Open Internship in the ESA Advanced Concepts Team in 2014

on

Dr.PaGMO/PyGMO Model Inspector

Topic Description

Optimisation problems are often provided as black box functions. A number of exploratory techniques based on sampling of the search space are available to help to gain knowledge about the optimisation problem [1] [2]. In particular we are interested in problem characteristics that can be critical for the performance of the algorithms or those that can help user to reformulate the problem in a more efficient way. The stagiaire will be involved in the development of the initial version of the module. In particular he will develop the methodology for the analysis of:

- Degree of non-linearity of the problem: study of the convexity of the function shape through sampling of the search space and statistical evaluation of its degree of nonlinearity;
- Box constraints hyper volume computation;
- Constraints redundancies: computation of the constraints effectiveness as a fraction of the sampled points that violates the constraint (equality constraints are treated with three indexes: violated per defect, violated per excess and satisfied within tolerances; the constraints is violated if one of the first two index is greater than zero and the others zero) (see [1] for details);
- Design variables redundancies: heuristic sensitivity analysis on the effectiveness of the optimization variables on the objective function through derivative approximations of the objective function in the sampling point of the search space;
- Objectives redundancies: sampling of the search space, evaluation of the correlation matrix of the data matrix (MxN where M is the number of objectives and N the number of sample points) in the standardized form;
- Disconnected feasible regions: evaluated statistically as in the case of the estimation of non linearities, distinguishing between transition from feasible to non-feasible regions;
- Function range and level set: all the function evaluations performed during the previous analysis are collected to evaluate the range of the objective function and its distribution.

Candidate's tasks

The stagiaire will implement a standing alone module that requires only the definition of the optimisation problem. The module can be coded in C++ or Python and should include the list of tests that can be performed. In addition, he/she should develop a visualization interface for results and an automatic writing of a final test report.

The ideal candidate

- Strong programming skills (C++, Python)
- Background in Optimization problems (evolutionary techniques and gradient-based optimization)

References

[1] John W. Chinneck, Discovering the Characteristics of Mathematical Programs via Sampling, Optimization Methods and Software, vol. 17 (2), pp. 319-352, 2002.

[2] Mersmann O., Bischl A.B., Trautmann H., Preuss M., Weihs C., Rudolph G., Exploratory landscape analysis, Proceedings of the 13th annual conference on Genetic and evolutionary computation, pp 829-836, 2011.

[3] Deb, K. and Saxena, D.K. On Finding Pareto-Optimal Solutions Through Dimensionality Reduction for Certain Large-Dimensional Multi-Objective Optimization Problems. KanGAL Report No. 2005011, IIT, Kanpur, 2005.