Editorial

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Biographical notes: Juha Tiihonen is a Researcher and Project Manager at the Department of Computer Science and Engineering of the Aalto University School of Science and Technology (previously Helsinki University of Technology). He received his MSc (Tech.) and Lic.Sc. (Tech.) in Computer Science from Helsinki University of Technology. His main interest is product and service configuration in its various forms, including modelling, configurators, operations management aspects of business processes based on product and service configuration, and design for configuration. The most recent work includes recommendation support for configurable offerings. He has led several configuration related research projects.

Alexander Felfernig is a Professor at the Graz University of Technology. His research concentrates on different aspects of intelligent systems and business informatics such as knowledge-based configuration of complex products and services, knowledge-based recommenders in e-commerce, and model-based

diagnosis with a special focus on knowledge acquisition and maintenance for complex products and services. In these research areas, he coordinates industrial and research projects, organises scientific events and has published more than 100 articles in international journals and conferences. Furthermore, he is the Managing Director of ConfigWorks, a company developing interactive recommendation technologies.

Markus Zanker is an Assistant Professor in the Department for Applied Informatics at the University of Klagenfurt. His research interests focus on knowledge-based systems, particularly in the fields of interactive sales applications such as product configuration and recommendation. He also works on knowledge acquisition and user modelling for personalisation. He is an Associate Editor of the *International Journal of Human-Computer Studies* and the Co-founder and Director of ConfigWorks GmbH, a provider of interactive selling solutions.

Tomi Männistö is a Professor of Software Engineering at the Aalto University School of Science and Technology. He leads the Preago research group conducting research on software architecture and quality variability, software product families and flexible requirements engineering. He lectures on software architecture and software engineering research methods. Previously, he has led a number of research projects in his above-mentioned topics of interest.

1 Introduction

Configurable products are an important way to achieve the benefits of mass-customisation. The design of a configurable product comprises a set of pre-designed components and rules on how these can be combined into valid product individuals that meet the requirements of particular customers. A configurable product has been pre-designed to meet a given range of different customer requirements. Within this range, only routine design is required (Mittal and Frayman, 1989; Tiihonen et al., 1998). Configurable products are applied in many industries such as automobiles, machinery, computers, telecommunications and furniture.

Business operations based on configurable products can provide many economical, organisational, operational and long-term benefits to the supplier and its customers these were reviewed in Heiskala et al. (2007). On the other hand, many challenges need to be addressed. These challenges include increased need for managing information and knowledge on product families, and creation and management of individual configurations for specific customers (Heiskala et al., 2007).

2 Configurators – high-tech support for business based on configurable products

Many challenges of business based on configurable products can be effectively alleviated by applying information technology. One could even state that large scale utilisation of configurable products is practically impossible without adequate and effective support of information technology. A class of systems, configuration systems or configurators, makes it possible to represent the variability of configurable products by creation and

management of configuration models that contain all the information on the possibilities of adapting the product to customer needs in pre-designed ways. Most importantly, they support users (customers, sales persons) in performing the configuration task, i.e. specifying a product individual conforming to customer requirements while ensuring consistency and completeness of the final configuration. A configuration specifies the corresponding product individual(s) and affects subsequent manufacturing or assembly (Tiihonen et al., 1998; Sabin and Weigel, 1998).

The history of knowledge-based configurators dates back to the first rule-based systems for ensuring the technical correctness of customer-defined orders for computer systems (Barker et al., 1989). Nowadays, different artificial intelligence (AI) techniques are well-established as central technologies in many industrial configuration systems. Powerful knowledge-representation formalisms are necessary to capture the great variety and complexity of configuration models, to facilitate shorter development cycles of configurator instances, and to provide a high degree of maintainability. Furthermore, efficient reasoning methods are required to provide intelligent interactive behaviour in configuration systems, such as solution search, satisfaction of user preferences, personalisation, optimisation, diagnosis, etc.

The field of configurators is more challenging than ever: the complexity of configurable products still increases, the mass-customisation paradigm is extended to fields like service and software configuration, and the integration of configurators into surrounding IT infrastructures like business information systems or web applications has become critical. Further, with the advent of web-based commerce, configuration systems have had to satisfy new requirements such as online availability, ease-of-use, and personalised user interaction and user preference elicitation in the configuration process. Tailoring the configuration process to the assumed informational needs and technical capabilities of the user, or personalising selection options based on past interaction logs has recently been identified as an avenue for further research in the field (Ardissono et al., 2002; Zanker and Tiihonen, 2008).

A natural 'home venue' for much of the configuration research have been configuration workshops. Since AAAI'96 Fall Symposium (Cambridge, MA), 12 workshops have been arranged in conjunction with leading AI conferences IJCAI, AAAI, and ECAI. The workshops have attracted both researchers working in the various fields of applicable AI technologies and industrial participants from major configurator vendors and large end-users organisations.

3 Research contributions in this issue

This special issue on configuration includes six papers. They are extended and revised versions of papers selected from the workshop on configuration systems arranged in conjunction with the 18th European Conference on Artificial Intelligence (ECAI, 2008) (Tiihonen et al., 2008), augmented with one paper from the 2009 workshop.

