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Abstract: Reliability analysis and other probabilistic techniques are becoming increasingly important tools in hydraulic modeling and decision making. Hydraulic variables, such as roughness coefficient and discharge, common to many hydraulic-engineering problems, are known to contain considerable uncertainty. Knowledge of the type and magnitude of this uncertainty is crucial for a meaningful interpretation of the hydraulic model results. Probabilistic uncertainty quantification framework aims to define the uncertain inputs in terms of random variables, to propagate these stochastic uncertainties through the numerical model and to quantify their impact on the simulated quantity of interest. Here, the latter is the water level field discretized upon an unstructured finite element mesh over the Garonne River (South-West France) between Tonneins and La Réole simulated with the numerical solver Telemac-2D.

Monte Carlo sampling is the most standard method used to propagate uncertainty through dynamical models. Although universal, the approach is rather greedy and its use in conjunction with finite element models, like Telemac-2D, is limited due to computational cost constraints. In moderate dimensions, surrogate modeling allows to overcome this issue. For instance, polynomial chaos expansion (PCE) approximation has proven powerful in a wide range of applications for emulating responses of computational models with random input, quantifying the output uncertainty and conveniently providing sensitivity indices. However, PCEs may experience some convergence difficulties when applied to problems related to unsteadiness, stochastic discontinuities, long-term integration, and large perturbation.

In this context, we propose a mixture of experts as a surrogate model, which is based on the divide-and-conquer principle. This non-intrusive method uses multiple PCE models as local experts to approximate the numerical solver on different parts of the input space. This parametric space partitioning is automated by means of machine learning techniques. These various PCE models are tested using shallow-water simulations data for unsteady flow regime in order to assess the efficiency and the convergence of the proposed approach. Our results show that the proposed mixture of experts approach is efficient for this unsteady flow problem related to discontinuities induced by random inputs together with environmental terrain properties.

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