Ontology-based Image Retrieval

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Abstract

Today, Information Technology (IT) is rapidly improving and then large-scale available data and information is demanded by information society. To get relevant and related information, efficient Information Retrieval (IR) system which is needed provides advanced searching facilities. To organize large information repositories and access these repositories efficiently, metadata can be used. Closely related to metadata is Ontology. Ontology is a formal explicit description of concepts in a domain of discourse, properties of each concept describing various features and attributes of the concept, and restrictions on slots. This paper intended to present the features and benefits of the IR system by applying ontology concepts and also point out how metadata is critical in supporting effective discovery.

1. Introduction

Information Retrieval (IR) deals with the representation, storage, organization and access to information items. The representation and organization of the information items should provide the user with easy access to the information in which he is interested. The purpose of the IR system is to capture wanted items and to filter out unwanted items.

Text-based information retrieval is lexically motivated rather than conceptually motivated, which leads to irrelevant search results in information retrieval. Lexically motivated means the text-based retrieval operates on the word-level, and not on the level of the meaning of words. The very idea of ontologies is that they are conceptually motivated, i.e., can be used to express the intended meaning of things, and not just words as textual strings [2].

Information is crucial in the process of planning and making decisions. The underlying vision is to automate the process of selecting, filtering and searching the needed information. In that way, much of the information will be reduced and the result will consist of higher information density more compact and valuable information.

2. Related work

Avril Styrman [2] described how ontologies can be used to create better image annotation and retrieval systems. In a nutshell, ontologies are used to overcome the problems that evolve from traditional text-based information retrieval when it is applied to images.

Wei Zheng, Yi Ouyang, James Fords and Filla S.Makedon [7] discuss an ontology-based image retrieval approach that aims to standardize image description and the understanding of semantic content. Ontology-based image retrieval has the potential to fully describe the semantic content of an image, allowing the similarity between images and retrieval query to be computed accurately.

3. Ontology

Ontology is a specification of an abstract, simplified view of the world [4]. Ontology defines a set of representational terms called concepts. Ontology can be constructed in two ways: domain-dependent or generic. Generic ontologies are definitions of concepts in general; such as WordNet, which defines the meaning and interrelationships of English words. A domain-dependent ontology generally provides concepts in a specific domain, which focuses on the knowledge in the limited area, while generic ontologies provide concepts more comprehensively.

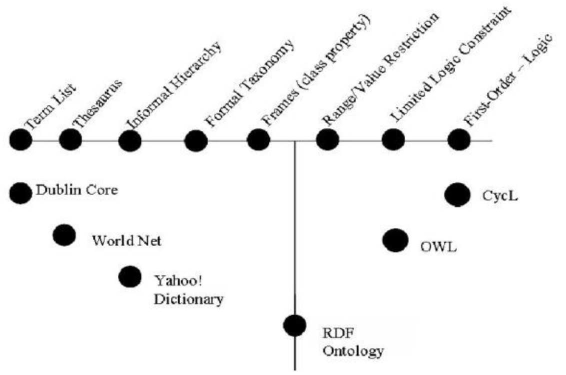
The implementation of ontology is generally taxonomy of concepts and corresponding relations. In ontology, concepts are the fundamental units for specification, and provide a foundation for information description. In general, each concept has three basic components: terms, attributes and relations. Terms are the names used to refer to a specific concept, and can include a set of synonyms that specific the same concepts. Attributes are features of a concept that describe the concept in more detail. Finally relations are used to represent relationships among different concepts and to provide a general structure to the ontology.

Ontologies are widely used in Knowledge Engineering, Artificial Intelligence, and Computer Science, in application related to knowledge management, natural language processing, e-commerce, intelligent integration, information retrieval, database design and integration, bio-informatics, education, and in new emerging fields like the Semantic Web.

Declarative knowledge is modeled by means of ontology while problem solving methods specify generic reasoning mechanisms. Both types of components can be used to configure new knowledge-based systems from existing reusable components [1].

