Numerical MOOC:
Collaborating in Open Education for CSE

Lorena A. Barba, George Washington University, USA, labarba@gwu.edu
Ian Hawke, Southampton University, United Kingdom, i.hawke@soton.ac.uk
Bernard Knaepen, Université Libre de Bruxelles, Belgium, bknaepen@ulb.ac.be

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Indie The MOOC space is dominated by start-ups

Mid-2014 —The fanfare of MOOCs was dying down and the "big three" were consolidating their positions:

1. **Coursera** introduced Signature Tracks, pushing heavily towards monetization.
2. **Udacity** pivoted to industry partnerships and employer-led curricula, and phased out free certificates.
3. **edX** is the only non-profit: its partners have to pay a hefty joining fee; it moved to paid verified certificates.

We opted to create an independent MOOC: self-hosted, self-produced, self-marketed.

Open Taking inspiration from the open-source world

Look at the impact of open source in software: programmers collaborate on large, complex projects, creating value together.

Think about the influence of this model in Open Education: *Teaching and learning resources are made public, under a license that permits reuse, remix, rework, redistributing.*

We collaborate internationally with like-minded instructors, peer-review materials, join in the same online platform, bring our students together, share content and assessments—while also inviting self-learners to join us in the MOOC.

Modular A course made of stackable learning units

Each module is motivated by a model governed by differential equations, and builds new concepts in numerical computing, new coding skills and ideas about analysis of numerical solutions.

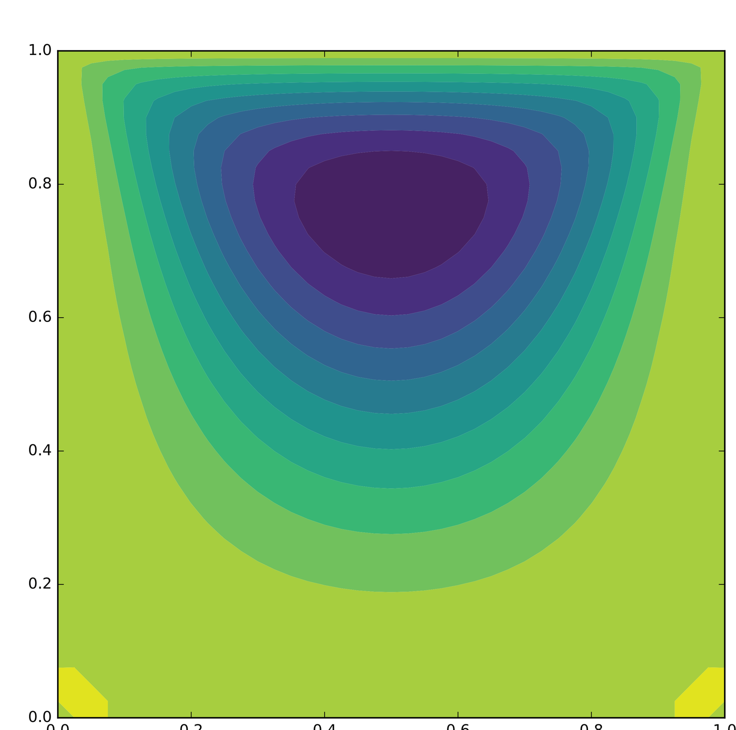
1. **The phugoid model of glider flight.**
Two nonlinear ordinary differential equations for longitudinal instabilities of a glider. Starts from simple harmonic motion, builds to the full nonlinear system, teaching Euler's method, convergence testing, Runge-Kutta methods.

2. **Space and Time.**
Introduction to finite-difference solutions of PDEs, using the linear convection equation. Motivates the idea of numerical diffusion, stability, and physical idea of conservation laws.

3. **Riding the Wave.**
Convection problems: using the traffic-flow model to learn different solution methods for problems with shocks: upwind, Lax-Friedrichs, Lax-Wendroff, MacCormack, MUSCL.

4. **Spreading Out.**
Diffusion problems: using the heat equation, learn details of implementing boundary conditions, and introduces implicit schemes; ends with Crank-Nicolson scheme.

5. **Relax and Hold Steady.**
Elliptic problems: Laplace and Poisson systems explained as systems relaxing under the influence of the boundary conditions and the Laplace operator. Linear solvers: Jacobi method, Gauss-Seidel, SOR, conjugate gradient.



Left — The student assignment for Module 5 solves the Stokes equation for flow in a square cavity at very low Reynolds number.

Digital Using the latest technology in digital pedagogy

Open edX is the only last-generation, full-featured open-source platform for online learning. We deployed our site on Amazon AWS, with support from technical partners at IBL Studios. More than 7,500 learners are registered.

Find it:
http://openedx.seas.gwu.edu

All the course materials are available publicly, outside the Open edX site. The GitHub repository has 300+ stars and 1,000+ forks. Followers of the course can contribute fixes via pull request.

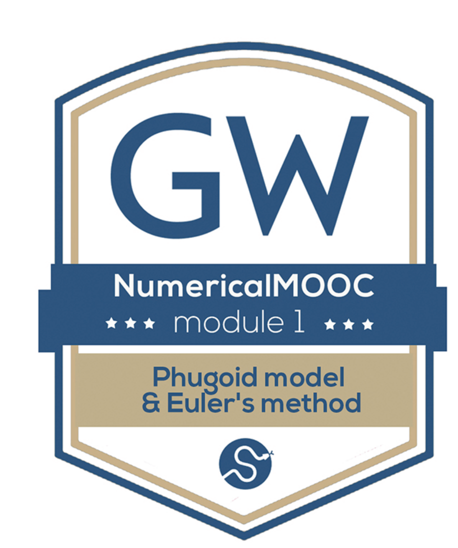
Find it:
https://github.com/numerical-mooc/numerical-mooc

Course lessons are Jupyter notebooks with multi-media content, and executable Python code. Jupyter is the "killer app" for CSE education!

Find out more:
http://jupyter.org

The MOOC offered open badges, thanks to a new XBlock (extension component for Open edX) developed by our tech partners. An open badge is made available to each student as soon as they complete the graded assessment for a course module.

Find out more:
https://code.badgeone.com



Left — The badge for Module 1 of the course.

Lorena A. Barba
George Washington University
United States

Ian Hawke
Southampton University
United Kingdom

Bernard Knaepen
Université Libre de Bruxelles
Belgium

@LorenaABarba @IanHawke @bknaepen

Please visit:
http://lorenabarba.com

Credits Images and thanks

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