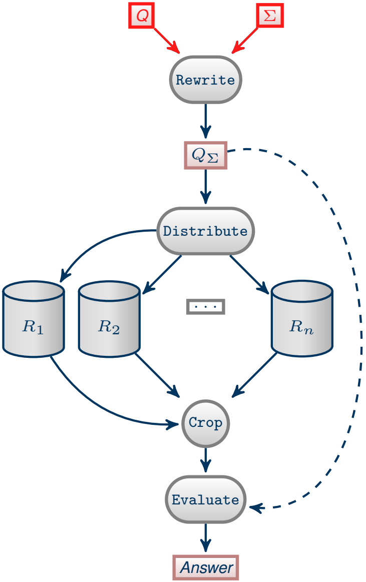

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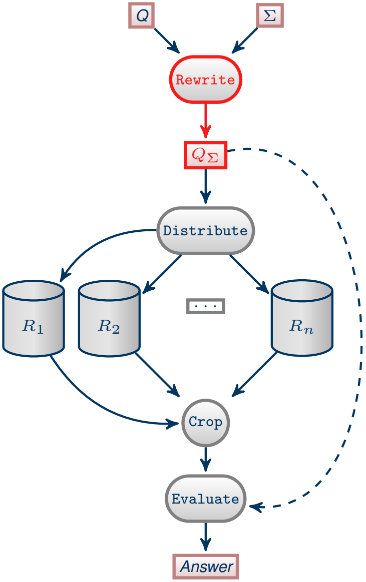

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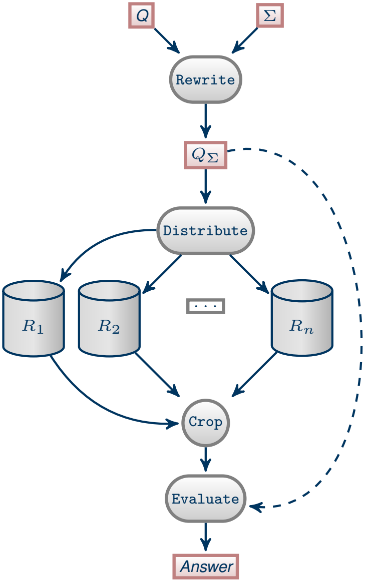

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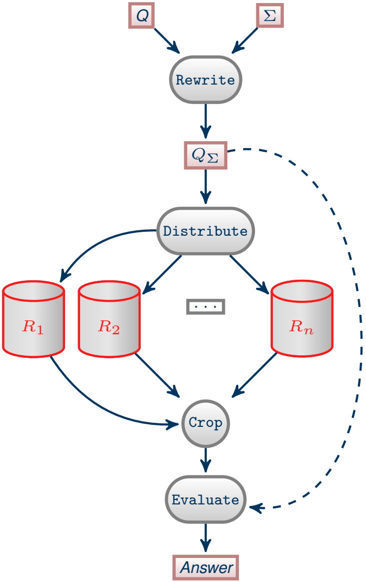

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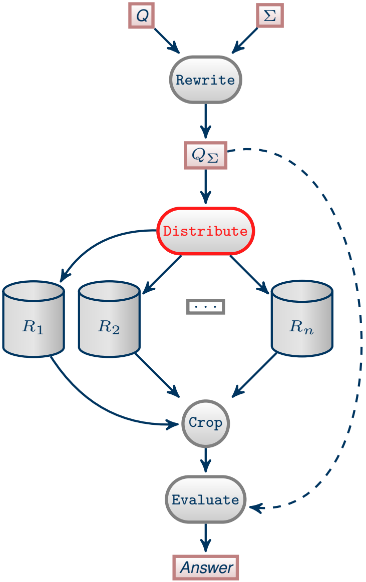

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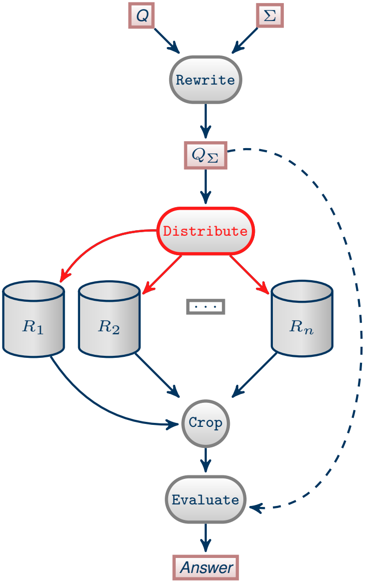

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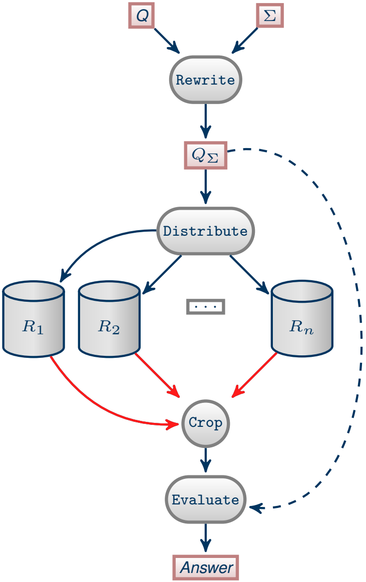

