The Hoonoh Ontology for describing Trust Relationships in Information Seeking

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Abstract. When seeking information through mechanisms such as word of mouth, people choose information sources and make trust judgments about these sources based on a range of factors, including the expertise of the source in relevant fields. In this paper we describe the Hoonoh Ontology, a vocabulary for describing these factors and publishing associated data on the Semantic Web. The ontology maps to existing vocabularies such as FOAF and SKOS, and when coupled with appropriate algorithms can be used to populate the Semantic Web with data to support expert finding initiatives.

1 Introduction

Numerous scenarios have been proposed in which expert-finding technology may be beneficial, such as human resources, electronic communications within communities and disaster response [3,4]. One similar scenario with day-to-day relevance for many people is information seeking via *word of mouth* recommendations. In such scenarios, where an individual encounters a problem or task for which their current knowledge is inadequate, they may engage in information-seeking in order to change their knowledge state [1]. Whilst the Web provides vast resources that may address the seeker's information need, "many information-gathering tasks are better handled by finding a referral to a human expert rather than by simply interacting with online information sources" (pp. 27) [9]. In typical word of mouth scenarios, the information seeker is faced with the task of finding the appropriate source who can help meet his or her information need.

In previous research [7] we investigated this issue, and found that the source selection process is influenced by five factors that determine the perceived trustworthiness of a source: *expertise*, *experience*, *impartiality*, *affinity* and *track record*. The first three of these factors (expertise, experience, impartiality)

represented a relationship between a person and a topic, whilst the latter two (affinity and track record) represented relationships between two people. For example, an individual may be perceived as an expert with respect to the topic of films, while two friends who have much in common may have a strong affinity. The reader is referred to [7] for fuller descriptions of each trust factor.

As reported in [8], we have developed algorithms that generate trust metrics based on these factors. These metrics can then be used in technical systems to help users identify experts and other people who may serve as relevant information sources. In the remainder of this paper we describe the Hoonoh Ontology[1], a vocabulary for describing these trust relationships relevant to the information seeking process.

2 The Hoonoh Ontology for Representing Computed Trust Relationships

The Hoonoh Ontology provides a vocabulary with which to represent computed trust metrics relevant to word of mouth information seeking. The ontology models person → topic and person → person relationships based on all five trust factors identified in our empirical research described above. Readers can view the ontology online at <http://hoonoh.com/ontology#>, while the following section describes the design of the ontology and related modeling decisions.

2.1 Modeling Trust Relationships

Nine classes are defined in total in the Hoonoh Ontology – eight of which relate to trust relationships and one to topics. Five of these are used to directly express trust relationships. `ExpertiseRelationship`, `ExperienceRelationship` and `ImpartialityRelationship` are subclasses of the `TopicalRelationship` class, and represent person → topic relationships. `AffinityRelationship` and `TrackRecordRelationship` are subclasses of the `InterpersonalRelationship` class and represent person → person relationships. `TopicalRelationship` and `InterpersonalRelationship` are not intended to be used to describe instance data but are provided simply as unifying superclasses, and are themselves subclasses of a unifying `Relationship` class.

Trust relationships are modeled in the Hoonoh ontology as instances of classes. This allows varying degrees of trust to be expressed by specifying numerical values as properties of these relationships. This is achieved using the `hoonoh:value`

1 The name "Hoonoh" is a play on the words "who" and "know"

property, which has an `rdfs:domain`[2] of `hoonoh:Relationship`[3] and an `rdfs:range` of `xsd:decimal`[4].

This modeling pattern was chosen for a number of reasons. Firstly, we found no evidence in our empirical work to suggest that trust was a binary relationship. Responses provided by participants in our study suggested that source selection decisions were rather subtle and nuanced, with trust relationships reflecting shades of grey rather than a binary 'trust/not trust' distinction.

Secondly, the algorithms we have developed to generate trust metrics based on our empirical work combine numerical data from a range of sources to compute a final metric for each factor. Inferring binary relations from such data would require the setting of an arbitrary numerical threshold at which to create a relationship, which would in turn limit the richness of relationships expressed in the ontology. Consequently, it was deemed preferable to expose numerical values for trust relationships and allow applications to interpret these as desired.

Our modeling approach contrasts somewhat with that adopted by [5], whose trust ontology allows trust relationships to be defined on a scale of 1-9, with each point in the scale having a dedicated property defined in the ontology. For example, 1 on the scale corresponds to the property 'distrustsAbsolutely', 5 to the property 'trustsNeutrally' and 9 to the property 'trustsAbsolutely'. While this approach does collapse into discrete values the notion of trust, which could be considered a continuous variable, it retains a reasonable degree of precision due to the use of a 9-point scale. However, we would argue that using a distinct property for each point in the scale adds complexity for those wishing to query the data with languages such as SPARQL [11].

