Engineers Code:

Re-usable, Open Educational Modules for Engineering Undergraduates

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We take inspiration in the ideas of Seymour Papert about computational thinking. In particular, we want to design course materials adhering to Papert's Power Principle: **What comes first, using or understanding?** The natural mode of learning is to first use, leading slowly to understanding. New ideas are a source of power to do something!

Motivation—Using computing to learn

Our approach follows research-based design directions for developing computational thinking skills, embedded in science contexts. These skills are:
1. Data practices
2. Modeling and simulation practices
3. Computational problem-solving
4. Systems-thinking practices

Ref.
– Weintrop, David, et al., "Defining computational thinking for mathematics and science classrooms," J. Science Ed. and Tech., Vol. 25(1): 127–147 (2016).

Design—Key principles

1. Idea of "computable content"—educational content made powerfully interactive, using Jupyter.
2. Idea of open pedagogy—reflecting in the teaching practice the ethos of open source.
3. Modularization—break-up the typical course format.
4. Harness the "worked-example effect"—empirically shown as better than problem-solving for novices.
5. Live-coding to structure active-learning in class.

Open—Inspired by open-source culture

Think of the impact of open-source development: people collaborate on large, complex projects, creating value together.

What is the influence of this model in Open Education? Teaching and learning resources are made public, under a license permitting reuse, remix, rework, redistributing.

We aim to collaborate with like-minded instructors, to peer-review materials, join in shared online platforms, and bring our students together.

Modular—Stackable self-contained modules

We can transform science and engineering education by making computational thinking infrastructural: embedded, ubiquitous, and contextual. To accomplish this, we need open instructional materials designed to be reusable, and community efforts to share good practices for using them. Our foundation modules are ready to adopt:

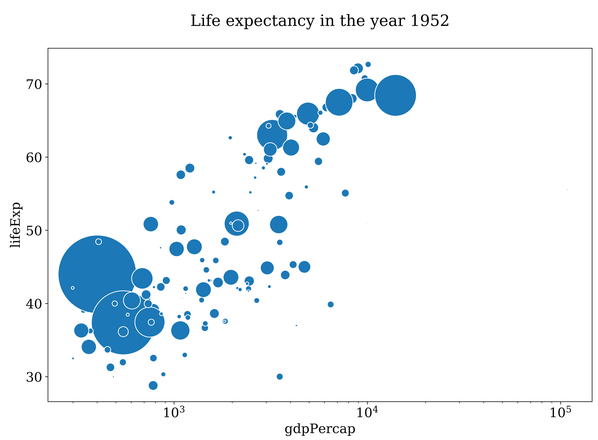
1. Get data off the ground: Learn to interact with Python and handle data.

2. Take off with stats: Hands-on data analysis using a computational approach and real-life applications.

3. Fly at changing systems: Tackle the dynamics of change with computational thinking.

Coming soon!
4. Land in vector spaces:
A graphical introduction to linear algebra.

All materials are under BSD-3 clause and CC-BY licenses.



From Module 2, lesson 4: "Life expectancy and wealth"—bubble plot of life expectancy vs. gross domestic product for 142 countries, with bubble size scaled by population.

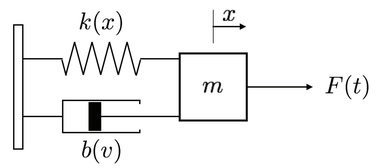
Digital —Using the latest technology in digital pedagogy

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 Education, NY.

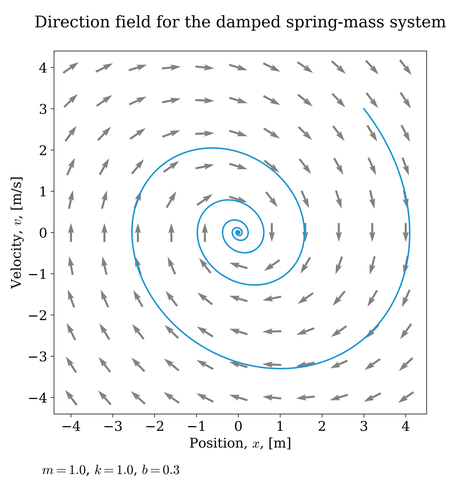
Find it:
https://openedx.seas.gwu.edu

Course lessons are Jupyter-first—created as Jupyter notebooks, displayed in Open edX via the new **jupyter-viewer-xblock**. Assessments are auto-graded via the **jupyter-edx-grader-xblock**, **nbgrader** and Docker, providing instant feedback to the learner.

Find it:
https://github.com/ibleducation/jupyter-viewer-xblock
https://github.com/ibleducation/jupyter-edx-grader-xblock



From Module 3, lesson 4: "Bird's eye view of mechanical vibrations"—top: system diagram; bottom: phase plot.



https://github.com/engineersCode/EngComp

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Please visit:
http://lorenabarba.com

Credits—Images and thanks
- Lolly sticks from Wiki Education CC-BY
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