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Poss-OWL 2: Possibilistic Extension of OWL 2 for an uncertain geographic ontology

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Abstract

The use of ontologies to represent geographical knowledge has received a lot of attention recently. Nevertheless, classical ontology languages are not able to represent incomplete and uncertain knowledge, which are very important characteristics of several situations in geographic domain. Based on our previous work, we propose a solution for handling uncertainty and for dealing with inconsistency in geographical applications. In this paper, we present an extension of the OWL 2, named Poss-OWL 2, based on our $\mathcal{P}oss-\mathcal{SROIQ}(\mathcal{D})$ description logic (DL). Then we describe some reflections about the inference system. Illustrative examples, from archaeological domain, are given.

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1. Introduction

Spatial data are an approximation of reality. They can be localized in space according to their different degrees of precision and dated with more or less precision and different levels of temporal granularity. This leads us to ask about the structure of the spatial data in their different dimensions, namely: spatial and temporal attributes under uncertainty.

Indeed, uncertainty is the inability to accurately specify something. Obviously, it is in the interest of users and decision makers to find out uncertainties in data, and should be aware of the serious consequences that can result from overly precise geographic information.

In the last few years, ontologies have gained increasing interest in the GIS community, because they are essential to create and to use data standards as well as human computer interfaces and to solve heterogeneity problems.

A geographic ontology defines the important geographical concepts and relationships in the geospatial domain. However, this latter is pervaded with uncertainty and classical ontologies have limitations to handle this aspect.

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There is currently no standard mechanism to represent the uncertain information over ontologies and even less a standard to reason on this type of information. However, many researches are recently trying to develop ontological capabilities concerning this field.

In our previous work [1], we defined a possibilistic extension of $\mathcal{SROIQ}(\mathcal{D})$ description logic [17] called $\mathcal{P}oss-\mathcal{SROIQ}(\mathcal{D})$.

The choice of $\mathcal{SROIQ}(\mathcal{D})$, on one hand, is essentially related to its ability to represent the spatio-temporal information usually presents in geographical application.

On the other hand the language OWL2 [19] has become a W3C recommendation for ontology representation which is an extension of the previous standard language OWL1. $\mathcal{SROIQ}(\mathcal{D})$ [17] is the subjacent DL of OWL 2. Since OWL 2 does not currently allow to define uncertain geo-informations, it seems interesting to develop Poss-OWL 2, a promising extension of OWL 2 supporting these kind of geo-informations. So, to add uncertainty information to an existing ontology, we treat a possibility as a kind of annotation properties.

In this paper we are interested in the study of some monuments in Algeria related to an ancient Roman ruins. The aim is to predict a spatial repartition of streets and buildings according to the Roman period. This seems, to be, relevant to illustrate our approach. Indeed, research in archaeological domain present many challenges. The reconstitution of the composition of the territory is one of them. Usually, archaeologist interpretations are based on limited amount of material remains and historical document and this induce different levels of uncertainty.

The paper is organized as follows. Section 2 provides main types of uncertainty in geographic information. Section 3 describes the possibilistic extension of OWL 2. Section 4 presents related work. Finally, section 5 concludes the paper and presents some future works.

2. Uncertainties in geographic information

Uncertainty exists in every life cycle phase of a geographic object (data collection, data representation, data analyses and final results). It can result from a lack of information [20]. Uncertainty of geographic information may be derived from measurement errors, registration, classification, clustering classes, generalization and temporal processing [12].

Shu and AL. [33] distinguish two main types of geographic information uncertainty :

- Uncertain spatio-temporal data type, which can be modeled by the uncertainty of its thematic attributes (identification, name,...), spatial attributes (point, line and zone) and temporal attributes (instant and interval).
- Uncertain spatio-temporal relationships, which refers to the topological spatial relationships and topological temporal relationships.

There are several forms of uncertainty in spatial domain. In our case, we consider two main types of uncertainty: the spatio-temporal object uncertainty and the relationships uncertainty.

