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# Integrating Uncertainty in the Semantic Web Stack

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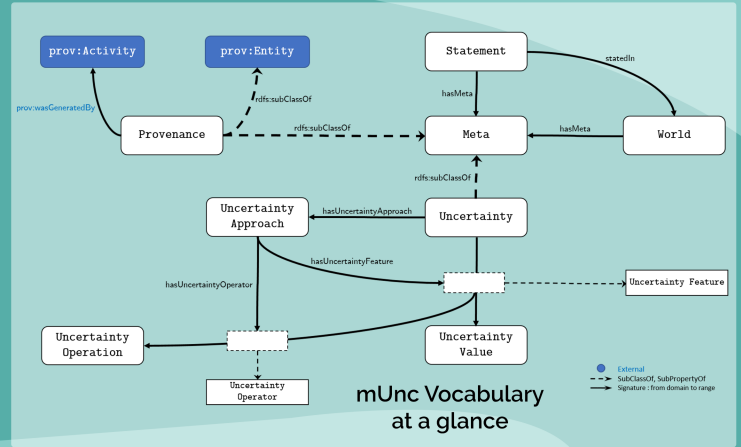
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## Problem

- Uncertainty is a common problem in any open world, and the Web makes no exception.
- A single data source (ex. Wikipedia) may contain contradictory information.
- Current Semantic Web standards allow the existence of invalid, incomplete or, in general, uncertain data.
- No standard representation of uncertainty.
- Data may not be linked to a context which allows different interpretations to one information.



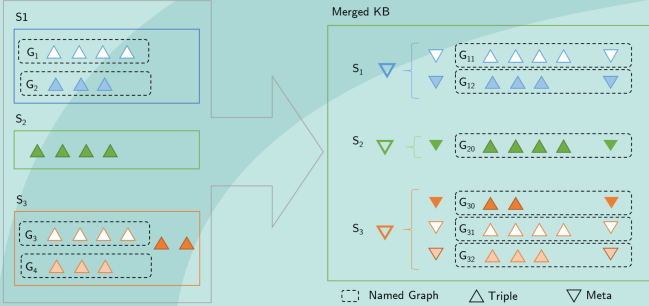
## Uncertainty Representation



- Several approaches for uncertainty representation, (probability, possibility, evidence theory, etc.) and several features (metrics, measurements, etc) to consider.
- A set of operations is linked to each uncertainty feature.

## Multi-level Granularity

Our approach provides a representation for different levels of granularity : triple, graph, dataset. The metadata are mapped to the triples after being evaluated.



```

@prefix ex: <http://example.org/>
@prefix munc: <http://inria.fr/metauncertainty/v1#>

exPossibility a munc:UncertaintyApproach;
  munc:hasUncertaintyFeature exValidity, exCompleteness.
  munc:hasUncertaintyOperator exAnd, exOr, exNot.

exValidity rdfs:subPropertyOf munc:UncertaintyFeature;
  rdfs:range xsd:decimal.
  ex:and ex:minPossibilityFun;
  ex:or ex:maxPossibilityFun;
  ex:not ex:negPossibilityFun.

exAnd rdfs:subPropertyOf munc:UncertaintyOperator.

exG1 | ex:Apple ex:hasColor ex:Red |
exG2 | ex:Apple ex:hasColor ex:Green |
ex:Apple ex:hasColor ex:Blue |
exG1 munc:hasMeta |
  a munc:Uncertainty;
  munc:hasUncertaintyApproach exPossibility;
  ex:validity 1; ex:completeness 0.2|.

exG2 munc:hasMeta |
  a munc:Uncertainty;
  munc:hasUncertaintyApproach exPossibility;
  ex:validity 0.8; ex:completeness 0.5|.
    
```

## In a few words...

The current Semantic Web standards allow the existence of incomplete, invalid or more generally, uncertain data. This work introduces a framework to handle uncertainty in the Semantic Web: uncertainty representation, reasoning over uncertain data, belief revision and propagation.

## Use cases

- class-matching, ontology-alignment,
- fuzzy knowledge representation,
- reasoning over distributed uncertain linked data,
- fact-checking,
- information and data fusion.

## Our goal

- Uncertainty Representation**  
A generic model for representing the different uncertainty approaches : mUnc vocabulary
- Provenance Integration**  
Integrate PROV-O to represent provenance metadata
- Reasoning over Uncertain Linked Data**  
Display the most suitable result for the user, based on his preferences and uncertainty values
- Belief Revision**  
Update the knowledge base depending on the selected information in the reasoning process
- Belief Propagation**  
Propagate the revised information through the links towards the distributed knowledge base

```

SPARQL Extension to write less complex queries

@metadata
SELECT ?g ?s ?o
WHERE {
  graph ?g { ?s ?p ?o }
}

function ex:metaSel(?Tm,?Gm) {
  // Evaluate the metadata to associate with each and every triple
  // that matches the graph pattern
}
    
```

