The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

A combination technique for optimal control problems under uncertainty

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Keywords: *combination technique, sparse grids, optimal control problems under uncertainty*

In this talk, we consider the minimization of a linear quadratic risk-neutral objective functional constrained by a random elliptic partial differential equation. One common approach to solve such problems is to discretize a-priori the probability space, by replacing the continuous expectation with a Monte Carlo or Quasi Monte Carlo approximation. As the computational cost grows with the number of quadrature nodes, it is often desirable to exploit any regularity of the problem with respect to the random input. Several works have then considered a Stochatic Collocation approximation on tensor product grids which, although very efficient for a small dimensional random input, becomes highly inefficient for moderate to high dimensional inputs, due to the curse of dimensionality.

The use of Stochastic Collocation combined with sparse grids is quite popular as it permits to reduce drastically the computational cost even for high dimensional inputs, but sparse grids are not always fully justified, as they might lead to a discretized nonconvex problem.

In this work, we solve the optimal control problem using the combination technique. Our approach requires to solve the optimal control problem on several low-fidelity tensor product grids, so that each problem remains convex. All these solutions are then linearly combined to get a final approximation which, under suitable regularity assumptions, preserves the same accuracy of a high-fidelity tensor product grid solution, while reducing drastically the computational cost.

REFERENCES

[1] Fabio Nobile, Tommaso Vanzan, *The combination technique for optimal control problems under uncertainty*, in preparation, 2022.