1. Spatio-temporal object uncertainty, which refers to the uncertainty of thematic, spatial and temporal attributes. This form is caused by: the fact that date are dated without updating, data are obtained from inaccurate calculation, data type error, imprecise data, the existence of several versions of the same object, missing data, lost historical data, etc.
   Example 1. Let us give some examples of attributes pervaded with uncertainty.
   - Completed time of a new street is uncertain and this is caused by unpredicted factors.
   - Position of objects is uncertain due to the influence of natural events (e.g., soil movement) or man-made events (e.g., transport).
   - Type and function of building is uncertain, in a given period, due to the existence of several descriptions of the same building or the missing of the historic data about this building.
2. Relationships uncertainty, which is related to the spatial objects as well as to their relations. It is divided into several forms:

a) Spatio-temporal relationships, which describes the uncertain spatial and the uncertain temporal relationships between objects. These relationships reflect: spatial relations associated to objects, temporal relations between intervals of time or durations associated to objects.

- A spatial relationships uncertainty is used to represent the uncertain spatial relationships between objects, such as: disjoint, touch, overlap, equal, contain, contained by, etc.
- A temporal relationships uncertainty is used to represent the uncertain temporal relationships between intervals of time or durations associated to objects, such as: before, during, meets, etc.

Spatio-temporal relationships uncertainty can be caused by an incomprehension or by a lack of clarity of the reality.
Example 2. The following statements show uncertain spatio-temporal relationships between two objects:

- It is certain that the area have two disjoint street segments SSA and SSB.
- It is possible that a wall A is belonging the the building B.
- It is certain that the construction of commercial Buildings is during the construction of Houses.

b) Subsumption relationships or spatio-temporal objects classification uncertainty, which reflects the uncertainty of relationships among concepts (set of individuals or objects), such as: is-a, kind-of, has-part, etc.
This form of uncertainty is caused by: uncertain labels, different data models, multiple meanings for definition of an object or a relationship, overlap between definitions of objects or disagreement on definition of others, etc.
Example 3. The following statements show the uncertain classification relationships:

- It is rather certain that House is a kind-of Building.
- It is possible that this Town is an Historic Area.

c) Belonging relationships uncertainty, refers to the uncertainty in the attribution of data or objects to the corresponding concept. This form is caused by: lack of informations, multiple meanings for definition of an object, etc.
Example 4. The following statement correspond to the Belonging relationships uncertainty:

- It possible that the building B1 is a house.

In order to illustrate these several forms of uncertainty in GIS, we analysed some data about streets, buildings and areas related to archaeological domain. This latter contains many kinds of uncertainty caused by the complexity of the historical data.

In what follow, we present our possibilistic extension of the OWL2.

3. Possibilistic extension of an ontological language

In this section, we describe the ontological language Poss-OWL 2, a possibilistic extension of OWL 2. This latter cannot encodes the feature of the uncertainty in an ontology. The idea is to use OWL 2 ontology and to extend their elements with annotation properties. Before presenting the proposed Poss-OWL 2, it is useful to recall some aspects of this language.

3.1. Web ontology language: OWL 2

The language OWL 2[19] has become a W3C Recommendation for ontology representation which is an extension of the previous standard language OWL 1. ”The W3C OWL 2 Web Ontology Language (OWL) is a Semantic Web language designed to represent rich and complex knowledge about things, groups of things, and relations between things. OWL is a computational logic-based language such that knowledge expressed in OWL can be reasoned with by computer programs either to verify the consistency of that knowledge or to make implicit knowledge explicit."[1]

The OWL Web Ontology Language is a language for defining and instantiating Web ontologies. Essentially, OWL 2 is based on the $\mathcal{SROIQ}(\mathcal{D})$ DL. The expressivity makes reasoning harder (N2EXPTIME).

An OWL 2 ontology contains descriptions of classes (or concepts in DL terminology), properties (roles in DL terminology) and individuals. There are two types of properties: object properties (abstract roles) and datatype properties (concrete roles).

There are two additional types of properties which do not have a counterpart in the DL, namely annotation properties (owl:AnnotationProperty) and ontology properties (owl:OntologyProperty). Theses types of properties include some meta-properties of the ontology.

OWL specifications provide various syntaxes: Functional-Style[27], RDF/XML[9], OWL/XML[26] and Manchester syntax[25]. For our proposition, we use the OWL/XML syntax.

The most widely used OWL editor is Protege[2], a free open-source editing framework developed at Stanford University. By virtue of its open plugin structure, it allows for the easy integration of special-purpose ontology editing components. Other editors include TopQuadrant's commercial TopBraid Composer[3] and the open-source systems SWOOP and NeOn-Toolkit[4]

For reasoning within OWL, the most famous and widely employed OWL reasoners are: HermiT[32] and Pellet[34].

