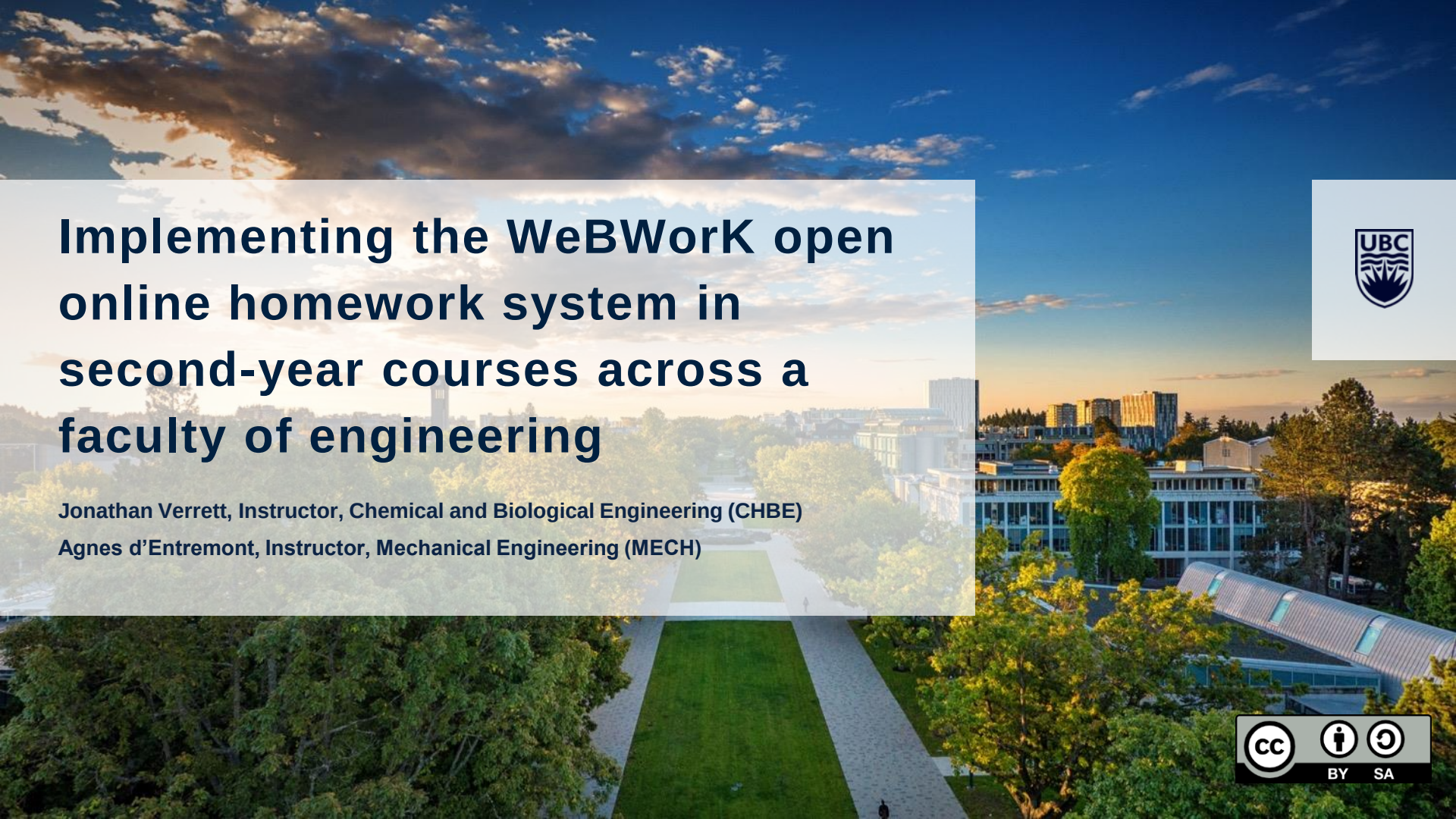


Implementing the WeBWorK open online homework system in second-year courses across a faculty of engineering

Jonathan Verrett, Instructor, Chemical and Biological Engineering (CHBE)

Agnes d'Entremont, Instructor, Mechanical Engineering (MECH)

WHAT HOMEWORK SYSTEMS HAVE YOU PREVIOUSLY USED?

Respond at **www.slido.com**

with this code: **#B198**

List a homework system you have used previously if it is not there, or upvote one listed already if you have used it.

PICK A HOMEWORK SYSTEM YOU ARE MOST FAMILIAR WITH, WHAT ARE SOME STRENGTHS/WEAKNESSES OF THIS HOMEWORK SYSTEM?

Respond at **www.slido.com**

with this code: **#B198**

List a strength (+) or weakness (-) if it is not there, or upvote one listed already if it applies to the system you are thinking of.

WHAT IS WEBWORK?

- Online homework system primarily used for **math**; increasingly used in **engineering**, but also **physics, chemistry, statistics, economics, geography…**
- Uses a programing language to specify exercises allowing instructors flexibility in problem presentation
- Provides unique question values to each student, instant feedback on answers (chance to correct errors), auto-grading of homework, shareable content via open-source problem bank
- Originally developed at the University of Rochester; now supported by the National Science Foundation and the Mathematical Association of America (MAA)
- Maintained by many contributors at a number of colleges and universities

WHY WEBWORK?

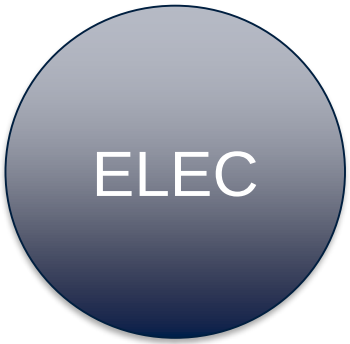
- Open-source and free
- Highly customizable
- Familiarity for our students through 1st year Math at UBC
- Independent of LMS
- Support through universities and the community
- Homework systems becoming a regular part of textbooks

USE OF WEBWORK IN UBC ENGINEERING BEFORE THIS PROJECT

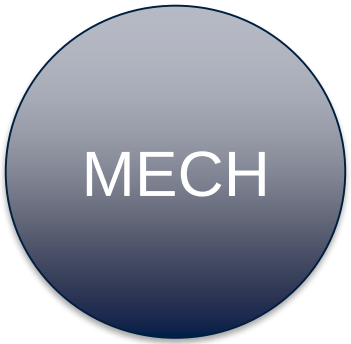
Departments working in isolation.

No (or very few) questions available openly.

No sharing of questions in courses that may have content overlap.



Electrical and Computer Engineering (ELEC)

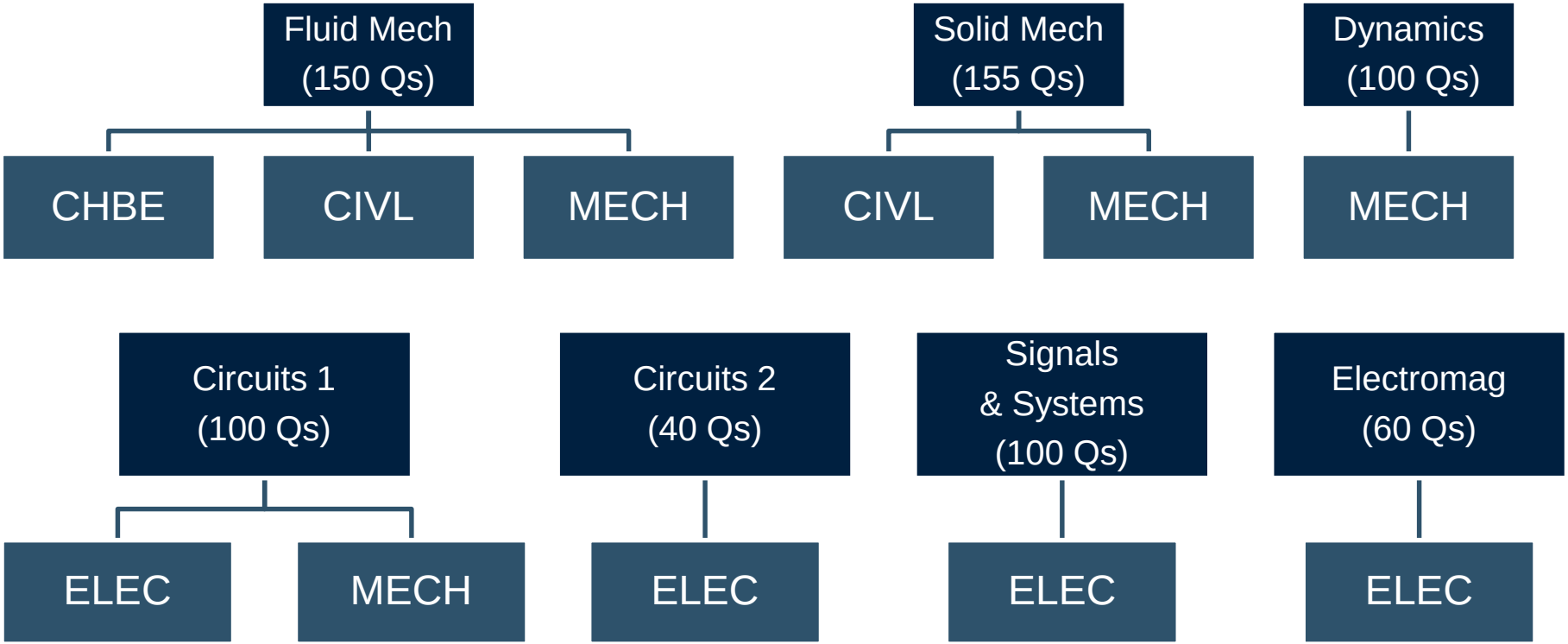


Mechanical Engineering (MECH)

