

MATH 676

-

**Finite element methods in
scientific computing**

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Lecture 2:

A real short overview of deal.II

deal.II

Deal.II is a finite element library. It provides:

- Meshes
- Finite elements, quadrature,
- Linear algebra
- Most everything you will ever need when writing a finite element code

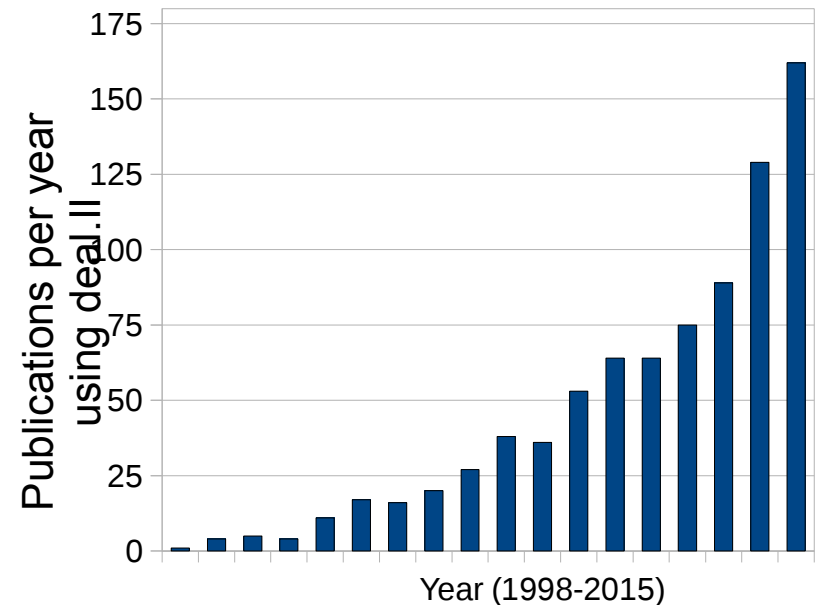
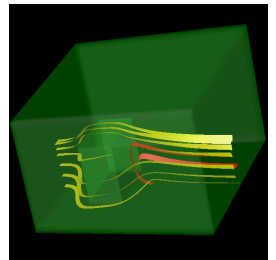
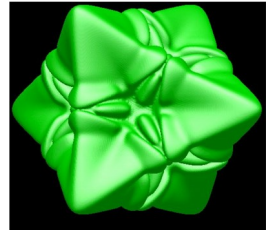
On the web at

<http://www.dealii.org/>

deal.II

deal.II is probably the largest FEM library:

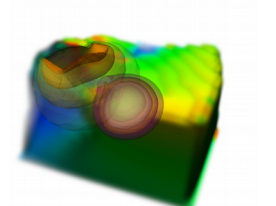
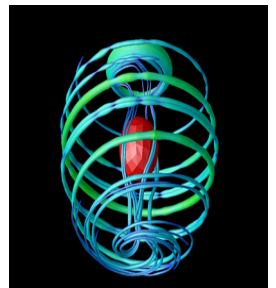
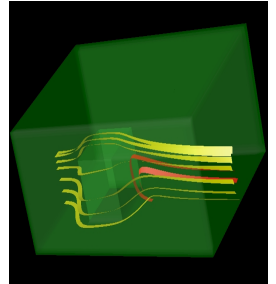
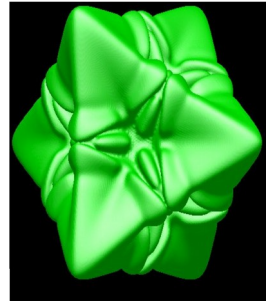
- Presently ~1,000,000 lines of C++ code
- 10,000+ pages of documentation
- ~55 tutorial programs
- Fairly widely distributed:
12,000+ downloads in 2015
- 160+ publications in 2015,
800+ overall, that use it
- Used in teaching at a number
of universities
- 2007 Wilkinson prize.



