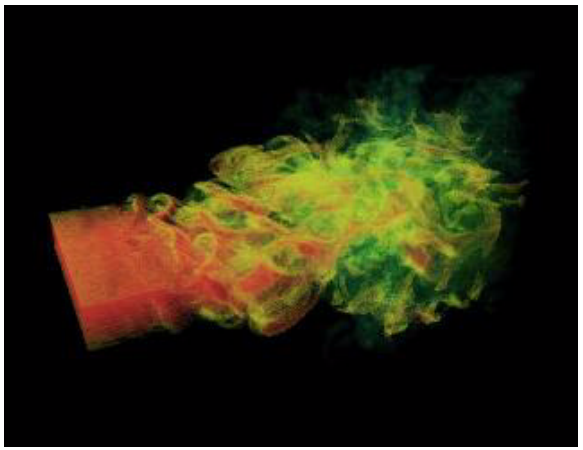
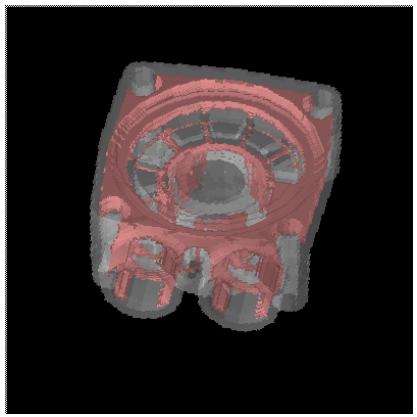
Computational Methods - Application Areas

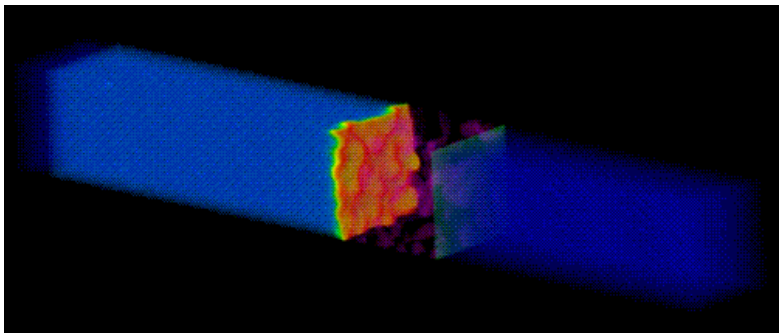
- Computational Field Simulations
- Computational Fluid / Flow Dynamics
- Computational Chemistry
  - electron-electron interactions
  - molecular surfaces
- Computational Mechanics
  - fractures
- Computational Manufacturing
  - die-casting