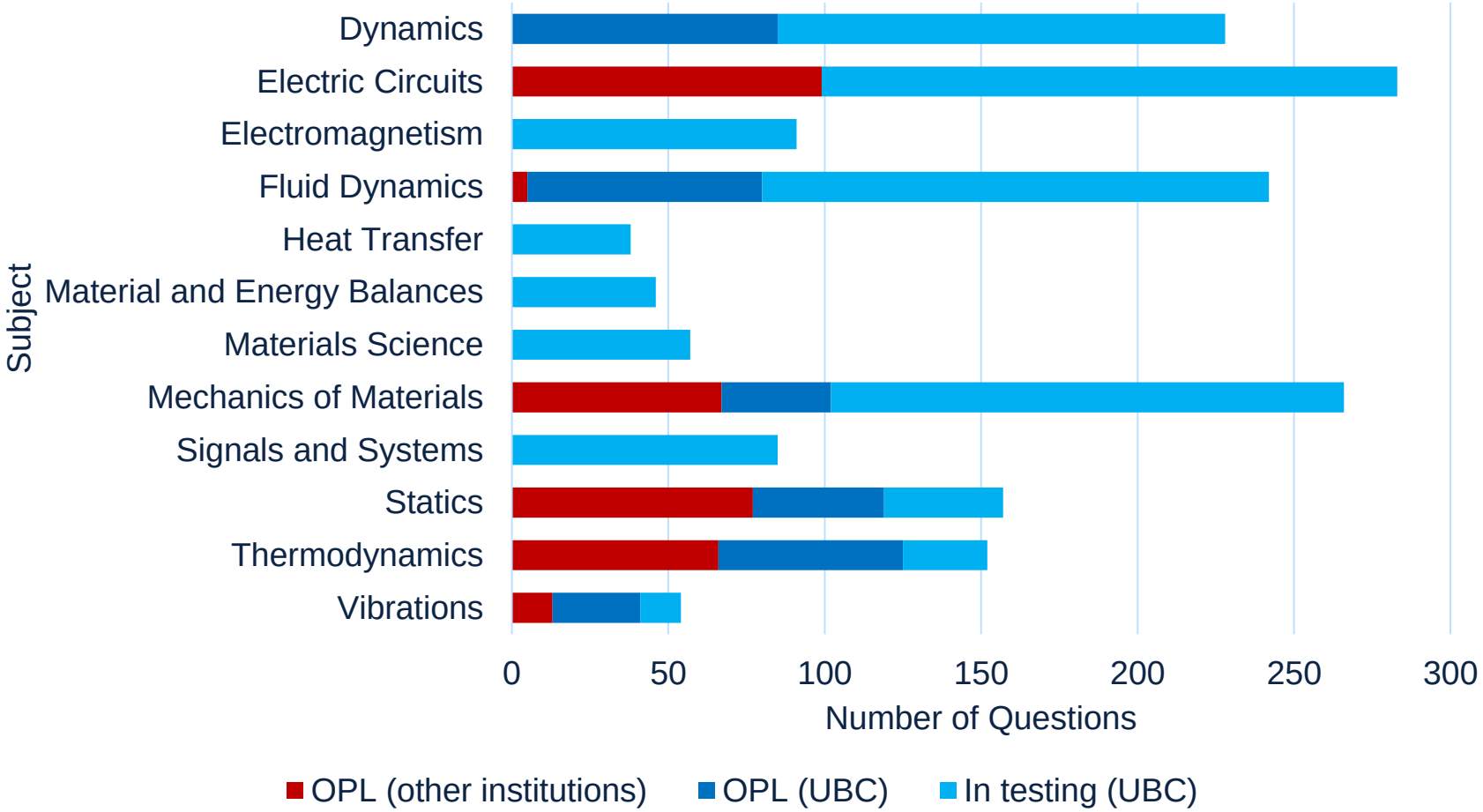
Chemical and Biological Engineering (CHBE)

ENGINEERING YEAR 2 WEBWORK PROJECT

- UBC Teaching and Learning Enhancement Fund (TLEF) $50,000
- BC Campus Open Educational Resources Grant Program $7,500

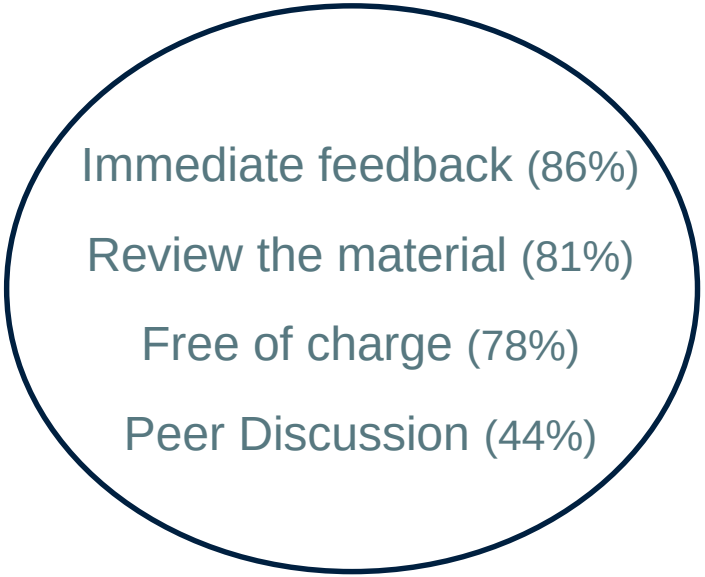


ENGINEERING QUESTIONS IN THE OPEN PROBLEM LIBRARY (OPL)



WHAT DO STUDENTS SAY ABOUT WEBWORK?

87.7%* rated their experience with WeBWorK as satisfactory



*Survey of students in Electrical and Computer Engineering Department (ECE) at UBC

92%** preferred WeBWorK to other systems

1 = Strongly disagree, 3 = Neutral, 5 = Strongly agree

Selected statements about specific tools	Ratings for Blackboard [mean (SD)]	Ratings for WeBWorK [mean (SD)]
The **feedback** given through the tool was EASY TO ACCESS	1.7 (1.0)	4.4 (0.9)
The **feedback** given through the tool was CLEAR	1.9 (1.0)	4.2 (1.1)
The tool **enhanced my learning**	1.9 (1.0)	4.5 (0.7)
I would **like to use** the tool in the future	1.3 (0.6)	4.7 (0.6)

**MECH students (d'Entremont, Canadian Engineering Education Association, 2017)

STUDENT SURVEY RESULTS FROM THIS PROJECT (MULTIPLE DEPTS)

How did WeBWorK impact your studies this term?

