

# PLOM

## PAPERLESS OPEN MARKING

EAMS 2020

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# ELEVATOR PITCH

# IMAGINE THE SCENE

1 midterm test

- 1250 students in 8 timeslots
- very crowded classrooms
- 6 version of the test
- 8000 sheets of paper

Need tools that

- simplify logistics
- improve feedback
- conserve instructor time and sanity



# FREE SOFTWARE SOLUTION



- Libre — open source built from FOSS components
- Gratis — no \$, €, £ or ¢
- Data is secure — all student information stays on your server

# WRITE ON PAPER

0007.01  
A: 1 of 4

Mathematics 220 — Midterm — 45 minutes  
October 17th 2018

- The quiz consists of 4 pages and 2 questions worth a total of 15 marks.
- This is a closed-book examination. **None of the following are allowed:** documents, cheat sheets or electronic devices of any kind (including calculators, cell phones, etc.)
- No work on this page will be marked.
- Fill in the information below before turning to the quiz.

Student number									
Section									
Preferred Name									
Given Name									
Family Name									

0007.02  
B: 2 of 4

1. **5 marks** (a) Write the negation of the following statement:  
"For every  $x \in \{q \in \mathbb{Q} : q > 0\}$ ,  $\frac{1}{x} \geq 1$  or  $\ln(x) < 0$ ."

(b) Write the negation of the following statement:  
"For every  $x \in \mathbb{R}$ , there exists  $r \in \mathbb{R}$  so that if  $x > 0$  then  $e^r = x$ ."

(c) Write the converse and contrapositive of the following statement:  
"If you do not like bad movies then 'Turkish Star Wars' doesn't make sense."  
Be sure to indicate which is which.

(d) Let  $a, b \in \mathbb{Z}$ . Carefully define what it means for  $a$  and  $b$  to have the same parity.

0007.03  
A: 3 of 4

2. **10 marks** Let  $n$  be an integer. Prove or disprove the following two statements

(a) If  $n \in \mathbb{Z}$  then  $n^2 + 4n + 8$  is even.  
(b) If  $n \in \mathbb{Z}$  then  $n^2 + 3n + 8$  is even.  
(c) Let  $x \in \mathbb{R}$ . If  $x < 0$  then  $\frac{x-2}{5} \leq \frac{2x+1}{2-x}$ .

0007.04  
A: 4 of 4

*This page has been left blank for your workings and solutions.*

- Interleave source tests — Q1 is ver B, Q2 is ver A
- E.g. 3 variants of 4 questions — Plom makes  $3^4 = 81$  test versions

# MARK ON COMPUTER

02 out of 10

0017.05

3. [10 marks] A long question goes here. In fact it is sufficiently long that we make sure you have a whole extra blank page for your work.  
[!But this is ver2 which is the same question but some details have been changed slightly.]

I am going to try to answer this

$$\frac{d}{dx}(\log(\cos x)) = \frac{1}{\cos x} \cdot \frac{d}{dx}(\cos x)$$
$$= \frac{1}{\cos x} \cdot \sin x$$
$$= \tan(x)$$

+1 good

Be careful  $\frac{d}{dx} \cos(x) = -\sin(x)$   
you are missing a minus.

$$\frac{d}{dx}(b^2 - x^2) = ?$$

Huh? What are you doing here?  
which question are you answering?

0017.06

This blank page is for your solution to Question 3 if you need more space.

I'm not sure what else to do  
So I'll write the answer to a question  
from the homework so you see I did learn  
something

$$\int x \cos x dx = \int u dv = uv - \int v du$$

set  $u = x, dv = \cos x$   
so  $u' = 1, v = \sin x$

$$= x \sin x + \int 1 \cdot \sin x dx$$
$$= x \sin x + \cos x$$

+1  
I'll give you something for this, though it is not really part of the question

Not int-by-parts  
careful of sign

Int by parts formula says  
 $\int u dv = uv - \int v du$

delta	comment
	algebra
	arithmetic
	meh
0	tex: you can write $\backslashLaTeX, \backslash$e^{(\backslashpi)+1}=0$$
0	be careful
+1	good

Page 5 of 6

Page 6 of 6

- Marker assigned one question/version — blind marking
- Demo video at end of elevator

# RETURN ONLINE

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## Midterm Demo using Plom - Online Return

This form can be used to retrieve an electronic copy of your paper.

