Finite Element Method

1. Divide our domain into small sub-volumes (finite elements)
2. Approximate our unknowns within elements by combinations of simple functions (shape functions)
3. Create matrix equations with nodal variables as unknowns
4. Solve matrix equations
Movies
Difficulty 1: efficient generation of computational grids

Many days of tedious work

Joldes et al. (2009), *MICCAI 2009, Part II, LNCS 5762, pp. 300-307*
Patient-Specific Finite Element Meshes
Joldes et al. (2009), *MICCAI 2009, Part II, LNCS 5762, pp. 300-307*
• One should keep in mind that the Finite Element Method is not a modelling method. Creation of appropriate models belongs to an analyst.

• The Finite Element Method is a very effective tool for solving problems in solid mechanics, and in biomechanics in particular.

• FEM is also very good for fluid dynamics, heat transfer, electromagnetism and other types of B.V. PDE.

• Software packages such as ANSYS, ABAQUS, LS Dyna, NASTRAN and others are very helpful tools in solving complex problems using FEM.
Implicit versus Explicit algorithms

-> implicit: requires solution of equations, hard to deal with non-linearities

-> explicit: stepping, “machine gun”-type algorithms untroubled by non-linearities and easy to parallelise
Graphics Processing Unit
http://www.gpucomputing.net/
Computational Biomechanics Community  http://gpucomputing.net/?q=node/218

Computing with CPU + GPU
Heterogeneous Computing