BUILDING E-COMMERCE WEB APPLICATIONS:
Agent- and Ontology-based Interface Adaptivity

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Abstract: E-Commerce Web based applications designed to facilitate Data-exchange collaboration are enjoying growing popularity. In the next few years, business companies will want their web resources linked to ontological content –because of the many powerful tools that will be available for using it by potential customers. Thus, product information will be exchanged between applications, allowing computer programs to collect and process web content, and to exchange information freely with each other. In this paper, few pointers are used for this emerging area, and then go on to show how the ontology languages of the semantic web can lead directly to more powerful agent-based approaches to using services offered on the web. As a result, e-commerce architecture is outlined as an agent-based system to retrieve information products. In this framework, an ontology representing fashion clothing domain used by potential consumers is also introduced, where RDF-S (Resource Description Framework Schema) is used.

1 INTRODUCTION

In the next few years virtually every business company, university or government agency would want their web resources linked to ontological content –because of the many powerful tools that will be available for using it. Information will be exchanged between applications, allowing computer programs to collect and process web content, and to exchange information freely with each other (Hendler, 2001). On top of this infrastructure, ontology negotiation between intelligent information agents (Bailin & Truszkowski, 2001) will become much more practical, in fact distributed computer programs interacting with non-local web-based resources may eventually become the dominant way in which computers interact with humans and each other, and will be a primary means of computation in the not-so-distant future. Nonetheless, for this vision to become a reality, a phenomenon similar to the early days of the web must occur.

Concretely, e.g. in a e-commerce context, the semantic web initiative (Berners-Lee, Hendler, & Lassila, 2001) reflects this problem by ”giving information a well-defined meaning, better enabling computers and people to work in cooperation”. In addition, Adaptive web, as envisioned in (Brusilovsky & Maybury, 2002), should provide business companies with optimized access to distributed electronic product information on the web according to particular needs of individual consumer or group of consumers. However, the main problem of current web systems their inability to support different needs of individual consumer. This can be achieved by making metadata about different resources explicit using standardized descriptions (SWCP, 2001).

The remainder of this paper is organized as follows. In section 2 we present our motivation about this emerging area like semantic resolution for e-commerce. In section 3 we introduce our design scenario in order to use ontologies and powerful agent-based approaches. In section 4 we outline the architecture of our e-commerce framework as an agent-based system to retrieve information products. Finally, in section 5 we present our conclusions and future work being in progress.

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2 MOTIVATION

Understanding the meaning of messages exchanged between software agents has long been recognized as a key challenge to interoperable multi-agent systems. Several proposed solutions (Hendler 2001) deals with for forcing all agents to use a common vocabulary defined inside one core ontology where semantic differences between individual agents in the system should be allowed and be resolved when they arise during agent interaction. For that reason, we have started with a simple e-commerce framework of buying and selling fashion clothing through internet in order to represent the first step of our ongoing effort toward a comprehensive solution to the problem of semantic resolution.

3 FRAMEWORK DESCRIPTION

In this section we introduce a simple context of an agent-based system to retrieve information resources for a specific e-commerce environment. We outline in Figure 1 this semantic web scenario.

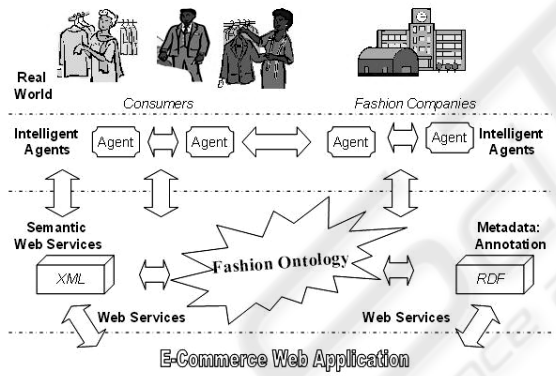

Figure 1: Semantic E-commerce Scenario

Firstly, we have developed a simple pilot semantic web explorer named *e-fashion* where users (i.e. potential consumers) could browse and search the information gathered in this repository. This semantic explorer is frame-based and allows searching metadata from fashion products; then search results are displayed in the right frame. In the left frame, a categorization of fashion products is displayed, used for searching information product by consumers.

We have proposed to build up this prototype using the eXtended Markup Language (XML) (XML, 1998) which has emerged in the Internet world as a standard representation format and because of can be useful to describe and transmit management information. However, XML formats alone do not give formal semantics to it. To solve this question, we have selected an ontology language based on the Resource Description Framework (RDF) (RDF, 1999) and its Schema (RDF-S) (RDF-S, 2004). Both are XML-based languages that provide a satisfactory way of defining structured sets of terms, with class hierarchies, and domain and range constraints. In fact, some ontology definition languages used in the Semantic Web are based on RDF-S so machines can perform useful reasoning tasks. Then, these ontology languages can be used to improve the semantic expressiveness of the management information specifications. With them it is even possible to reason with the knowledge handled in the management tasks. More to this point, RDF-S recommendation offers terms that allow the representation of concepts, their relationships and their attributes, all of which formed the metadata.

By last, agents are autonomous software components (Tveit, 2001) that possess the following properties:

(1) autonomy: operate without intervention and have control over their states and actions;

(2) reactivity: perceptive and are aware of their environment and have the ability to respond in a timely manner to the changes and actions that occur;

(3) proactiveness: take the initiative and are able to exhibit goal-directed behavior; and

(4) social ability: co-operative or have the ability to interact with other agents and objects with some kind of language.

In addition to these, agents in the strong sense, may possess additional characteristics that include:

(5) mobility: ability to move around;

(6) rationality: ability to perform in optimal manner to achieve goals;

(7) benevolence: obey; and

(8) veracity: truthful.