OWL 2 has some limitations such as the management of uncertainty and vagueness[23] which have been tried to overcome by different approaches: Probabilistic, Possibilistic and fuzzy based approaches (see Section 4 for a detail of different approaches).

3.2. Poss-OWL 2: Possibilistic extension of OWL 2

The contribution in this paper is to propose an extension of OWL 2. It is the language chosen by the major ontology editors because of its expressiveness and its decidability of reasoning. However, OWL 2 does not allow to handle the information represented with uncertainty. Our aim is to present an extension of OWL 2, named Poss-OWL, based on our description logic $\mathcal{P}oss - \mathcal{SROIQ}(\mathcal{D})$[1].

Poss-OWL 2 Ontology has three main classes representing different elements of an ontology :

1. Concept: This class represents concept constructors correspond to concept constructors of OWL 2. To this concept we have added a degree to obtain a weighted concept denoted (A, α) and weighted nominals denoted (o_i, α_i). Where α is a real value in the interval (0, 1] representing the certainty level of the proposed concept or nominal.
2. Role: This class represents the possibilistic roles (object property and data property). Role constructors correspond to the role constructors of OWL 2.
3. Axiom: This class represents the possibilistic axioms: PossTBoxAxiom and PossABoxAxiom. Each axiom is associated to a real value α in (0, 1] representing the certainty level of an axiom.

The proposed approach extend OWL 2 annotation properties with possibilistic annotation properties. For this, we propose an annotation property PossComment to represent this latter new annotation. Every possibilistic annotation property is delimited by a start tag < possOWL2> and an end tag < possOWL2> which has an attribute of "possType" specifying the element being tagged.

There is an optional tag Degree, with an attribute value. If it is omitted, the degree is assumed to equal 1.

There are three cases to distinct depending on the annotated element:

1. Weighted concepts: In this case we create a new concept then we add an annotation property corresponding to the type of the constructor and the value of their parameters.

[1] http://www.w3.org/TR/2009/REC-OWL 2-primer-20091027/
[2] http://protege.stanford.edu/
[3] http://www.topquadrant.com/products/TB-Composer.html
[4] http://www.neon-toolkit.org/

The value possType is class and there are two additional attributes to the tag class: value α (a real number in (0, 1]) and base A (the name of the concept that is being weighted). The Syntax of this annotation is:

```
<possOWL2 PossType ="class">
    <class type ="concept" value=<DOUBLE> base=<A> />
</possOwl2>
```

Example 5. Let us consider the weighted concept (House 0.8), which states that House is a concept associated to the degree of uncertainty 0.8. To represent this concept, we create the atomic concept (House0.8) then we add the following annotation:

```
<AnnotationAssertion >
    <AnnotationProperty IRI="possComment"/>
      <IRI >#House0.8</IRI >
      <Literal datatypeIRI =&rdf;PlainLiteral >
          <possOwl2 possType ="class">
             <class type ="concept" value ="0.8" base ="House" />
          </possOwl2>
      </Literal>
</AnnotationAssertion>
```

2. Weighted nominals: Here, the value possType is class and the value of type is nominal. There are also two additional attributes: the value α (a real number in (0, 1]) and the individual o (the name of the individual that is being weighted).
The Syntax of this annotation is:

```
<possOwl2 possType ="class">
      <class type ="nominal" value=<DOUBLE> individual=<o> />
</possOwl2>
```

Example 6. Let us consider the weighted nominal (Casbah, 0.40) which states that Casbah is a nominal associated to the degree of uncertainty 0.4. To represent this concept, we create the nominal (Casbah0.40) then we add the following annotation:

```
<AnnotationAssertion>
    <AnnotationProperty IRI="possComment"/>
    <IRI <# Casbah040 </IRI >
    <Literal datatypeIRI =&rdf;PlainLiteral >
       <possOwl2< possType ="class">
       <Concept type ="nominal" value ="0.40" individual ="Casbah" />
       </possOwl2 >
    </Literal >
</AnnotationAssertion>
```

3. Weighted axioms: In this case, the value possType is axiom. There is an additional attribute: Degree value α (a real number in (0, 1]).
The Syntax of this annotation is:

```
<possOwl2 possType ="axiom">
    <Degree value=<DOUBLE> />
</possOwl2>
```

