Converting Test Goals To Condition Automata

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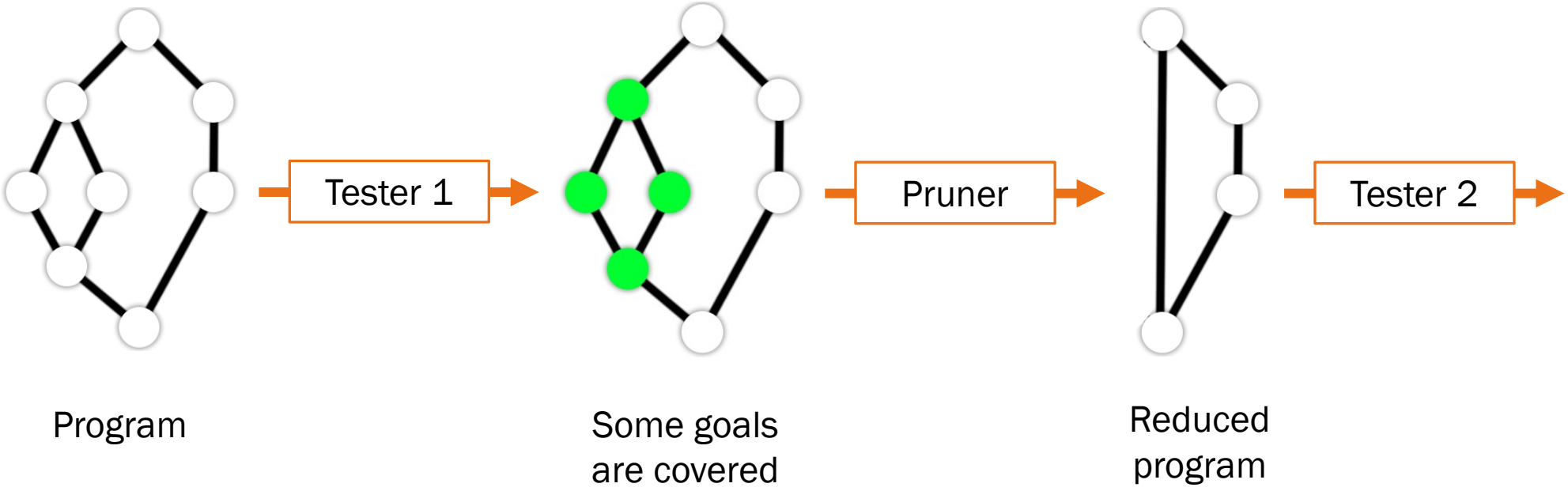
BACHELOR'S THESIS

Introduction

- Software correctness is important
- Testing is expensive, up to 50% of all development costs go into testing
- Hence, automatic test generators

- Test generation is **hard**
  - We could **combine the strengths** of each generator

