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Editorial: Robust Design Optimization with Ārtap Framework

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Optimization is a crucial part of many engineering disciplines. The final design of a product is a result of an optimization problem. Generally, optimization of real-world designs and processes needs to solve multi-objective non-linear optimization tasks, where the best design should be selected from the Pareto-front of the most appropriate designs. In many cases, accurate modeling of partial differential equations is essential to evaluate the goal functions' and the optimized parameters. Moreover, simulation programs and finite element tools should be used together to create better designs. Therefore these optimization tasks are usually complex, numerically expensive, and time-consuming tasks.

From a practical point of view, an optimized design is a local optimum that has better performance, reduced cost, or improved quality. However, finding a global optimum of an optimization problem means more because a distinction should be made between the found global and local optimums. If an optimization problem is convex, this is not a problem. If a local optimum is an interior, it is the global optimum. However, most of the industrial optimization problems are nonconvex and belong to the most general branch of the non-linear optimization problems. Many commercial and open-source solvers are proposed to solve nonconvex problems. Nevertheless, most of them cannot guarantee that the found optimum is the global optimum. In many cases, this question is not so important from the industrial point of view because the difference between a local and global optimum is not significant. Another problem is that, generally, it is impossible to model the design and every manufacturing process altogether. It is a typical problem in the industry that engineers want to create the most optimal and fine-tuned design, then it is very hard and needs expensive engineering solutions to manufacture the selected design with an acceptable scrap rate.

It can be a more cost-effective optimization strategy for many industrial applications to consider the manufacturing tolerances and the different uncertainties from the beginning of the design process. Due to Wolperts' no free lunch theorem, there is no optimization methodology that has the best performance for every kind of optimization problem. Therefore, there is a need for some kind of framework that can provide a wide range of optimization methods and artificial intelligence techniques to support different kinds of design optimization problems. Moreover, due to the complexity of the applied simulation models, it is an essential question that how we can reduce the number of function evaluations without the loss of accuracy.

Ārtap is an optimization framework for robust design optimization. It is developed within the Department of Theoretical Electrical Engineering at the University of West Bohemia jointly with a fully *hp*-adaptive FEM-solver: Agros Suite. Ārtap is written in Python. It provides a simple, general interface to facilitate the solution of real-life engineering design problems. The code contains evolutionary and genetic algorithms, wrappers to derivative-free methods, machine learning methods, and an integrated FEM solver. The realized multi-layered architecture aims to separate the problem definition, optimization solvers, and other numerical libraries' interfaces. Moreover, Ārtap provides automatic parallelization and supports different databases for data management.

The articles which are published in this special issue present the latest results of current research fields. Hopefully, the presented models and various application fields provide useful information for researchers and professionals either they are interested in these techniques themselves or have another problem from different fields. I hope some of the papers can explain how the proposed tool: Ārtap, is used in different fields and for different tasks. In many cases, the presented papers' model files are openly available and can be downloaded from projects' Github repository: https://github.com/artap-framework/artap.

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