What's in deal.II

Meshes and elements:

- Supports adaptive meshes in 1d, 2d, and 3d
- Easy ways to adapt meshes: Standard refinement indicators already built in
- Many standard finite element types (continuous, discontinuous, mixed, Raviart-Thomas, ...)
- Low and high order elements
- Full support for multi-component problems



What's in deal.II

Linear algebra in deal.II:

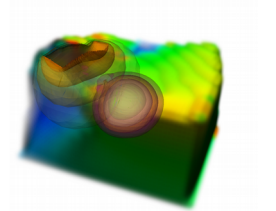
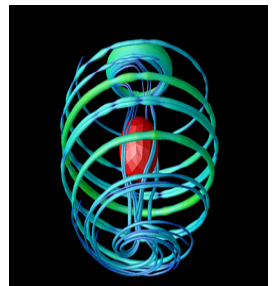
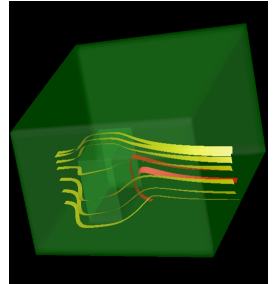
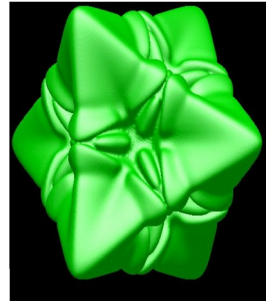
- Has its own sub-library for dense + sparse linear algebra
- Interfaces to PETSC, Trilinos, UMFPACK

Pre- and postprocessing:

- Can read most mesh formats
- Can write almost any visualization file format

Parallelization:

- Uses threads and tasks on multicore machines
- Uses MPI, up to 10,000s of processors

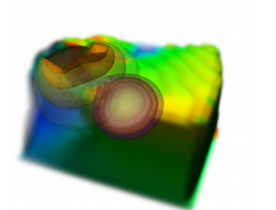
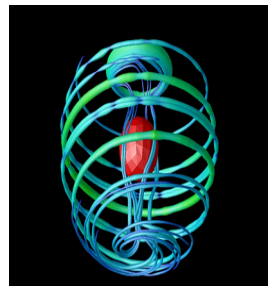
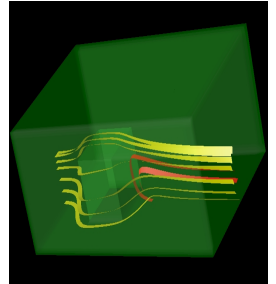
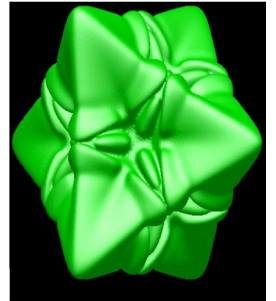


What deal.II is used for

Apparently any PDE can be solved with deal.II.

In 2008–2010, papers were published that simulate:

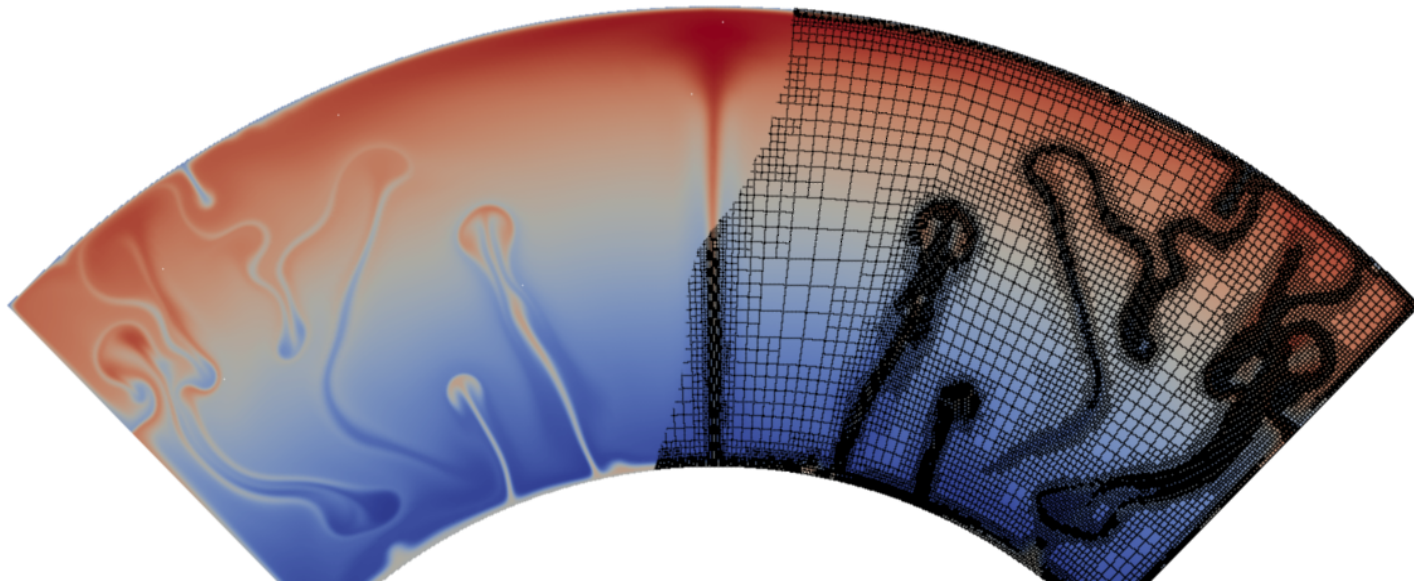
- Biomedical imaging
- Heart muscle fibers
- Microfluidics
- Oil reservoir flow
- Fuel cells
- Aerodynamics
- Quantum mechanics
- Neutron transport
- Numerical methods research
- Fracture mechanics
- Damage models
- Sedimentation
- Biomechanics
- Root growth of plants
- Solidification of alloys
- Glacier mechanics
- Deterioration of statues due to air pollution



