FEniCS Course

Overview

Lecturer
Anders Logg

23rd Jyväskylä Summer School
Aug 12–16 2013

Course outline

Mon	**L00**	Introduction to FEM
	L01	Introduction to FEniCS
	L02	Static linear PDEs
Tue	**L03**	Static nonlinear PDEs
	L04	Time-dependent PDEs
	L05	Happy hacking: Tools, tips and coding practices
Wed	**L06**	Static hyperelasticity
	L07	Dynamic hyperelasticity
Thu	**L08**	The Stokes problem
	L09	Incompressible Navier–Stokes
Fri	**L10**	Discontinuous Galerkin methods for elliptic equations
	L11	A posteriori error estimates and adaptivity

Lectures can be downloaded from

`http://fenicsproject.org/pub/course/`

Key distinguishing features

The FEniCS Project is a collection of open-source software components aimed at the numerical solution of partial differential equations using finite element methods

- FEniCS (Python/C++) code is quick to write and easy to read
- 'Any' finite element formulation of 'any' partial differential equation can be coded
- Automated code generation is heavily used under the hood to create efficient, specialized, low-level code
- Performance – implicit problems with over 200M degrees of freedom can be solved in minutes

http://fenicsproject.org/

FEniCS can be, and has been, used for a wide range of equations and applications

Reaction-diffusion equations; Stokes with or without nonlinear viscosity; compressible and incompressible Navier–Stokes; RANS turbulence models; shallow water equations; Bidomain equations; nonlinear and linear elasticity; nonlinear and linear viscoelasticity; Schrödinger; Biot's equations for porous media, fracture mechanics, electromagnetism, liquid crystals including liquid crystal elastomers, combustion, ... and coupled systems of the above, ...
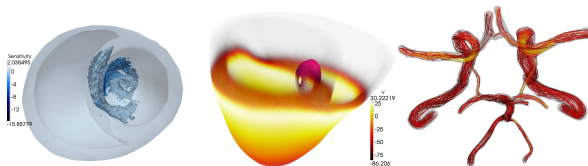
for simulating blood flow, computing calcium release in cardic tissue, computing the cardiac potential in the heart, simulating mantle convection, simulating melting ice sheets, computing the optimal placement of tidal turbines, simulating and reconstructing tsunamis, simulating the flow of cerebrospinal fluid and the deformation of the spinal cord, simulating waveguides, ...

Sounds great, but how do I find my way through the jungle?

Three survival advices

Use the right Python
tools

Explore the
documentation

Ask, report and
request

Documentation for FEniCS ~~1.0.0~~ *1.2.0!*

Our documentation includes a book, a collection of documented demo programs, and complete references for the FEniCS application programming interface (API). Note that the FEniCS API is documented separately for each FEniCS component. The most important interfaces are those of the C++/Python problem solving environment *DOLFIN* and the form language *UFL*.

(This page accesses the FEniCS 1.0.0 documentation. Not the version you are looking for? See all versions.)

The FEniCS Tutorial

A good starting point for new users is the *FEniCS Tutorial*. The tutorial will help you get quickly up and running with solving differential equations in FEniCS. The tutorial focuses exclusively on the FEniCS Python interface, since this is the simplest approach to exploring FEniCS for beginners.

The FEniCS Book

The FEniCS Book, *Automated Solution of Differential Equations by the Finite Element Method*, is a comprehensive (700 pages) book documenting the mathematical methodology behind the FEniCS Project and the software developed as part of the FEniCS Project. The FEniCS Tutorial is included as the opening chapter of the FEniCS Book.

The FEniCS Manual

The FEniCS Manual is a 200-page excerpt from the FEniCS Book, including the FEniCS Tutorial, an introduction to the finite element method and documentation of DOLFIN and UFL.

Demos

A simple way to build your first FEniCS application is to copy and modify one of the existing demos:

Documented DOLFIN demos (Python)

Documented DOLFIN demos (C++)

The demos are *already installed on your system* or can be found in the *demo* directory of the DOLFIN source tree.

Quick Programmer's References

Some of the classes and functions in DOLFIN are more frequently used than others. To learn more about these, take a look at the

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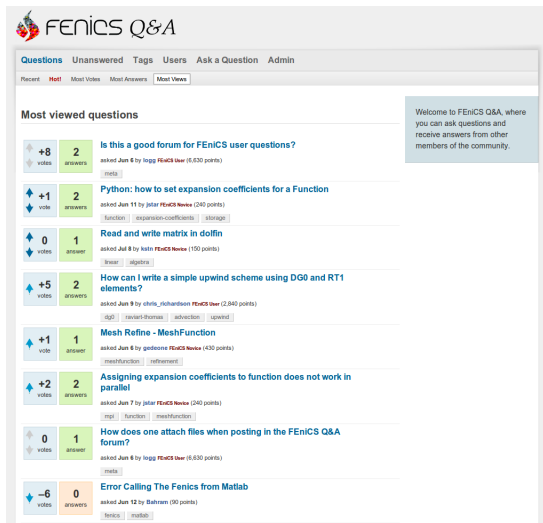
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Getting help from the FEniCS community

http://fenicsproject.org/qa/

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Community resources

- The FEniCS mailing list

  `fenics@fenicsproject.org`

- The FEniCS QA forum

  `http://fenicsproject.org/qa/`

- The FEniCS Google+ community

  `http://plus.google.com/`

- Twitter

  `#fenicsproject`

- The FEniCS developer site (Bitbucket)

  `https://bitbucket.org/fenics-project/`

  http://fenicsproject.org/

Installation

Official packages for Debian and Ubuntu

Drag and drop installation on Mac OS X

Binary installer for Windows

Automated installation from source

http://fenicsproject.org/download/

Let's get started and remember:

- **Lectures** can be downloaded from

  `http://fenicsproject.org/pub/course/lectures/`

- **Data** for exercises can be downloaded from

  `http://fenicsproject.org/pub/course/data/`

- **Solutions** for exercises can be downloaded from

  `http://fenicsproject.org/pub/course/src/`

  (Secret password needed!)