4 ARCHITECTURE

We have employed an architecture where users (i.e. consumers) specify requests and queries through specified fashion ontology via user-interfaces. The queries are routed to specialized agents for data retrieval and their corresponding analysis of results. Figure 2 depicts the overall architecture in terms of its agents.

Consequently, we make use of this architecture with three types of agent:

- UserAgent
- SearchAgent
- OntologyAgent

Each agent is in charge of different tasks such as user interaction, ontology retrieval and metadata search. Concretely, the architecture depicted in Figure 2 includes three main agents which communicate each other through information messages according to FIPA-ACL standard (FIPA, 2002).

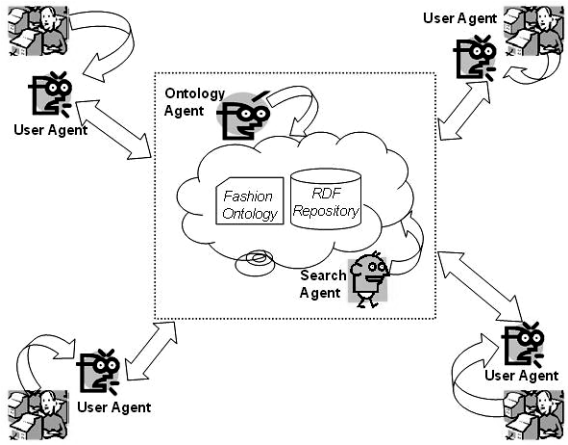

Figure 2: Architecture overview

Firstly, "UserAgent" constitutes the user's intelligent gateway into this architecture. It uses knowledge of the system's common domain model (i.e. fashion ontology) to assist the consumer in formulating queries and in displaying their results. Furthermore, "UserAgent" interacts directly with the agents "SearchAgent" and "OntologyAgent".

Secondly, "SearchAgent" is responsible for retrieving the metadata of documents. In this architecture the RDF Data Query Language (RDQL) (RDQL, 2004) was used to retrieve the metadata of documents. We also used a search semantic tool like JENA (Carroll et al., 2004) in order to search RDF expressions.

Thirdly, the "OntologyAgent" provides an overall knowledge of the e-fashion ontology so offer answering queries about this domain and its structure. The bulk of this e-commerce ontology is devoted to define the common terms of fashion clothing and organizing them as taxonomy.

In this stage of this research work we focus on how to represent the selected ontology using mark-up languages as described before. This will allow the reusability and sharing of this knowledge between different users (i.e. consumers). Thus, Figure 3 depicts fashion ontology (partial view) using RDF graphs where some concepts are represented like nodes, e.g. DesignSchool, DesignBranch, Style, etc. Besides, links between nodes represent properties like rdf:type and rdf:SubClassOf().

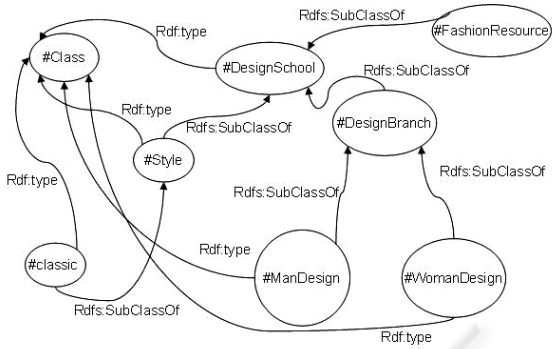

Figure 3: Fashion Ontology using RDF Graphs (partial view)

On the other side, the subject ontology could be expressed through RDF-S where several nodes are represented in Figure 4.

```
<rdf:Description rdf:ID="DesignSchool" rdfs:label="DesignSchool">
        <rdf:type rdf:resource="#Class">
        <rdfs:subClassOf rdf:resource="#FashionResource">
</rdf:Description>
<rdf:Description rdf:ID="DesignBranch" rdfs:label=" DesignBranch">
        <rdf:type rdf:resource="#Class">
        <rdfs:subClassOf rdf:resource="#DesignSchool">
</rdf:Description>
<rdf:Description rdf:ID="ManDesign" rdfs:label="ManDesign">
        <rdf:type rdf:resource="#Class">
        <rdfs:subClassOf rdf:resource="#DesignBranch">
</rdf:Description>
```

Figure 4: Fashion Ontology using RDF-S (partial view)

5 CONCLUSIONS

This paper has introduced a few pointers about impact of the growing intelligent agent technologies and the Semantic Web on the phenomenon of e-commerce. In particular, we have resumed how the integration of ontologies and intelligent agents could provide a new environment for e-commerce applications. To conclude, the key advantages of our outlined framework are:

(*i*) The use of techniques based on ontologies is very important in order to enable concept identification used more often in the knowledge domain that e-commerce applications use. Then, such techniques allow identifying core properties and basic relationships existing among the concepts in a given domain, becoming a powerful knowledge representation metadata for knowledge repositories.

(*ii*) Well recognized technologies like RDF and RDFS allow constructing refined knowledge representations, even also providing a full set of primitives in order to represent different kinds of

information resources which are part of any e-commerce operation process.

(*iii*) Software agent technologies offer an enormous potential of managing the information that potential consumers use and generate. For that reason, common tasks such as product search and retrieval could be delegated to agents.

As a result, our prototype promises very good results although our ongoing work clearly deals with testing deeply our framework even also with more powerful semantic languages like Ontology Web Language (OWL) or the well-recognized Darpa Agent Markup Language and Ontology Inference Language (DAML-OIL). Another parallel future goal being in progress is offering semantic resolution and searching from new wireless communications interface methods like PDA´s or Screen Mobile Phones.

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