Example 7. The possibilistic concept assertion (H004: House, 0.8), is represented by annotating the concept assertion with the degree 0.8, which is done as follows:

```
<ClassAssertion>
     <Class IRI=#House />
     <NamedIndividual IRI=#H004/>
     <Annotation>
         <AnnotationProperty IRI="possComment"/>
         < Literal datatypeIRI =&rdf;PlainLiteral >
             < possOwl2 possType ="axiom">
                 < Degree value ="0.8" />
             </possOwl2>
         </Literal>
    </Annotation>
</ClassAssertion>
```

3.3. Inference system

Inference problems can be expressed as a question of consistency, applied to the knowledge base to which some formulas are added[3]. The knowledge base is consistent if there exists an interpretation that satisfies all its axioms and inconsistent otherwise. The definition of inconsistency degree of a knowledge base Σ is defined as:

$Inc\Sigma = \{\alpha/\Sigma \vdash (\bot, \alpha)\}$, where $\bot$ denotes the contradiction and $\vdash$ the syntatic deduction. If $Inc(\Sigma)$ is 0, the knowledge base is consistence; if it is 1, the knowledge base is inconsistent.

The folllowing inference services can be reduced to the possibilistic knowledge base consistency.

• **Subsumption:** a concept C is subsumed by a concept D with degree α (C $\sqsubseteq$ D, α) if $\Sigma \sqcup$ {a:C $\sqcap\neg$ D, β} is inconsistent, where a is a new individual.

• **Instantiation:** an individual "a" is an instance of a concept C to degree α (a:C, α) if $\Sigma \sqcup$ {a:C, β} is inconsistent for all $\beta > \alpha$.

The tableau algorithms[2] constitute a set of methods to perform such consistency checking in the underlying description logics. Similary to Couchariere and al. proposition[10], we propose an extension of the tableau algorithm for the case of SROIQ[17]. The proposed inference system relies on new definitions for the clash notion and for the completion rules.

The different steps of the process of inference using the tableaux algorithm can be summarized as follows:

1- Rewriting all formulas in negation normal forms (NNF): is the initial extended Poss-ABox.

2- Definition of Possibilistic clashes: The notion of a clash is used in order to denote that a contradiction has occurred in the completion forest. A knowledge base Σ contains clashes, if there are two formulas such that: $\Sigma = \{(\varphi, \alpha), (\neg\varphi, \beta)\}$. According to the definition of the extension of $\wedge$ to possibilistic, Contradiction is derived $\Sigma \vdash (\varphi \wedge \neg\varphi, \min(\alpha,\beta)) \Rightarrow \Sigma \vdash (\bot, \min(\alpha,\beta))$.

3- Definition and application of Possibilistic completion rules: The principale is to apply the proposed completion rules as extensions of the classical rules[17] the appropiate completion rule to formula, looking for contradiction.

To note that it is not easy to take into account all completion rules and to select formulas need to be or need not be considered.

3.4. Illustrative example

In this section, we will provide some examples, related to our archaeological domain, illustrating how to use Poss-OWL2 to model knowledge in real application problems.

Firstly, we assume the existence of some experts which define some propositions and the weights. Each proposition is associated to a certainty degree.

1. It is rather certain at degree 0.9 that all houses are buildings, 2. It is certain at degree 0.2 that all houses are buildings, 3. It is rather certain at degree 0.9 that houses are settlements, 4. It is certain at the degree 0.9 that building B001 is beside of the building B002. It is rather certain at degree 0.7 that this latter is beside of the building B004, 5.

It is rather certain at degree 0.8 that the Room R200 is belonged to the building H004 and rather certain at degree 0.9 that the Wall WH2019 is a part of this Room, 6. It is almost certain at degree 0.3 that the House H004 is delimited at the east by the wall WH2019, rather certainat the degree 0.5 that this house is dated of 3 Century and its surface is 400 m^2.

Let us show now how to represent the relevant knowledge. The possibilistic knowledge base (possibilistic ontology) composed of a PossTBox and an PossABox.

So we can define the possibilistic knowledge base Σ=(PossTBox, PossABox), where PossTBox={(House ⊑ Building, α), (House ⊓ Settlement, α), (Building ⊑ ∃ is-beside-of.Building, α), (House ⊓ ∃ hasposition.String, α), (⊓ ∃ hasdate.String, α), (⊓ ∃ hassurface.Integer, α), (Room ⊑ ∃ belongs.Building, α), (Wall ⊑ ∃ is-parts-of.Room, α), (House ⊑ ∃ delimited-at-east.Wall, α)}.

