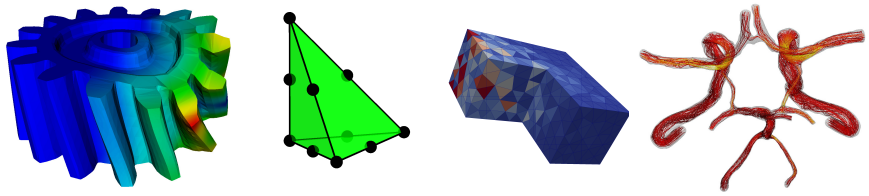
Solving Partial Differential Equations in Python

Mini-course December 17–18 2012 at 10–16 in MV:H12



Everyone interested in mathematical modeling and computational mathematics is invited to a two-day mini course on solving partial differential equations in Python. The course will be based on the free/open-source software FEniCS for automated solution of differential equations in Python (and C++). FEniCS has a powerful set of features and allows finite element variational problems to be specified in near-mathematical notation directly as part of a Python program. For example, the variational problem for the Poisson equation,

$$\int_\Omega \operatorname{grad} u \cdot \operatorname{grad} v \,\mathrm{d}x = \int_\Omega f v \,\mathrm{d}x \quad \forall v \in V, \tag{1}$$

can be directly translated to the following FEniCS program:

Python code

```python
u = TrialFunction(V)
v = TestFunction(V)

a = dot(grad(u), grad(v))*dx
L = f*v*dx
```

Variational problems like the one above may be solved automatically in FEniCS:

Python code

```python
u = Function(V)
solve(a == L, u)
```

Other key features of FEniCS include high performance linear algebra, automatic adaptive mesh refinement, postprocessing, and support for a wide range of finite element function spaces, including high order spaces and vector elements.

Topics covered in the course include: installation of FEniCS on GNU/Linux, Mac OS X, and Windows, solving linear static PDEs, solving nonlinear static PDEs, solving linear time-dependent PDEs, mixed problems, splitting methods, and postprocessing of solutions in ParaView. Partial differential equations solved in the course include the Poisson equation, a nonlinear Poisson equation, the Stokes equations, nonlinear hyperelasticity (St. Venant–Kirchhoff), and the incompressible Navier–Stokes equations.

Participants are expected to have a working knowledge of Python. Bring your laptops and be ready to solve a set of interesting exercises. Participants are encouraged to download and install the FEniCS software on their laptops prior to the course, but this is not a requirement. Participants are also encouraged to buy or download a copy of the FEniCS book. The book and the software are freely available from the FEniCS Project web site: `http://fenicsproject.org/`

The course will be given by Anders Logg, Senior Research Scientist at Simula Research Laboratory in Oslo and one of the leading developers of the FEniCS Project.

The course is organized by C3SE and the Chalmers e-Science Centre. Sign up by email to Stig Larsson `<stig@chalmers.se>` no later than **2012–11–30**.

FENICS PROJECT

C³SE Chalmers Centre for Computational Science and Engineering

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