

Research Topic for the ParisTech/CSC PhD Program

Subfield: Computer Science

ParisTech School: the French agronomic research institution INRA (inra.fr)

Title: Agri-Food Model Exploration Using Interactive Machine Learning, Application to Sustainable Food Supply

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Short description of possible research topics for a PhD:

The search space for exploring models and their parameters is huge. Model builders have to answer many questions prior to selecting a particular model or family of models, such as: Which parameters are more influential, which ones are more sensitive to noise? Which models better explain the data, and which ones make more sense and are simpler? Although it is possible to explore and select models automatically, providing satisfying answers to the previous questions relies on direct feedback from domain experts, who often need to find the right compromise between multiple conflicting criteria.

Modelling frameworks that take into account human-model interactions at all model development stages are still a subject of ongoing research. Much work is still needed to enable domain experts to become truly co-builders of these models [2,5]. This requires thinking about new human-model interfaces and visualization techniques to bridge the gap between model specification & generation, and model inspection & validation. The aim of this thesis is to investigate suitable Interactive Machine Learning (IML) techniques to explore agri-food models [4], and to exploit user feedback to steer this exploration towards desirable areas of the search space [1,3].

The application concerns sustainable complex agri-food systems [4], namely cereal-based production. The candidate will explore a scenario of wheat-legume intercropping practices, which allows a strong reduction of fertiliser input use, and thus of pollution risks, while not compromising on the quality of the output product (e.g. protein content). The applicant needs to build models from data provided by the host institution, create an interactive environment to explore the model space, and evaluate their work with domain experts (also available at the host institution).

Required background of the student: Applicants need to have a masters degree in computer science or related discipline. Knowledge in agri-food or the application domain is not required. Candidates need to be proficient in a programming language such as Python, C++ or Java. Experience in machine learning and/or interactive visualization is an advantage.

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

- [1] N. Boukhelifa, A. Bezerianos, W. Cancino, and E. Lutton. 2017. Evolutionary visual exploration: evaluation of an IEC framework for guided visual search. *Evol. Comput.* 25, 1 (March 2017), 55-86.
- [2] N. Boukhelifa, A. Tonda, I. C. Trelea, N. Perrot, and E. Lutton. 2017. Interactive Knowledge Integration in Modelling for Food Sustainability: Challenges and Prospects. ACM CHI workshop on Designing sustainable food systems. http://www.foodchi.org/wp-content/uploads/2016/12/99.boukhelifa_foodchi.pdf
- [3] W. Cancino, N. Boukhelifa, and E. Lutton. EvoGraphDice: Interactive evolution for visual analytics. 2012. IEEE Congress on Evolutionary Computation, 1-8.
- [4] 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.