The PossAbox ={ (Building(H004), 0.9), (House (H004), 0.9), (House (H005), 0.9), (Building (H005), 0.2), (Settlement(H005), 0.6), (is-beside-of (B001, B002), 0.9), (hasposition (H004, (36.320782, 5.736546)), 0.8), (hasdate (H004, 3), 0.5), (hassurface (H004, 200), 0.5), (belongs (R200, H004), 0.8), (is-parts-of (WHR2019, R200), 0.9), (delimited-at-east (H004, WH2019), 0.3) }.

We can built the ontology by using the ontology editor, supporting OWL2, Protege 4.3. The representation of the possibilistic part of the ontolgy can be done using OWL2 new annotation property ”PossComment”, as shown by the examples below.

```
<-- Class hierarchies-->
<owlx:SubClassOf>
    <owlx:Class IRI="House"/>
    <owlx:Class IRI="Building"/>
    <Annotation>
       <AnnotationProperty IRI="possComment"/>
       <Literal datatypeIRI =&rdf;PlainLiteral >
           <possOwl2 possType ="axiom">
             <Degree value ="0.9" />
           </possOwl2>
      </Literal>
    <Annotation>
</owlx:SubClassOf>
<-- Class and instance-->
<owlx:ClassAssertion>
     <owlx:Class IRI="House">
     <NamedIndividual IRI="H004">
     <Annotation>
        <AnnotationProperty IRI="possComment"/>
        <Literal datatypeIRI =&rdf;PlainLiteral >
            <possOwl2 possType ="axiom">
               <Degree value ="0.9" />
            </possOwl2>
        </Literal>
      <Annotation>
<owlx:ClassAssertion>
</owlx:SubPropertyOf>
  <-- Datatypes-->
<DataPropertyAssertion>
   <DataProperty IRI="hassurface"/>
   <NamedIndividual IRI="HOO4"/>
   <Literal datatypeIRI="http://www.w3.org/2001/XMLSchemainteger">200</Literal>
   <Annotation>
      <AnnotationProperty IRI="possComment"/>
```

```
      <Literal datatypeIRI =&rdf;PlainLiteral >
         <possOwl2 possType ="axiom">
             <Degree value ="0.5" />
         </possOwl2 >
      </Literal >
   <Annotation>
<DataPropertyAssertion>
  <-- Object properties-->
<ObjectPropertyAssertion>
   <ObjectProperty IRI="delimited-at-east"/>
   <NamedIndividual IRI="H004"/>
   <NamedIndividual IRI="HW2019"/>
   <Annotation>
      <AnnotationProperty IRI="possComment"/>
      <Literal datatypeIRI =&rdf;PlainLiteral >
         <possOwl2 possType ="axiom">
             <Degree value ="0.3" />
         </possOwl2 >
      </Literal >
   <Annotation>
</ObjectPropertyAssertion>
```

However, we can develop a Protege plug-in with options corresponding to the propositions described in section 3.2. The user can choose to define the possibilistic element (Weighted concepts,Weighted nominals and Weighted axioms) in the ontology.

The plug-in is integrated with the possibilistic reasonner to check consistency of the ontology and to offer services such as subsumption and instantiation.

4. Related Work

A few approaches for managing uncertainty in geographic information have been proposed recently. Inspired by the theories of stochastic, fuzzy, methods of probabilistic and statistic databases, Hong shu and AL.[33] suggest an uncertainty model including uncertain spatio-temporal data types and spatio-temporal relationships.

Li and AL.[20] describe a framework, based on fuzzy approach, to handle both uncertainty and time in spatial domain. In[31], spatial objects are modeled as a set of points and fuzziness modeled by means of memberships. Pfoser and AL.[28] present probabilistic models to model position and attributes errors.

Dupin[14] develops logical framework in a possibilistic approach for handling uncertain spatial information called attributive formula, and merging it when it comes from multiple Source. Attributive formula is a pair made of a property and a set of parcels (to which the property applies). The notion of spatial relationships is not considered.
In addition, several general approaches have been proposed to extend description logics with probabilistic, fuzzy and possibilistic logic.

There are several probabilistic extensions of web ontology OWL. In particular: BayesOWL[12], Pronto[18], PR-OWL[11] and OntoBayes[39].

The work on fuzzy extension of ontology languages has also received a lot of attention[36],[37],[35] and[7]. Some fuzzy DL reasoners have been implemented, such as fuzzyDL[5] and DeLorean[8].