Motivated to attempt "for-mark" questions

Motivated to attempt "practice" questions

Motivated to finish "for-mark" questions

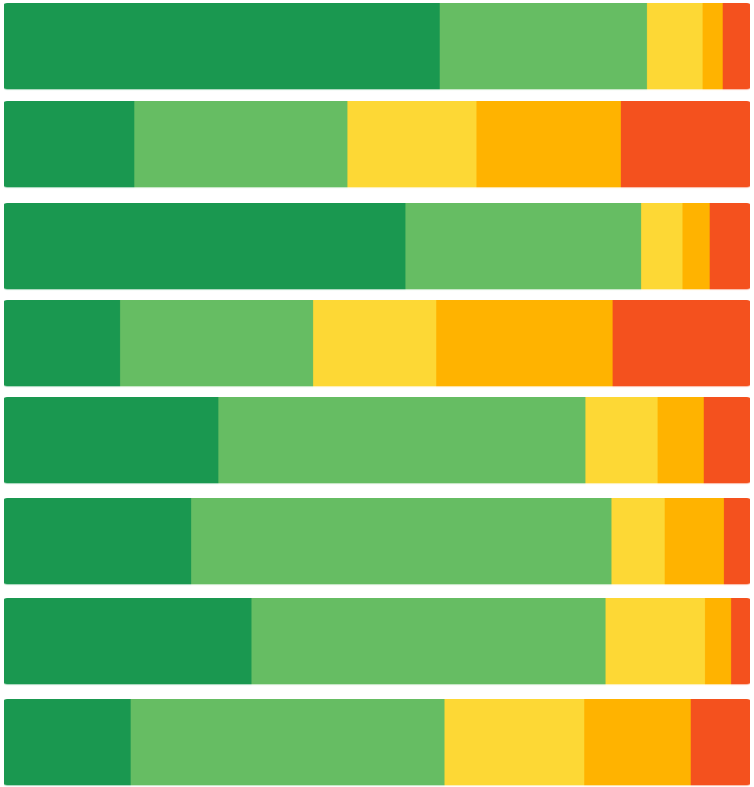
Motivated to finish "practice" questions

Motivated to correct my understanding

Expect WW will help with the final exam

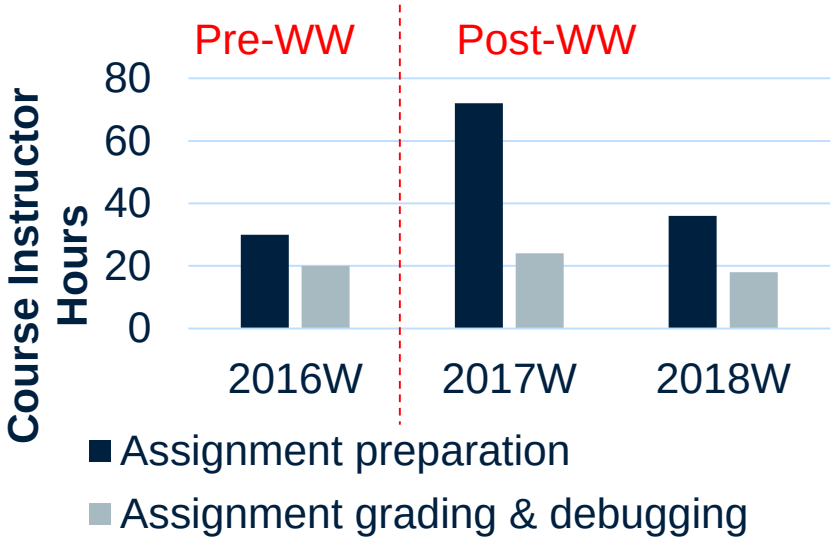
Believe WW enhanced my learning

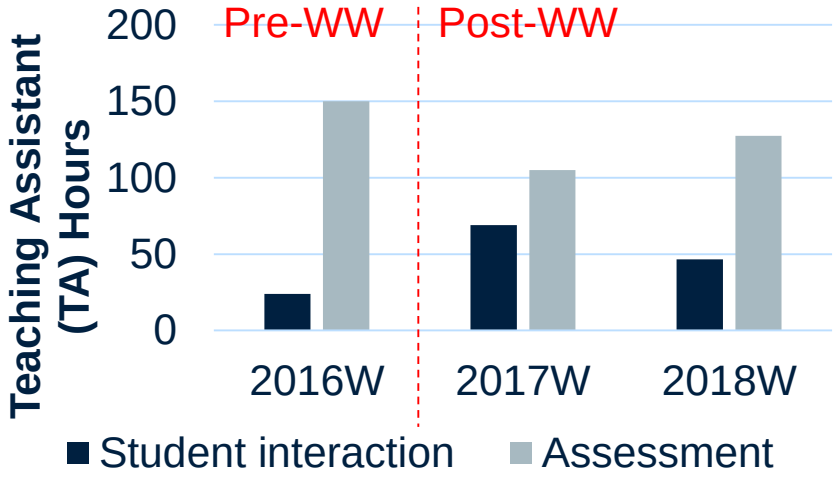
Enjoyed using WW



IMPACT ON INSTRUCTORS?

Impact on instructors in 2nd year CHBE course, WeBWorK (WW) implemented in 2017W.

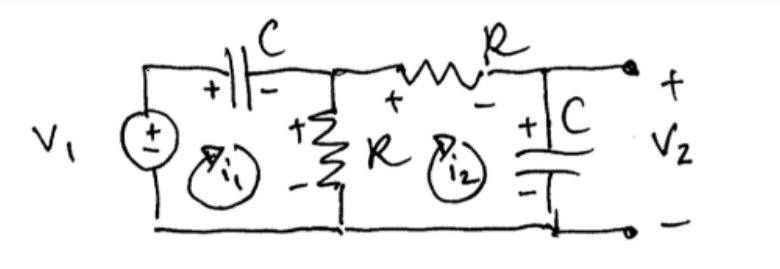




- More TA time spent on interacting with students through office hours, in tutorials.
- Significant time dedicated to question creation initially by instructors.

A TYPICAL SAMPLE QUESTION

Consider the RLC circuit:



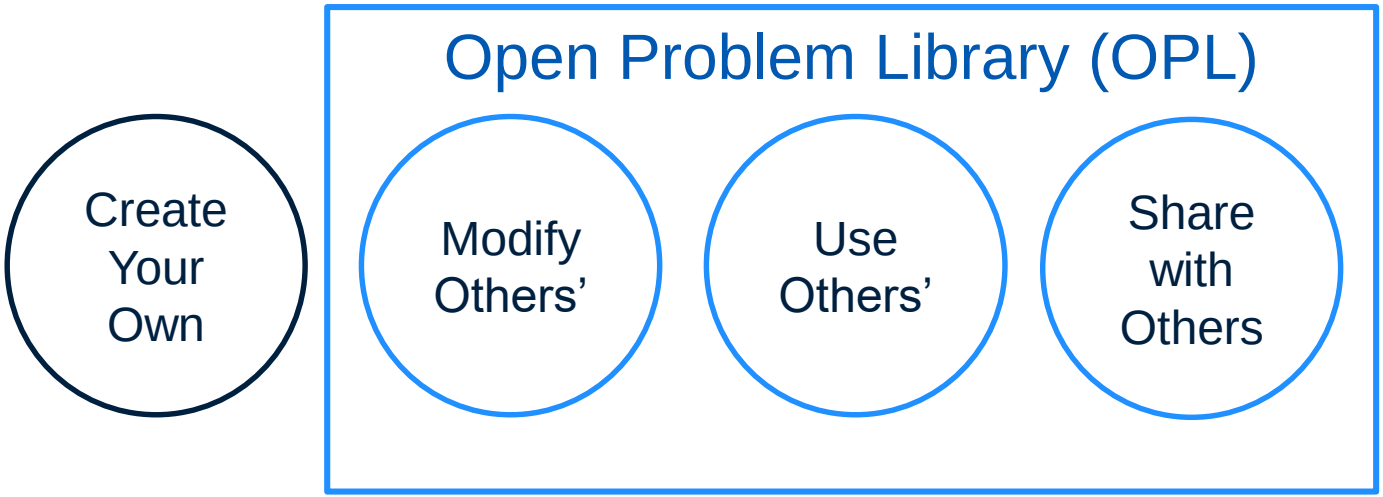
Find the transfer function $H(s) = \dfrac{V_2(s)}{V_1(s)} =$

Suppose the components are $R = 160\Omega$ and $C = 0.18F$ and the input is $v_1(t) = \sin(3t)$.

