



## Master internship in applied mathematics

### Black-box optimization with continuous and categorical inputs

#### Context

This internship is proposed within the framework of the OQUAIDO Chair, which brings together partners from industry / technological research (BRGM, CEA, IRSN, STORENGY, IFPEN, SAFRAN) and academics (UPS Toulouse, ECL Lyon, Mines Saint-Etienne, UGA Grenoble, UNICE). The Chair is carrying on research at the cutting edge of uncertainty quantification, inversion and optimization for numerical simulation. Resulting works are regularly published in first level scientific journals and conferences. Additionally, R packages are developed and made available on the CRAN archive website.

The internship regards more particularly inversion and optimization questions guided by some industrial challenges and is conducted collaboratively with the CEA-DAM (Paris) and the CEA-LETI (Grenoble).

The intern will take part in the Chair life. In particular, he will be invited to the scientific meeting planned on May 22-24 at Lyon, as well as to a summer training session.

The work can be continued in a PhD in the Optics and Photonics Department of the CEA-LETI.

#### Research topic

The master work concerns the optimization of black-box functions guided by Gaussian process meta-modeling [1, 2]. The case of continuous inputs is well-known. On the other hand, little is known when there are some categorical inputs. This internship aims at filling the gap. Two real world applications will be considered.

#### Intern's agenda

- Bibliographic synthesis of optimization problems within a mixed variables framework ;
- Development of a relevant methodology ;
- Test on synthetic examples ;
- Application to an inversion problem in nuclear engineering ;
- Application to an optimization problem in photonics.

Deliverables include a technical report and algorithmic developments. The main contributions of the work may also be included in a publication.

## Required skills

Applicant should have in-depth knowledge in applied mathematics, especially in optimization and probabilistic modeling, and is familiar with a scientific programming language such as R or Matlab. An interest for physics and its applications would be appreciated.

## Research environment

- Main location : Ecole des Mines, 158 cours Fauriel, 42000 Saint-Etienne.  
A research stay at CEA-LETI (Grenoble) is possible.
- Duration : 6 months, from April 2018.
- Net salary : 550 €/ month.

## Key-words

Statistical learning, mixed variables optimization, Gaussian processes, numerical simulations, computationally expensive simulation, meta-modeling.

## Contacts

The applications should be sent as soon as possible to the following contacts.

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## References

- [1] Donald R. Jones, Matthias Schonlau, and William J. Welch. Efficient global optimization of expensive black-box functions. *J. Global Optimization*, 13(4) :455–492, 1998.
- [2] Carl Edward Rasmussen and Christopher KI Williams. *Gaussian processes for machine learning*, volume 1. MIT press Cambridge, 2006.