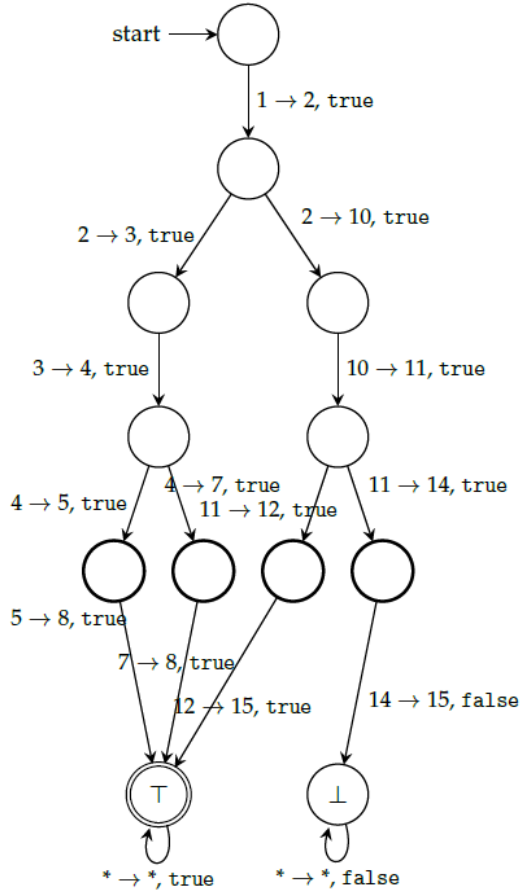
Conditional Testing

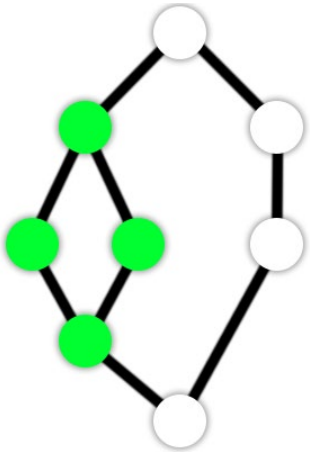


Conditions

- Automaton that describes which paths have been verified
- *Assumptions*: Conditions under which a path has been explored

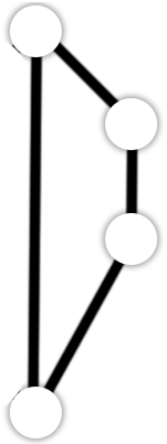
- A condition *covers* a path iff there is a run s.t.
  - the run ends in an accepting state
  - all assumptions are satisifed