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In order to access your midterm you need to fill in your student number and your 12-digit “return code” from your LMS.

*NOTE:* the request will fail if incorrect information is entered.

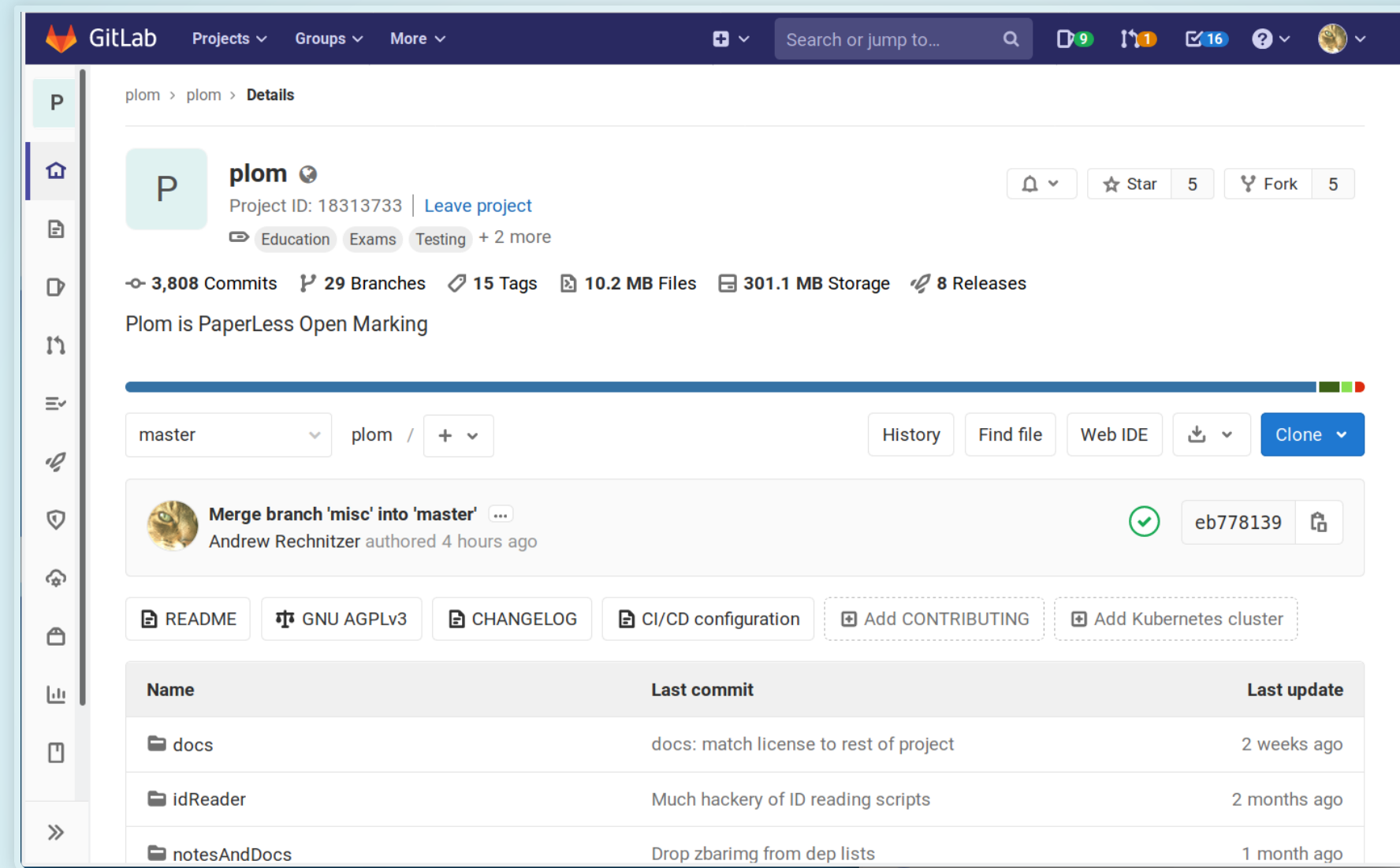
**Student number:**

**Code:**

Retrieve paper

- Auto-generated return site, all data stays local
- Minimal LMS interaction

# COME JOIN US



- Functional — used in  $O(20)$  courses,  $O(60)$  markers,  $O(20,000)$  tests
- Documentation, demonstrations
- Testers, users, feedback, ideas, codevelopers — community



