Learnersourcing in an Engineering Class at Scale

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Problems

- It is difficult and time-consuming for teachers to:
  - help students design solutions that pass all tests (**debugging)**
  - anticipate which tests solutions will commonly fail and why (**debugging)**
  - guide students through reflections on their own design (**reflection**)
  - help students optimize their own design (**optimization**)

Approach

- **Learnersourcing:** crowdsourcing within the community of students enrolled in a course
  - **Students become experts** on their own:
    - bugs
    - optimizations
  - Systems can harvest and organize students' **collective expert knowledge** for fellow students.
  - Students benefit from **reflection** and generating **explanations**.

Learnersourcing Debugging Hints

Students add hints for errors they encounter and resolve.

Check-off file	Node(s)	Time (ns)	Hint *If you were a lab assistant helping a student with this problem, what would you say to help them fix it?*	# Upvotes	Upvote Here *Did this hint help you?*	Give A Hint *Do you have your own advice to add about an error at this time and node?*
lab6basicblock.	ma[31:0]	399	Look carefully on how the WDSEL mux works, pay attention to the ordering of its inputs.	9	upvote	give a new hint for this error
lab6basicblock.	ma[31:0]	399	it could also be that your bsel is wrong	1	upvote	give a new hint for this error
	ma[31:0]	399	Check that your ALU is functioning correctly - it's possible to pass Lab 3's checkoff without actually having a fully functional ALU	0	upvote	give a new hint for this error
	lock. mwd[31:0]	1499	It's most likely a problem with your REGFILE. Make sure you're handling R31 correctly both for radata and rbdata.	3	upvote	
	lab6basicblock. mwd[31:0]	1499	make sure d0 in your mux4 for wdsel is connected to gnd, not ia[31:0].	1	upvote	for this error
	[31:0]	1499	Remember that wmd should be connected to one of the output of the regfile, and not the wd of the regfile itself	1	upvote	give a new hint for this error
	mwd[31:0]	1499	mwd is the memory write address. It is not the same thing as the memory you want to write in the registers.	1	upvote	give a new hint for this error
	mwd[31:0]	1499	Don't forget about BSEL!	0	upvote	give a new hint for this error

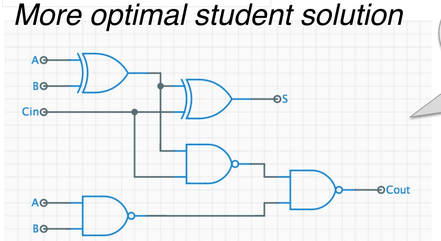
Failed test case are identifiable by file, node, and time.

Hints are indexed by failed test case.

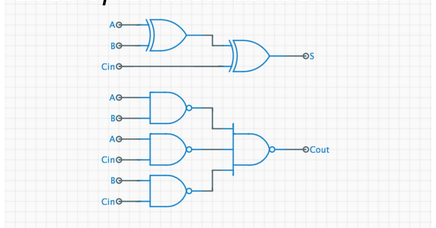
Students upvote hints they find helpful.

Personalized Reflection and Learnersourced Optimization Hints

More optimal student solution



Less optimal student solution



Students reflected on pairs of different correct peer solutions, one of which was their own.

These are examples of learnersourced hints for optimizing the lesser solution in a given pair.

While the reflection exercise itself is valuable, these hints could be passed on to other students.

"Do not try to be too clever with C_{out}---design your schematic as the expression is written. This way you will achieve the [standard] schematic."

"I would ask: is there a way for you to use some intermediate node in one circuit to bypass a CMOS gate in the other, leading to a reduction of used mosfets?"

"Mutate the boolean function for C_{out} such that all OR and AND operations are being NOT'ed. This allows you to design a circuit using only naturally inverting CMOS gates."

Interventions

Debugging

- Students consult and contribute to system while debugging failed *class-specific* test cases.
- Students write hints immediately after resolving their own failed test case.

Optimization and Reflection

- Each student is shown their own solution next to:
  1. a less optimal peer-designed solution
  2. the most optimal peer-designed solution
- Students write hints to future students about how to improve the less optimal solution in each pairing.

Case Studies

On-going Deployment: Computer Architecture Design

- MIT undergraduate engineering course
- 250 students enrolled each semester

Future Deployments

- Computer architecture MOOC
- Residential software engineering course

Ongoing and Future Work

- Meteor-based system for learnersourcing debugging hints
- Deeper analysis of reflections

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