On adapting SEGO to solve multi-objective optimization problems, with applications in aircraft design.

Keywords: Bayesian optimization, multi-objective optimization, multi-disciplinary optimization.

Location: ISAE-SUPAERO.

Duration: 5 to 6 months, starting as soon as possible.

Supervision:

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Application: please send us by email a curriculum vitae.

Context:

In the context of the AGILE 4.0 project (2019-2022), ISAE-SUPAERO and ONERA offer an internship related with numerical optimization and aerospace engineering. The AGILE 4.0 project is the AGILE (2015-2018) follow-up project that intended to develop the next generation of aircraft multidisciplinary design and optimization processes, which target significant reductions in aircraft development costs and time to market, leading to cheaper and greener aircraft solutions.
The internship is proposed in collaboration with ONERA (the French aerospace lab). The successful candidate will be welcomed in a multidisciplinary team. A net gratification will be around 550 Euros per month with possible housing facilities in the ISAE-SUPAERO campus.

Subject:

Super-Efficient Global Optimization (SEGO) is a well-established Bayesian solver to optimize expensive-to-evaluate and black box optimization constrained problems. SEGO has been successfully applied to a variety of industrial problems in particular those arising from aircraft design. SEGO focuses on problems with pure continuous design variables. However, in the field of aircraft design, optimization problems may involve multiple of objectives.

Multi-objective Optimization (MOO) has been paid increasing attention and applied to the building design domain in recent years MOO is based on a concurrent design optimization process which allows designers to incorporate multiple conflicting objectives and to specify the trade-offs between them. Instead of obtaining one single optimal solution, a set of non-dominated solutions (Pareto frontier) can be derived by using MOO.

The successful candidate will study existing works related to the use of Bayesian multi-objective optimization. Then, the student will modify SEGO to solve MOO problems. The goal is to calculate the Pareto front approximation of optimization problems with fewer objective functions evaluations than other methods, which makes it appropriate for costly objectives.

The obtained solver will be validated, first, in a set of academic test problems. Last, we will test the obtained method on realistic test cases related to AGILE 4.0 project.

The python implementation will be done withing the opensource Surrogate Modeling Toolbox[1].

References:

- AGILE project https://www.agile-project.eu/
- AGILE 4.0 project, https://www.agile4.eu
- Jones D.R., Schonlau M., Welch W.J. Efficient global optimization of expensive black-box functions, J Global Optim, 13 (4) (1998), pp. 455-492
- M. A. Bouhlel, N. Bartoli, R. G. Regis, A. Otsmane, J. Morlier, Efficient Global Optimization for High-Dimensional Constrained Problems by Using the Kriging Models Combined with the Partial Least Squares Method, Engineering Optimization 1–16, 2018.
- V. Picheny, Multiobjective optimization using Gaussian process emulators via stepwise uncertainty reduction, Stat Comput, 25: 1265-1280, 2015
- P. P. Galuzio, E. Hochsteiner, L. D. S. Coelho , V. C. Mariani, MOBOpt — multi-objective Bayesian optimization, 12:100520, 2020.

[1] https://github.com/SMTorg/smt