Find the amplitude of the steady state response:

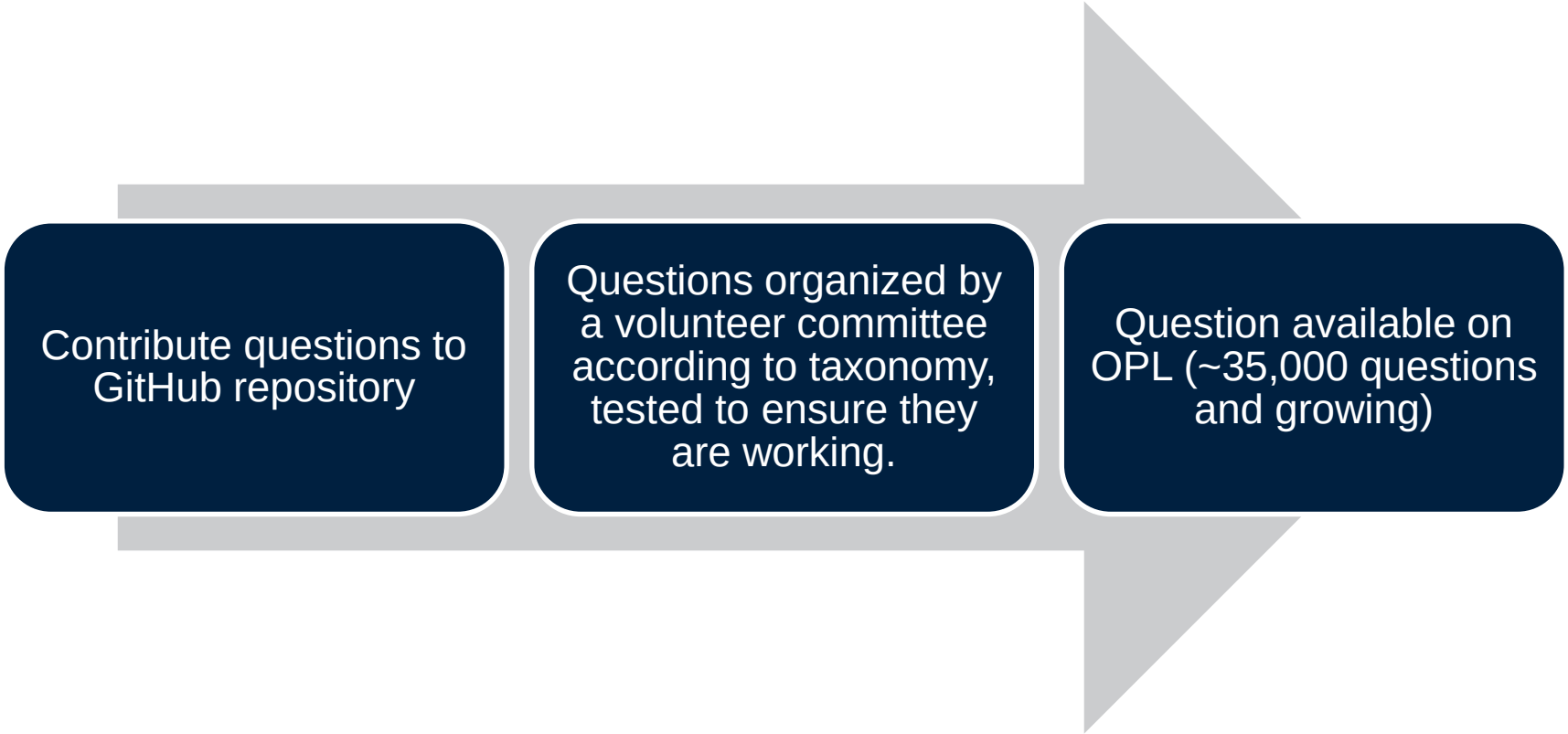
https://webwork.elearning.ubc.ca/webwork2/APSC_TLEF/

WHERE TO START?



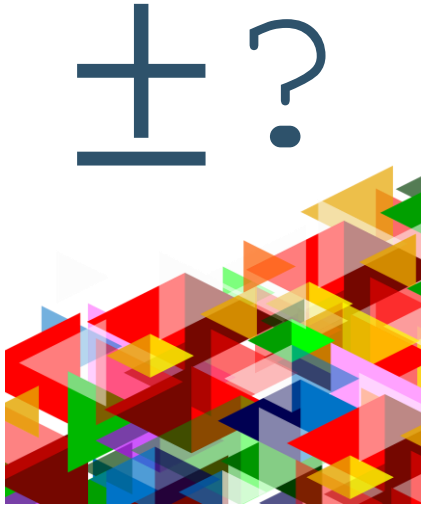
webwork.maa.org/wiki

CONTRIBUTING TO THE OPL



OPPORTUNITIES

- Scripts for automated conversion of questions from other problem systems. Successfully done with Desire2Learn.
- Local or regional WeBWorK community and users group
- Sharing scripts and resources: https://github.com/ubc-mech2



CHALLENGES

- Time to create 1 problem: ~1.5-2 hours
- Getting the right tolerances for final answer (with the right variable ranges)
- Making shareable graphics
- Errors in code and correction of these

Error!

ACKNOWLEDGEMENTS

Collaborators

- Dr. Negar M. Harandi – UBC Electrical and Computer Engineering
- Gianni Co – UBC Mechanical Engineering

Support provided by:

- UBC Teaching and Learning Enhancement Fund (TLEF)
- BCcampus
- UBC Centre for Teaching, Learning and Technology (CTLT)
- UBC Applied Science Centre for Instructional Support (APSC CIS)
- UBC Department of Mechanical Engineering
- UBC Department of Chemical & Biological Engineering
- UBC Department of Electrical & Computer Engineering

QUESTIONS AND DISCUSSION?

Respond at **www.slido.com**

with this code: **#B198**

Can ask questions here and up-vote questions

BUILDING WEBWORK QUESTIONS

WHAT TYPE OF QUESTIONS?

Consider the matrix $A = \begin{bmatrix} 2 & 3 \\ 4 & 1 \end{bmatrix}$ and the matrix $B = \begin{bmatrix} -1 & 2 \\ 2 & 1 \end{bmatrix}$. What is $A + B$?

- **A.** $\begin{bmatrix} -2 & 6 \\ 8 & 1 \end{bmatrix}$
- **B.** $\begin{bmatrix} 1 & 5 \\ 6 & 2 \end{bmatrix}$
- **C.** $\begin{bmatrix} 2 & 1.5 \\ 2 & 1 \end{bmatrix}$
- **D.** $\begin{bmatrix} 4 & 7 \\ -2 & 9 \end{bmatrix}$
- **E.** none of the above

WHAT TYPE OF QUESTIONS?

Consider a circle of radius $R = 4$ units.

a. What is the area of the circle?

b. What is the circumference of the circle?

c. What is the area of the largest square that fits inside the circle?

WHAT TYPE OF QUESTIONS?

Let $f(x, y, z) = 6xyz^3 + 3xy^2 + 9x^2yz + 1$.

a. Compute the partial derivative $\frac{\partial f}{\partial x} =$

b. Compute the partial derivative $\frac{\partial f}{\partial y} =$

c. Compute the partial derivative $\frac{\partial f}{\partial z} =$

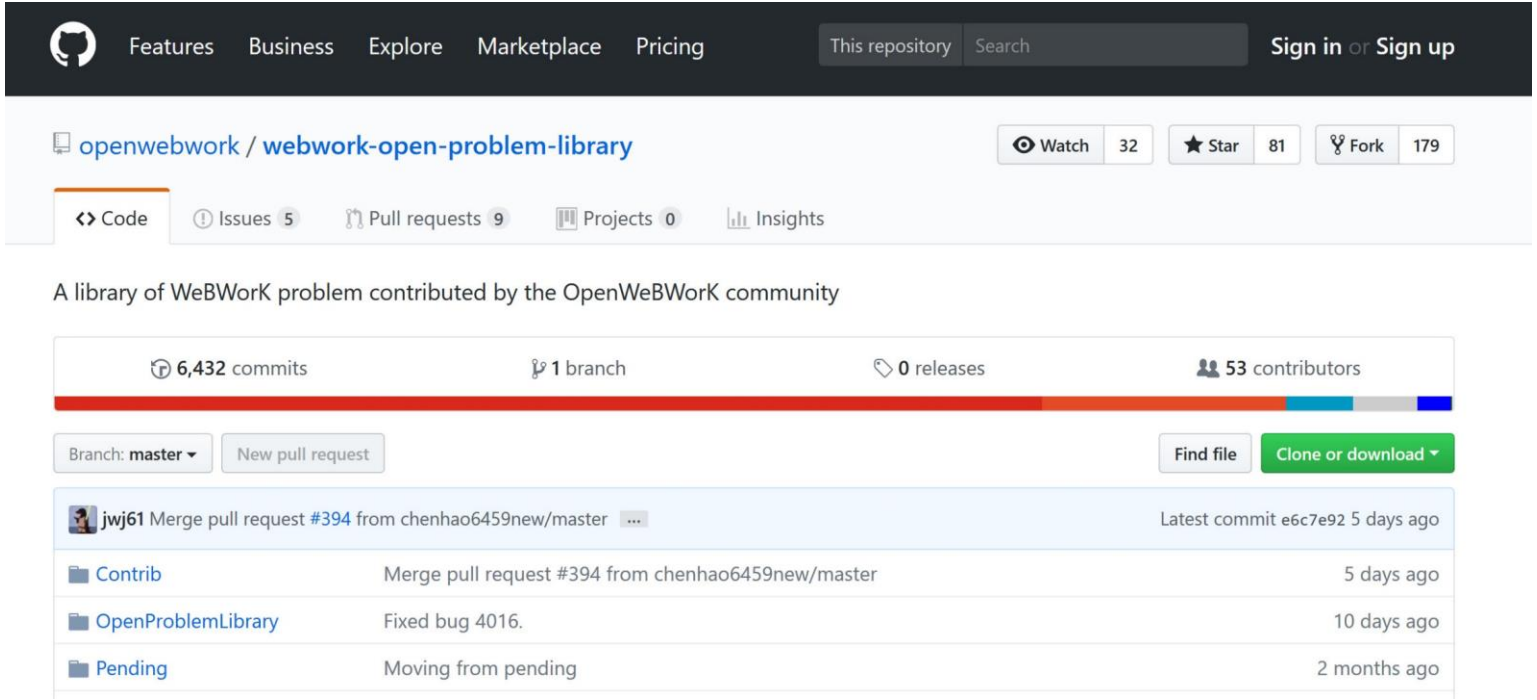
Q & A / DISCUSSION

- What are the advantages of using WeBWorK for your course/program?
- Do you feel confident that you can code appropriate problems?
- What are the barriers to adopting WeBWorK in your course/program?
- Would you be willing to share problems via the OPL? What would make it easier or more attractive to do so?

