Code Validation

- Demonstrate convergence under spatial mesh refinement $\Delta x \to 0$ (in 3D, Δx, Δy, $\Delta z \to 0$)
- Demonstrate convergence as $\Delta t \to 0$
- Compare with *science* &/or experiment
- Compare with analytical or approximate solutions (in limiting cases): for example, approximately linear regime of nonlinear problem or Riemann problem for 1D gas dynamics
- Vary physical parameters (for example, in Burgers' equation, vary viscosity for shock profile solution)
- Compare with results using other numerical methods & other codes
- Vary computational parameters (for example, in compressible fluid flow, vary artificial viscosity & CFL factor)
- Check symmetry & conservation

Recommended Methods for Initial Value Problems

Always dynamically adjust Δt based on an estimate of the local truncation error

- TRBDF2, especially for *stiff* problems
- Fourth-order Runge-Kutta
- Adams-Bashforth-Moulton predictor-corrector

Recommended Methods for PDEs

- *Parabolic PDEs:* TRBDF2 for nonlinear diffusion or drift-diffusion; Chorin's method plus predictor-corrector timestep for Navier-Stokes
- *Hyperbolic PDEs:* Lax-Wendroff for wave equations; WENO or higher-order Godunov (PPM or CLAWPACK) for gas dynamics; FDTD for Maxwell's equations
- *Elliptic PDEs:* For Poisson's equation, banded or sparse direct solvers, or SOR, PCG, or multigrid iterative solvers