soft (deformable) bodies

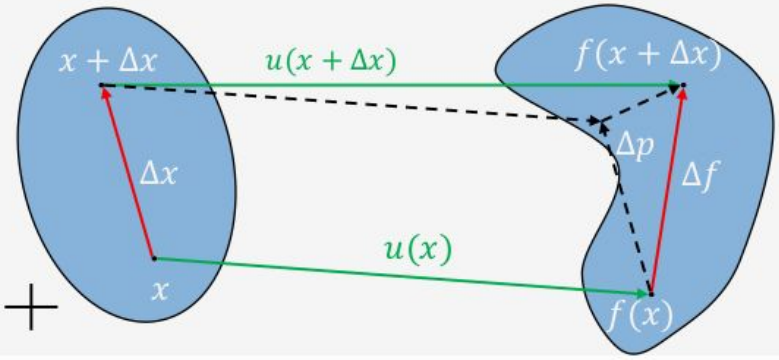
- Generalization: soft (deformable) bodies
  - Deformed by force: car body, punched or shot at.
  - Prone to stress: piece of cloth, flag, paper sheet.
  - Not solid: snow, mud, lava, liquid.

http://www.games73.com/media.games73.com/files/2012/05/Crysis-3-soft-physics-demo-thumb-610x239.jpg

http://i.huffpost.com/gen/1480563/images/o-DISNEY-facebook.jpg

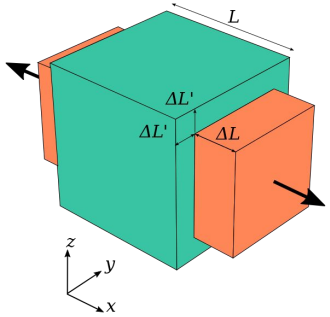
Grinspun *et al.* "Discrete Shells"

Relative displacement field: $f(\vec{x}) = \vec{x} + u(\vec{x})$.



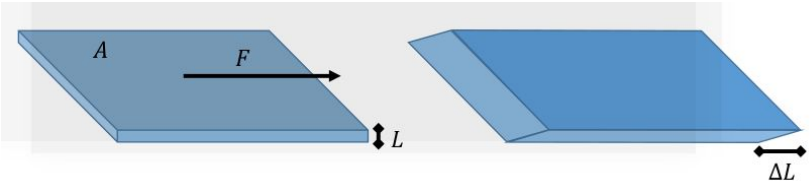
soft (deformable) bodies

Poisson's ratio



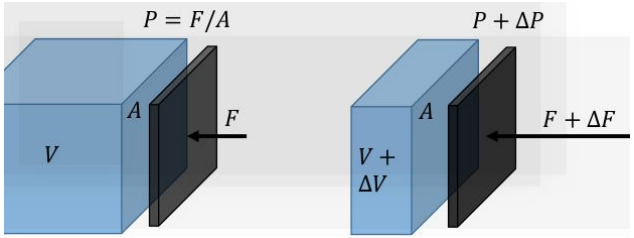
Young's modulus

linear stress / linear strain force/area



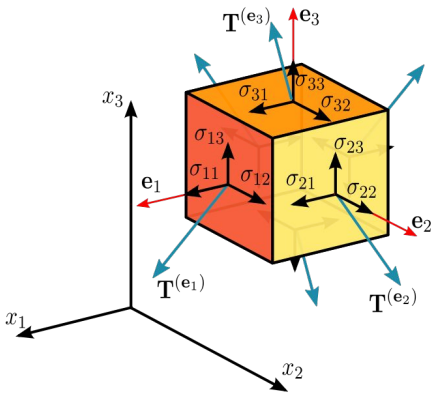
Bulk modulus

volume stress / volume strain



soft (deformable) bodies

Strain Tensor: df'df + df +df'
Stress Tensor: force/area
normal stress, shear stress



Hook's law: $\sigma = C\bar{\varepsilon}$ C: 9x9

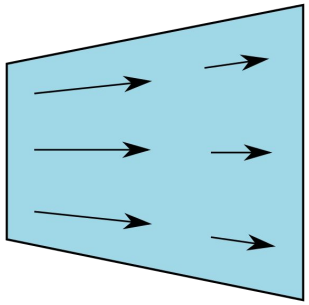
force = -k

Linear Elasticity: int $\bar{\varepsilon}C\bar{\varepsilon}$

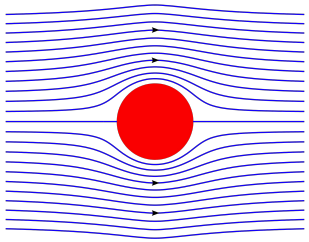
Dynamic Elastic: F=m a
density u'' = div(stress) + external body force

Flow

https://www.windy.com/?2017-09-12-09,26.883,-80.211,6



- steady: u'=0
- incompressible: div(u) = 0
- irrotational curl(u) = 0



Navier-Stokes Equations

- Representing the conservation of mass and momentum for an incompressible fluid ($\nabla \cdot u = 0$):

$$\overbrace{\rho\underbrace{(u_t}_{\text{Unsteady acceleration}} + \underbrace{u \cdot \nabla u)}_{\text{Convective acceleration}}}^{\text{Inertia (per volume)}} = \overbrace{\underbrace{\nabla \cdot (\nu\, \nabla u)}_{\text{Viscosity}} - \underbrace{\nabla p}_{\text{Pressure gradient}}}^{\text{Divergence of stress}} + \underbrace{f}_{\text{External body forces}}$$

- p: pressure field
- ν: kinematic viscosity.
- f: body force per density (usually just gravity ρg).