BeliefOWL: An Evidential Representation in OWL ontology

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Outline

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Motivation

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So...

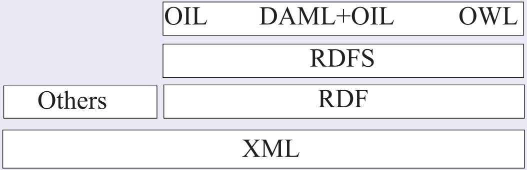
A need to a powerful tool to capture knowledge about concepts and their relations.

↓

Ontology

Motivation

XML Markup Languages



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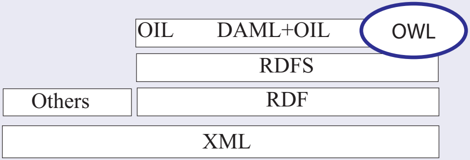

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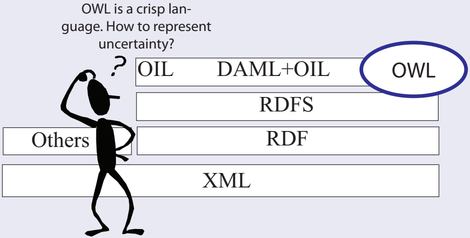

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We propose a new approach for representing uncertain information in an OWL ontology:

- Ontology Tasks: Representation and Reasoning
- Formalism for the representation: Evidence Theory
- Formalism for the reasoning: Directed Evidential Network
- Only classes and the relations between them will be considered.

How uncertainty is used in OWL?

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But...

Not all the problems can be solved with one of these theories.

Motivation for The Dempster-Shafer theory

Dempster-Shafer theory vs probability theory

A generalization of the probability theory.

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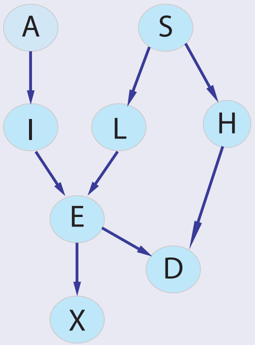
Dempster's combination rule [Shafer, 1976]

Demspter's combination rule is used to combine heterogeneous information.

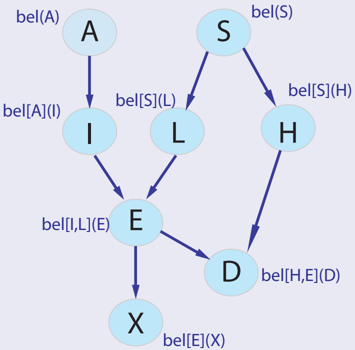
Directed Evidential Network

Qualitative Level: DAG



Directed Evidential Network

Quantitative Level: Conditional belief functions for each variable given its parents



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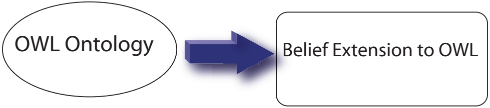
BeliefOWL Framework



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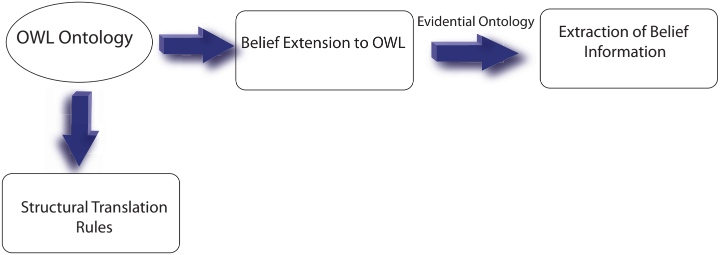

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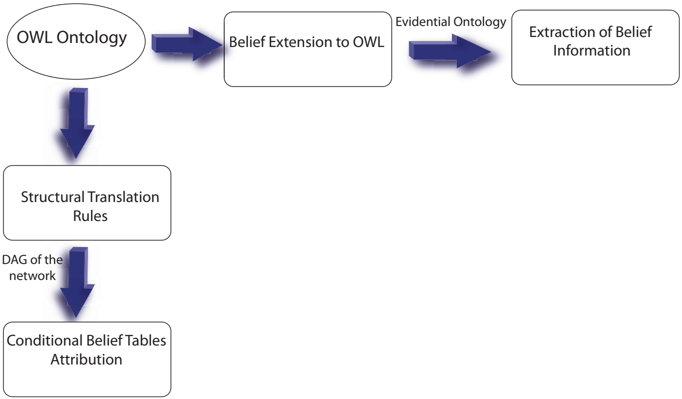

