A Semantic Web Tool for Knowledge-based Software Engineering

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Abstract. With ontologies as formal knowledge representation scheme for product and process domains, knowledge-based software engineering environment is realizable using Semantic Web technology. The formal logic representation of software engineering knowledge enables automated acquisition, retrieval and reuse of knowledge. This improves software engineering activities through specific applications for knowledge access, automated code generation or process workflow automation. A Semantic Web tool based on multi-agent architecture, to realize these applications is proposed and a prototype confirms the implementation feasibility.

Keywords: Semantic Web, Ontology, Knowledge-based Software Engineering

1. Introduction

Basically, software engineering is a knowledge-intensive process. Software developers are the producers and consumers of knowledge. The management of software engineering knowledge, to improve quality and productivity, needs pragmatic tools. In our early work, we proposed a framework for knowledge-based software engineering with ontologies as the foundation, named as Ontology-driven Software Engineering Environment (OSEE) [1]. Using ontologies for product and process domains, a knowledgebase is built by accumulating the software engineering knowledge as instances of ontological categories. This knowledgebase effects information dissemination for software developers, who are distributed across multiple locations, through a semantic search engine. It provides input for knowledge applications to automate code generation from the structured domain model stored as product ontology or automates process execution based on the process structure defined as software process ontology. This position paper projects software engineering knowledge resources and the realization of a knowledge-based engineering environment using the applications built on ontologies with multi-agent architecture-centric Semantic Web tool.

2. Semantic Web and Knowledge Manipulation

Though the original vision of Semantic Web is to make web documents machine-processable as a web of data and information, Semantic Web provides a complementary vision as a knowledge management environment [2]. Any knowledge item, be it a document, object, concept or an event of the real world is a resource in Semantic Web. Each resource has a Unique Resource Identifier (URI) enabling universal identification. These resources are annotated with metadata expressed in Web Ontology Language (OWL) [3] enabling inference and entailment of information. This principle is applied in developing a knowledge-based tool for software engineering encompassing explicit and tacit knowledge.

Explicit knowledge items are documents such as project documents, plans, process structure and package, technical guidelines and manuals. These resources can be easily added as instances to the respective ontological categories. The tacit knowledge is the implicit knowledge of an organization, which is immanent in human resource and is difficult to articulate. Each tacit knowledge item is considered as a *knowledge thread* [4], because it is fluid and is stabilized gradually with intertwining of many threads of the same concept under distinct ontological categories into explicit knowledge. Knowledge threads are obtained from myriads of software engineering activities. A system specification can provide knowledge threads that update concepts and their relationships about an application domain in its ontology. Use cases from requirements specification are the threads, which update the features of the system in domain ontology. Problem resolution records of project execution or project closure reports presenting problem/solution cases are the threads, which enhance process ontologies. The built-in knowledgebase using Semantic Web framework with explicit project documents or implicit knowledge threads is resourceful for the developers to have access to instant information from anywhere and at any time.

3. The Tool

The architecture of OSEE is designed in the following three layers as shown in figure 1.

- The Data layer comprises all domain ontologies of the environment regarding product and process. Each project is represented by a distinct ontology. This sets the environment for a project by tailoring and linking product and process ontologies with concepts and terminologies pertaining to a specific project.
- The Semantic middleware layer is assembled using multi-agent architecture for Semantic Web proposed by Wei Dai [5]. The middleware consists of a set of agents, which do independent tasks like cooperating, competing or coexisting with one another.

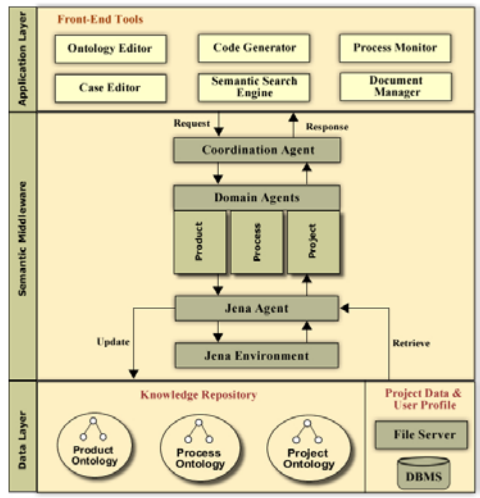

Figure- 1. Tool Architecture

These agents are grouped into three categories.

1. Coordination agent receives all requests from the application layer and processes the requests by identifying the task. It also splits tasks into subtasks and allocates them to domain agents. After execution or termination of each task, it sends the result to the application layer.
2. Domain Agents accomplish specialized tasks on behalf of the domain ontology such as formulating queries, a specific domain solution or communicating with other agents. Separate domain agents represent product, process and project.
3. Jena Agent creates ontology models and interacts with Jena middleware for ontology modeling, reasoning or updating of instance data.

- The application layer consists of front-end tools that enable acquisition and manipulation of knowledge threads. Each application is an independent entity, which interacts with the middleware by requesting for a service and getting a response. For instance, in the Semantic Search engine, user input is parsed and eliminating aliens identifies the key tokens. Mapping with concepts and properties of the selected domain does this identification. Based on the number of tokens and possible combination of terms with regard to concepts and properties, queries are formed in RDQL and are executed with the help of Jena query engine. As part of code generation technique [6], Ontology mapping technique is used to convert OWL classes to object-oriented classes.

4. Implementation and Further Works

A prototype of OSEE is built in the context of a health care application namely Patients Administration system. A tailored version of Rational Unified Process is selected as the process ontology and the application domain ontology is developed based on HL7 Reference Information Model [7]. The pilot implementation of the system confirmed the proof-of-concept of the architecture. The system must be tested with integration of all applications with large volume of data to validate the performance and results.

This work aims to harness the ontologies of product and process to build a knowledgebase and use it in software engineering activities. Integration of rules into ontologies and providing rule-based inference is the next major effort. This tool will further benefit if the application ontology, derived from the product domain is given as input for Computation Independent Model of MDA [8]. While there is a slackening in developing Semantic Web content for global access, the development of semantic content within a software organization to improve its productivity paves way for the success of the vision of Semantic Web.

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