

Research Topic for the ParisTech/CSC PhD Program

Field: Mathematics and their applications

Subfield: Computer science

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

ParisTech School: The National Institute of Agricultural Research INRA (inra.fr)

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Lab: GMPA (team MALICES): https://www6.versailles-grignon.inra.fr/gmpa_eng/Research-teams/MALICES

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? 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 [2]. Robust human-model interfaces and visualization techniques are needed to bridge the gap between model specification & generation, and model inspection & validation. The aim of this thesis is to investigate suitable interactive visualization and machine learning techniques to explore agri-food models [4], and to exploit user feedback to steer this exploration towards “interesting” areas of the search space [1,3].

The application concerns sustainable complex agri-food systems [4], namely for cereal-based production. The applicant needs to work with data provided by the host institution, build on existing models, and create interactive machine learning and visualization techniques to explore the model space. He or she needs to evaluate their work with domain experts from the host institution.

Required background of the student:

Applicants need to have a master degree in computer science or related discipline. 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. Knowledge in agri-food or the application domain is not required.

A list of representative publications of the group:

- [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.