Doctor of Business Economics

On the Symbioses between Conceptual Modeling and Ontology Engineering: Recommendation-Based Conceptual Modeling

Nadejda Alkhaldi

Promotors: prof. Wouter Verbeke, PhD, prof. Frederik Gailly, Phd and prof. Sven Casteleyn, Phd

Abstract

Within an enterprise, different conceptual models, such as process, data, and goal models, are created by various stakeholders. These models are fundamentally based on similar underlying enterprise (domain) concepts, but they have a different focus, are represented using different modelling languages, take different viewpoints, utilize different terminology, and are used to develop different enterprise artefacts (such as documents, software, databases, etc.); therefore, they typically lack consistency and interoperability. Another issue is that modelers have different vocabulary selections and different modeling styles. As a result, the enterprise can find itself accumulating a pile of models which cover similar aspects in different manners. Those models are not machine-readable and cannot be processed automatically. Enterprise-specific ontologies (ESOs) aim to solve this problem by serving as a reference during the conceptual model creation. Using such a shared semantic repository makes conceptual models interoperable and facilitates model integration. However, managing those ontologies is complicated; an enterprise is an evolving entity, and as it changes, the ESO might become outdated.

This research aims on the one hand, to assist modelers within an enterprise to create interoperable conceptual models by basing them on the ESO. To do so, the ESO has to be encapsulated and presented to the modelers through an interface which does not require advanced knowledge on ontologies. Since the ESO can be very extensive in size, the proposed solution must incorporate recommendation services to support the modeler in viewing the ESO concepts in an ordered and supportive manner. On the other hand, the thesis proposes a solution for ESO maintenance within the enterprise, and investigates possibilities to systematically update the ESO according to the evolving knowledge of the enterprise.
During the years of research dedicated to this dissertation, the Recommendation-Based Ontology Evolution and Conceptual Modeling (CMOE+) framework was developed. This framework establishes a symbiotic relationship between the Ontology engineering and the Conceptual modeling fields. CMOE+ consists of two cycles: the Ontology Evolution cycle and the Conceptual Modeling cycle. The Ontology Evolution cycle is responsible for setting up the initial version of the ESO and updating it as the knowledge within the enterprise is updated. Additionally, this cycle encapsulates recommendation services to perform ontology look-up and to present the most relevant ESO concepts in support of the modeler. The Conceptual Modeling cycle is responsible for the creation of conceptual models in different modeling languages based on the ESO. This cycle is also concerned with the quality evaluation of the created models. CMOE+ was developed based on requirements identified as a result of a literature review and a case study. The development process follows the Design Science Research Methodology (DSRM). After the initial version of CMOE+ was put forward, I continued to gradually improve the framework in iterations until it reached its current state. CMOE+ is a general framework which is not bound to a particular modeling language. Moreover, different phases of CMOE+ can be adapted to accommodate the particular needs of the enterprise.

In order to demonstrate the performance and usability of CMOE+, it was exemplified for process modeling using BPMN. This thesis presents a detailed instantiation, and explains which steps are to be performed in order to instantiate CMOE+ for other modeling languages. In order to evaluate this instance of CMOE+, a CMOE+BPMN tool was implemented. This tool incorporates a BPMN modeler, facilitates storage and access of the ESO, and includes all algorithms functioning within CMOE+ for the BPMN modeling language (as some of the algorithms are language dependent). Next, CMOE+ was exemplified using the i* goal modeling language. Finally, we tested the ability of CMOE+ to perform alignment between i* and BPMN models, in order to show that CMOE+ is indeed beneficial in achieving interoperability among models created in different modeling languages and covering distinct aspects of the enterprise.

The main contributions of this thesis are summarized as following:

1. Proposing a comprehensive framework for conceptual model creation based on an ESO, while simultaneously updating the ESO based on the knowledge captured from those models. This framework is language-independent, and it improves model interoperability already during model creation. Additionally, this framework applies the theory of ontological analyses of the modeling language in practice.

2. Establishing recommendation services which access the ESO, scan it, and, by using a reconfigurable set of algorithms determine the ESO concepts with the most potential relevance for the modeler during model creation.

3. Implementing a prototype of the CMOE+BPMN tool which incorporates all the features addressed in this thesis. This tool was evaluated with students using Moody’s Method Evaluation Model (MEM). Moreover, this work explains what needs to be adjusted while instantiating CMOE+ for other modeling languages.
4. Presenting guidelines for maintaining the ESO up to date and relevant to the enterprise. Those guidelines include capturing the changes, evaluating them, and using the worthwhile changes to evolve the ESO to its next version.