- Do you have questions for us?

FINDING WEBWORK QUESTIONS

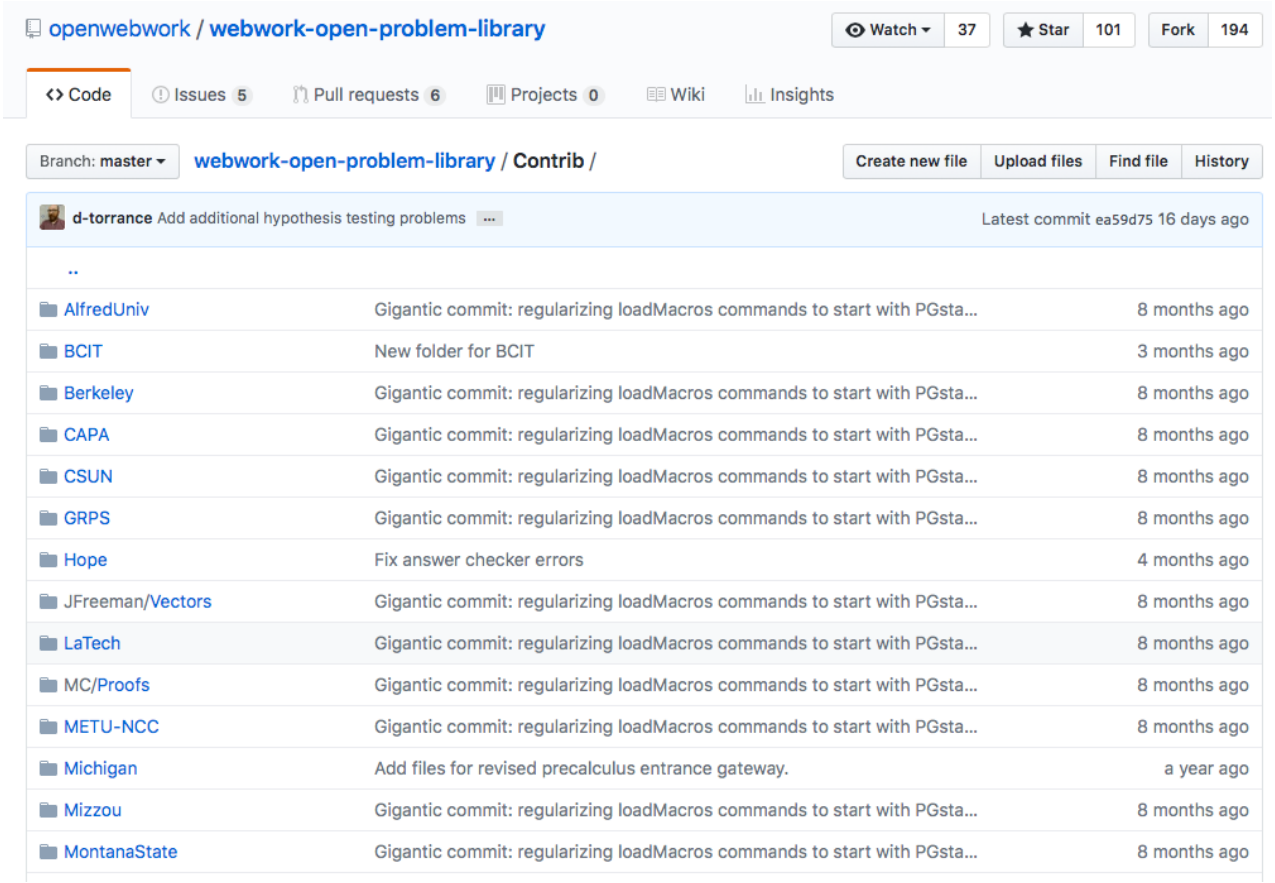
Github.com, home of the Open Problem Library (OPL)



Three main folders

- Contrib – new contribution to the OPL, problems automatically considered for OPL unless flagged not to be
- Open Problem Library – Problems that are also available on the OPL browser
- Pending – For problems being reviewed by OPL editorial board

Each institution has its own folder on the Open Problem Library (OPL)



(In upcoming Activity B4, you can create a school folder in Contrib if none existing currently)

Library Browser

Add problems to **Target Set:** Select a Set from this Course | Edit Target Set

Create a New Set in This Course:

Browse | Open Problem Library | Local Problems | From This Course | Set Definition Files

