Performance studies of HYMLS for bifurcation analysis of some canonical fluid flow problems

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Many flow problems deal with transport of matter and/or heat. This constitutes a challenging multiphysics problem if the transported entity also influences the flow, leading to a two-way coupling. From a computing efficiency view point, it is best to treat the associated equations in a coupled manner [3]. To perform experiments for such flows we developed a finite volume package FVM, which can compute right-hand sides and associated Jacobian matrices, and a solver HYMLS [1] which can compute the Newton updates. Both packages are based on elements of EPETRA (available within Trilinos (see http://trilinos.sandia.gov/)). This solver is robust for the associated saddle-point problem and shows a regular convergence behaviour.

To study the physical behaviour of the flows we follow a dynamical systems approach for large systems [4]. In the talk we will show continuation and bifurcation results of (i) the Lid-Driven cavity problem, which is incompressible Navier-Stokes only, (ii) the Rayleigh-Bénard problem and (iii) the differentially heated cavity. In the last two problems also buoyancy forces are acting, hence, we also have a temperature equation.

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