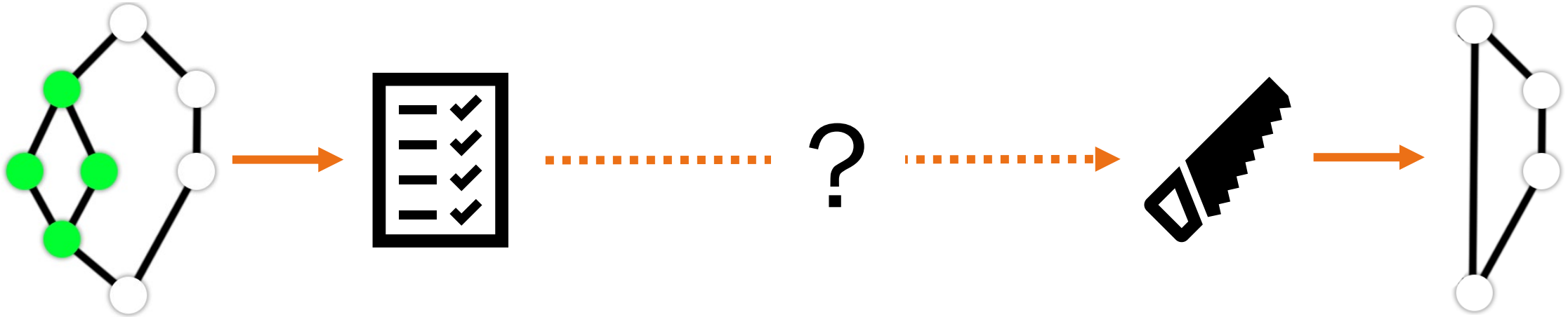


Some goals
are covered

Pruner



Reduced
program



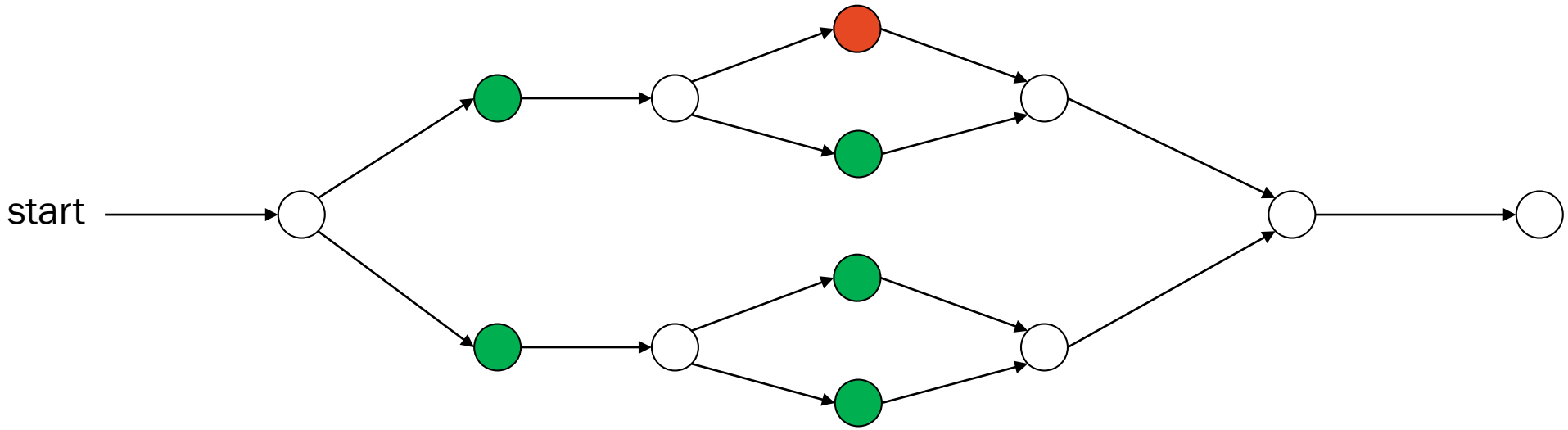
Some goals are covered

List of covered goals

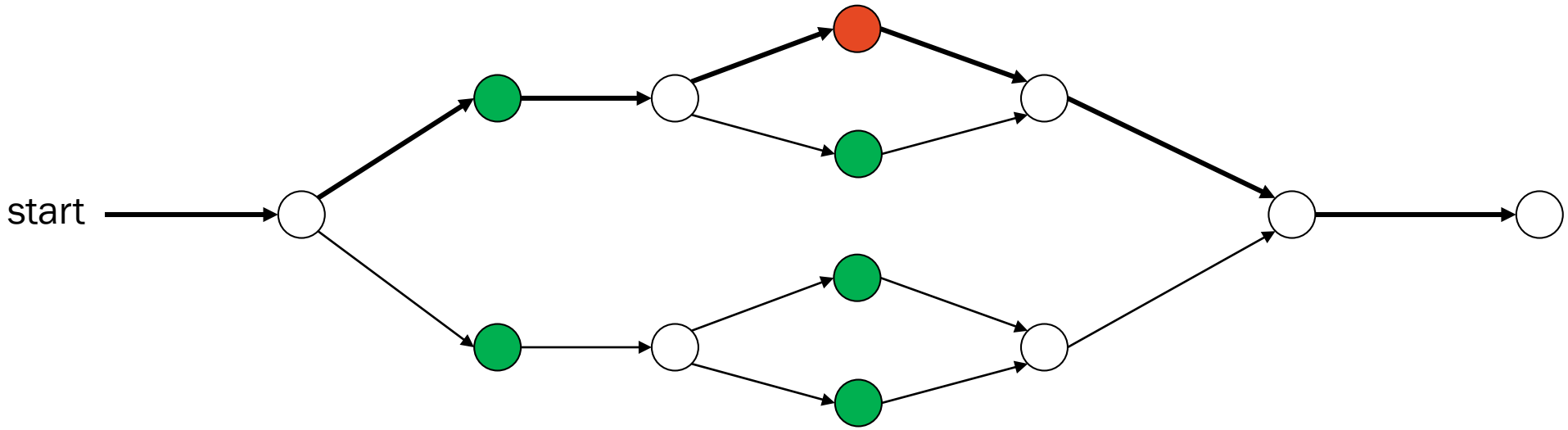
CPAchecker's reducer

Reduced program

Converting Test Goals to Condition Automata



