SOLVING THE INVERSE PROBLEM UNDER SEVERE UNCERTAINTY AND WITH MULTIPLE INFORMATION SOURCES.

Doctoral position, HEUDIASYC (UTC)

Thesis supervisors: Sebastien Destercke and Pierre Feissel

Context

Solving the inverse problem [3, 2] is an essential step in different domains (mechanic, biology, chemistry) to characterize a system by inferring model parameters through observed measurements. Such measurements are often of different natures and of varied precision.

For example, the multi-instrumentation of mechanical tests for the characterization of materials is based on the use of multiple measurement systems. While the use of digital cameras (coupled with digital image correlation tools) is generalized during the tests and makes it possible to obtain rich kinematic information (displacement fields), these data can be supplemented by thermal and acoustic emission measurements.

The idea of this thesis is to explore the challenges and opportunities raised by recent uncertainty theories to solve the inverse problem, in particular when multiple sources of information provide measurements.

Topic

The aim of this thesis is two fold:

- Develop new algorithms for the inverse problem exploiting new uncertainty approaches relaying on random sets or probability sets [1];
- Develop dedicated fusion methods to merge the obtained results from various measurement devices.

The objective is in particular to quantify the ouput uncertainties, in order to identify the models and to characterize the behaviors of the system or model. To achieve this, the applicant will have the possibility to rely on previous work and exploit the general framework of non-deterministic methods, in particular random sets and probability sets. THe results will be applied to mechanical systems studied at Roberval, and it will therefore be necessary to develop a strategy for the exploitation of mechanical tests and to implement it numerically, using in particular computational mechanics tools such as finite elements.

The targeted applications concern the characterization of aeronautical composite materials with two aspects: characterization of damage during loading and identification of non-linear material model. Yet the developed methods should be generic enough to be applied to inverse problems in general.

Environment

- Place of research: Roberval laboratory, CompiÃĺgne University of Technology (40 minutes by train from Paris)
- Salary: ∼ 20K€/year basic salary, possibly complemented by paid teaching activities
- Duration: 3 years
- Starting date: September/October 2017

The Roberval laboratory has also been recognized as a laboratory of excellence (LABEX) by the French government, providing it with necessary funds to ensure top-quality research as well as an international recognition.

Applicant profile and application requirements

The candidate must demonstrate (through her/his formation, previous projects, recommendations, grades, . . .) excellent skills in either mechanic, applied mathematics or computer science. In particular, we are searching for excellent skills in at least one of the following fields:

- Computational mechanics
- Optimisation
- Probability/statistics
- Numerical analysis

Applications and questions can be sent to <sebastien.destercke@hds.utc.fr>. Applications **must** include the following items:

- a letter of motivation detailing explicitly what are the interest of the applicant in the proposed topic;
- a curriculum vitae clearly showing how the candidate profile matches the above requirements;
- contact information of at least one reference (two or more would be appreciated).

Any application not containing these three items, or not tailored to this proposal, will not be considered further. In addition, the following optional items may be included:

- existing scientific papers or significant project reports;
- any link to significant realisations (e.g., software, . . .)
- copy of previously obtained grades.

References

[1] T. Fetz and M. Oberguggenberger. Imprecise random variables, random sets, and monte carlo simulation. *International Journal of Approximate Reasoning*, 78:252–264, 2016.
[2] A. Tarantola. *Inverse problem theory and methods for model parameter estimation.* SIAM, 2005.
[3] C. R. Vogel. *Computational methods for inverse problems.* SIAM, 2002.