

# 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)