What deal.II is used for

Example: The mantle convection code ASPECT

<http://aspect.dealii.org/>



Methods:

- 2d, 3d, adaptive meshes, multigrid solvers
- Higher order finite elements
- Fully parallel

How deal.II is developed

Development:

- 6–8 core developers (in the US, Germany, Italy)
- ~10 occasional contributors (around the world)
- 200+ people have contributed over the past 15 years
- ~4,000 lines of new code per month

deal.II is a typical open source project:

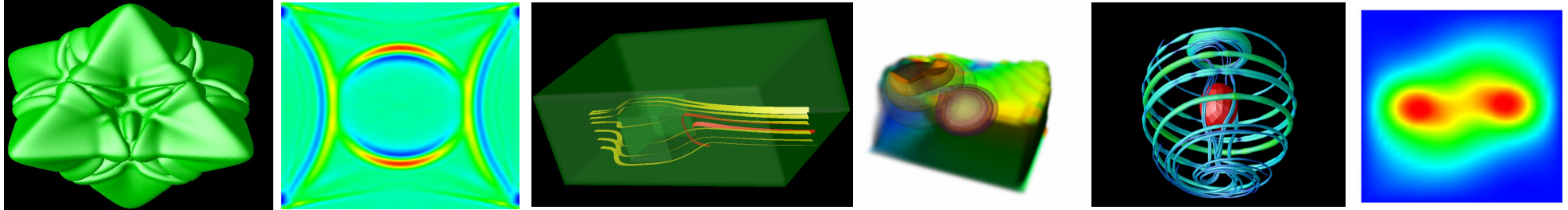
- People primarily develop what they need
- Open culture:
 - All development happens in the open
 - We (really) welcome everyone's contributions!

How deal.II is developed

Professional-level software management:

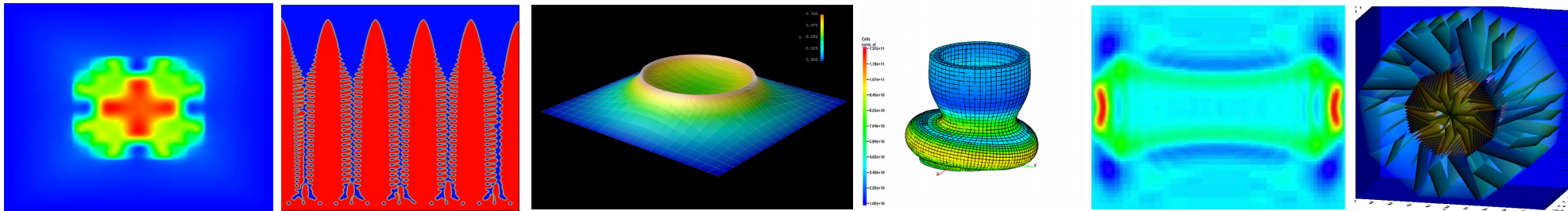
- Globally accessible repository
- Mailing lists with significant volume
 - for user questions
 - for developer discussions
- ~8,800 tests run after every change
- Multi-platform build systems
 - Linux/Unix
 - Mac OS X
 - Windows
- Web sites tracking changes, tests, builds, ...

On the web



Visit the deal.II library:

<http://www.dealii.org/>



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