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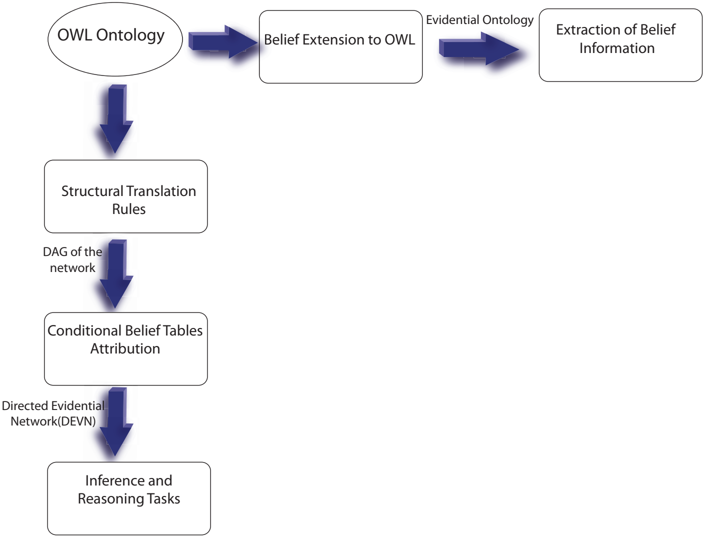
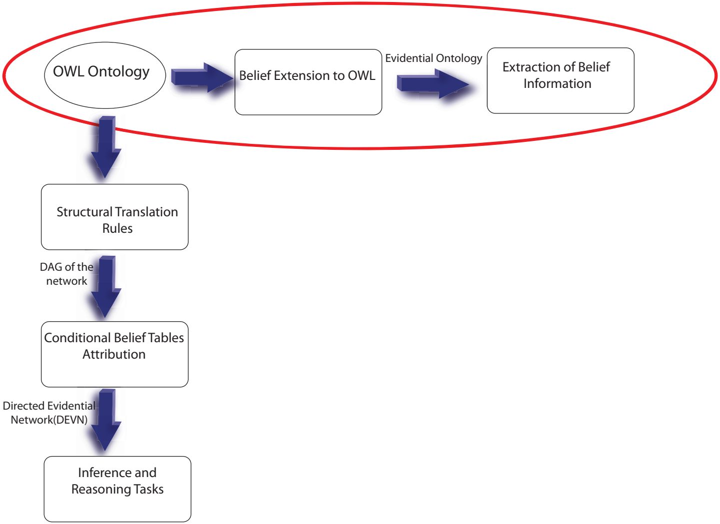


Step 1: Belief Extension to OWL



Step 1: Belief Extension to OWL

Prior Evidence

The ontology taken as an example is from the Zhongli Ding's thesis (BayesOWL: A Probabilistic Framework for Semantic Web).

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Prior Evidence

- < beliefDistribution> enumerates the different masses of the elements of the frame of discernment. It has an object property <hasPriorBel>

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Example

```
<beliefDistribution rdf:ID="bel(Animal)">
    <hasPriorBel rdf:resource ="# m(a)/>
    <hasPriorBel rdf:resource ="# m(ā)/>
    <hasPriorBel rdf:resource ="# m(θa)/>
</beliefDistribution>
<PriorBelief rdf:ID= "m(a)">
    <massValue>0.4</massValue>
</PriorBelief>
<PriorBelief rdf:ID= "m(ā)">
    <massValue>0.5</massValue>
</PriorBelief>
<PriorBelief rdf:ID= "m(θa)">
    <massValue>0.1</massValue>
</PriorBelief>
```

