

Postdoctoral research associate position opened

Kriging-based distributed optimization on computing grids

**Ecole Nationale Supérieure des Mines de Saint-Etienne, France
Department of Applied Mathematics**

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Field of studies : applied mathematics and/or mechanical engineering and/or computer science.

Starting time : From June 2011 on (16 months).

Collaborators : Rodolphe Le Riche (CNRS permanent research associate), Janis Janusevskis (postdoctoral researcher).

Contacts : Rodolphe Le Riche (leriche@emse.fr), Janis Janusevskis (janisj@latnet.lv).

Laboratory : Henri Fayol Institute, National Institute of Science and Technology, Saint-Etienne, France (Ecole Nationale Supérieure des Mines de Saint-Etienne).

Salary : 1850 euros/month.

Scientific context for the postdoctoral position

Numerical optimization is a fundamental part of engineering sciences. It is involved for optimal design, optimal control and model identification. Numerical optimization is an iterative search process where an optimization algorithm repeatedly calls a simulation program in order to assess the performance of proposed solutions. An important difficulty for engineering optimization is the never decreasing computational cost of high-fidelity simulations.

The computational cost bottleneck can be tackled in two principal ways. Firstly, some of the high-fidelity simulations can be approximated by fast models. Kriging (i.e., conditioned gaussian processes) have proved [1] to be a promising way to approximate simulations because it provides an expected simulation result along with its uncertainty. Secondly, progress in computing power will mainly been achieved through networks of computers. The optimization methods studied will therefore be thought for distributed computing, which can be achieved using kriging [2,3].

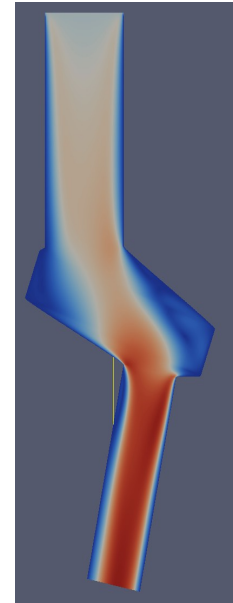
Related research program : this work is part of the French OMD2 research program (Distributed MultiDisciplinary Optimization, cf. <http://omd2.scilab.org>), funded by the French National Research Foundation (ANR, « Agence Nationale de la Recherche »). The OMD2 program is a joint work between Renault, INRIA, Université de Technologie de Compiègne, Ecole Centrale de Paris, Ecole Normale Supérieure de Cachan, Sirehna and CD-Adapco.

The Applied Mathematics Department has been the principal investigator of two national research programs (OMD and DICE) on design of experiments, uncertainty propagation in large simulation softwares and robust optimization. The Department is

also part of the national ANR / ID4CS (Integrated Design for Complex Systems) and reDICE projects.

Project Objectives

- *Methodological objectives* : development of formulations and methods for the kriging-based optimization of functions on computer grids.
- *Applications* : test cases will be *i)* analytical and *ii)* address the optimal design of air vents in car engine intake valves (which involves fluid mechanics simulations, in collaboration with Renault cars).
- *Programming* : the programming will be based on Scilab (an opensource clone to Matlab) and the ProActive middleware for distributing computations.



Project scientific originalities

- *Computing* : from the outset, the work specifically addresses the issue of working with computer grids, which means that the algorithms should be asynchronous and fault tolerant (to computing node crashes).
- *Methods* : Kriging offers a new optimal way to achieve asynchronous distribution of the optimization simulations. The distribution is optimal in the sense of a generalized expected improvement criterion [3].

References

- [1] Donald R. Jones, Matthias Schonlau, and William J. Welch. 1998. *Efficient Global Optimization of Expensive Black-Box Functions*. J. of Global Optimization 13, 4 (December 1998), 455-492.
- [2] Ginsbourger, D., Le Riche, R. and Carraro, L., *Kriging is well-suited to parallelize optimization*, chapter 6 of *Computational Intelligence in Expensive Optimization Problems*, Springer series in Evolutionary Learning and Optimization, Yoel Tenne and Chi-Keong Goh, Editors, *published online in March 2010*, ISBN: 978-3-642-10700-9, pp. 131-162, April 2010.
- [3] D. Ginsbourger, J. Janusevskis and R. Le Riche, *Dealing with asynchronicity in parallel Gaussian Process based global optimization*, Technical report hal-00507632, version 1, July 30 2010.

Candidate profile :

- Have a PhD in mechanical engineering (with a good background in mathematics) or applied mathematics (optimization) or computer science with a link to optimization.
- The candidate should like real world applications (an application in fluids mechanics will be done).
- The candidate should like programming (Scilab, use of a middleware).