OverCode: Visualizing Variation in Student Solutions to Programming Problems at Scale

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Problem

• In MOOCs, a single programming exercise may produce **thousands of solutions** from learners.
•There may be **several distinct, correct solutions** to coding assignments.
•**Some solutions may be unknown** to the teaching staff.
•Understanding solution variation is important for providing **appropriate feedback to students at scale**.

OverCode Approach

•**Visualize and explore** thousands of **programming solutions**
•Use both **static and dynamic analysis to cluster** similar *correct* solutions
  •*rename variables* to create clean composite solutions that reflect student naming choices
  •*scale linearly* with solution length and number of solutions, unlike CodeWebs.[1]
•**Let instructors further filter and cluster** solutions based on different criteria.

Evaluation

Dataset of Solutions

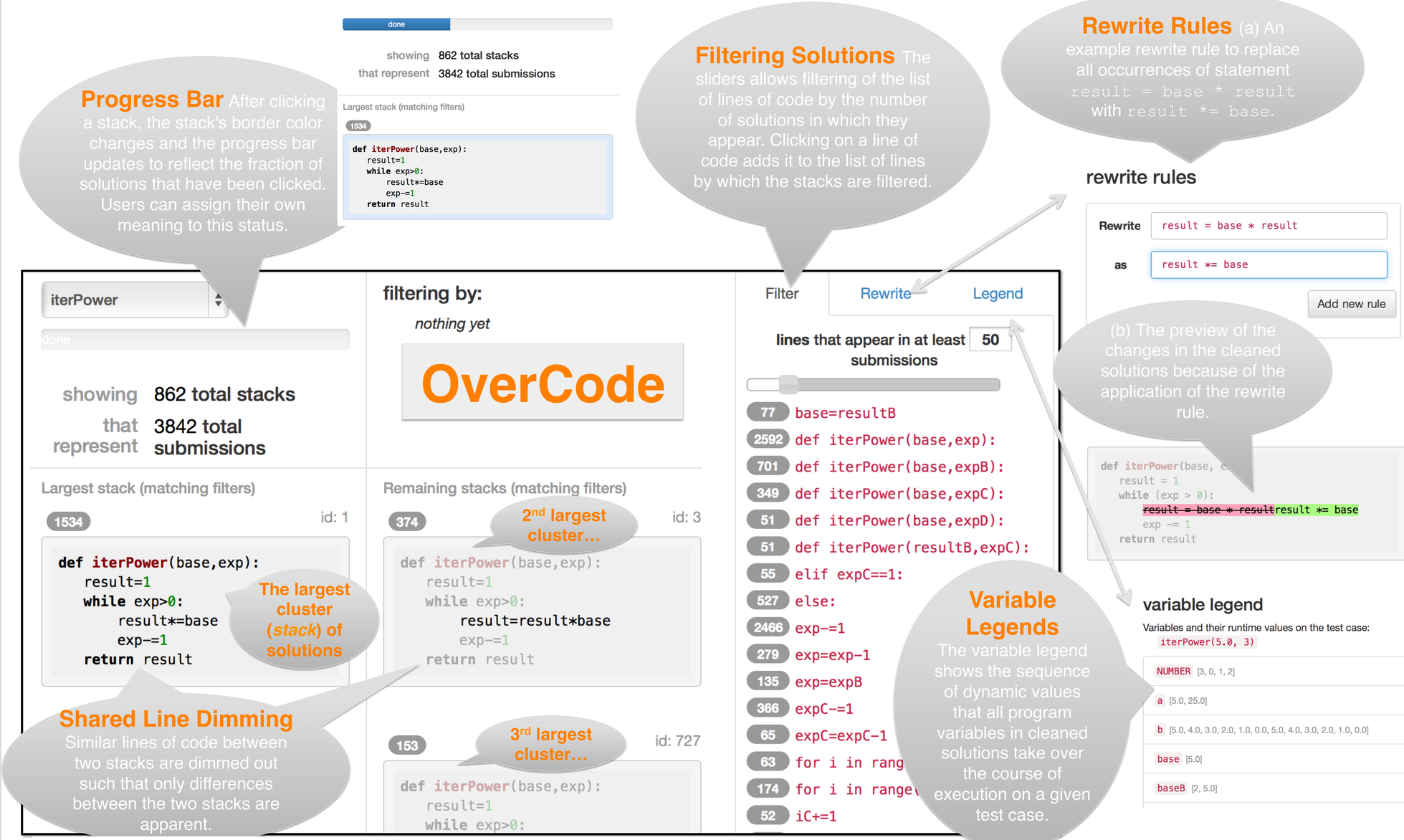
- We use a dataset of 1000's of *correct* solutions from 3 exercise problems in edX's 6.00x, an introductory programming course in Python.

User Studies

- We ran two user studies with **24 current and potential teaching assistants**.
- *Compared to an unclustered baseline*, OverCode allowed instructors to
  - more **quickly develop a high-level view** of students' understanding and misconceptions
  - **provide feedback that is relevant to more students**.

Summary

- **An information visualization approach is necessary** for instructors to explore the variations among solutions at the scale of MOOCs.
- **OverCode is an important step towards that goal.**



The OverCode user interface

- The top left panel shows the number of clusters, called *stacks*, and the total number of solutions visualized.
- The next panel down in the first column shows the largest stack, while the second column shows the remaining stacks.
- The third column shows the lines of code occurring in the cleaned solutions of the stacks together with their frequencies.

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[1] Andy Nguyen, Chris Piech, Jonathan Huang, Leonidas Guibas. "Codewebs: Scalable Homework Search for Massive Open Online Programming Courses." In *Proceedings of the 23rd International World Wide Web Conference* (WWW 2014). Seoul, Korea, April 2014.