Example CFA of a program with two branching if/else blocks



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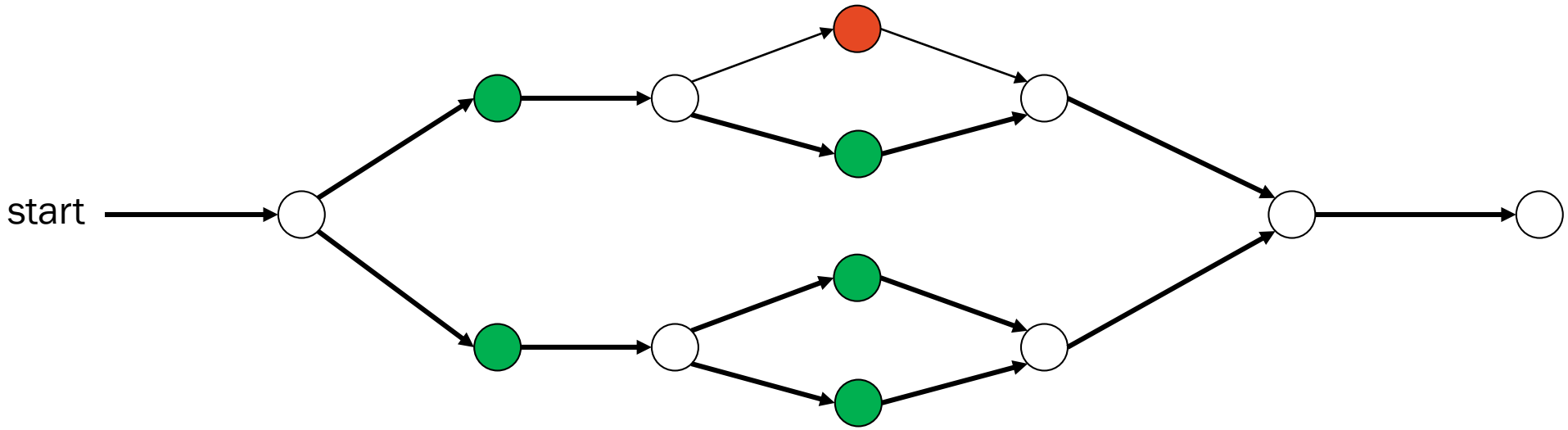

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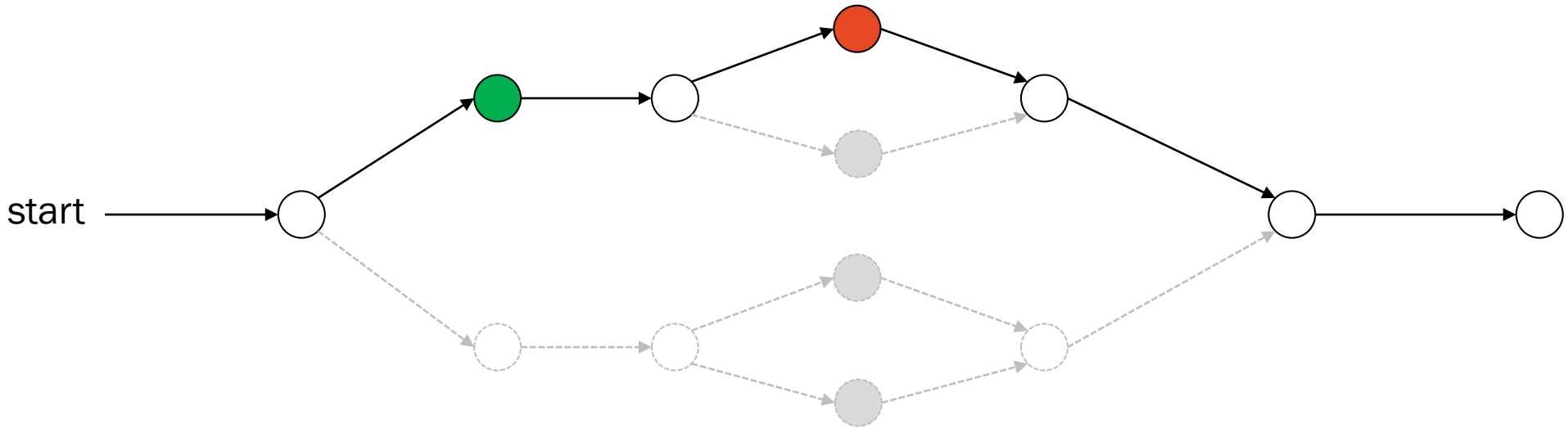
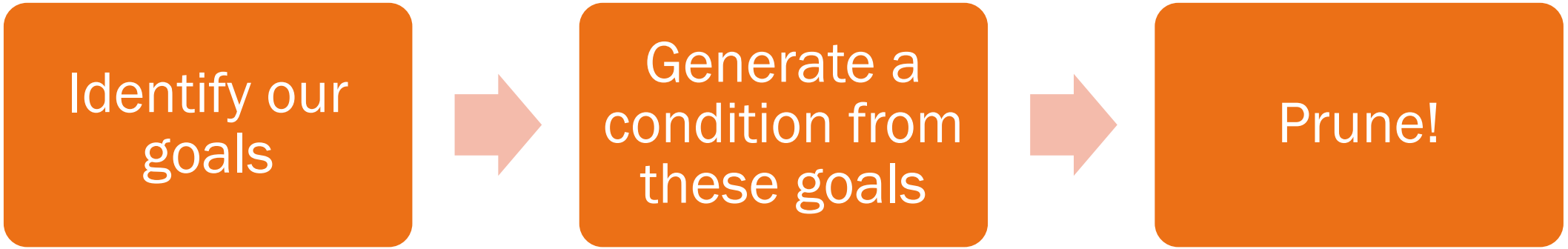