3.1. Expressiveness in ontologies

In order to classify ontologies according to their expressiveness, we distinguish several expressiveness levels based on the ontology spectrum introduced by McGuinness (2003, see Figure.1)



Light-weight Ontology Heavy-weight Ontology

Figure 1. Expressiveness in Ontology

- *Controlled vocabulary* – a list of terms;
- *Thesaurus* – relation between terms, such as synonyms, are provide;
- *Informal taxonomy* – there is an explicit hierarchy (generalization and specialization are supported), but there is no strict inheritance; an instance of a subclass is not necessarily also an instance of the superclass;
- *Formal taxonomy* – there is strict inheritance;
- *Frames* – a frame (or class) contains a number of properties and these properties are inherited by subclasses and instances;
- *Value restrictions* – values of properties are restricted (for example by a datatype);
- *General login constraints* – values may be constraint by logical or mathematical formulas using values from other properties;
- *First-order logic constraints* – very expressive ontology languages such as those seen in Ontolingua or CycL allow first order logic constraints between terms and more detailed relationship such as disjoint classes, disjoint coverings, inverse relationships, part–whole relationships, etc.

Figure 1: also provides the distinction between light weight and heavy weight ontologies. Corcho et al. (2003) [1] clarify the distinction between light weight and heavy weight ontologies. The Yahoo! Dictionary, for example, is sometimes called ontology, because it does provide a consensual conceptualization of some domain, but actually it is little more than taxonomy, and thus a light weight ontology.

Heavy weight and light weight ontology can be modeled with different knowledge modeling techniques and they can be implemented in various kinds of languages. Ontology can be highly informal if they are expressed in a restricted and structured form of natural language; semi-formal if expressed in an artificial and formally defined language; and rigorously formal if they provide meticulously defined terms with format semantics, theorems and proofs of properties such as soundness' and completeness [1].

3.2. Ontology markup language

The first ontology markup language to appear was SHOE. SHOE is language that combines frames and rules. It was built as an extension of HTML. It used tags different from those of the HTML specification, thus allowing the insertion of ontology in HTML documents. Later its syntax was adapted to XML.

The rest of ontology markup language presented here is based on XML. RDF is a semantic-network based language to describe Web Resources. The RDF Schema language was also built by the W3C as an extension to RDF with frame-based primitives [1].

3.3. Resource description framework

The Resource Description Framework (RDF) is a language for representing meta-data. The RDF data model defines the structure of the RDF language. The data model consists of three data types:

- *Resources*: All data objects described by a RDF statement are called resources. For example, resources are web sites or books.

- *Properties*: A specific aspect, characteristic or relation of a resource is described by a property. For example, properties are the creation date of a web site or the author of a book.
- *Statements*: A statement combines a resource with its describing property and the value of the property. RDF statements are the structural building blocks of the language.

A RDF statement is typically expressed as "resource-property-value" – triple, commonly written as P(R, V): A resource R has a property P with value V. These triple can also be seen as object-attribute-value triple.

Statements can also be expressed as graphs with nodes for resources and values where directed edges represent the properties. Figure 2 shows the graph of the resource R with an edge for the property P directed to the property value V.

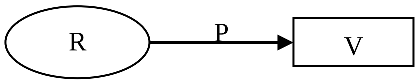


Figure 2. Graph representation of a "resource-property-value" – triple

Resources are represented in the graph as a circle. Properties are represented by directed arcs. (Property-) values are represented by a box. These values are called graph end-nodes. Values can also become resources if they are described by further properties, i.e., if a value forms a resource in another triple. They are then represented by a circle [6].

3.4. Jena

Jena is a programming toolkit, using the Java programming language. It is written for the programmer who is unfamiliar with RDF and who learns best prototyping, or, for other reasons, to move quickly to implementation. The advantage to ontology is that it is an explicit, first-class description. Since Jena is an RDF platform, we restrict ourselves to ontology formalisms built on top of RDF.

Jena offers a simple abstraction of the RDF graph as its central internal interface. This is used uniformly for graph implementations, including in-memory, database-backed, and inferred graphs. The main contribution of Jena is a rich API for manipulation RDF graphs.

The main building blocks of Jena are its RDF API with RDF/XML parser and persistence subsystem, its ontology subsystem, its reasoning subsystem, and the RDQL query language.

The RDF API provides methods for manipulating the set of RDF triples. It also provides a way for extending the behavior of resources. An important part of RDF API is ARP, the Jena's RDF/XML Parser. Another building block of Jena is its persistence subsystem that provides a way to store models using database.

The persistence subsystem supports also a capability for RDQL queries that dynamically generates SQL queries in order to perform as much of the RDQL query within an SQL database engine as possible [5].

