PhD position in applied mathematics

Title: Spectral methods and non-stationary kernels in computer experiments

Domain: Applied mathematics.

PhD advisor: R. Le Riche (leriche@emse.fr).
Co-advisor: X. Bay (bay@emse.fr), O. Roustant (roustant@emse.fr).

Application deadline: 31st of May
PhD starts: October 2010
Location: Ecole Nationale Supérieure des Mines de Saint-Etienne (National Institut of Science and Technology at Saint-Etienne), France.
Salary: 1300 to 1600 euros / month

Scientific context
Computer experiments is addressing the study of costly industrial computer codes such as car crash-test simulators, neutronic softwares, etc. (see [Fang, Li, Sudjianto 2006], or [Santner, Williams, Notz, 2003]). Through the DICE project (www.dice-consortium.fr), the CROCUS team (http://3mi.emse.fr/) has developed successful methods for metamodeling. For instance, it has risen the interest of unusual spectral methods: in [Picheny, 2009], a close connection has been made between the design of experiments under a constant budget assumption and the spectral representation of Hilbert-Schmidt operators. In addition, promising results have been obtained with non-stationary kernels which allow taking into account some problem specificities such as symmetric response surfaces ([Ginsbourger, 2009]). Nevertheless, difficulties remain when modeling irregular response surfaces (a first solution is the treed Gaussian processes [Gramacy, 2007]).

Objectives
The objectives of this PhD are to extend the methodologies of response surfaces using spectral methods and non-stationary kernels. More precisely, two directions are going to be explored:
• The spectral representation of Hilbert-Schmidt operators will be used to i) find optimal designs suited for kriging metamodeling, ii) build Gaussian process models in high dimensions.
• The systematic analysis of non-stationary kernels will be performed, allowing to add application related knowledge to the kernel (e.g., symmetry), and as a consequence address a wider range of industrial applications.

The developed methods will be applied to problems related to fluids mechanics.

Bibliography
• Picheny V. (2009), Propagation d'incertitudes dans les grands codes de calcul modélisés par surfaces de réponses, Thèse de doctorat en co-tutelle avec l'université de Floride.


**Anticipated added value**

• Methodological improvements in the design and modeling of computer experiments.

**Candidate profile**

Applied mathematics: probability, functional analysis.  
Programming skills (R).  
Interest for computer experiments and their applications (fluids).