TEMPLE UNIVERSITY
Department of Mathematics

Applied Mathematics and Scientific Computing Seminar

Wednesday, 27 September 2017, 4:00 p.m.
Room 617 Wachman Hall

(refreshments and social at 3:45 p.m)

Low-rank methods for PDE-constrained optimization under uncertainty

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Abstract. We discuss optimization and control of unsteady partial differential equations (PDEs), where coefficients in the PDE as well as the control may be uncertain. This may be due to the lack of knowledge about the exact physical parameters like material properties describing a real-world problem (epistemic uncertainty) or the inability to apply a computed optimal control exactly in practice. Using a stochastic Galerkin space-time discretization of the optimality system resulting from such PDE-constrained optimization problems under uncertainty leads to a large-scale linear or nonlinear system of equations in saddle point form. Nonlinearity is treated with a Picard-type iteration in which linear saddle point systems have to be solved in each iteration step. Using data compression based on separation of variables and tensor train (TT) format, we show how these large-scale indefinite and (non)symmetric systems that typically have 10^8 to 10^{11} unknowns can be solved without the use of HPC technology. The key observation is that the unknown and the data can be well approximated in a new block TT format that reduces complexity by several orders of magnitude. As examples, we consider control and optimization problems for the linear heat equation, the unsteady Stokes and Stokes-Brinkman equations, as well as the incompressible unsteady Navier-Stokes equations. (This is joint work with Sergey Dolgov, Akwum Onwunta, and Martin Stoll)