M2P - A NEW ECCOMAS THEMATIC CONFERENCE IACM SPECIAL INTEREST CONFERENCE:
Kernel-based surrogate for fluid dynamics simulation of wind assistant propulsion

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ABSTRACT

In the present work, we investigate high dimensional parametrized fluid dynamics problem raising from optimization in real-time of wings of a Wind Assistant Propulsion for TransOceanic Cargo.

To seek an optimal pareto of wind propulsion, we predict the momentum and forces acting on sailing wings by means of turbolent computational fluid dynamics. The computational fluid dynamics models choosed is RANS and it is performed on HPC (CINECA) with OpenFOAM. A dataset of input-output is computed by parametrizing this fluid model, varying different angles of attack of the wings. To obtain a surrogate model, we adopt a Kernel-based Gaussian process. To reduce the complexity of surrogate model, accommodate the interpretability of data-driven methods, we adopt a suisse knife of low-rank approximations (”pivoted-cholesky” [2]) and compression method ” multiresolution clustering knowns as ”samplets” [1]”.
Regarding the trade-off of exploration of input design space versus accuracy of surrogate model and variation with respect to the Pareto front of optimizer, we perform an active learning procedure based on Bayesian optimization coupled with constrained optimization.
The results are validated on airfoils profile simulated with Xfoils, where the input parameters are defined by control points of airfoils, and on fluid dynamics of industrial configuration of Wind Assistant Propulsion TransOceanic Cargo.

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REFERENCES

[1] Harbrecht, Helmut and Multerer, Michael D., Samplets: Construction and Scattered Data Compression. Accepted J. of Computational Physics, Available at SSRN: http://dx.doi.org/10.2139/ssrn.4053305

[2] H Harbrecht, M Peters, R Schneider, On the low-rank approximation by the pivoted Cholesky decomposition, Applied numerical mathematics, 2012