UNSW Engineering Education Showcase 2017

Context and confidence for numerical methods

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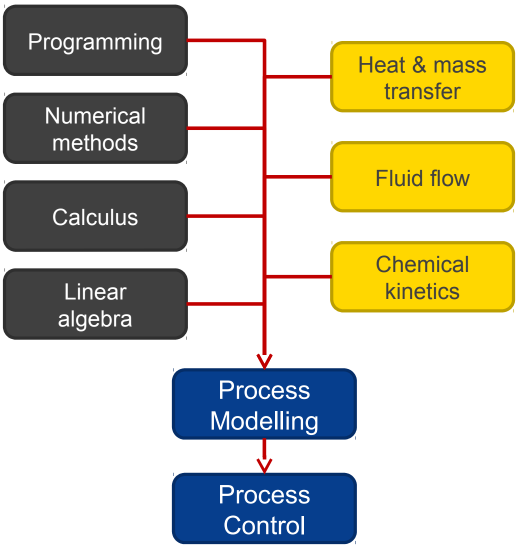
Process modelling

- senior level course, core (CEIC3000)
- reliant on *lots of prerequisite knowledge* maths, computing, chemical engineering
- students should be able to …
  - *build a model of a process*
    - » heat flow, material flow, chemistry
  - *analyse the model*
    - » analytical maths with DEs
    - » numerical solutions of DEs
    - » qualitative analysis of system



Notebook computing

Jupyter notebooks: literate computing

- code *plus*
  - » context, output, analysis
- no barrier to entry
  - » runs on cloud via web browser
- lots of languages
  - » **Python**, **Octave**, R, Julia…

cocalc.com @co_calc
Jupyter notebooks + more
freemium: free to use, US$7/mo for upgrades

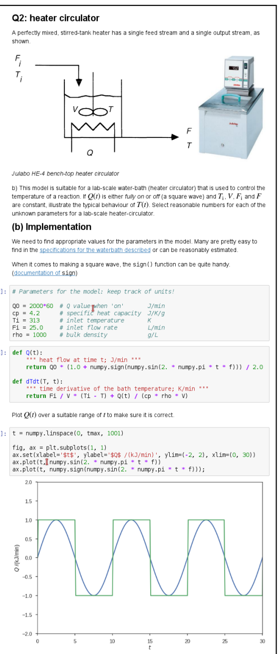
problem statement
- rich text (Markdown)
- graphics, equations, links, videos

solution
- rationale, approach, description

code (input)
- Python with `numpy`, `matplotlib`

descriptive
- "why?" not just what

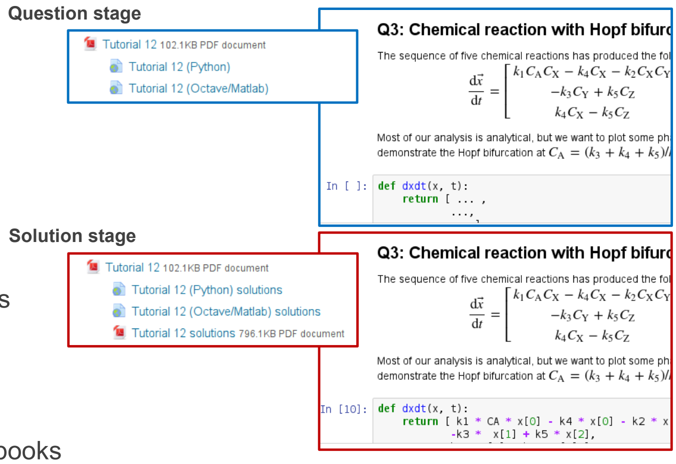
results (output)
- text, plots, …



Scaffolding

Template for the solution for each tutorial and assignment question

- Question details *plus*
  - » hints, partial code
- Solutions including
  - » complete code
  - » tips, discussion, extensions
- Sustainable
  - » template with metadata
    + processing scripts
    = question + solution notebooks



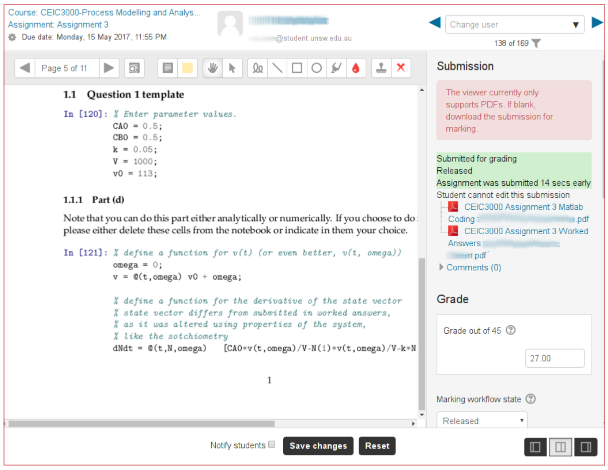
Templates for assignments

For the student

- » template gives hints, guidance
- » Jupyter: File → Download → PDF

For the marker

- » compatible with Moodle PDF grader
- » fully electronic workflow for grading
- » easy to make verbose, insightful comments, annotations
- » faster to mark



Evaluation: Where next?

Students say: best features of this course…

- good guidance provided for computation work in templates
- Sage Math Cloud (now called CoCalc)
- lots of help in tutorial questions
- use of computational tools
- cooperative learning between theory, hand solving and computer solving
- strong links between maths and applications in practice
- developed mathematical thinking required to apply maths to the world
- challenging but at an appropriate level

We saw:

- more 'aha' moments in tutorials
- more assignments are own work not copied code

Next steps:

- Remove PDFs of tutorial sheets and assignments completely
  - » everything via Jupyter
- Further experimentation:
  - » CoCalc's "Course" tools
  - » notebook grading tools (`nbgrader`)