

CHOCO SLANG

Ph.D. position on CSP-based Modeling Language for Configuration Problems

Ph.D. Context

One of the characteristics given for Industry 4.0 strategy is the strong customization of artefacts (products and services) under the conditions of highly flexible (mass-) production. This concept of customization, also called personalization or configuration, of artefacts consists in assembling predefined components or modules, to produce a unique and specific product or service among a large set of possible configurations.

For businesses and organisations, this is a way to offer personalized products or services to stand out from the competition, to enhance the service quality, to improve customer satisfaction and to build customers' loyalty through more accurately reflecting their tastes and needs. In one hand, this is true whatever the targeted activity sector: (1) secondary sector with configurable products, such as cars, computers, etc, (2) tertiary sector with personalized services, such as insurance, care pathways, etc. On the other hand, the need for customizable artefacts is totally independent of the company's business model, i.e. business-to-customer (B2C) or business-to-business (B2B) models. Thanks to IT technologies and especially configurators, this personalization is done directly and interactively online.

The major difficulty of personalization or configuration of products, and services lies in managing the offered diversity : how to be sure that all the combinations of choices, variants and options are consistent, achievable in a reasonable time, affordable price and best service quality ?

Work to be done during the Ph.D.:

Artefact configuration relies on a generic model gathering knowledge about:

- requirements and desires on artefact definition,
- artefact components and modules including their compatibility, incompatibilities and dependency (defining the generic artefact architecture),
- product production or manufacturing process.

Constraint satisfaction problems or CSP are very often used to formalize product configuration problems in both research and industry. CSP formalize relevant knowledge through variables, each one associated to a definition domain, linked by constraints, limiting the combinations of their permissible values. Thus, CSP make it possible to describe exhaustively the solution space, corresponding to a set of all possible products.

The formalization of this generic problem as a CSP is one of the key issues of configuration problem. The modelisation language on the top of a CSP has to be generic enough to cope with all the sources of knowledge, all the natures of constraints and several application fields.

One of the methods of processing CSP in an interactive way lies on problem filtering methods (reasoning directly on the CSP network and removing inconsistent values). Dedicated tools, such as ChocoSolver¹, can be used to progressively converge to a solution.

¹<http://www.choco-solver.org/>

Knowing this context, the aim of the Ph.D. is therefore to:

- define a generic and complete modelisation language able to formalize various types of knowledge,
- design, develop and test a configuration problem modeler,
- interface it with ChocoSolver,
- validate the proposals on several industrial cases coming from academics and Cosling².

This work is part of a broader configurator development initiative at Cosling, with which the Ph.D. student will work closely together.

Ph.D. Applicant Profile and General Information

The candidate with the following interests are welcome:

- advanced skills in programming in Java (design and implementation),
- knowledge in Operation Research / Constraint Programming
- interest in knowledge-based systems and design-aiding systems,
- willingness to combine theoretical with practical work,
- good spoken and written communication skills (French and English).

An accepted article in a conference on Artificial Intelligence or Industrial Engineering topics would be an advantage.

The Ph.D. student will be directly employed by Mines Albi for 3 years. The salary is approximately 1800 euros per month (gross salary). The Ph.D. thesis is conducted between two teams: the ORKID research team³ of the Industrial Engineering Lab of IMT Mines Albi and the TASC research team⁴ of the lab of digital sciences of Nantes (LS2N) supported by IMT Atlantique.

Therefore, the Ph.D. student's time will be split between Albi and Nantes (18 months in Albi then 18 months in Nantes) with every two months trips from one site to another.

²<https://www.cosling.com/>

³<https://gind.mines-albi.fr/en/axe/orkid>

⁴<https://www.ls2n.fr/equipe/tasc/?lang=en>

Ph.D. Supervisors Biographies

The thesis is co-supervised by Dr. Élise Vareilles as Ph.D. director, Dr. Charles Prud'Homme as Ph.D. co-director, Pr. Michel Aldanondo as Ph.D. supervisor and Dr. Jean-Guillaume Fages as Ph.D. industrial expert.

Dr. Élise Vareilles⁵ has been an Associate Professor at the Toulouse University Mines Albi, France since 2005. She received her Ph.D. in 2005 and won the prize for the best Ph.D. thesis of INP Toulouse in the same year. She received her accreditation to supervise research (HDR) in the field of Industrial Engineering in 2015. She works on the development of interactive aiding design tools based on knowledge and is part of the development and the improvement of the CoFiADe software. Since 2005, she has supervised 7 thesis and she has been involved in 6 national or international research projects, always with industrial partners. She is the co-author of more than 65 papers including 15 articles in Web of Sciences journals and 45 papers in high level international conferences with a selective committee. Since January 2016, she has been the leader of the ORKID (Organization, Risk, Knowledge in Design) research team.

Dr. Charles Prud'Homme⁶ obtained his Ph.D. in 2014 at the Ecole des Mines de Nantes, France. After having been a research engineer for 4 years, he has been working as an Associate Professor at IMT Atlantique, Nantes campus, since 2018. His research interests include Constraint Programming, Solver Design and Operational Research. He is the author of 8 international publications, including top-ranked conferences and revues in his field (CP, Constraints) and he has been involved in 3 national research projects. He is also the project leader and main contributor of Choco solver, a Free Open-Source Java library dedicated to Constraint Programming. Over the years, Choco won many prizes in various international constraint programming solvers competitions (MiniZinc, XCSP3).

Pr. Michel Aldanondo⁷ is a Full Professor, former head of the Industrial Engineering Laboratory of Toulouse University - Mines Albi, France. He teaches some design and operation management courses mainly at the graduate level. He concentrates his researches on the development of interactive knowledge based aiding design tools and more specifically aiding configuration systems. He has directed 15 Ph.D. students and more than 80 master students. He has published more than 150 articles in journals and conference proceedings. He has been involved in six large multipartner collaborative research projects at the national and international levels.

Dr. Jean-Guillaume Fages⁸ obtained his Ph.D. in 2014 at the Ecole des Mines de Nantes, France. His work has been awarded by the AFIA prize and the ACP Doctoral Research award. His research interests include Constraint Programming, Solver Design, Configuration and Operational Research. He is also a major contributor of Choco solver. After his doctoral studies, he founded Cosling to supply the industry with decision support solutions relying on these technologies. Cosling has developed configurators and schedulers for major players, such as the French Air Force, Airbus, SNCF, VINCI and REXEL (read more www.cosling.com).

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Procedure and Contact

Send your detailed Curriculum Vitae and references to [Élise Vareilles⁹](mailto:elise.vareilles@mines-albi.fr), [Charles Prud'Homme¹⁰](mailto:charles.prudhomme@imt-atlantique.fr) and [Jean-Guillaume Fages¹¹](mailto:jg.fages@cosling.com) highlighting your assets. You will be informed rapidly whether you have been selected for an oral presentation, which will take place either in Nantes, Albi or by Skype. The Ph.d. starts at Fall 2019.

Please contact us for more information:

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