Problem Set 9

Finite-element meshing

In this example, we focus on 3D seismic wave simulations based on a spectral-element method. To that end, we will use the open-source, spectral-element package SPECFEM3D available at: `https://geodynamics.org/cig/software/specfem3d`

For any finite-element method, mesh generation is often the most time consuming process. Significant amount of user intervention may be needed to create a mesh and to correct problems related to distorted elements. The spectral-element method works with unstructured (irregular) grids and is optimized for hexahedral elements. Unfortunately, a hexahedral element mesh is a very stiff structure from a geometrical point of view. Delaunay-type algorithms, which work well for tetrahedral meshing, will fail for hexahedral meshing. For this example, we will resort to a (commercial) FEM meshing tool CUBIT/Trelis: `https://cubit.sandia.gov/`

The CUBIT research group at SANDIA National Laboratories is working on algorithms that generate a mesh starting from discretization of the object surface into quadrilaterals. CUBIT is a full-featured software toolkit for robust generation of two- and three-dimensional finite element meshes (grids) and geometry preparation. For academic institutions, licensing is handled by csimsoft and the software toolkit is available as Trelis: `http://www.csimsoft.com/trelis`

Problem:

Create your own 3D model, i.e. a hexahedral element mesh for an arbitrary geometry or region. Use CUBIT/Trelis and run seismic waves through it using the spectral-element package SPECFEM3D.

(a) Use CUBIT/Trelis to create your own 3D model of arbitrary shape.

(b) Install the spectral-element package SPECFEM3D, the preferred way is via git:

```
git clone --recursive https://github.com/geodynamics/specfem3d.git
```

(c) Run seismic wave simulations with your own model.

Feel free to play around with setting different source and receiver locations. Try to make movie snapshots to visualize the wavefields.