On the Design and Use of Adaptive PDAE Solvers

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A persistent trend in computational science and engineering is that dynamical multi-physics systems become large in scale and the underlying mathematical models become more complex. Performing accurate simulations more than ever requires suitable adaptive strategies based on robust error estimation tools to effectively resolve the multi-scale nature of the solutions. Nowadays the field of error estimation and adaptivity goes beyond classical local or global error assessment and mesh refinement. It currently includes adaptive modelling, where the aim is to adaptively control a hierarchy of surrogate models which have been obtained by model reduction techniques, and new specific aspects which are relevant for engineering purposes, such as goal-oriented procedures or the control of errors due to uncertainty.

In this talk I will emphasize on the design and use of adaptive strategies in numerical algorithms to solve systems of time-dependent partial differential-algebraic equations (PDAEs) more effiently and reliably. Furthermore, recent developments in using adaptive multilevel strategies for PDAE-constrained optimization and uncertainty quantification are presented. Throughout my talk I will present numerical results for academic as well as real-life applications including optimal control of glass cooling and steel hardening as well as the simulation and optimization of water and gas supply networks.