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Particle Methods for nonlinear filtering and uncertainty propagation analysis

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Modern computers are capable of simulating complex physical and engineering systems. The reliability and the accuracy of these computational models often relies on complex filtering and calibration processes combined with the dispersion analysis of inputs and other sources of randomness. In another context, with a successfully calibrated model one may be also interested in computing the probability that simulation outputs belong to some critical event; that is, to find the law of the input parameters and the sources of randomness leading to such events. To treat these problems, we present new emerging probabilistic and simulation type strategies involving bayesian inference theory, sequential Monte Carlo methods, and stochastic particle algorithms. We illustrate these models with a recent joint work with A. and E. Tantar (Univ. Luxembourg) and Z. Guede (Ifremer) on the numerical analysis of the reliability and the calibration of offshore structures in extreme sea conditions.