

Research Topic for the ParisTech/CSC PhD Program

Subfield: Computer Science

ParisTech School: AgroParisTech

Title: Evolutionary Multi-Objective Optimization for Eco-Design of Dairy Food Products

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Short description of possible research topics for a PhD:

Food systems need considerable environmental improvements to face sustainability challenges. Such improvement, termed eco-design, can only be achieved by jointly considering sustainability objectives with constraints on quality of food (sanitary, nutritional, sensory...) and on processes (available technologies, mastering of the working conditions...). Current research on the topic is starting to address the need for innovative approaches, using a combination of model simulations and multi-objective optimization on different criteria related to environmental impacts, quality of food and process conditions.

Evolutionary algorithms (EA) are optimization techniques that are routinely used to tackle NP-hard problems, for which traditional Operational Research algorithms are unable to find the optimal solution in a finite amount of time. EAs also represent the de-facto state of the art in Multi-Objective optimization (MOEA). While there are already publications coupling environmental assessment with MOEAs, eco-design still represents a considerable challenge even for such effective optimization algorithms: in particular, as the number of objectives to optimize grows, the performance of MOEAs decreases, with repercussions on the quality of the solutions.

The objective of this project is to develop and apply innovative MOEA techniques to the eco-design of food products, in particular fermented dairy products such as cheese. Reproducing computer models from literature, and obtaining new models from available datasets (resorting to machine learning or classical modelling techniques), the candidate will simulate a considerable part of the production chain, with the ultimate objective of optimizing its parameters and obtain a set of optimal trade-offs between relevant criteria related to environmental impact, food quality and process conditions.

Required background of the student: Applicants need to have a master's degree in computer science or related disciplines, and a curiosity for real-world applications in the food processing/eco-design domain. Candidates need to be proficient in a modern programming language such as Python, C++ or Java. Experience in machine learning and/or multi-objective optimization is an advantage.

A list of 5(max.) representative publications of the group: (Related to the research topic)

- [1] N. Perrot, H. De Vries, E. Lutton, H. G.J. van Mil, M. Donner, A. Tonda, S. Martin, I. Alvarez, P. Bourguine, E. van der Linden, M. A.V. Axelos. 2016. Some remarks on computational approaches towards sustainable complex agri-food systems, Trends in Food Science & Technology, Volume 48, February 2016, Pages 88-101.
- [2] Aceves-Lara et al. In Press. The virtual food system: innovative models and experiential feedback in technologies for winemaking, the cereals chain, food packaging and ecodesigned starter production. Innovative Food Science and Emerging Technologies, accepted 10/2017.
- [3] P énicaud, C., Monclus, V., Perret, B., Passot, S., Fonseca, F. 2016. Production of Stabilized Lactic Acid Bacteria viewed from a Life Cycle Assessment perspective. LCA Food 2016, Dublin, IRL (2016-10-19 - 2016-10-21).
- [4] P énicaud, C., Trelea, I.-C., Perret, B., Fonseca, F., Passot, S. 2016. Freeze-Drying Control by taking into account Environmental Considerations. Food Factory 2016, Laval, FRA (2016-10-19 - 2016-10-21).