PEOPLE

# THANKS

- Students

Elvis Cai

Victoria Schuster

Vala Vakilian

---

Dryden Wiebe

Michael Zhang

- Faculty

Omer Angel

Michael Bennett

Richard Brak

---

Matt Coles

Eric Cytrynbaum

Seckin Demirbas

---

Sathish Gopalakrishnan

Ben Williams

Elyse Yeager

and

- UBC's Centre for Teaching, Learning and Technology
- The testers of early prototypes

# CLIENT DEMONSTRATION

TRY IT YOURSELF

# INSTALL

- If you just want to try the Plom client, we can host a server
  - get in touch via email
  - download client from [plomgrading.org](http://plomgrading.org)
- Install Plom server on your own Linux machine
  - Get dependencies

```
apt install python3 imagemagick zbar-tools texlive ...
```
  - `pip3 install plom`
  - (alternatively use docker)

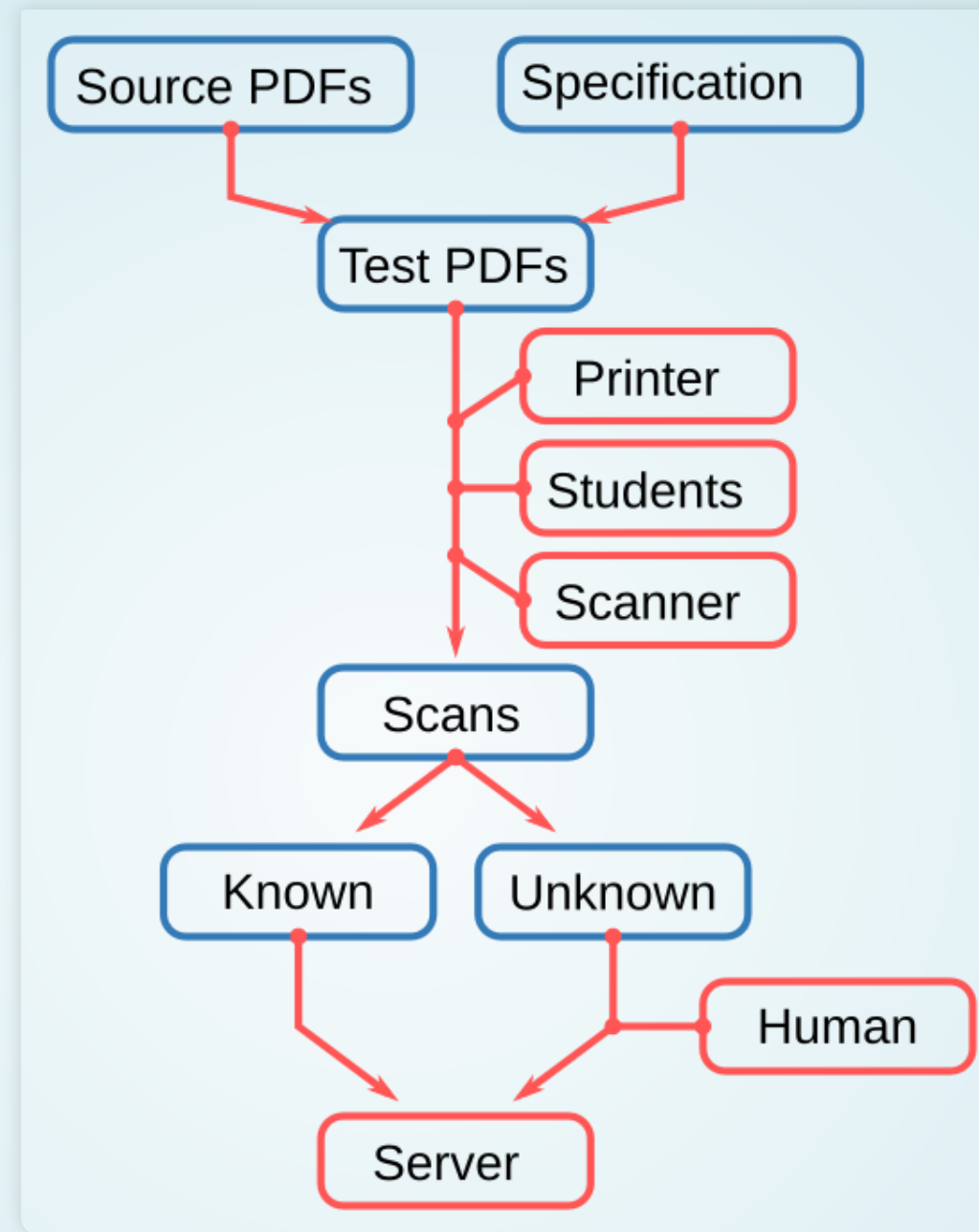
# RUN THE BUILT-IN DEMO

- After server install:
    - `mkdir testdemo`
    - `cd testdemo`
    - `plom-demo`
  - Run client
    - `plom-client`
    - Connect to `localhost` (your new server!)
  - Thanks for watching!
- Visit us at <https://plomgrading.org>

# APPENDIX A — WORKFLOW

# OVERVIEW — BUILD AND SCAN

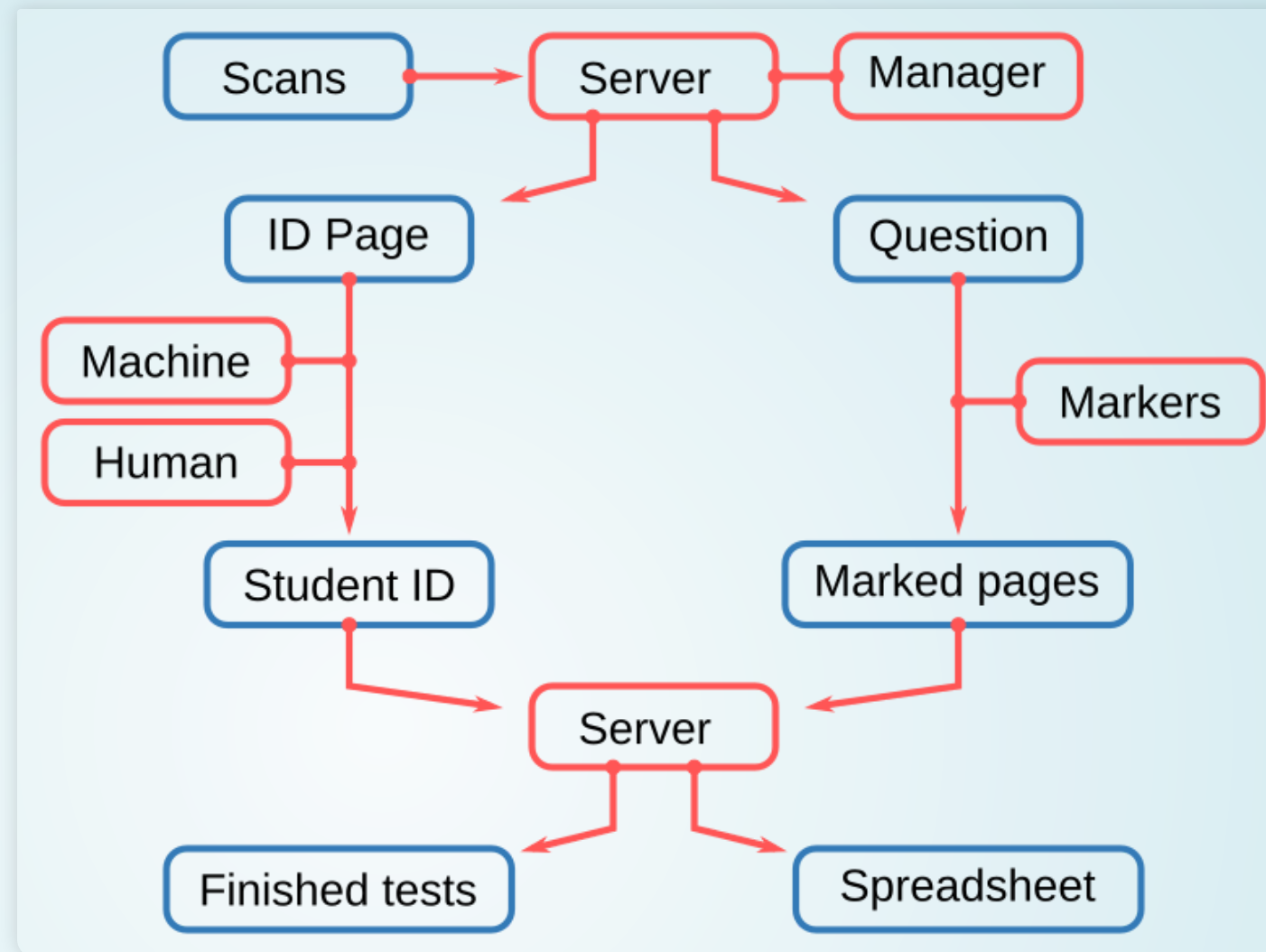
- Input
  - Source test PDFs
  - Specification
- Output
  - One PDF/paper per student
- Students write on paper
- Scan paper → PDFs
- Process and upload
  - qr-codes → identify images
  - human → identify images





