THESIS G-SCOP 2019

Title : Robust Multiphysics Optimization and Multi goal Design

Thesis director (s) : Jean Bigeon / Co direction avec le professeur Michael Kokkolaras (McGill university –Montreal – Canada) optimisation

Phd school : IMEP2

Start date : October 2019

Financements envisagés – Contexte – Partenaires éventuels :

Brief Description:

Context :

Some continuous optimization problems in engineering do not have the structure to be able to use classical optimization methods. Indeed, optimization target and its constraints are given as black boxes obtained by numerical simulations. Usually the simulation takes a lot of time. Sometimes the computation can fail due to internal reasons of the black box. As it's impossible to evaluate the derivatives in these cases, we have to use derivative free methods (DFO).
The team of polytechnique de Montreal (GERAD) have developed an optimization toolbox named NOMAD (Nonlinear Optimization by Mesh Adaptative Direct Search).Today, it allows to take into account inequalities and bounded constraints, continuous or hybrid problems.
Actually, in engineering, we need to handle data uncertainties in order to find a robust optimum.
G-SCOP have developed a tool (Pro@DESIGN) dedicated to preliminary design (white box oriented) taking into account uncertainties using automatic code generation from the analytical equations. Both approaches must be combined to improve the optimization process and new techniques must be developed for this purpose.
To check the correctness of our proposed approach, we will use industrial cases from Aerospace scientific field (due to McGill skills) and from preliminary design in electromechanical industry (G-SCOP competencies).

Perspectives :

A key success factor need to elaborate a new methodology following some steps:
- First to identify the needs in applied mathematics optimization, we are starting with a synthesis of different industrial test cases in the fields mentioned here up (aerospace design and quality, electromechanical design in electrical industry).

- Second to develop new ideas for algorithmic purpose.

- Third to define the software architecture in order to be able to add new functionalities in the future.

- Last to build and integrate in the same open platform these new optimization method and industrial simulation software.

Finally to validate with practical industrial cases.
To succeed, we want to exploit the strengths of all partners
- Polytechnique de Montreal GERAD for algorithmic development and theoretical analysis in applied mathematics and also software skills

- G-SCOP (Grenoble) for multi physics modelling in preliminary design in electrical engineering and skills in

software architecture and development, automatic code generation and optimization (gradient based and evolutionary optimization).
- McGill (optimization Lab in Aerospace industry from prof. M.Kokkolaras) for multiphysics modelling.

Objectives:

- To develop a new methodology issued from the expertise of NOMAD and Pro@DESIGN,in order to be able to take as good as possible multi physics problems, output constraints (fixed?), uncertainties and multi objectives (until 3 objectives). In multi physics problems we need to interconnect different models which constitute the simulation system. The constraints in this case must be considered as internal constraints but they interact with the optimization process. Consequently, classical optimization methods often fail to converge.

- To build an integrated open-source platform that includes a transparent call of industrial simulation software (Catia or SiemensTools) in this multi physics approach.

Furthermore this platform will be able to take directly in the optimization loops uncertainties allowing robust optimization.

Contact(s) : Jean BIGEON, DR2 CNRS, jean.bigeon@grenoble-inp.fr, mobile : 06 77 99 49 63