## PROPOSITION DE SUJET DE THESE

**Intitulé : High dimensional multidisciplinary design optimization for aircraft design**

Référence : **TIS-DTIS-2020-23**
*(à rappeler dans toute correspondance)*

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| **Début de la thèse :** octobre 2020 | **Date limite de candidature :** |

**Mots clés**

Multidisciplinary Optimization, Surrogate based Optimization, Gaussian process

**Profil et compétences recherchées**

Bac+5, ingénieur ou université

Mathématiques appliquées, sciences de l'ingénieur

**Présentation du projet doctoral, contexte et objectif**

Nowadays, there has been significant and growing interest in improving the efficiency of vehicle design processes through the development of tools and techniques in the field of multidisciplinary design optimization (MDO). In fact, when optimizing both the aerodynamics and structures, one needs to consider the effect of the aerodynamic shape variables and structural sizing variables on the weight which also affects the fuel consumption. MDO arises as a powerful tool that can perform this trade-off automatically.

The objective of the Ph. D project is to propose an efficient approach for solving an aero-structural wing optimization process at the conceptual design level. The latter is formulated as a constrained optimization problem that involves a large number of design variables (typically 700 variables). The targeted optimization approach is based on a sequential enrichment (typically efficient global optimization (EGO)), using an adaptive surrogate model. Kriging surrogate models are one of the most widely used in engineering problems to substitute time-consuming high fidelity models.

EGO is a heuristic method, designed for the solution of global optimization problems that has performed well in terms of quality of the solution computed. However, like any other method for global optimization, EGO suffers from the curse of dimensionality, meaning that its performance is satisfactory on lower dimensional problems, but deteriorates as the dimensionality of the optimization search space increases. For realistic aircraft wing design problems, the typical size of the design variables exceeds 700 and, thus, trying to solve directly the problems using EGO is ruled out.

In practical test cases, high dimensional MDO problems may possess a lower intrinsic dimensionality, which can be exploited for optimization. In this context, a feature mapping can then be used to map the original high dimensional design variable onto a sufficiently small design space. Most of the existing approaches in the literature use random linear mapping to reduce the dimension, sometimes active learning is used to build this linear embedding. Generalizations to non-linear subspaces are also proposed using the so-called variational autoencoder. For instance, a composition of Gaussian processes (GP), referred as deep GP, can be very useful.

In this PhD thesis, we will investigate efficient parameterization tools to significantly reduce the number of design variables by using active learning technics. An extension of the method could be also proposed to handle mixed continuous and categorical inputs using some previous works on low dimensional problems.
Practical implementations within the OpenMDAO framework (an open source MDO framework developed by NASA) are expected.

**Collaborations envisagées**

Thèse co-encadrée entre l'ONERA et l'ISAE-SUPAERO. Collaborations envisagées avec l'Université du Michigan (MDOlab) et/ou le Polytechnique Montréal, Canada.

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