or Problems from | OPL Directory

Subject: All Subjects | Advanced Search

Chapter: All Chapters

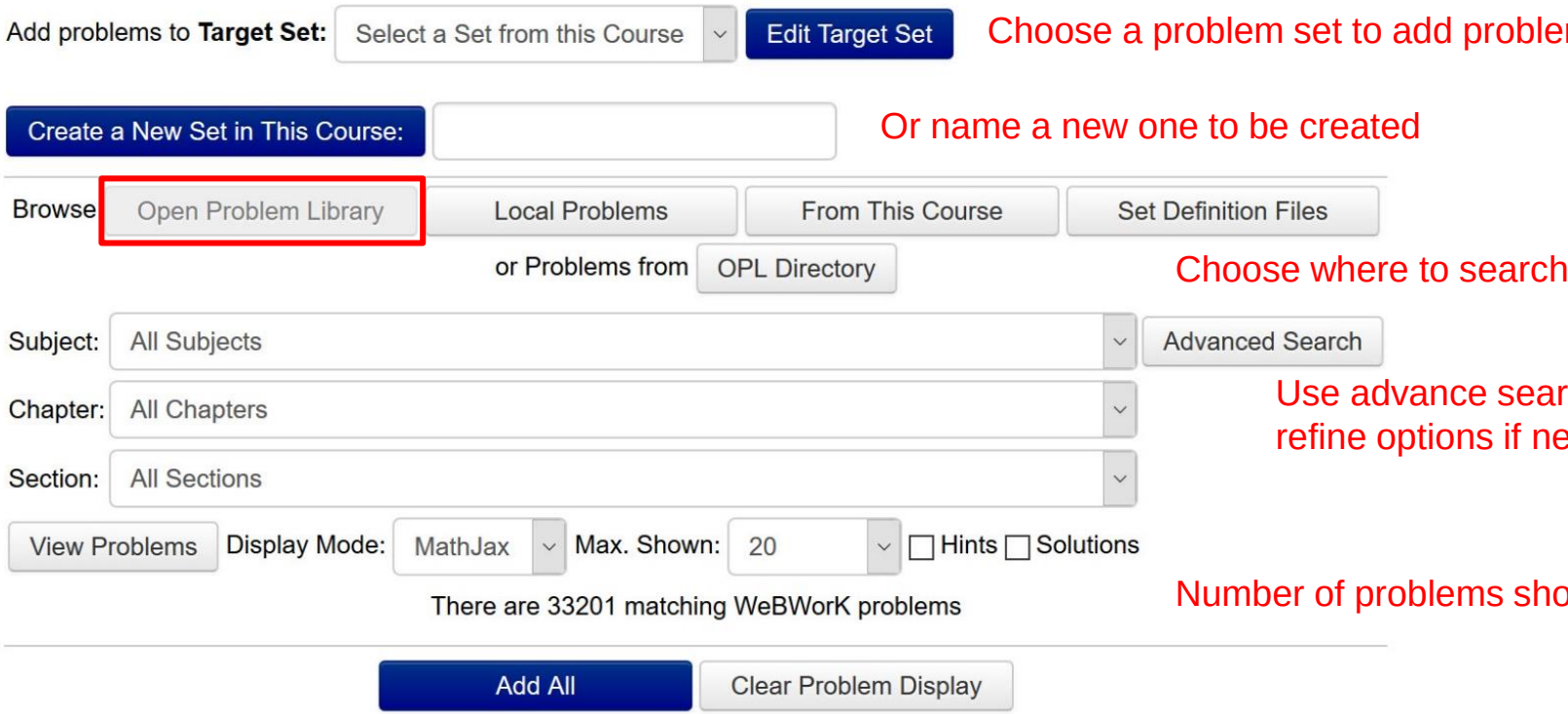
Section: All Sections

View Problems | Display Mode: MathJax | Max. Shown: 20 | Hints | Solutions

There are 33201 matching WeBWorK problems

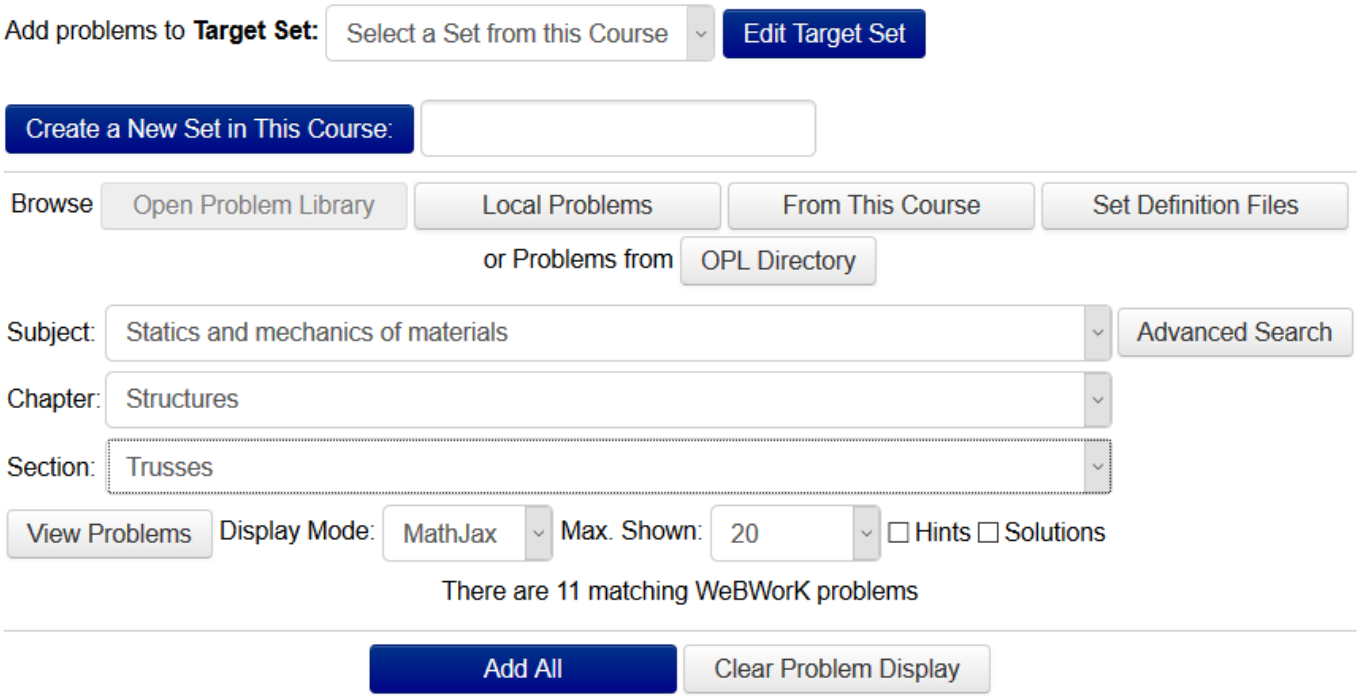
Add All | Clear Problem Display

Library Browser



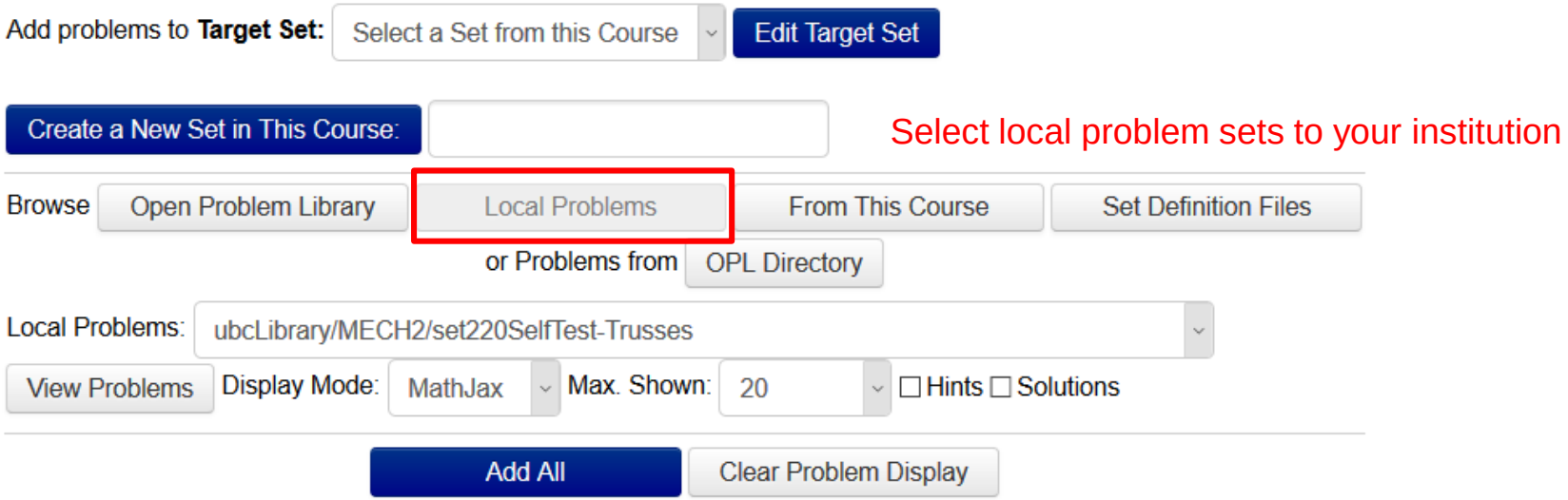
The OPL has many problems (we see 33,201 listed at the bottom). We will use the advanced search (Subject, Chapter and section) to narrow this down

Library Browser



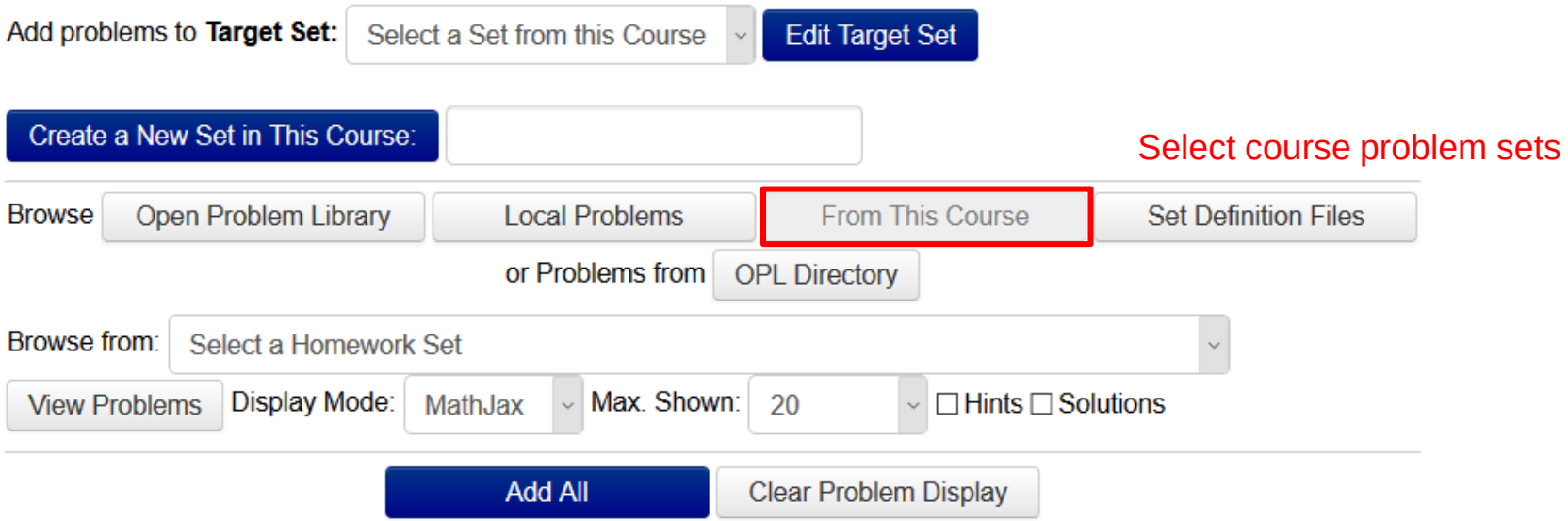
The OPL reduces the number of problems listed as we search by subject, chapter and section.