2.2 Modeling People and Topics

The person from whom a relationship originates (the 'source') is identified using the `hoonoh:from` property, which has a domain of `hoonoh:Relationship` and a range of `foaf:Person`[5]. A class for people is not defined in the Hoonoh ontology; instead the Person class from the FOAF ontology [2] is reused to avoid duplication. For example, a relationship might exist between a person *A* and a topic *B*, or between a person *A* and another person *C*. In both cases the `hoonoh:from` property would be used to indicate the role of *A* in this relationship.

The topic to which experience, expertise and impartiality relationships relate is defined using the `hoonoh:toTopic` property, which has a domain of `hoonoh:Relationship` and a range of `hoonoh:Topic`, itself a subclass of the `Concept` class from the SKOS Vocabulary [10].

Figure 1 provides a schematic view of how an `ExpertiseRelationship` is modeled in the Hoonoh ontology.

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2 prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>

3 prefix hoonoh: <http://hoonoh.com/ontology#>

4 prefix xsd: <http://www.w3.org/2001/XMLSchema#>

5 prefix foaf: <http://xmlns.com/foaf/0.1/>

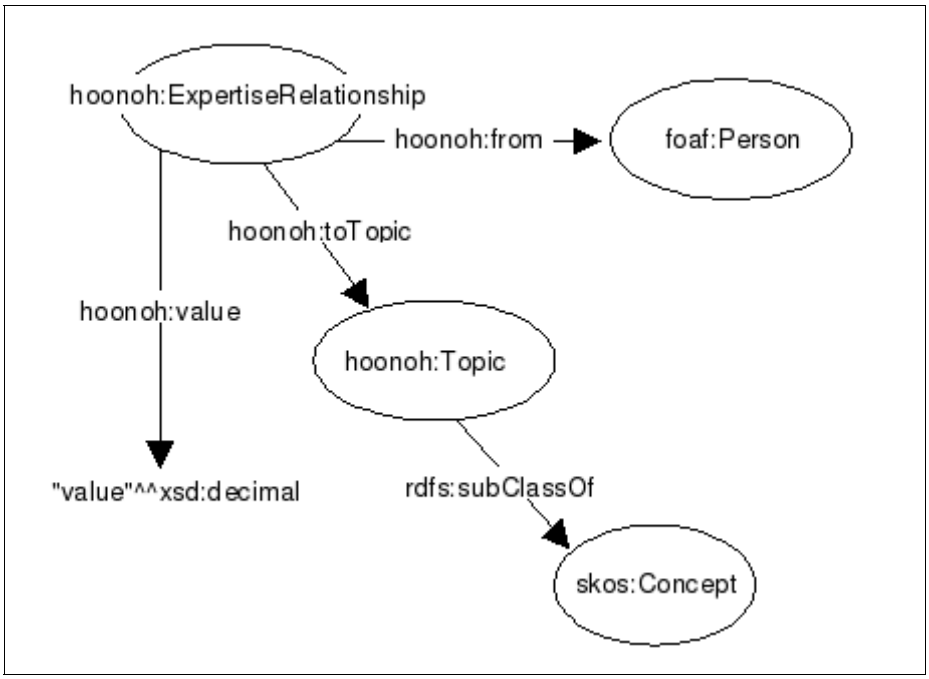

Fig. 1. Schematic diagram showing how expertise relationships are modeled in the Hoonoh ontology

In contrast to descriptions of experience, expertise and impartiality relationships, the description of affinity and track record relationships is completed by use of the `hoonoh:toPerson` property which defines the individual to whom the relationship refers. This property has a domain of `hoonoh:Relationship` and a range of `foaf:Person`, as shown in Figure 2 .

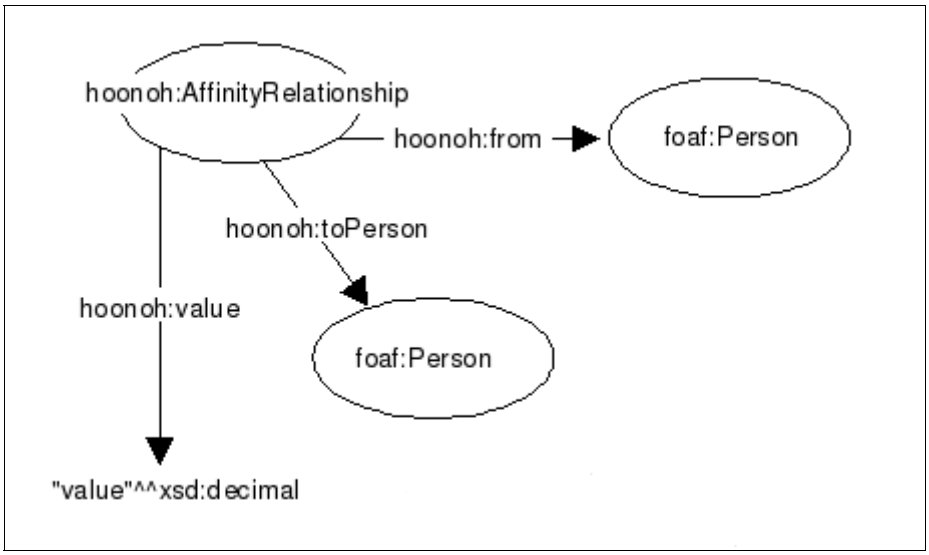

Fig. 2. Schematic diagram showing how affinity relationships are modeled in the Hoonoh ontology

To complement the schematic views, Code Fragment 1 and Code Fragment 2 below show examples of how an `ExpertiseRelationship` and an `AffinityRelationship` can be modeled using the Hoonoh ontology[6].