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Example

<beliefDistribution rdf:ID= "bel[A](ml)">
    <hasCondBel rdf:resource = "# m[{a}]({ml})/>
    <hasCondBel rdf:resource = "# m[{a}]({$\bar{m}l$})/>
    <hasCondBel rdf:resource = "# m[{a}]({$\theta_m l$})/>
</beliefDistribution>
<condBelief rdf:ID= "m[{a}]({ml})">
    <massValue>0.5</massValue>
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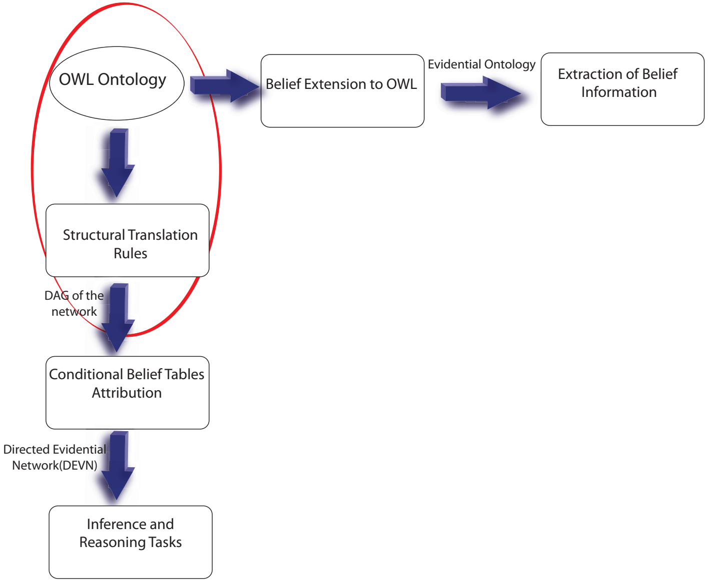
Step 2: Construction of the DAG



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Primitive Class <owl:Class>

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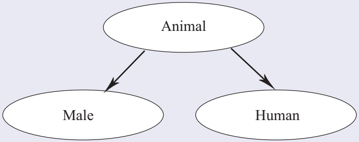
Subsumption Hierarchy <rdfs:subClassOf>



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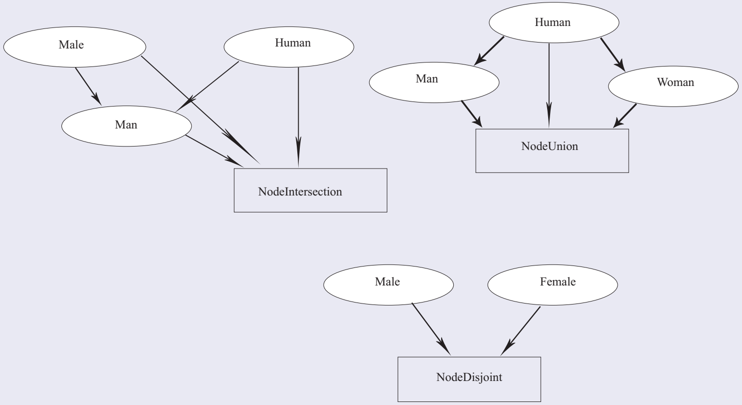
<owl:intersectionOf>,<owl:unionOf>,<owl:disjointWith>



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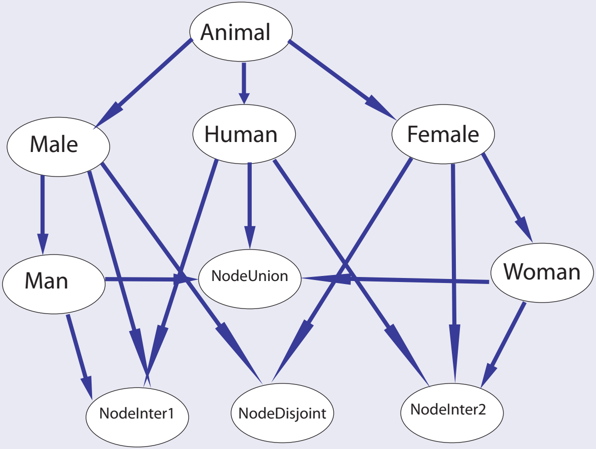
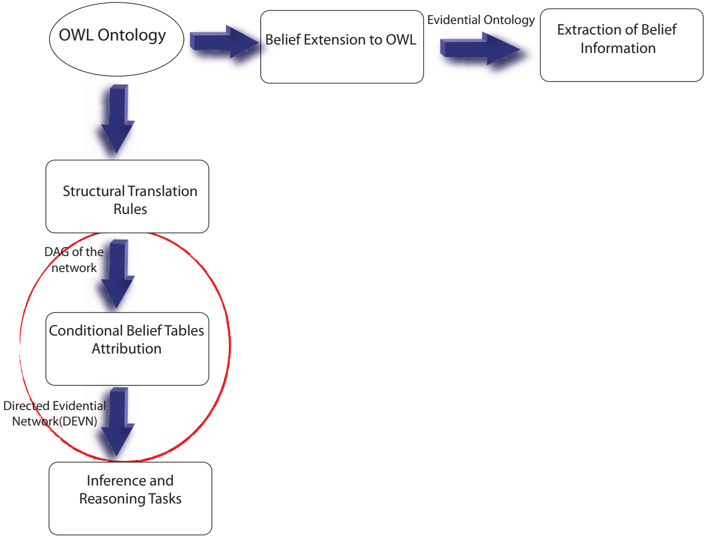
DAG of the evidential network