Example CFA of a program with two branching if/else blocks

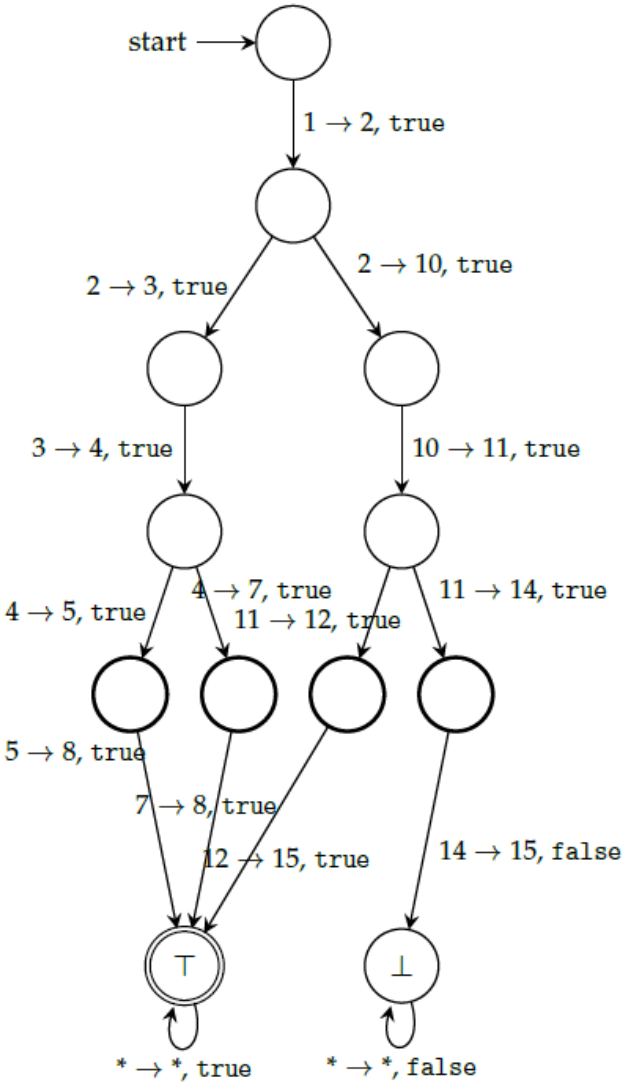
Our Approach



Phase 1: BFS

- We want to find **leaf** goals
- Partition them into covered/ not covered

- We can at most remove **covered leaf** goals



Phase 2: Condition generation

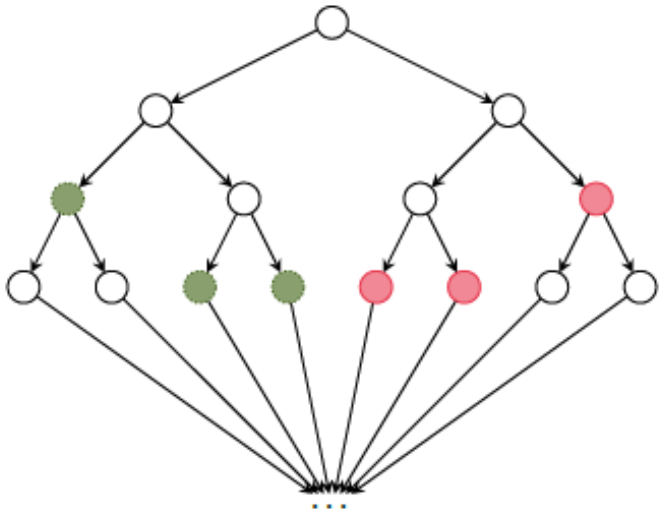
- **Covered leaf goals:** `True` assumption
- **Uncovered goals:** `False` assumption
  - To avoid issues with non-linear program flows we use all nodes
- **Everything else:** `True` assumption

- This condition satisfies our requirements:
  - All paths that only contain covered goals are pruned
  - Others are kept