Library Browser

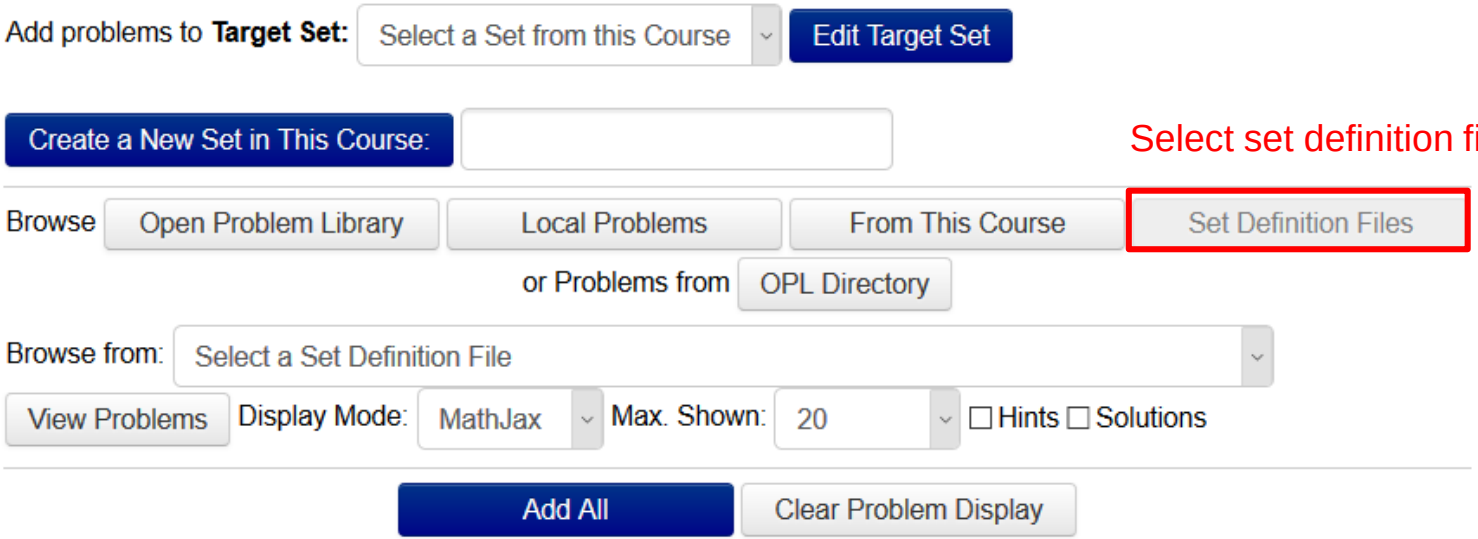


This will show problem sets in your course, as well as those shared through the your institution's OPL folders. Note this will also have problems from the contrib folder on the OPL.

Library Browser



Library Browser



Set definition files is a file format that can be used to share WeBWorK problems between courses. This can be created in the “homework sets” menu under the “export” tab.

GITHUB AND THE OPL

WHY GITHUB?

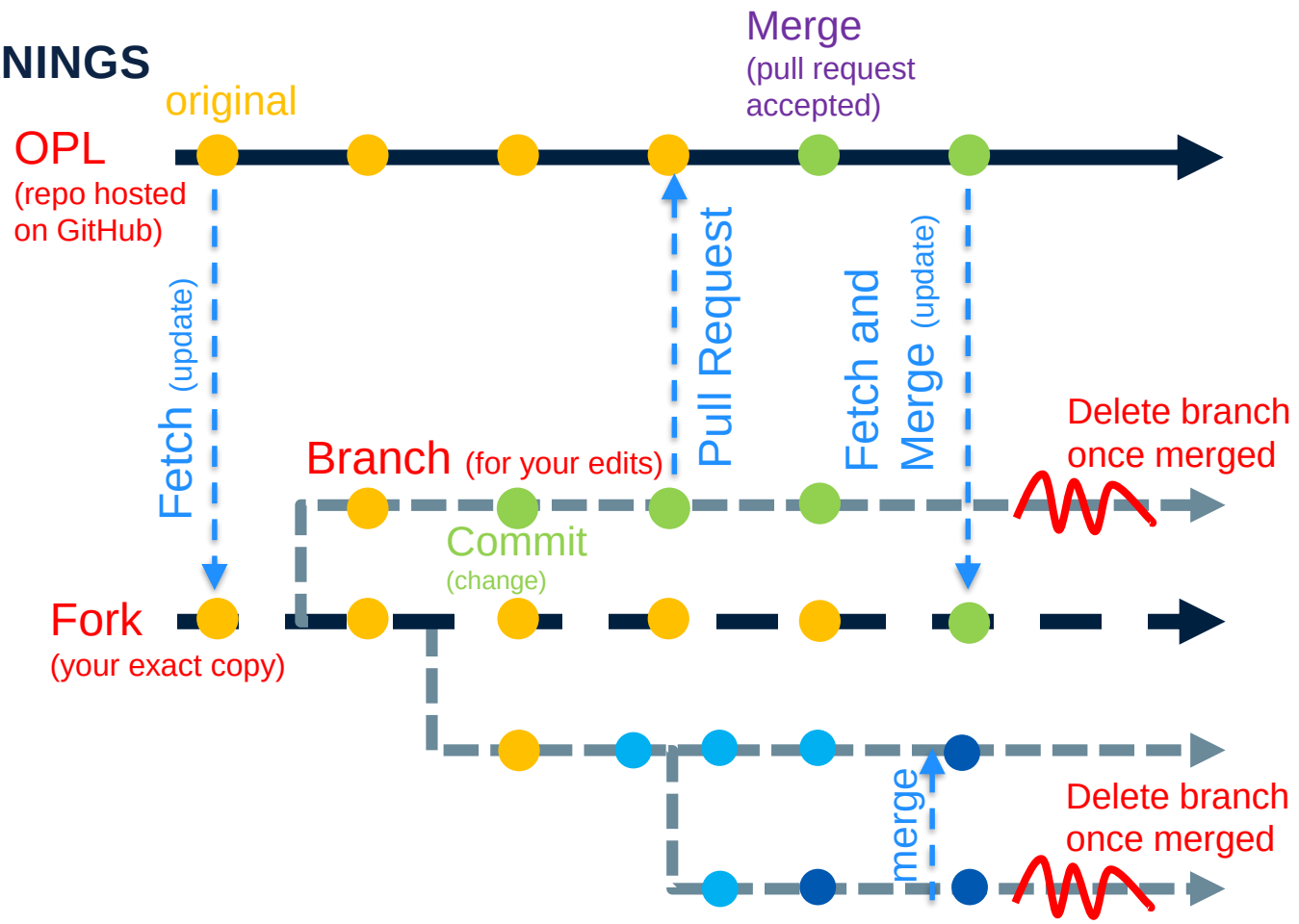
This is a WeBWorK workshop – *why are we talking about GitHub?*

- The OPL is a public code repository (repo) on GitHub
- To contribute to the OPL, you need to submit your problems through GitHub
- We want instructors to create **and share** their problems

(**Note about copyright** – since the OPL is open source and available to anyone on the web, it's not very clear if coding and posting textbook problems would fall under fair dealing (i.e. access is not limited to your students). For this reason, we are creating original problems and images to share).

