Application of Semantic Web technologies in Informatics Education

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Abstract. The Semantic Web is an extension of the World Wide Web in which information is represented in a machine-understandable way. In addition, hyperlinks of the Semantic Web connect semantically related information based on ontologies. Thanks to these properties, it becomes possible to automate reasoning over a set of hyerlinked information on the Semantic Web using computational agents. In this paper, we propose to use a Semantic Web reasoner in order to help students understand concepts in informatics. More specifically, our approach consists of three parts. First, learning materials are collected from DBpedia (https://wiki.dbpedia.org) that is an online knowledge base whose contents are provided in several formats including RDF, Notation3, etc. Second, a teacher defines inference rules according to which new facts can be derived from the set of learning materials taken from DBpedia. Third, a learner executes a system called EBRS that is a simple-to-use interface for a well-known Semantic Web reasoner, EYE (http://eulersharp.sourceforge.net/). EBRS shows the result of reasoning on a screen so that learners can understand the relationship of learning materials easily. The theme of this research is to exploit Semantic Web technologies such as RDF, ontologies, reasoning programs, etc in order to support informatics education.

Keywords: Semantic Web · Reasoning · Informatics.

1 Introduction

Ever since the Semantic Web [1] was introduced, a lot of information have been published on the Semantic Web. Units of information are hyperlinked according to the semantic relationship based on ontologies. In this paper, we present our ongoing project that addresses possible ways by which Semantic Web technologies can be exploited to help students learn concepts in informatics. The ultimate goal of the project is in line with the Linked education [2] in which various aspects and applications of adopting Linked Data principles [3] in educational data are investigated.

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The basic idea behind our approach is to use a reasoning system over the set of educational linked data on the Semantic Web so that the system can show a list of inter-related concpets which is the reasoning result. Since the data on the Semantic Web are represented in a machine-understandable way, the identification of two or more related concepts can be automated using inference rules. To this end, we use a system called EBRS [4] that shows both the input and output of the reasoning. EBRS is currently available at https://github.com/comjang/EBRS. Fig. 1) shows that a learning material called Algorithm.n3 encoded in Notation3 format (https://www.w3.org/TeamSubmission/n3/) as well as Algorithmrule.n3 that contains inference rules are fed into EBRS and the reasoning result is returned from EBRS.

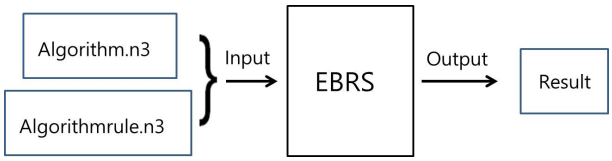

Fig. 1. The input and output of EBRS

More specifically, Algorithm.n3 is downloaded from DBpedia and it contains a list of triples in which each triple takes on the form of "subject-predicate-object". In a triple, a predicate can be interpreated as a hyperlink that connects a subject and an object. A part of Algorithm.n3 where the predicate "hypernim" is used is shown below. "ns0" in front of "hypernim" denotes the namespace http://purl.org/linguistics/gold/ in which this word is defined. For example, the first line means that Multiple_signal_classification and Algorithm are in a hypernim relation.

```
...
dbr:Multiple_signal_classification ns0:hypernym dbr:Algorithm .
dbr:Intelligent_Water_Drops_algorithm ns0:hypernym dbr:Algorithm .
dbr:Bareiss_algorithm ns0:hypernym dbr:Algorithm .
dbr:Weak_NP-completeness ns0:hypernym dbr:Algorithm .
...
```

Algorithmrule.n3 is shown below and it is the file that contains inference rules that a teacher can define. This file consists of three namespaces followed by an inference rule that states that if "s" and Algorithm are in a hypernim relation, then "s" and Complexity are related. There can be various possible inference rules that can be defined here and which inference rules can be defined depends on the structure of learning materials. It is this part that a teacher should be careful about in order to provide students with helpful knowledge that can be derived by reasoning.

```
@prefix db: <http://dbpedia.org/> .
@prefix dbr:  <http://dbpedia.org/resource/> .
@prefix ns0: <http://purl.org/linguistics/gold/> .

{?s ns0:hypernym dbr:Algorithm.}=>{?s "is_related" dbr:Complexity.}
```

EBRS shows the result of applying the inference rule in Algorithmrule.n3 to Algorithm.n3 on a screen and a part of the result is shown below. Note that the following four triples are newly generated based on the reasoning process. This can help learner understand concepts and their relationship because it is explicitly stated that they are related. In other words, before the reasoning process, these exist separately without being connected in Algorithm.n3 file, but the reasoner identifies them and provides them with leaners as an explicit list of triples so that learners can understand the interrelationship of the learning materials easily.

```
...
dbr:Multiple_signal_classification "is_related"  dbr:Complexity.
dbr:Intelligent_Water_Drops_algorithm "is_related"  dbr:Complexity.
dbr:Bareiss_algorithm "is_related"  dbr:Complexity.
dbr:Weak_NP-completeness  "is_related"  dbr:Complexity.
...
```

2 Conclusions

In this paper, we report our ongoing project which aims at exploiting Semantic Web technologies in informatics education. The proposed approach is to use a machine-understandable format such as Notation3 to represent learning materials and present students with reasoning results over the set of learning materials so that implicit hyperlinks that exist among the set of learning materials can become explicit. This can help students understand the relationship among a set of concepts that they are not familiar with. Currently, we are investigating ways by which concepts in theoretical computer science [5] can be introduced to non-computer science major students using the proposed approach.

References

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