Modelling and approximation

Modelling and approximation

- Starting point: real-life problem
  - flow around a car or airplain
  - flow in the Golf stream
  - flow of blood in the cardiovascular system
  - propelling of liquid ink droplets in inkjet printers

- CFD always a compromise between
  - Computational resources
  - Modelling level

Flow physics

complex and unintuitive flow fields

- level of approximation
- turbulence (and transition to) modelling
- structure interaction
- real gas effects
- combustion
- non-newtonian fluid
- two-phase flows
- magneto hydro dynamical flows

boundary conditions

Defines the problem

- inflow, outflow
- far field
- wall
- symmetries

Computational grid

Solution never better than the grid

- resolving gradients

  shocks, boundary layers, free shear layers, vortices, adaptation, ...

- scale separation

  global scales, viscous scales (turbulence), molecular scales (shocks), ...

- grid topology

  stretching, cell orientation and shape, structured/unstructured/hybrid grids

- geometry

  approximations of details

Numerical method

no universal method

- basic concept

  FEM, FVM, FDM, ...

- solution methods

  pressure or density based, multi-grid, implicit, explicit, steady state, ...

- spatial schemes

  central, upwind, higher order, ...

Computational resources

Never enough

- Computational time
  - parallelization
  - number of grid points (~100.000 points - 1 CPUh)
- Memory use
  - number of grid points (100-1.000 byte / grid point)