By contrast, there is relatively few work on combining possibilistic logic and description logic.

Possibilistic extensions of description logics is first studied in[15] and is then developed in[13] and more recently in[29]. An implementation of reasoning in possibilistic description logics using KAON2 is reported in[29]. We recall that Liau and Yao[21] define a possibilistic generalization of the description logic ALC and show that it can be used in information retrieval problems. Possibilistic description logics can also be used for handling inconsistencies in ontologies[29]. Qi develops PossDL[30], a reasoner of a possibilistic description logic, which is an extension of Pellet for uncertainty reasoning and inconsistency handling.

The probabilistic model is still the most used model. Nevertheless, it presents some limits. For example, it does not make distinct between the ignorance and the uncertainty, and it does not allow the representation of total ignorance. The possibilistic logic is particularly suitable for the representation of states of partial or complete ignorance. Possibilitistic logic allows representing the qualitative aspects of uncertainty. Furthermore, possibilistic DLs can be used to deal with inconsistency contrarily to the probabilistic ones. In the qualitative direction, the possibility measure permit the evaluation of the knowledge by using the order notion, where Knowledges are organized on stages according to their degrees of incertitude. So, we have focused on the qualitative possibilistic approach to represent uncertainty related to geographic objects and their relationships.

The relevant works related to our solution are[29], [10], [6] and [7]. Bobillo and Straccia[6], [7] propose a fuzzy version of $\mathcal{SROIQ}$ and provide a reasoning capabilities of fuzzy $\mathcal{SROIQ}$. This work is more adapted for fuzzy information than uncertain one. Qi[29] propose a possibilistic description logic as an extension of the description logic ALC applying the classic tableau algorithm. The syntax of description language is the same as the standard DL and the interpretation is based on possibility theory with a thorough study of its semantics. Couchariere and al.[10] propose a direct extension of the tableau algorithm ALC. They introduce extensions of the clash definition and completion rules to handle necessity values. This solution is then not adapted for managing the various forms of geographic uncertainty such as the type 1, corresponding to the uncertainty of spatio-temporal object, mentioned, in section 2. In addition the ontological language extensions present the same reproaches than for the description logic ones. Our approach differs from the existing ones by the fact that it extends the description logic $\mathcal{SROIQ}(\mathcal{D})$ by possibilistic logic, which seems to be more appropriate logic to GIS. We have defined, also, Poss-OWL 2 based on $\mathcal{P}oss - \mathcal{SROIQ}(\mathcal{D})$ allowing to handle geographic uncertainty. Concepts, individuals and axioms are extended to the possibilitic case. This allows to represent the several forms of geographic uncertainty at the spatio-temporel objects level and relationships level.

5. Conclusion

In this paper, we have considered the problem of uncertainty in GIS. First, two main categories of uncertainty were identified according to the taxonomy of geographic information uncertainty, namely, spatio-temporal object uncertainty and relationships uncertainty. Then, we have proposed a solution to deal with these uncertainties.

In this solution, we have proposed, in previous work, a possibilistic extension of the $\mathcal{SROIQ}(\mathcal{D})$ called $\mathcal{P}oss - \mathcal{SROIQ}(\mathcal{D})$ by incorporating uncertainty level for the different element of the $\mathcal{SROIQ}(\mathcal{D})$ description logic. This allows us to consider geographic objects and phenomena, described by, the uncertainty of their concepts, individuals, attributes and relationships.

Based on our $\mathcal{P}oss - \mathcal{SROIQ}(\mathcal{D})$ DL, we have proposed an extension of the OWL 2, named Poss-OWL 2. Each entity and each axiom are extended with possibilistic annotation properties to represent the uncertain aspect in geographic ontologies.

The representation of the uncertain geographic ontology suggests to build the ontology by using an ontology editor supporting OWL2, such as Protege 4.3. Since OWL2 reasoners such as Fact++ and HermiT does not support the possibilistic extension, we develop our reasoner by extending the OWL2 API2 to support possibilistic ontology. A protege plug-in will be developed to edit the possibilistic ontology. Furthermore, the plug-in is integrated with a possibitistic reasoner to offer reasoning services such as subsumption and instanciation and to check consistency. The possibitistic reasoner is an extension of the tableau algorithm for SROIQ[17]. The implementation of this algorithm and an experimental study are underway.

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