Optimization: Propagation

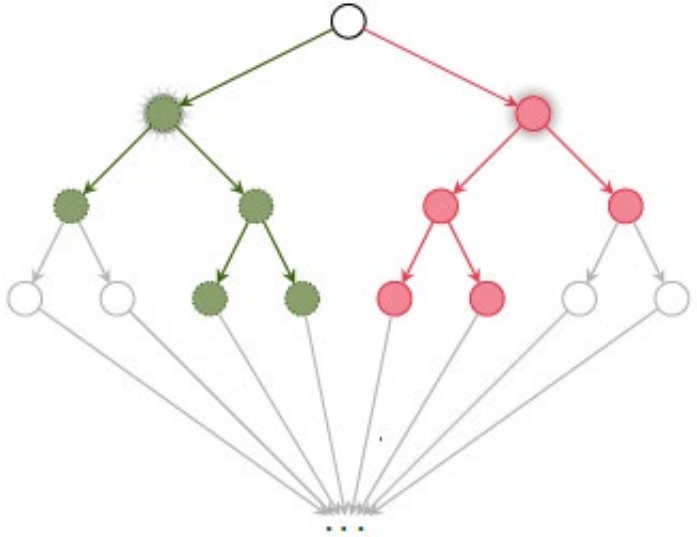
NAÏVE APPROACH

We just identify leaf goals.



APPROACH W/ PROPAGATION

We merge nodes whose ancestors are all either covered or uncovered



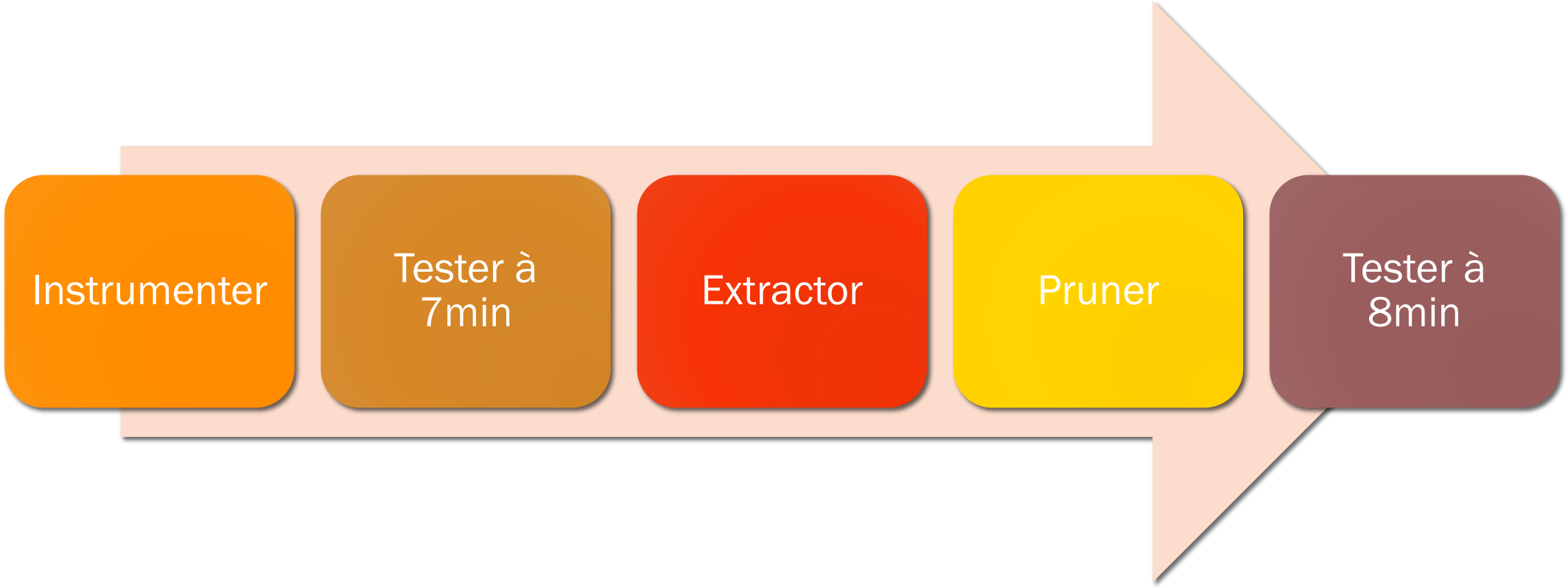
Evaluation

Evaluation

- Branch coverage
- Resource consumption
  - CPU
  - RAM
- Number of tasks that were successfully completed

