Large dimension multi-fidelity surrogate model : Co-Kriging models compare to neural network approaches

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Ph.D. expected duration: Sep. 2019 - Sep. 2022

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Abstract:

We focus on multi-fidelity hierarchical computer codes, which are codes modelling the same phenomenon, but which can be hierarchically sorted according to their accuracy and numerical cost. To improve the high-fidelity surrogate model prediction we want using information from low-fidelity. Standard techniques for surrogate modelling have been extended in multi-fidelity framework via Co-Kriging models.

Recent codes can have large dimension outputs, such as time-series. Until now, used methods were involving a reduction in the size of the outputs. We have therefore proposed to extend a method that deals with dimension reduction and time-depending kernel in Co-Kriging, [1]. The code output is expanded on a basis built from the experimental design. The first coefficients of the expansion of the code output are processed by a co-kriging approach. The last coefficients are collectively processed by a kriging approach with covariance tensorization.

This method will be compare to a neural network based method as presented in [2] and adapt to time-series outputs on an example. The main drawback is the lack of uncertainties in the prediction. To tackle this issue we will introduce a Bayesian approach.

References

[1] Baptiste Kerleguer. Multi-fidelity surrogate modeling for time-series outputs. *SIAM/ASA Journal on Uncertainty Quantification*, Submitted December 2021.

[2] Xuhui Meng and George Em Karniadakis. A composite neural network that learns from multi-fidelity data: Application to function approximation and inverse pde problems. *Journal of Computational Physics*, 401:109020, 2020.

Short biography – Baptiste Kerleguer got a Master's Degree in applied mathematics from Ecole Normale Supérieure Paris-Saclay. His thesis, funded by CEA DAM, focuses on surrogate models at functional input and output for the analysis and quantification of uncertainties in complex models.