6 URIs shown in the http://hoonoh.com/ namespace, and values of foaf:mbox_sha1sum are deliberately shortened due to formatting limitations.

```
<?xml version="1.0" encoding="UTF-8" ?>
<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-
   ns#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
   xmlns:hoonoh="http://hoonoh.com/ontology#"
   xmlns:foaf="http://xmlns.com/foaf/0.1/"
   xml:base="http://hoonoh.com/">

<hoonoh:ExpertiseRelationship

rdf:about="relationships/expertise/abc123/example">
 <hoonoh:from rdf:resource="people/abc123"/>
 <hoonoh:toTopic rdf:resource="topics/example"/>
 <hoonoh:value
     rdf:datatype=
      "http://www.w3.org/2001/XMLSchema#decimal">
      0.7292
 </hoonoh:value>
</hoonoh:ExpertiseRelationship>

<foaf:Person rdf:about="people/abc123">
 <foaf:mbox_sha1sum>abc123</foaf:mbox_sha1sum>
</foaf:Person>

<hoonoh:Topic rdf:about="topics/example">
 <rdfs:label>example</rdfs:label>
</hoonoh:Topic>

</rdf:RDF>
```

Code Fragment 1. An example Expertise relationship described using the Hoonoh ontology

```
<?xml version="1.0" encoding="UTF-8" ?>
<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-
   ns#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
   xmlns:hoonoh="http://hoonoh.com/ontology#"
   xmlns:foaf="http://xmlns.com/foaf/0.1/"
   xml:base="http://hoonoh.com/">

<hoonoh:AffinityRelationship
     rdf:about="relationships/affinity/abc123/xyz789">
 <hoonoh:from rdf:resource="people/abc123"/>
 <hoonoh:toPerson rdf:resource="people/xyz789"/>
 <hoonoh:value
     rdf:datatype=
      "http://www.w3.org/2001/XMLSchema#decimal">
      0.8500
 </hoonoh:value>
</hoonoh:AffinityRelationship>

<foaf:Person rdf:about="people/abc123">
 <foaf:mbox_sha1sum>abc123</foaf:mbox_sha1sum>
</foaf:Person>

<foaf:Person rdf:about="people/xyz789">
 <foaf:mbox_sha1sum>xyz789</foaf:mbox_sha1sum>
</foaf:Person>

</rdf:RDF>
```

Code Fragment 2. An example Affinity relationship described using the Hoonoh ontology

3 The Hoonoh Ontology in Practice

Having developed the Hoonoh Ontology, we have used algorithms similar to those described in [8] to generate trust metrics based on data from Revyu.com [6] and the *del.icio.us* social bookmarking service[7]. These metrics are described in RDF according to the Hoonoh Ontology and published online at Hoonoh.com[8], as crawlable RDF and via a SPARQL endpoint[9], to enable reuse in other applications.

7 http://del.icio.us/
8 http://hoonoh.com/
9 http://hoonoh.com/sparql

It is worth noting that both the Hoonoh ontology and the Hoonoh triplestore are oriented specifically towards describing and storing trust relationship data about individuals who have trust relationships generated by the algorithms, not generic information such as a names or home page addresses. The Hoonoh ontology and triplestore provide the necessary hooks with which these trust metrics can be merged with other data sources on the Semantic Web, such as an individual's FOAF file. In this way, trust metrics can be published on the open Web, whilst detailed personal information can remain under the control of the individual.

Building on the trust data in the Hoonoh triplestore we have implemented the Hoonoh.com social search engine[10], which enables users to search for topics of interest, and receive suggestions of trusted information sources from among members of their social network. Results (i.e. members of the user's social network who may have relevant information) are ranked according to the trust metrics described with the Hoonoh ontology. The result is an application that allows people to search for information online using the same criteria for selection of information sources that they may use when seeking information offline.

4 Conclusions

In this paper we have presented the Hoonoh Ontology for describing trust relationships in the context of word of mouth information seeking. The ontology itself has been developed based on empirical research in the field and as such provides a domain model with high ecological validity. While the ontology is not specific to describing individuals' expertise, it does enable these relationships to be expressed, thereby making it suitable for use in expert-finding applications. Furthermore, it also provides the means to model a number of other relationships that, while they may not be isomorphic to expertise, remain highly relevant to applications and services in this domain.

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10 http://hoonoh.com/

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