4. System architecture

The main objectives of our paper are to describe how ontologies can be used to create better image annotation and retrieval systems, to study the ontology concept and the development of Resource Description Framework (RDF), and to query and retrieve student information from Ontological database.

In our system user would like to search the student in the University Of Computer Studies (Mandalay) and see their images. So Ontology is built by using Resource Description Framework (RDF). We build Ontology but this is not visible by user, then we use Student searching process to demonstrate our ontology. These students are stored in preprocess database

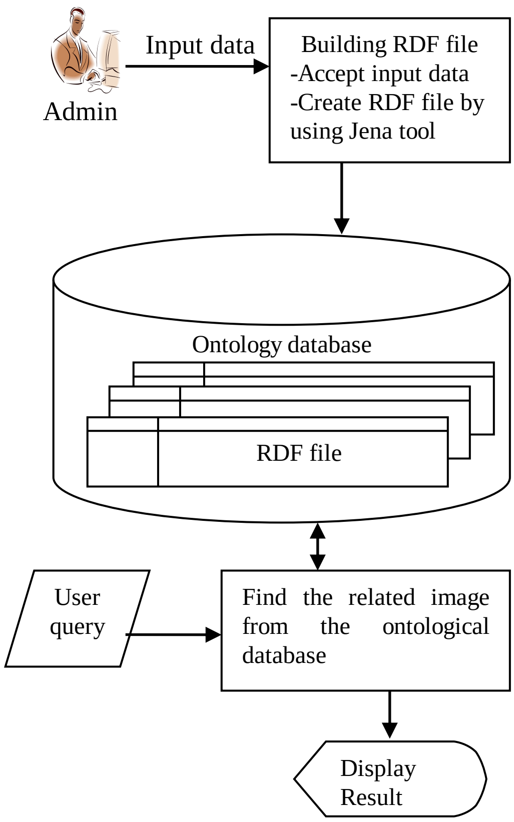


Figure 3. Overview of the system

If user enter a word for searching, our system shows the Students in University of computer Studies, Mandalay and their related images. For example, if user enters "Mg Mg", our system displays Mg Mg's image and information. One database is used in system: it is ontology database that stored RDF statement files with XML format.

4.1. Implementation

Jena Statement:Create Resource

Model modelName =
ModelFactory.createDefaultModel();
Resource resourceName=modelName.createProperty (location);

Adding Property

Property propertyName=modelName.createProperty (property);

Create Statement

Statement statementName = model.createStatement (subject,property.object);
modelName.add(statementName);

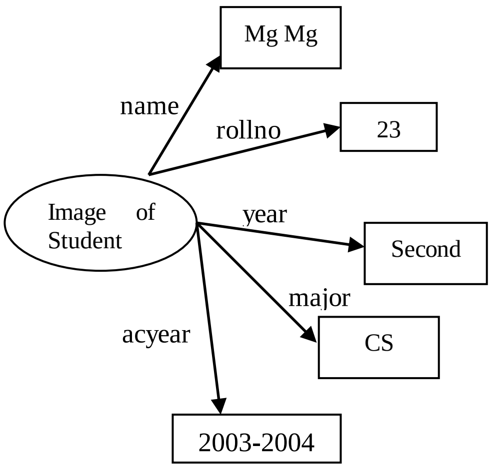


Figure 4. Graph model of student

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<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
          syntax-ns#"
xmlns:rdf="http://somewhere/Image-rdf/1#">
<rdf:Description rdf:ID="I0/"
rdf:about="http://somewhere/Image/Mg Mg#">
<Image:name>Mg Mg</Image:name>
<Image:rollno>23</Image:rollno>
<Image:year>Second</Image:year>
<Image:major>CS</Image:major>
<Image:acyear>2003-2004</Image:acyear>
</rdf:Description>
</rdf:RDF>
```

5. Conclusion

On the Web, management of data includes retrieving, integration, and dissemination and so on. World Wide Web users are finding information relevant to their interests without restriction. So the acquisition of data from the data sources on the web will be one of the important activities for the world.

Therefore, ontology-based information retrieval system is useful for easily finding user information need more effective and relevant, and giving better response to user without knowing the internal processing of the system. Ontology will develop as a unifying structure for giving information common representation and semantics.

6. References

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