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GUEST EDITORIAL

Special Issue: Configuration

ALEXANDER FELFERNIG,[1] MARKUS STUMPTNER,[2] AND JUHA TIIHONEN[3]

[1]Institute for Software Technology, Graz University of Technology, Graz, Austria
[2]Advanced Computing Research Centre, University of South Australia, Adelaide, Australia
[3]Department of Computer Science and Engineering, Aalto University, Helsinki, Finland

Configuration can be defined as the composition of a complex product from instances of a set of component types, taking into account restrictions on the compatibility of those component types. For supporting product configuration, different artificial intelligence (AI) approaches are well established as central technologies in industrial configuration systems. However, the wide industrial use of configuration technologies and the increasing size and complexity of configuration problems make the field more challenging than ever. Today the mass customization paradigm has been extended from traditional physical products to the fields of software and service configuration. Configuration systems have evolved into interactive Web-based applications that need to support highly sophisticated knowledge representation and reasoning methods. A wide range of AI techniques are applied in this context: just to mention a few, constraint satisfaction, intelligent user interfaces, preference handling, and explanations.

As a successful AI application area, configuration has attracted lasting industrial interest and renewed research, as demonstrated by a series of workshops on configuration that have been arranged in conjunction with leading AI conferences such as IJCAI, ECAI, and AAAI.

The goal of this Special Issue on configuration is to demonstrate novel and innovative configuration research as well as new industrial applications of configuration technologies. The contributions of this Special Issue on configuration are a continuation of high-quality papers in previous special issues on configuration published in such journals as *IEEE Intelligent Systems* (1998), *AI EDAM* (1998 and 2003), and *International Journal of Mass Customization* (2010). The seven papers (five full-length papers and two short papers) were selected from 17 submissions, which corresponds to a full-length paper acceptance rate of 29%. Each paper underwent two to four double-blind reviews by experts in the configuration domain. Papers with a positive reviewer feedback after the first review round were reviewed again to assure that all of the reviewer comments of the first round had been taken into account. The reviews of papers that included a coeditor as an author were managed in a screened manner by uninvolved coeditors or members of the Special Issue program committee.

The major topics of the current Special Issue include personalization techniques and algorithms in knowledge-based configuration, different issues of configuration knowledge representation, industrial configuration environments and new application domains, and business-oriented aspects of the application of configuration technologies.

"Modeling and Solving Technical Product Configuration Problems" by Andreas Falkner, Alois Haselboeck, Gottfried Schenner, and Herwig Schreiner contains an introduction to the "partner units" problem and provides a discussion of possible alternative knowledge representation approaches (e.g., Unified Modeling Language/Object Constraint Language and Alloy). In addition, the paper contains a discussion of possible approaches to solve the "partner units" problem (from basic backtracking to local search approaches such as "simulated annealing"). The paper is concluded with an in-depth analysis of the applied search algorithms.

In their short paper on "Product Configuration as Decision Support: The Declarative Paradigm in Practice" Albert Haag and Steffen Riemann discuss knowledge representation issues in the SAP configuration environment. As an application domain for configuration technologies they introduce the customization of SAP systems. Besides the discussion of the advantages and trade-offs of procedural and declarative knowledge representations, the authors provide an in-depth discussion of the application of assumption-based truth maintenance approaches in their configuration environment.

"A Declarative Framework for Work Process Configuration," written by Wolfgang Mayer, Markus Stumptner, Peter Killisperger, and Georg Grossmann, extends established constraint-based configuration approaches with a constraint representation language for representing specific properties of execution paths in work processes. In this context, a framework for semiautomated process customization is introduced. It integrates the extended constraint approach with a metamodel of work processes. Valid process configurations are then semiautomatically built on the basis of heuristic search.

In their short paper on "Reasoning about Conditional Constraint Specification Problems and Feature Models" Raphael

Reprint requests to: Alexander Felfernig, Institute for Software Technology, Graz University of Technology, Inffeldgasse 16b, Graz A-8010, Austria. E-mail: alexander.felfernig@ist.tugraz.at

Finkel and Barry O'Sullivan show how techniques from formal methods and answer set programming can be applied to represent conditional constraint satisfaction problems. Besides the intuitive handling of variable existence, their knowledge representations allow for "model reflection" in that several kinds of model flaws can be automatically detected, for example, a variable declared as optional is actually required in all solutions.

"Personalized Diagnoses for Inconsistent User Requirements" by Alexander Felfernig and Monika Schubert provides a discussion of the advantages of applying different types of personalization techniques (e.g., utility-based and content-based recommendation) to identify preferred diagnoses in interactive configuration settings. A diagnosis denotes a minimal set of user requirements that has to be adapted or relaxed to identify a solution. Such functionalities are especially useful in "open configuration" scenarios where the user is free to select options and the configurator provides explanations in the case of inconsistencies.

In their paper on "Adaptive Attribute Selection for Configurator Design Via Shapley Value" Yue Wang and Mitchell Tseng introduce concepts that support the personalized ranking of questions posed to users within the scope of interactive configuration sessions. The overall goal is to keep the number of needed interaction steps with a configurator as low as possible, that is, to ask only those questions that are relevant for the user in a certain configuration context. The method that they introduce iteratively selects the attributes (questions) that best contribute in terms of information content from the pool of remaining unanswered questions.

Finally, "The Impact of Product Configurators on Lead Times in Engineering Oriented Companies," by Anders Haug, Lars Hvam, and Niels Henrik Mortensen, summarizes the results of a study on the impact of configuration technologies in commercial environments. Fourteen companies applying configuration technologies were analyzed regarding the impact of configuration technologies on processes related to the creation of quotes and product specifications. The study includes impressive outcomes, for example, the quotation lead time was reduced on an average by about 85%.

In sum, the papers of this Special Issue exhibit configuration as a continuously active field of research with new and challenging research questions and application domains attracting lasting industrial interest.

Alexander Felfernig is a Professor of applied software engineering at Graz University of Technology. Alexander is also Cofounder and Director of ConfigWorks, a company focused on the development of knowledge-based recommendation technologies. Prof. Felfernig's research focuses on intelligent methods and algorithms supporting the development and maintenance of complex knowledge bases. Furthermore, he is interested in the application of AI techniques in the software engineering context, for example, the application of decision and recommendation technologies to make software requirements engineering processes more effective. In 2009, Dr. Felfernig received the Heinz-Zemanek Award from the Austrian Computer Society for his research.

Markus Stumptner is a Professor of computer science at the University of South Australia, where he directs the Advanced Computing Research Centre. He received MS and PhD degrees in computer science from the Vienna University of Technology. Dr. Stumptner's research interests include object-oriented modeling, knowledge representation, and model-based reasoning in areas such as configuration and diagnosis.

Juha Tiihonen is a Researcher in the Department of Computer Science and Engineering at Aalto University School of Science (previously Helsinki University of Technology). He received his MS and LicSc degrees in computer science from Helsinki University of Technology. His main interest is product and service configuration in its various forms, including modeling, configurators, operations management aspects of business processes based on product and service configuration, and design for configuration. Mr. Tiihonen's most recent research includes recommendation support for configurable offerings and installed base management of complex products.

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