# OVERVIEW — MARKING

- Extract student ID
  - ML predictions & human verify
- Mark question
  - annotate & give feedback
- Finishing
  - recombine & build spreadsheets
- Manager oversight
  - progress & histograms



# APPENDIX B — HISTORY

# MOTIVATION — FEBRUARY 2018

- Mathematics-101 midterm test
  - 1250 students in 8 sections, Th-9:30am → F-4pm
  - Classrooms are full — cannot space students
- Problems with having test outside usual class-time
  - Equity of access — some students have lives outside maths
  - Hard on students / instructors with long days and commutes
  - Time conflicts require multiple seatings
- You cannot give 1 version, instead you give 6
  - 3 versions for Thursday and 3 versions for Friday

# LOGISTICS & HEADACHES

- Instructor-in-charge (IIC) creates master-version
- Team then creates similar versions in multi-week process
  - Solution and rubric creation with IIC oversight
  - Multiple rounds of edits — harmonise format, language and difficulty
- Feed test to students (or vice-versa)
- Marking logistics with much ad-hoc management by IIC
  - Physically separate different versions
  - Two markers per version
  - Rubric updating — no marking scheme survives first contact with students
- *IIC burnout*

# HOW CAN WE IMPROVE THIS PROCESS?

- Things that are hard to change
  - Number and size of classrooms
  - Number of seatings of test
  - Available TA power and their level of experience
    - “Its too slow to give feedback” — anonymous TA
    - “There is very minimal feedback provided on the midterm markings.” — anonymous student
- What can we change (maybe?)
  - Number of versions
  - Paper-handling logistics
  - Quality and consistency of feedback

# VERSION REDUCTION

- Fewer versions leads to tension between
  - easier logistics + harmonising difficulty, and
  - higher potential for “leakage”
- Solution — interleave versions
- For example,
  - 3 versions of each of 4 questions on a test =  $3^4 = 81$  versions.
- Fewer source versions required
  - Leakage can still occur, but hopefully reduced
  - Pre- and mid-test logistics reduced
  - More markers/time per question/version

# LOGISTICAL NIGHTMARE

- *[easy]* Production of interleaved versions
  - Specification — which pages belong to which question
  - python script processes spec into one watermarked PDF per paper
- *[hard]* Paper-handling during marking
  - Movement of physical paper between markers
- *[moderate]* Data wrangling
  - Version scaling requires more data-entry
- *[ ??? ]* “Just” write some software

PLOM



# 27K LINES OF PYTHON3 $\Rightarrow$ PLOM

- Command-line tools for
  - building, scanning, and finishing
  - python3 and foss components (`imagemagick`, `latex`, `zbarimg`, ...)
- Server
  - images/data  $\leftrightarrow$  clients
  - python3, aiohttp, sqlite, peewee
- Marking client
  - compiled desktop UI application for annotation & marking
  - python3, PyQt5, pyinstaller
- Manager client
  - desktop UI application for overseeing process

# FULLY FUNCTIONAL PROTOTYPE

## Initial development

- March-September 2018 — dev & hackery
- Early October 2018 — 350 practice quizzes
- Mid-October 2018 — 350 real midterm tests

## 2019 – 2020

- Much user feedback → bug fixes, new features
- Many coding / development improvements

## Now

- Used in about 20 courses
- Around  $O(60)$  users of marking client
- Around  $O(10^4)$  quizzes, midterms and exams marked

# ONGOING DEVELOPMENT

Under development right now

- code clean-up and documentation for easier dev
- simplification of install (pip & docker)
- unstructured uploads for homework and take-home tests
- improved feedback / rubric sharing between clients
- webonisation of scripts

Student involvement

- testing
- documentation and demonstrations
- coding projects — software engineering students