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Better solvers through optimization, or how to avoid doing the hard work yourself

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In this talk we show how optimization and control ideas can be used to obtain robust solvers and better methods for the numerical solution of mathematical models comprising of PDEs with fundamentally different mathematical properties. We will present an additive decomposition approach for coupled multiphysics problems which uses optimization formalism to expose the constituent component physics operators. In this setting, our optimization-based approach allows to synthesize a robust and efficient solver for the coupled problem from simpler solvers for the component physics equations. To illustrate the scope of the approach we show how a scalable solver for a scalar advection-dominated PDE can be derived from a standard, off-the-shelf algebraic multigrid for the Poisson equation, that does not work for this equation.