Quality
and
sources of error

Convergence

- Steady state problem
  - Residual vanishes
  - Forces levels out
  - Flow field does not change
- If oscillations
  - Problem **might be** unsteady
  - Do time accurate computation
- Time dependent computations
  - Estimate time scales ($\sim L/U$)
  - Implicit or explicit in time – subiterations
  - Might become steady

Grid

- Grid convergence studies

  Compare solutions on different grid levels (3 grids needed)

  – Manually generated e.g. with Δ ~ 1.5, 1, 0.7
  – Grid adaption

- y^+ in first grid points

  Check requirements depending on

  – turbulence model and
  – boundary conditions

  Verify by plotting y^+

- Resolution of gradients
  – Look carefully at the solution
  – identify the different gradients

Geometry

- Resolution of details
  - Wing trailing edge
  - Junctions
  - Small holes, screws et.c.
- wind tunnel effects
  - Blockage
  - 3D effects
  - wall effects
  - “free stream” conditions

Physical model

- Flow assumptions:
  - Viscous – inviscid
  - Compressibility
  - Turbulence & transition
  - Other flow physics
- Turbulence model

  Critical if flow contain
  - boundary layer separation from smooth surfaces
  - rotation and swirl

  - Check sensitivity by computing with other models

Numerical scheme

- Check influence of scheme
  - at least 2nd order scheme
- Sensitivity of scheme decreases on finer grids
  - A 1st order scheme might need more than 10 times the number of grid points compared to a 2nd order scheme.
- Check convergence rate:
  - 3 decade reduction is default in Fluent - must be changed !!!
  - Residuals reduced at least 5 decades (**not universal**)
  - Monitor quantities of interest (lift, drag, heat transfer, ...)
  - Do more iterations and compare solution.