Scalable solvers for nonlinear equations: mini-course on Newton-Krylov methods

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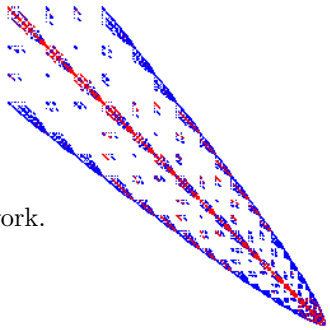


Time and place

- Five lectures: Tuesday and Thursday, 13:00 to 14:00
- Chapman building, room 106

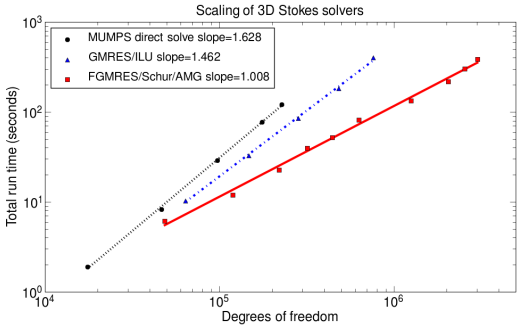
What is a scalable solver?

- A *scalable solver* can solve N equations in N unknowns with $\mathcal{O}(N)$ work.
- Newton-Krylov methods offer:
  - *Quadratic* convergence on the nonlinearity
  - Parallel scalability and *mesh-independence* for the linear solve

Is it time to look at your solver?

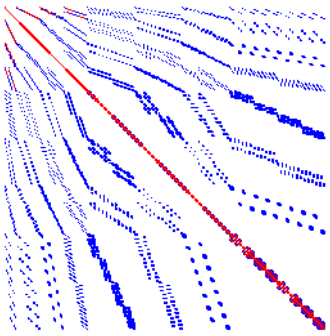
- Is your solver using significantly more time or memory than the physics?
- Is your time stepping limited by stability?
- Are you putting loops *around* the analysis?

Proposed schedule



Jan 22: Nonlinear systems
- Motivation for coupled implicit methods
- Scalability
- Newton's method for large systems
- Globalization

Jan 27: Linear solvers
- Limitations of direct methods
- Krylov methods
- Representation of matrices and Jacobian-free methods
- Preconditioners for simple definite problems
- Parallel scalability



Jan 29: Constraints and coupling
- Preconditioners for indefinite problems
- Preconditioners for multi-physics

Feb 3: Parallel software day: PETSc
- Generic solver components
- Physics-based preconditioners
- Working with legacy code

Feb 5: Higher order finite elements
- High-order elements at the cost of low-order elements
- Exploiting the memory hierarchy and tensor-product operations

- Schedule and content are flexible, let me know if you have requests.
- Updates will be posted at `http://59A2.org/newton-krylov`