Low-rank methods in large scale constrained optimization

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Many challenging problems in computational science and engineering are formulated as constrained optimization problems. In particular, the constraint is often a partial differential equation (PDE) or a system of PDEs. When discretizing such optimization problems in both space and time the resulting linear or nonlinear systems are of very large scale. Adding parameters or uncertainties to this makes the dimensionality even larger. This poses a significant challenge to the numerical algorithms and storage availability. But we are often in luck as the systems come with an inherent Kronecker product structure where we will show in this talk is amenable to employing low-rank optimization techniques based on matrix or tensor factorisations. We start reviewing the basic technique on a simple PDE-constrained optimization problem and then illustrate how this technique can be carried over to more challenging examples coming from fractional PDEs, discretizations via isogeometric analysis, or uncertainty quantification.