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Path integrals and sparse representations in computational stochastic dynamics

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Addressing current engineering challenges requires collaborative efforts that span across multiple areas of specialization. In this regard, uncertainty quantification represents a significant complement to fields such as computational mechanics and materials science, and has become an essential branch of contemporary engineering research. In engineering dynamics, the task of uncertainty propagation relates to the development of analytical and numerical methodologies for determining response and reliability statistics of complex systems. Specifically, recent advances in stochastic dynamics, ever increasing computational capabilities and advanced experimental setups have contributed to an exceedingly sophisticated mathematical modeling of related systems and excitations, which consequently, demands the development of novel and versatile solution techniques. In this webinar, promising results will be presented based on path integrals, which are considered a potent tool in theoretical physics. By adapting and extending the path integral concept, multidimensional nonlinear dynamical systems subject to various excitations processes can be addressed with satisfactory accuracy. Indicative results pertain to both integer- and fractional-order systems with smooth and non-smooth nonlinearities subject to non-white and non-Gaussian excitation processes. Further, it will be demonstrated how regularization and sparse representation concepts are appropriately exploited for enhancing the computational efficiency of the technique. Preliminary results suggest orders of magnitude gain as compared to Monte Carlo simulation schemes.