Numerical Software for the Computation of Error-Controlled Continuous Approximate Solutions of Differential Equations

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In this talk, we provide an overview of our recent work in the development of numerical software packages that yield error-controlled continuous approximate solutions of initial value ODEs (IVODEs), boundary value ODEs (BVODEs), and time-dependent PDEs in one spatial dimension (1DPDEs). Error control means that the software adapts the computation based on error estimates of trial approximate solutions until an approximate continuous solution is obtained that has a corresponding error estimate that satisfies a given user tolerance. The software is "production-level" or "software library-level", meaning that it is intended to be used by application experts who are not experts in the numerical solution of differential equations.
We will discuss our ongoing work on the development of software packages for IVODEs that control the defect (or residual) of a continuous numerical solution based on the use of discrete and continuous Runge-Kutta methods. We will also describe our recently completed work on the development of an updated version of a BVODE solver that controls an estimate of the error of a continuous approximate solution based on the use of collocation methods. Our recent work on the development of a 1DPDE solver that provides time and space dependent event detection for an error-controlled continuous numerical solution based on the use of BDF methods in time coupled with collocation in space will also be reviewed.