Testing

CS 485/698: AI-Assisted SE

Today’s Agenda

- Team meeting (~15 minutes)
  - Sprint retro/planning: how did P4 go? What will you be testing for P5?
  - Michael and I will be coming by to check in with your teams
- Testing basics lecture
- In-class activity: testing testing strategies with AI tinder

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Aside: testing is the canonical example of a ***dynamic analysis***, which is program analysis that requires running the program

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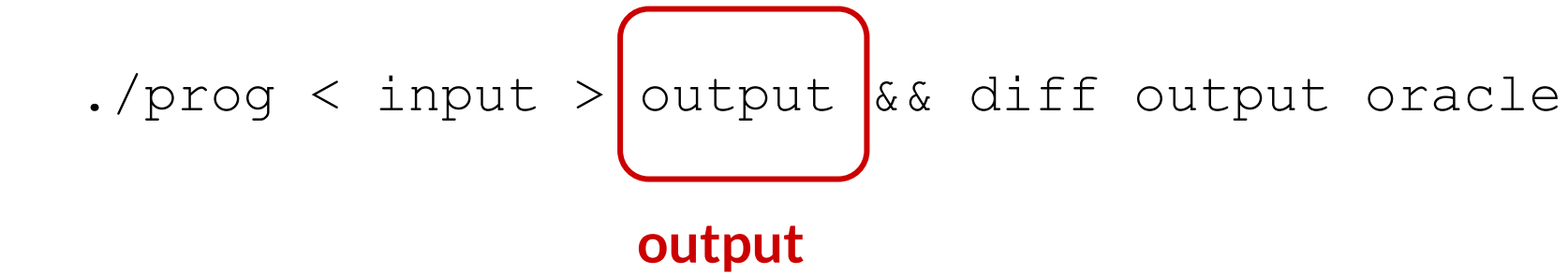

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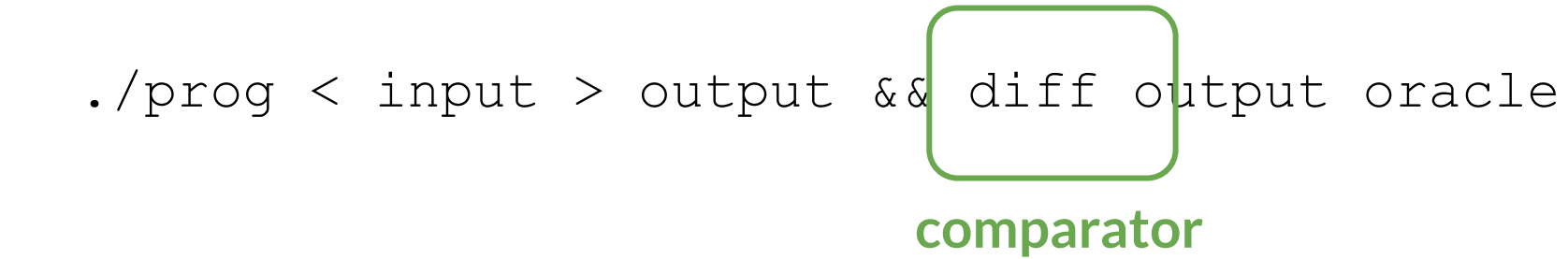

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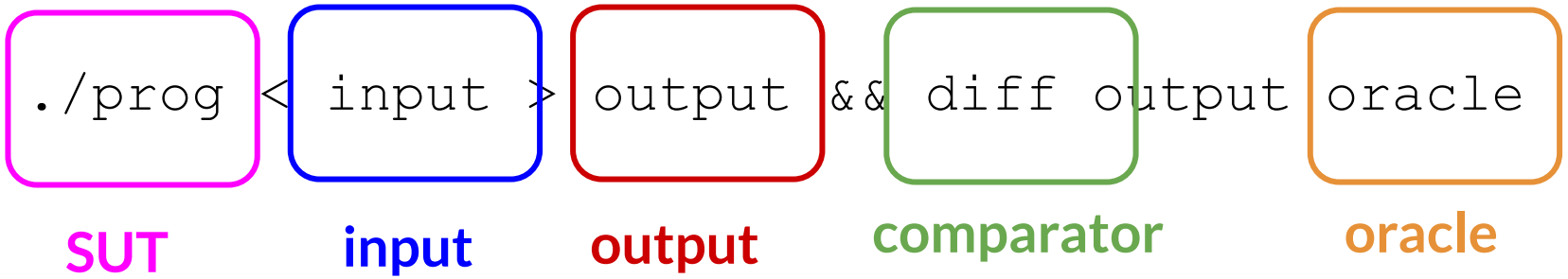

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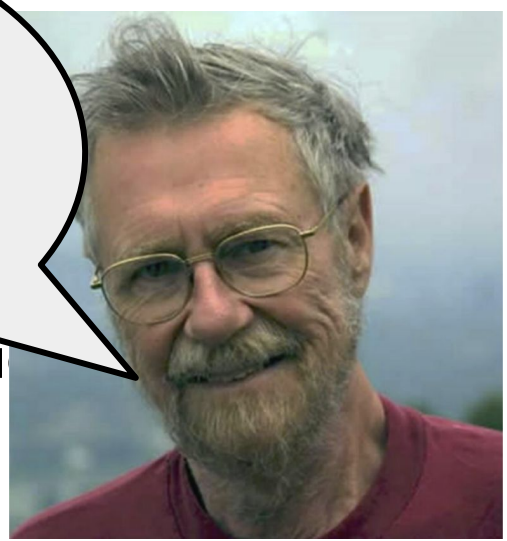

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Can we use an LLM as the comparator? What might go wrong if we did?