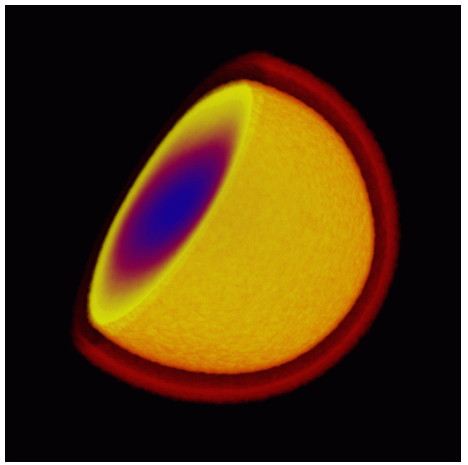
Simulated flame



Thick regions in
a die-cast



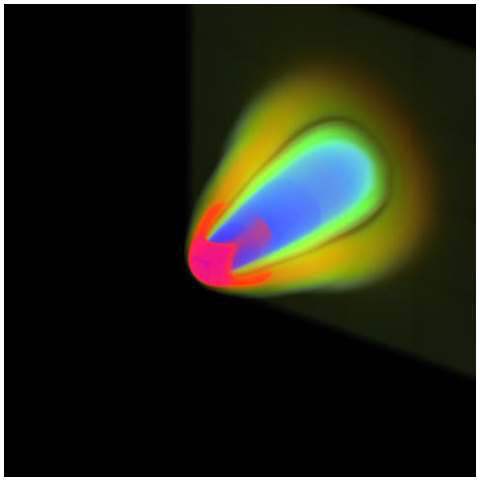
Shockwave



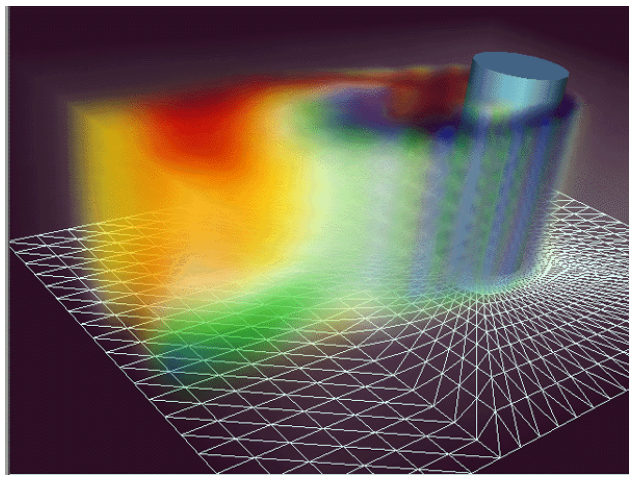
Particle density field

Computational Methods - Approach

- Start with underlying (continuous) physical model
  - Partial / ordinary differential equations (ODE / PDE)
  - Navier-Stokes equations for fluid flow
  - Schroedinger equations for waves / quantum
- In most non-trivial cases, continuous solutions do not exist
- Use numerical solutions on a discretized model
  - finite elements
  - finite differences
  - Newton
  - Runge-Kutta



Solar wind



Simulated flow around a submarine fairwater

Grid Types

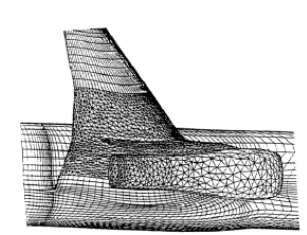
- The resolution of the discretized model is usually spatially variant

  - more sample points (finer grid) in areas with more potential variation (larger derivatives)

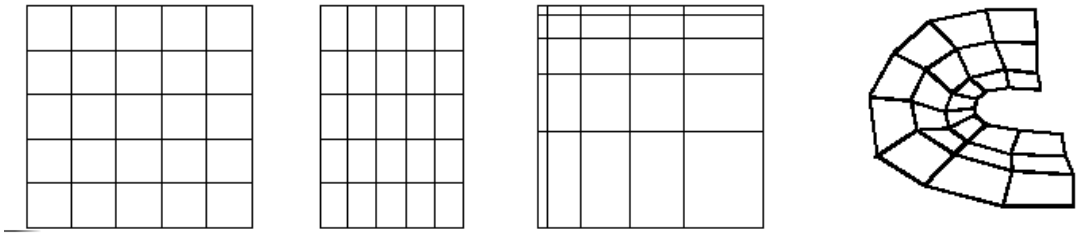
- Example: flow around an airplane fin varies most at the curved surfaces

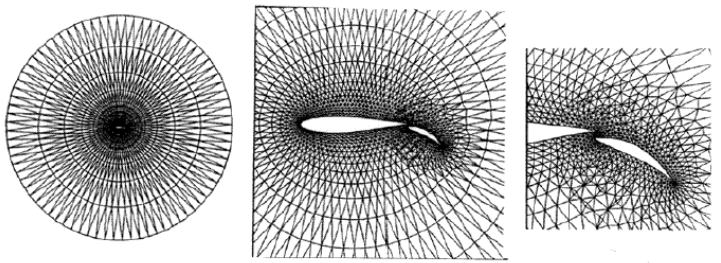
  → more dense and curved grid at the curved fin hull

bluntfin



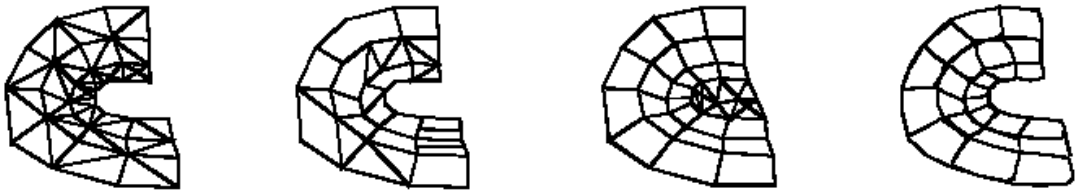
Structured grids

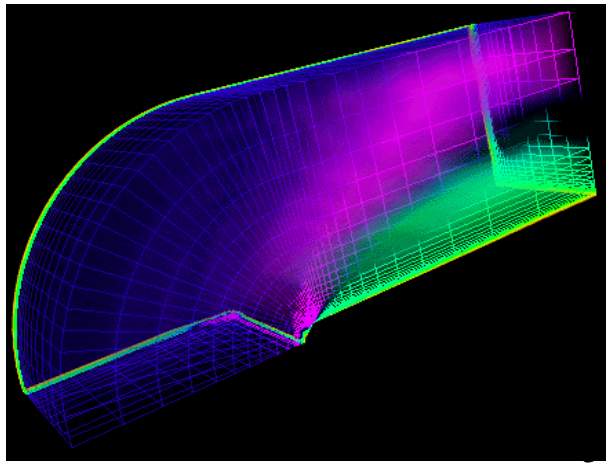




addressing: cell[i, j ,k] provides location of neighbors

Unstructured (irregular) grids





no addressing mechanism: adjacency list is required