ANSLib Flow Solver Overview

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Space Discretization Highlights

- **Cell**- or vertex-centered unstructured finite-volume solver; density based
- Core: k-exact reconstruction
  - Reconstruction of conserved or **non-conserved** variables
  - Pre-solve least-squares system (via SVD) and store
  - Local body-fitted coordinates for high AR cells near walls
- Inviscid fluxes via Roe's scheme
- Viscous fluxes
  - Use arithmetic average of cell gradients reconstructed at Gauss points
  - Add a jump term (a la Nishikawa) for stability and accuracy
- Negative Spalart-Allmaras turbulence model
  - Full-order discretization, include source terms
  - Fully coupled to flow equations
- Boundary integration by Gauss quadrature
  - Arclength-based
  - Support from GRUMMP

Time Discretization and Steady-State Convergence

- Implicit Euler time advance, with local time stepping
- Compute the exact Jacobian via chain rule
- Solve linear system using GMRES
  - Matrix explicit
  - Unknowns ordered along lines perpendicular to wall for high AR meshes
  - Preconditioning
    - Variant on block tri-diagonal solution along those lines
    - ILU(3) for low AR meshes
  - Converge linear system to relative tolerance of 10^{-5}
  - Implemented using PETSc
- Non-linear solver follows Ceze and Fidkowski
  - Use line search backtracking to avoid aphysical solution states
  - By default, increase CFL number even if the non-linear residual increases slightly
  - If backtracking is severe, decrease CFL number
  - For mild backtracking, keep CFL number constant