Role of Ontology Training to Software Engineering Students

Arvind W Kiwelekar  
Department of Computer Engineering  
Dr. B. A. Technological University  
Lonere-402103 Raigad (MS) India  
awk@dbatu.ac.in

ABSTRACT

Students of software engineering struggle to develop a systems perspective because most of the software engineering methodologies focus on developing a particular aspect of a system. Lack of unified coverage to the topic of systems modeling is identified as the root cause behind this problem. The paper explains the role of ontology in building systems perspective. A case for the necessity of ontology training as a means to overcome this problem is presented. The course content for a typical course on ontology is also described in the paper.

1. INTRODUCTION

The skill of systems modeling is one of the necessary skills for executing software engineering projects beside other generic skills such as project management and communication skills. One of the shortcomings of the curricula followed for computer engineering programmes specially in Indian Universities is that the topic of systems modeling is either taught in a fragmented way or underemphasized. Some of the effects of the lack of unified coverage to the topic of systems modeling are that students fail to develop a systemic view of an engineering application and they also fail to relate theoretical concepts to real world objects.

2. LIMITATIONS OF SE CURRICULA

Table 1 depicts the coverage of the topic of systems modeling included in a typical computer engineering curriculum. These courses mainly focus on different approaches to systems modeling and to explain various process models for building software systems. Few problems associated with such kinds of course curricula are: (i) Fragmented treatment to the topic of systems modeling. Systems modeling related topics such as data modeling, function modeling, agent modeling, kinds of systems are covered in different courses. The effect of such isolated treatment to these topics reflect in students failure to grasp the commonalities among similar concepts and their failure to relate the concepts studied in different courses. For example, students struggle to relate the similar concepts of Finite Automata and State Diagram that are taught in the subjects of TOC and OOAD. (ii) Emphasis on symbolic expression over semantic expression. While teaching the subjects like TOC, OOAD, DM there is more emphasis on writing efficient symbolic expression and on syntax of a particular formalism such as state machines, first order logic and programming languages. Often neglecting that symbols stand for the objects from reality. This emphasis get reflected in student’s failure to relate theoretical concepts to real world knowledge. Most of the students always label states with symbols such as s1, s2 ... and transitions with e1, e2 ... when students are asked to draw a state transition diagram for a library book. More meaningful terms such as onTheRack, issued, newArrival are rarely thought over. (iii) Lack of explicit coverage to the notions of System and Time The notions of system, kinds of systems, emergent properties of systems, environment, and time which are central to the task of systems modeling are unaddressed in present undergraduate computer engineering curricula. Due to this students face difficulties in understanding more advanced courses such as Temporal Logic, and systems architecting. (iv) Abstract mathematical concepts are taught before concrete concepts The abstract mathematical concepts of graph theory, relations, algebraic structures, queuing theory are taught prior to more concrete SE concepts and they are explained through non-software engineering applications. Students find easier to learn abstract concepts when they are taught in terms of familiar and more concrete applications. As a result building mathematical models of software systems appear as a major challenge.

3. ONTOLOGY AND SYSTEM MODELING

The term Ontology is primarily used in two different ways. Ontology as a philosophical discipline[1] studies various kinds of objects found in reality. From the information science point of view, the term ontology formally specifies concepts found in a particular application domain[2]. In this paper, the term ontology is used in both senses to explain the role of ontologies in addressing the issues raised in the last section.

As a philosophical discipline, ontologies formally define the notions of things, properties, events, processes, agents, intentions and relationships among them thus providing a single unified framework to the concepts employed in systems modeling. In field of information systems modeling, ontologies have been applied as a foundational framework to evaluate the effectiveness of modeling languages. The topic of ontology is currently partially covered in AI courses with an objective to represent domain knowledge in AI applications. In such applications, a domain ontology is one of the core components. The current trend of building intelligent applications and devices further justifies the necessity of ontology training to software engineers.

Ontologies provide a set of categories that can be employed to describe a particular application domain, analyze an application domain, and express the facts about domain entities. During the task of ontological analysis, the focus of a modeler is directed on semantic issues of model elements and relating model elements to the kinds of objects found in the reality. During many systems analysis task (eg. CRC card, DFD), modelers are trained to think in terms of language constructs. During ontological analysis, a modeler engages in a systemic thinking rather than on capturing some fragmented views of a system. The philosophical discipline of Ontology makes least number of assumptions and it defines the concepts that are taken for granted in many specialized engineering courses on modeling languages, mathematics and logics. Hence the notion of system, kinds of systems, relationships of
| Systems Modeling Tasks       | Course                                      | Typical Coverage                                                                 |
|-----------------------------|---------------------------------------------|-----------------------------------------------------------------------------------|
| Data Modeling               | Data base Management (DBMS)                 | Entity and Relationship modeling, Query Languages, Transaction management, Architecture of DBMS |
| Object Modeling             | Object Oriented Analysis and Design (OOAD)  | Object-Oriented Programming, UML notation, Data Abstraction, Inheritance, Polymorphism, and Design Patterns |
| Function Modeling           | Information System Analysis and Design (ISAD) | Information gathering, Structured analysis, Functional decomposition. |
| Agent Modeling              | Artificial Intelligence (AI)                | Problem solving techniques, Knowledge representation, Logical reasoning. |
| Mathematical Modeling       | Discrete Mathematics (DM) and Theory of Computations (TOC) | First Order logic and Finite State Automata/State Modeling |
| Software Systems Development| Software Engineering (SE)                   | Engineering processes of software systems such as requirements analysis, design, coding, maintenance etc. |

Table 1: Systems Modeling Topics coverage in a Computer Engineering Curriculum

Systemic properties with its component, time, and time dependent properties are explicitly defined in an ontology. Thus bridging the loose connections existing between modeling abstractions and domain knowledge. The abstract concepts of finite automata, logical formulae, language abstractions provide system modelers a set of mechanisms to represent the objects from reality. Ontologies provide the content to employ these mechanisms during the task of systems modeling. The existing curricula adopt the mechanisms first approach while teaching systems modeling topics. The student’s comprehension of abstract concepts can be improved if these concepts are introduced through concrete ontological categories.

4. ONTOLGY: COURSE CONTENT
The course on ontology [3] can be taught during third or fourth semester of the undergraduate engineering programme. A typical course on ontology may include the topics such as: (i) Ontology as a philosophical discipline (ii) Upper level ontologies (iii) Ontological categories from Aristotle and Bunge ontology. (iv) Role of Ontology in Information Systems Modeling. (v) Ontology Specification Languages: Description Logic, OWL. (vi) Building Domain Ontologies. (vii) Applications of ontologies in engineering applications. The effect of ontology training in understanding scientific concepts has been assessed in other disciplines such as Physics and Medicine. Similar experiments can be conducted before introducing a full fledged course on ontology in computer engineering programme.

5. REFERENCES
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