Strategies to Quantify Epistemic Uncertainty -- Dealing with Uncertainty of Uncertainty

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Stochastic methods are widely used to quantify uncertainty in practical problems. One of the key requirements to conduct stochastic simulations is the ability to prescribe probability distribution to uncertain inputs. This, however, maybe very difficult, if not impossible, for complex systems. In many practical problems, there is hardly sufficient information to determine the distributions of the input uncertainty. Uncertainty of this kind is often referred to as epistemic, which is due to lack of knowledge. Most of the existing stochastic tools are not readily applicable because of the lack of probability distributions.

In this talk we discuss some strategies to deal with epistemic uncertainty. In particular, we discuss how to construct accurate approximation to the uncertain solution without requiring input probability. We also discuss how to obtain reliable estimate to the upper and lower bounds of the uncertain solution. These bounds can serve as good estimate for the "best case scenario" and "worst case scenario". In addition to the mathematical derivation we also discuss efficient implementation of the methods. The common feature is that all of these methods require only a one-time forward stochastic simulation.