Chapter XII

Learning Systems and Their Engineering: A Project Proposal

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ABSTRACT

This chapter presents a project proposal that defines future work in engineering the learning processes in cognitive systems. This proposal outlines a number of directions in the fields of systems engineering, machine learning, knowledge engineering and profile theory, that lead to the development of formal methods for the modeling and engineering of learning systems. This chapter describes a framework for formalization and engineering the cognitive processes, which is based on applications of computational methods. The proposed work studies cognitive processes in software development process and considers a cognitive system as a multi-agents system of human-cognitive agents. It is important to note that this framework can be applied to different types of learning systems, and there are various techniques from different theories (e.g., system theory, quantum theory, neural networks) can be used for the description of cognitive systems, which in turn can be represented by different types of cognitive agents.

BACKGROUND

It is recognized that most software development tasks are cognitively driven and the focus on people quality and their management may provide considerable software process improvement (Curtis, 1981; Kellner & Hansen, 1989; Kellner& Rombach, 1991; Sommerville & Rodden, 1996). However, most existing process models and conventional project management approaches do not consider cognitive processes (Plekhanova, 1999a) and human resource quality (Sommerville & Rodden, 1996). Instead, they over emphasize the technical components. For this reason, their practical application is restricted to those projects where human resources are not a critical variable. Formal representation and incorporation of cognitive processes (Plekhanova, 1999a) and human aspects in modeling frameworks is seen as very challenging for software engineering research (Kellner & Hansen, 1989; Kellner & Rombach, 1991; Rombach, 2001).

The proposed project brings together work in systems engineering, knowledge engineering and machine learning for modeling cognitive systems and cognitive processes. We consider engineering the cognitive processes as the application of mathematical techniques and engineering methods to cognitive processes. We believe that the establishment of engineering methods with a sound theoretical basis can lead to the improvement of cognitive processes in software projects. We also use a synthesis of formal methods and heuristic approaches to engineering tasks for the evaluation, comparison, analysis, evolution and improvement of processes.

In this work we consider human resources as a cognitive system. The aims of the project are to develop a formal method for the modeling and engineering of a cognitive system in order to support the required learning processes.

In order to define learning processes, we engineer cognitive processes via a study of knowledge capabilities of cognitive systems. We are not interested in chaotic activities and interactions between cognitive agents, nor interested in detailed tasks descriptions, detailed steps of performance of the tasks and internal pathways of thoughts. Rather, we are interested in how available knowledge/skills of cognitive agents satisfy required knowledge/skills for the performance of the cognitive tasks.

We address the problem of cognitive system formation with respect to the given cognitive tasks and consider the cognitive agent's capabilities and compatibilities factors as critical variables, because these factors have an impact on the formation of cognitive systems — the performance processes and different learning methods.

We recognize that different initial knowledge capabilities of the cognitive system define different performance and require different hybrid learning methods. We study how human-cognitive agents utilize their knowledge and skills for learning the cognitive tasks. Learning methods lead the cognitive agent to the solution of cognitive problems/tasks. We consider a learning method as a guider to the successful performance. That is, we correlate initial knowledge capabilities of human agents with learning methods that define cognitive processes. We analyze

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