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- sometimes caused by **non-determinism** in the program itself or in the test infrastructure
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- are a **major problem in practice**
  - difficult to debug, so waste a lot of developer time
  - detecting them is an active research area

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  - ask yourself: “what should the program do with this input?”
- Traditionally, choosing oracles automatically is considered **implausibly difficult**
  - big promise of LLMs in testing: the LLM can pick the oracle
- However, the ***intent*** of the human operator still needs to be conveyed somehow
  - *“The act of describing a program in unambiguous detail and the act of programming are one and the same”* (Kevlin Henney)

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  - edge cases
  - partition testing
  - white-box testing
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- typical oracle: **crashes**
- modern fuzzers can deal with **structured input**, given seeds
- fuzzing is **common in industry**
  - AFL (most famous coverage-guided fuzzer) was built at Google
  - oss-fuzz project fuzzes many important open-source projects constantly using industry resources

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  - What’s an appropriate policy?
    - pick “at random” (***fuzzing***)
    - pick using logic (***symbolic execution***)
- Can also pick using an LLM; LLMs generally use **same strategies as humans**
  - so let’s review human strategies so that you can use them in your prompting

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Edge case examples:

- 0, 1, -1
- null
- empty list
- empty file
- etc.

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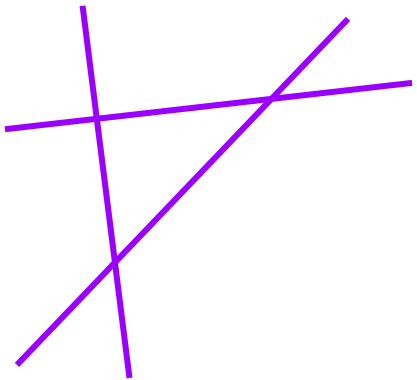

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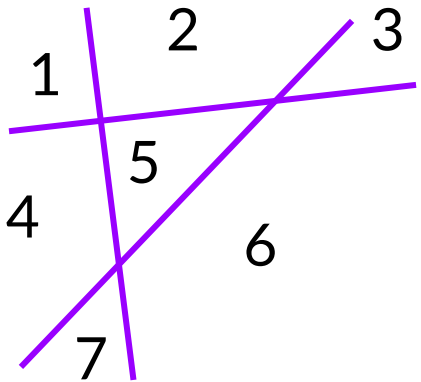

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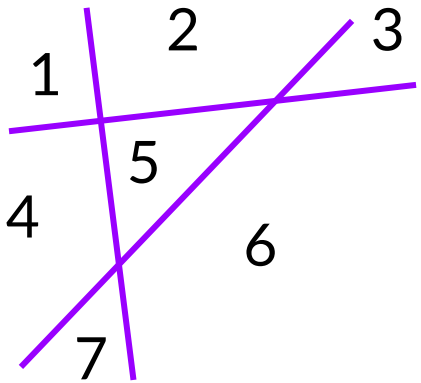

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- possible ways to split up the input:
  - parity (even, odd)
  - positive, negative, zero
  - jpg files vs png files
  - correctly-formatted input vs incorrectly-formatted input

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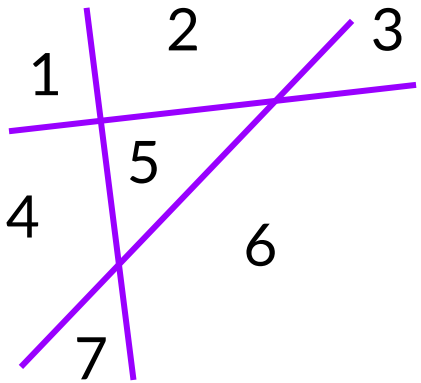
Common technique: split up input space k ways, write 2^k tests



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Disadvantages:

- you have to actually read the code
- easy to accidentally "bias" yourself towards what the code already does

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- key advantage over white-box testing: you aren't biased by the implementation
- key disadvantage vs white-box testing: you can't tell how well you're covering the implementation, only the specification
    - hard to choose edge cases, get high coverage, etc.

Black-box vs white-box with LLMs

- **Question:** How do you control whether you are doing “white-box” or “black-box” testing when you’re using an LLM to generate test cases?

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  - **Answer:** ***CONTEXT***. Is the code in the prompt or not?
- LLMs can suffer from the same biases as humans when conducting white-box testing
  - In fact, early evidence suggests that LLMs may actually be *more* impacted: “my AI-generated tests always pass”

In-Class Activity: Testing AI Tinder

- I gave you a slip of paper with a PR number and an instruction
  - e.g., if your paper says “PR #19”, you will test https://github.com/kelloggm/ai-tinder-fork/pull/19
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- Prompt an LLM to generate tests based on your instruction
  - e.g., if your instruction says “PARTITION”, try to get the LLM to do partition testing
  - feel free to discuss with others in your group/help each other

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- While we discuss the in-class activity, **open a PR** with whatever tests you've created during class today
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- **Discussion questions:**
  - Which strategies worked surprisingly well or poorly?
  - Did the LLM-generated tests match your intent?
  - How much did the quality of the tests generated by different members of your group differ?
    - What caused the differences? Prompts? Models?

Wrapup and Reminders

- Sign up for A5