TERMS AND MEANINGS

- Git
- GitHub
- Repo(sitory)
- Fork
- (Fetch)
- Branch
- Commit
- Pull request
- Merge

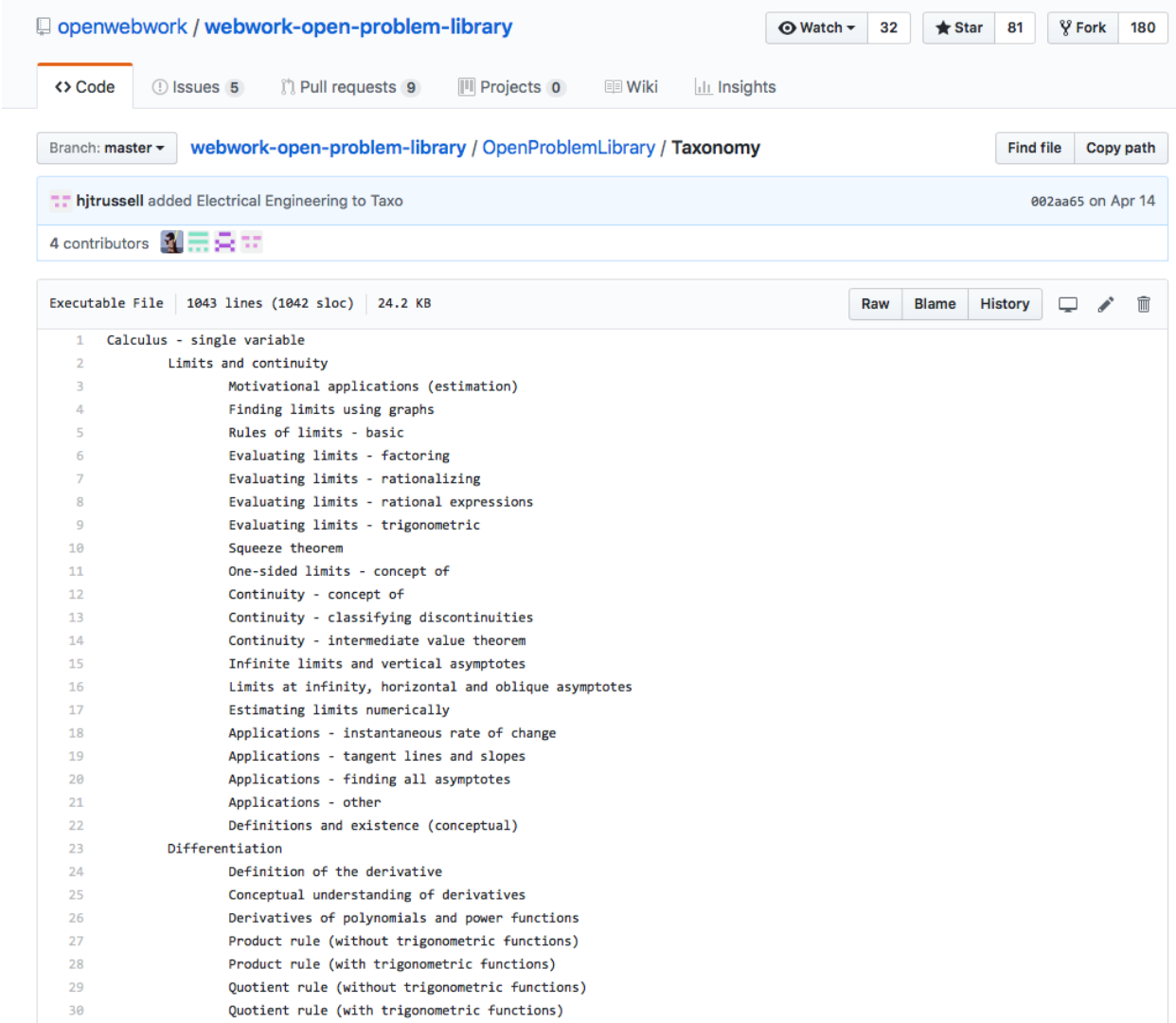


TAXONOMY

How problems are categorized in OPL (allows browsing):

- **Subject** – Geometry
- **Chapter** – Angles
- **Section** – Bisectors

(Aside: we've been creating engineering taxonomies – talk to us/see our talk ***ASEE session W138 Wed 8-9:30, Rm 252****)*



openwebwork / webwork-open-problem-library

Watch 32 | Star 81 | Fork 180

Code | Issues 5 | Pull requests 9 | Projects 0 | Wiki | Insights

Branch: master ▾ webwork-open-problem-library / OpenProblemLibrary / Taxonomy — Find file | Copy path

hjtrussell added Electrical Engineering to Taxo — 002aa65 on Apr 14

4 contributors

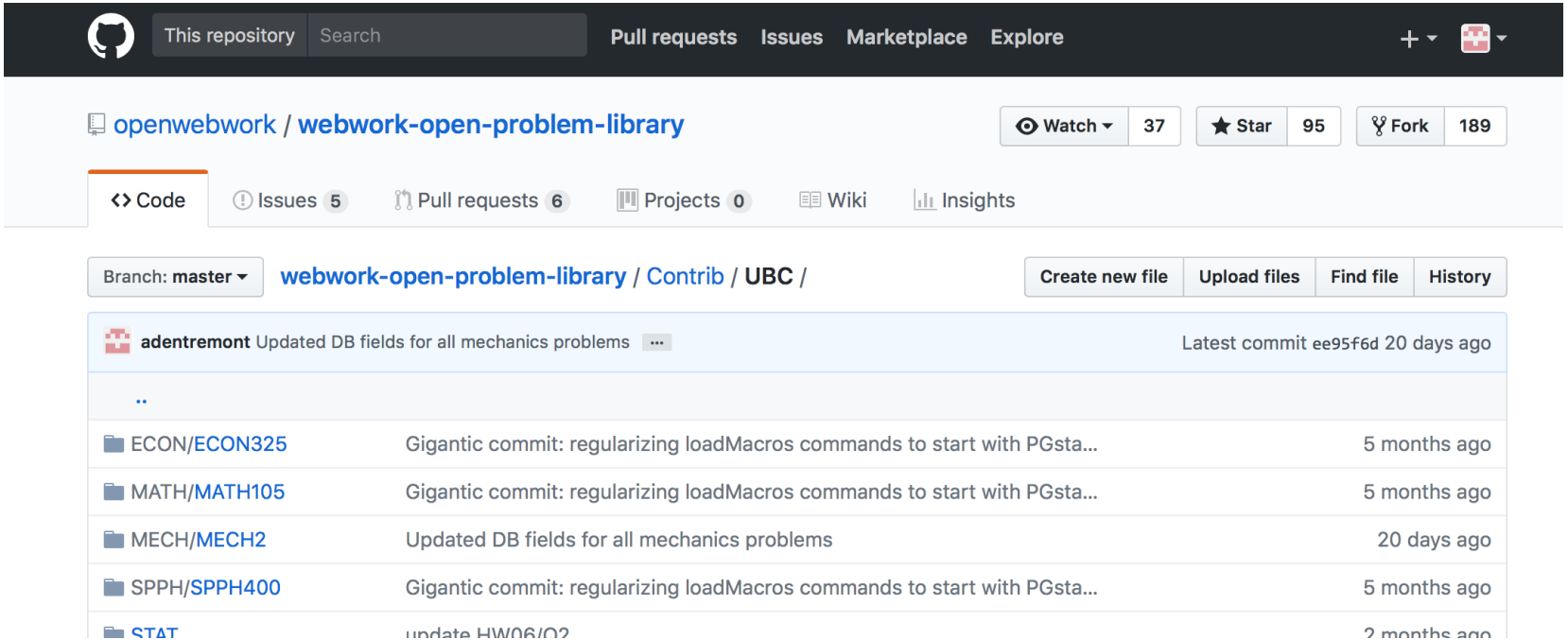
Executable File | 1043 lines (1042 sloc) | 24.2 KB — Raw | Blame | History

```
1   Calculus - single variable
2           Limits and continuity
3                   Motivational applications (estimation)
4                   Finding limits using graphs
5                   Rules of limits - basic
6                   Evaluating limits - factoring
7                   Evaluating limits - rationalizing
8                   Evaluating limits - rational expressions
9                   Evaluating limits - trigonometric
10                  Squeeze theorem
11                  One-sided limits - concept of
12                  Continuity - concept of
13                  Continuity - classifying discontinuities
14                  Continuity - intermediate value theorem
15                  Infinite limits and vertical asymptotes
16                  Limits at infinity, horizontal and oblique asymptotes
17                  Estimating limits numerically
18                  Applications - instantaneous rate of change
19                  Applications - tangent lines and slopes
20                  Applications - finding all asymptotes
21                  Applications - other
22                  Definitions and existence (conceptual)
23          Differentiation
24                  Definition of the derivative
25                  Conceptual understanding of derivatives
26                  Derivatives of polynomials and power functions
27                  Product rule (without trigonometric functions)
28                  Product rule (with trigonometric functions)
29                  Quotient rule (without trigonometric functions)
30                  Quotient rule (with trigonometric functions)
```

… / Contrib / UBC / MECH / MECH2 / (course org)

institution / course subject / specific course

STRUCTURE



OR … / Contrib / UBC / STAT / (problem org)

institution / “set”*Generalsubject*


a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA
THE UNIVERSITY OF BRITISH