BEE-SMART: A Natural Language Interface for Knowledge Retrieval and Service Execution over the Semantic Web

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Abstract: Semantic Web technologies allow for a simplified way to represent machine perishable knowledge over Web and have significant implications in extending Web capabilities beyond our current imagination. However, in order to bring its unprecedented power to Web users, we need an intuitive, easy to use interface to retrieve knowledge and execute services over the Web. In this paper we describe a system - BEE-SMART, which provides a natural language interface to sophisticated Semantic Web technologies. Broadly the system facilitates users with a) Simple Chat b) Knowledge Query c) Semantic Service Execution interfaces. The system was developed by the graduate students at University of Missouri under guidance of Dr. Yugyung Lee.

1. The Semantic Web

The Web was started with a vision of connecting conceptually related information and accessing them irrespective of location and time. With the success of Web publishing, today's Web has become the single most significant information source existing on the planet. Unfortunately, as a negative byproduct, retrieving precise information from the Web is an insurmountable task. Within the traditional Web paradigm, searching and navigation are only means to access the information.

Semantic Web [B01] is an emerging effort that advocates encoding of information and services in a structured machine interpretable manner. With the promising Semantic Web technologies, it is possible that not only humans but also machines can interpret and retrieve the required information and services. With advent of Web services technologies, it also provides a ubiquitous execution platform to execute services regardless of platform. Even with the benefits of Semantic Web technologies, there are no adequate tools or applications, which reveal the potentials of semantically, encoded knowledge and services over Semantic Web.

Responding to the urgent needs of tools, we have developed a Semantic Web portal to convey its real power to en masse over Web. Within our knowledge, BEE-SMART is only tool that incorporates humans' natural language interface, dynamically extracts knowledge from the Web and Semantic Web, and provides service discovery and execution using Semantic Web technologies. Our BEE-SMART project focuses on three major tasks (1) Intelligent information retrieval (2) Service discovery and execution (3) a Natural Language interface to knowledge and services present over (Semantic) Web. BEE-SMART serves the role of a personal agent by providing a single stop intuitive interface to Semantic Web.

2. 'SMART' Semantic Technologies

Our work is influenced and cooperated with the vision of Semantic Web, namely sharing and reusability of web information and technologies. In building the conceptual prototype system, we have employed extensive tools developed by Semantic Web community: Natural Language (AIML[1], Link42[2]), Ontology Crawler (RDF Crawler[3], Jena[4], etc), Ontology Query and Storage (KAON[5], etc), Ontologies (SUO[6], WordNet [GA95], etc). We've also developed our own tools such as Ontology Search (OntoKhoj), Ontology concept mapping and instance building (OntoGenie), and Ontology Ranking.

One of the most important aspects in the Semantic Web's success is to make it widely accepted, the reason being unless people will put out content (Ontologies) similar to HTML pages on Web, we cannot realize its complete power. Hence, several interesting tools and projects have been developed facilitating easy and smooth transition for the community. For Semantic Web Ontology editing and authoring we have (Protégé-2000[7], OilEd[8], Joseki[4]), some of interesting projects are Semantic Search [Gu03], Semantic Service Matching [Mp03], FOAF[9] and Semantic Pervasive Computing [Ry03]. We believe that our efforts contribute to maximize the productivity of such endeavors to bring these technologies close to people.

3. 'SMART' Functionalities

The BEE-SMART portal supports natural language virtual chat and two kinds of queries from the user:

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[1] AIML, http://www.aiml.org/
[2] Link42 – Syntactic parser of English. http://www.link.cs.cmu.edu/link
[3] RDF Crawler, http://ontobroker.semanticweb.org/rdfcrawl/help/specification.html
[4] HP Jena Semantic Web Toolkit, http://www.hpl.hp.com/semweb/jena.htm
[5] KAON. http://kaon.semanticweb.org/
[6] Standard Upper Ontology, SUO Home Page. http://suo.ieee.org
[7] Protégé-2000, http://protege.stanford.edu
[8] OilEd, http://oiled.man.ac.uk/
[9] FOAF, http://www.foaf-project.org/

- o Virtual Chat: For example, "How are you?" and "I am fine"
- o Information Retrieval: For example, an Information specific query may look like this: "Who is Pete Sampras"
- o Task Execution: For example, a task specific query may look like this: "Find the stock price for the stock ticker *IBM*"

Depending upon these functionalities the core architecture of BEE-SMART can be classified into four major components

a. Personal Agent Component (PAC): handles the task related to natural language parsing, tokenizing and formation of the query. Embeds a simple pattern matching based chat module. Breaks down the Natural language question into morphological elements of sentence and extracts the subject, verb and object. Depending upon the query, determines the nature of the query and routes to either Knowledge Assistant or Semantic Web Services component.

b. Knowledge Assistant (KA): basically assists the PAC component in retrieving answer to queries on the knowledge retrieved from Semantic Web by the mediator component (KM).

c. Knowledge Mediator (KM): interfaces Web and Semantic Web in sense that it crawls and fetches Ontologies over Semantic Web (represented in RDF, RDFS, OWL) and also performs Information Extraction over Web pages to semi-automatically create Ontology Instances for the crawled Ontologies.

d. Semantic Web Services (SWS): connects to all major UDDIs and retrieves services matching the given query. Dynamically extracts the required input fields, presents to the user and executes the services in real time. Performs naïve semantic matching for a few set of inbuilt marked up services
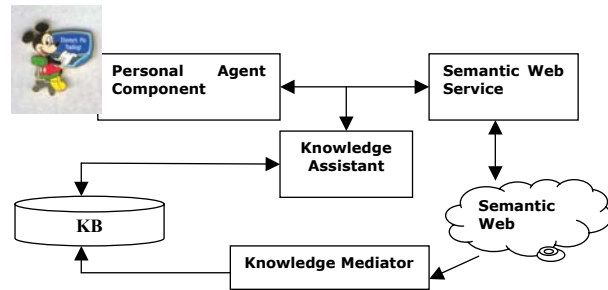

Fig1. BEE-SMART Architecture

3. BEING 'SMART'

BEE-SMART is an effort of Semantic Web and Knowledge Discovery class headed by Dr Yugyung Lee at University of Missouri-Kansas City. Fifteen graduate students developed the project over a period of three months that includes learning curve for Semantic Web and plethora of related technologies.

Web URL: http://sice527.ddns.umkc.edu/beesmart/

BEE-SMART: Coined after BEE that goes around the flowers (Web) to collect nectar (information). BEE is SMART enough to interpret the queries from humans and do task (execute services) in SMART manner.

Fig 2. BEE-SMART snapshot showing Knowledge Query Interface

Currently, local Kansas City Area Life Sciences institutes have shown interest in using BEE-SMART for researchers working in highly interdisciplinary areas of life sciences for making simple cross domain knowledge queries and for executing advanced bioinformatics services.

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