Step 3: Evidence Attribution



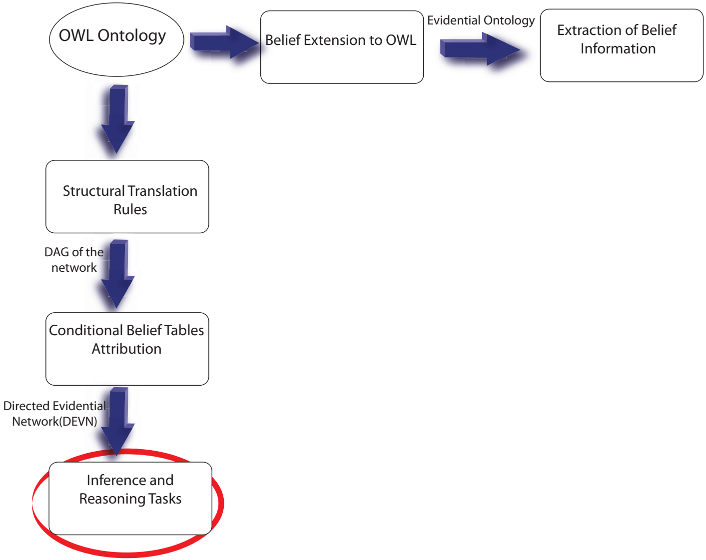
Step 3: Evidence Attribution

Assigning Masses

$$m(A) = \begin{matrix} a \\ \bar{a} \\ \theta_A \end{matrix} \begin{pmatrix} 0.4 \\ 0.5 \\ 0.1 \end{pmatrix} \quad m[A](Ml) = \begin{matrix} \\ ml \\ \bar{ml} \\ \theta_{ml} \end{matrix} \begin{matrix} a & \bar{a} \\ \begin{pmatrix} 0.5 & 0 \\ 0 & 0.6 \\ 0.5 & 0.4 \end{pmatrix} \end{matrix} \quad m[A](H) = \begin{matrix} \\ h \\ \bar{h} \\ \theta_h \end{matrix} \begin{matrix} a & \bar{a} \\ \begin{pmatrix} 0.1 & 0 \\ 0 & 0.5 \\ 0.9 & 0.5 \end{pmatrix} \end{matrix}$$

$$m[A](F) = \begin{matrix} \\ f \\ \bar{f} \\ \theta_f \end{matrix} \begin{matrix} a & \bar{a} \\ \begin{pmatrix} 0.8 & 0 \\ 0 & 0.6 \\ 0.2 & 0.4 \end{pmatrix} \end{matrix} \quad m[F](W) = \begin{matrix} \\ w \\ \bar{w} \\ \theta_w \end{matrix} \begin{matrix} f & \bar{f} \\ \begin{pmatrix} 0.75 & 0 \\ 0 & 0.5 \\ 0.25 & 0.5 \end{pmatrix} \end{matrix} \quad m[Ml](M) = \begin{matrix} \\ m \\ \bar{m} \\ \theta_m \end{matrix} \begin{matrix} ml & \bar{ml} \\ \begin{pmatrix} 0.75 & 0 \\ 0 & 0.5 \\ 0.25 & 0.5 \end{pmatrix} \end{matrix}$$

Step 4: Inference in the network



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Future Work:

- Include properties and instances in the translation process.
- Masses attributed automatically by a learning process.

Thanks For Attending