The articles respond to the trend of extending configurator functionality towards personalised recommendations and to new application areas such as embedded software and service configuration. Further, the foundations of configuration are addressed through a novel metamodelling approach that can unify existing conceptualisations and could effortlessly generate conceptualisations with a close match to specific domains

while providing an efficient implementation. Integer programming is presented as an alternative reasoning approach for declarative configuration models, augmenting the traditionally applied constraint satisfaction and logic-based approaches.

'Towards an association of product configuration with production planning' by Michel Aldanondo, Elise Vareilles and Mériem Djefel addresses a highly relevant topic: ensuring the completeness and consistency of a configuration is not enough, it is also often crucial to know the expected delivery time. When delivery time is critical, selections in the configuration process may be affected by their corresponding delivery times, and some options are not feasible. Modelling configuration and production planning problems as connected constraint satisfaction problems enables taking both configuration and production planning views simultaneously into account.

'A metamodelling approach to configuration knowledge representation' by Timo Asikainen and Tomi Männistö discusses conceptual and semantic foundations of product configuration. They present the metamodelling language Nivel that can represent configuration knowledge on three levels of abstraction, starting from configuration modelling concepts through configuration models describing product families to actual configurations specifying product individuals. Major parts of the semantics for existing configuration modelling languages are obtained as a by-product of defining a configuration modelling language using Nivel.

'Computing product configurations via UML and integer linear programming' by Andreas Falkner, Ingo Feinerer, Gernot Salzer and Gottfried Schenner describes an approach for declaratively modelling configuration problems with specific UML elements, and translating the models to systems of integer inequalities, which provides a well-defined semantics and enables efficient reasoning. In addition, the paper identifies challenges arising from applying class diagrams for product configuration and proposes corresponding solutions.

'Constraint-based configuration of embedded automotive software' by Mihai Nica, Bernhard Peischl and Franz Wotawa presents a new application domain for configuration. Embedded software deployment to hardware units in complex products such as cars is critical for security. Simultaneously, costs need to be optimised. The authors apply configuration techniques for optimally assigning software function blocks to available hardware units while respecting performance and safety constraints. The problem scenario is described, and the problem domain formalised. Furthermore, empirical results are provided.

'Towards recommending configurable offerings' by Juha Tiihonen and Alexander Felfernig. Avoiding the phenomenon of mass-confusion is of great practical relevance for customers of companies offering configurable products and services. The paper proposes augmenting knowledge-based configurators with recommendation systems. It identifies different scenarios for such hybrid systems, reviews the existing literature on the topic, and proposes extensions to existing case-based recommendation algorithms.

Finally, 'Constraint-based personalised configuring of product and service bundles' by Markus Zanker, Markus Aschinger and Markus Jessenitschnig proposes an actual system design that combines recommendation technology with constraint-based configuration. They configure customer specific service bundles such as proposals for tourist agendas or financial services. The combination of these techniques ensures correctly configured solutions while supporting the user with personalised recommendations. A prototype implementation shows performance that is adequate for practical scenarios.

References

Ardissono, L., Felfernig, A., Friedrich, G., Goy, A., Jannach, D., Meyer, M., Petrone, G., Schäfer, R. and Zanker, M. (2002) 'Personalizing on-line configuration of products and services', in Harmelen, F.V. (Ed.): *Proceedings 15th European Conference on Artificial Intelligence*, IOS Press, p.225.

Barker, V.E., O'Connor, D.E., Bachant, J. and Soloway, E. (1989) 'Expert systems for configuration at digital: XCON and beyond', *Communications of the ACM*, Vol. 32, No. 3, pp.298–318.

Heiskala, M., Paloheimo, K. and Tiihonen, J. (2007) 'Mass customization with configurable products and configurators: a review of benefits and challenges', in Blecker, T. and Friedrich, G. (Eds.): *Mass Customization Information Systems in Business*, 1st ed., IGI Global, pp.1–32.

Mittal, S. and Frayman, F. (1989) 'Towards a generic model of configuration tasks', *Proceedings of the Eleventh International Joint Conference on Artificial Intelligence (IJCAI)*, p.1395.

Sabin, D. and Weigel, R. (1998) 'Product configuration frameworks-a survey', *IEEE Intelligent Systems*, Vol. 13, No. 4, pp.42–49.

Tiihonen, J., Felfernig, A., Zanker, M. and Männisto, T. (Eds.) (2008) *Proceedings of ECAI 2008 Workshop on Configuration Systems*.

Tiihonen, J., Soininen, T., Mannisto, T. and Sulonen, R. (1998) 'Configurable products – lessons learned from the Finnish industry', *Proceedings of the 2nd International Conference on Engineering Design and Automation (ED&A '98)*, Integrated Technology Systems, Inc.

Zanker, M. and Tiihonen, J. (2008) 'Configuration and recommender systems: two converging research fields – conference report: ECAI 2008 workshops on configuration and recommender systems', *IEEE Intelligent Informatics Bulletin*, Vol. 9, No. 1, pp.3–4.