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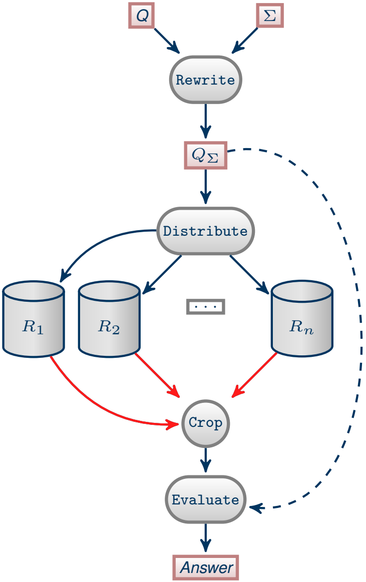

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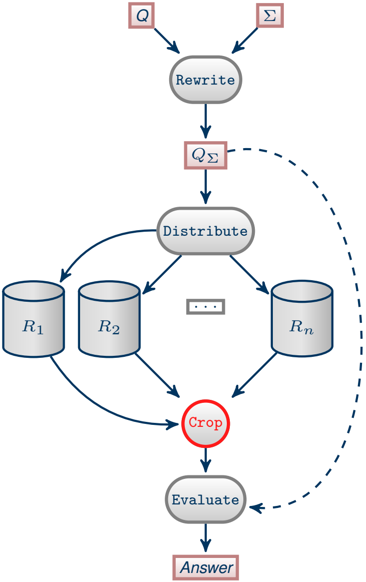

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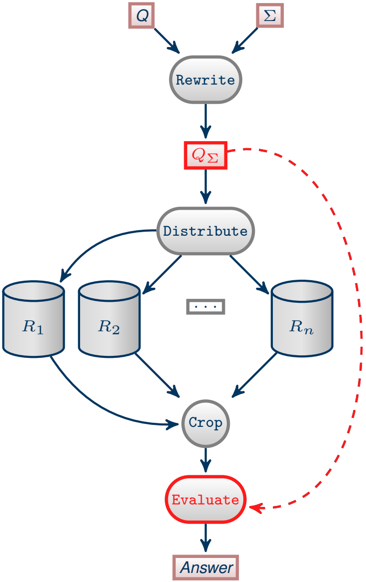

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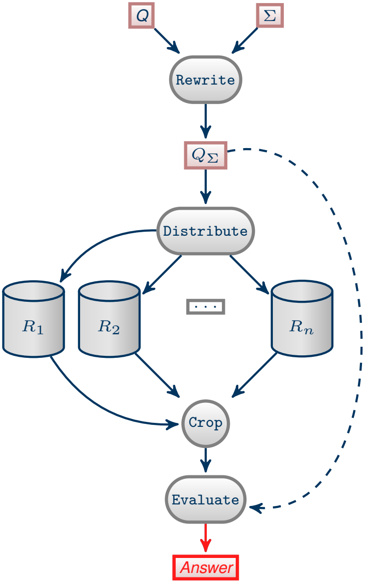

Sample query

Query pattern:

```
?mission medics:missionType medics:Rescue.
?mission medics:jocWatchIncident ?incident.
?incident jocw:status ?stat.
```

Routed to `MedWatch`:

```
CONSTRUCT {
 ?_1 medics:missionType medics:Evac.
 ?_1 medics:jocwIncident ?_2.
 ?_3 jocw:status ?_4.
 } WHERE {
 { ?_1 medics:missionType medics:Evac.
   ?_1 medics:jocwIncident ?_2.}
 UNION
 { ?_3 jocw:status ?_4.}}
```

Routed to `JOCWatch`:

```
CONSTRUCT {
 ?_1 jocw:instigator ?_2.
 ?_3 jocw:status ?_4.
 } WHERE {
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```

Each query is built as a union of exclusive/nonexclusive groups

Soundness/completeness

- Note the renaming of variables in the queries
- necessary for the *soundness* of query answering
- `CONSTRUCT` queries are defined to adhere to a logical form
- guarantees soundness/completeness in the sense:

> *Distributing a query Q over a set of sources R yields the exact same answer, as if Q were evaluated directly against a single repository containing the union of R.*

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Adapting to a dynamic network topology

- Important design goals:
  - do not hard-wire a query to a predefined set of sources
  - sources should be selected once per query
  - as sources come and go, the federator adapts

- Facilitated by FOL-rewritable ontology languages
  - FOL-rewritability decouples reasoning from data access
  - queries are precompiled (potentially cached)
  - selection and distribution performed afterwards
  - thus, network topology allowed to change

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  - eliminates the issue of network fragmentation.

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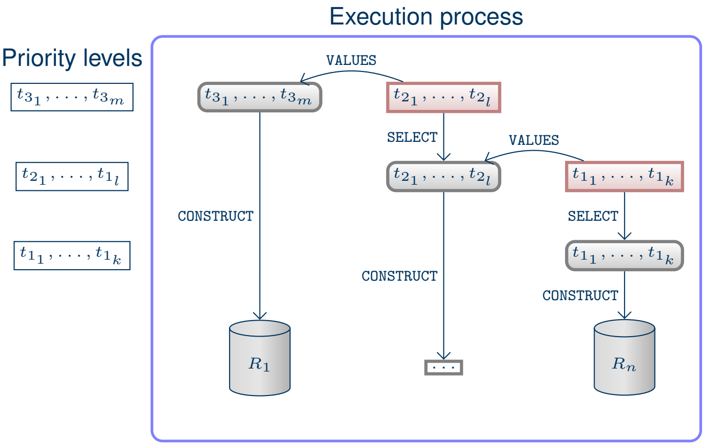
Incremental construction of the cropping:



Summary of key properties

- federated query answering is provably sound/complete
- only one HTTP request is sent to each source
- query answering is tractable, i.e. takes only polynomially many computation steps
- source selection is dynamic and once-per-query

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  - design a general purpose system around the current core