Chapter XI
Research Issues in Knowledge-Based Configuration

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ABSTRACT

Knowledge-based configuration systems have made their way into industrial practice. Nowadays, all major vendors of configuration systems rely on some form of declarative knowledge representation and intelligent search techniques for solving the core configuration problem, due to the inherent advantages of that technology: On the one hand, changes in the business logic (configuration rules) can be accomplished more easily because of the declarative and modular nature of the knowledge bases, while on the other hand highly-optimized, domain-independent problem-solving algorithms are available for the task of constructing valid configurations. Still, the development has not come to an end as, in a world that becomes increasingly automated and wired together, constantly new challenges for the development of intelligent configuration systems come in: Web-based configurators are being made available for large heterogeneous user groups, the provision of mass-customized products requires the integration of
companies along a supply chain, and configuration and reconfiguration of services become an increasingly important issue, just to name a few. This chapter gives an overview on these current and future research issues in the domain of knowledge-based configuration technology, and thus summarizes the state-of-the-art, recent achievements, novel approaches, and open challenges in the field.

INTRODUCTION

One of the earliest and most successful expert systems introduced in an industrial environment was a product configurator, when, in the early 1980s, Digital Corporation developed the R1/XCON (McDermott, 1982) system for automating the configuration process for their complex computer systems. Although R1/XCON was one of the first systems of that kind, two typical aspects in the context of configuration systems have not changed since then:

a. It has been proven that using an intelligent product configurator will lead to significant business benefits: Suitable configurations and accompanying offers can be calculated much faster, the quality of the configurations is comparable or better than the one of manually-engineered solutions, and the process itself is less error-prone, which in turn leads to considerable savings for a company (Barker, O’Connor, Bachant, & Soloway, 1989; McDermott, 1982).

b. There is also another side of the medal, which is, for instance, documented in Barker et al. (1989), also for the R1/XCON system: The configuration task itself can become very complex, and the corresponding knowledge bases soon have to contain information on thousands of components and configuration rules; that is, after 10 years of production, the R1/XCON system contained around 10,000 configuration rules. This in turn leads to different problems. So, for instance, maintenance of the knowledge base becomes an issue, in particular in domains where product life cycles are short and changes in the products are frequent. In addition, when the knowledge bases grow, also the running times for checking or constructing a configuration can significantly increase, potentially resulting in performance problems. Finally, as also mentioned already in McDermott (1982), for all of the engineering tasks, highly-skilled and trained development staff is needed for maintaining the knowledge bases and/or improving the configurator software.

Due to the inherent complexity of the task, configuration problems have since then always been subjects of interest for researchers in different areas, in particular in the field of artificial intelligence (AI). In fact, significant advances have been made since these early, “rule-based” years: Powerful knowledge representation schemes for configuration problems have been developed (McGuiness & Wright, 1998b; Mittal & Frayman, 1989), a formalization of the problem has been done (Felfernig, Friedrich, Jannach, & Stumptner, 2004), the invention of new algorithms was driven by the challenges of the domain (Fleischanderl, Friedrich, Haselböck, Schreiner, & Stumptner, 1988; Mittal & Falkenhainer, 1990), industrial-strength software libraries are now available (Mailharro, 1998) and knowledge-based configurators are nowadays already incorporated in standard business software (see, for instance, Haag, 1998).

Nonetheless, the developments of today’s networked economy constantly bring in new challenges and requirements for current and future product configuration systems. For instance, the life cycles of, for example, electronic products still continue to become shorter and shorter while, on the other hand, the products tend to be more complex, which in turn requires even better knowledge-representation and modeling
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