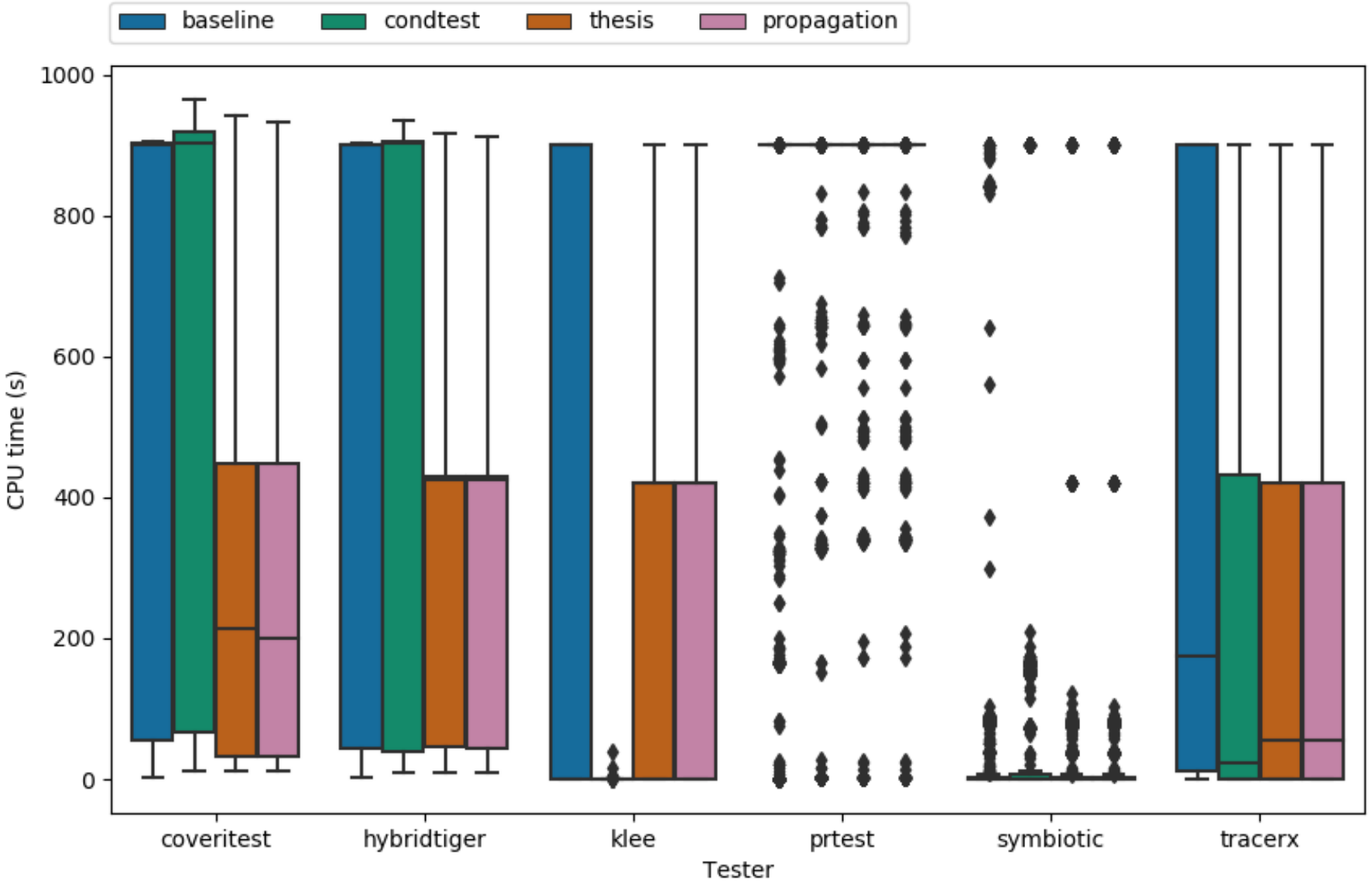
- Benchexec as benchmarking tool, orchestrated by CoVeriTeam
- Testers participants of Test-Comp 2020

Setup

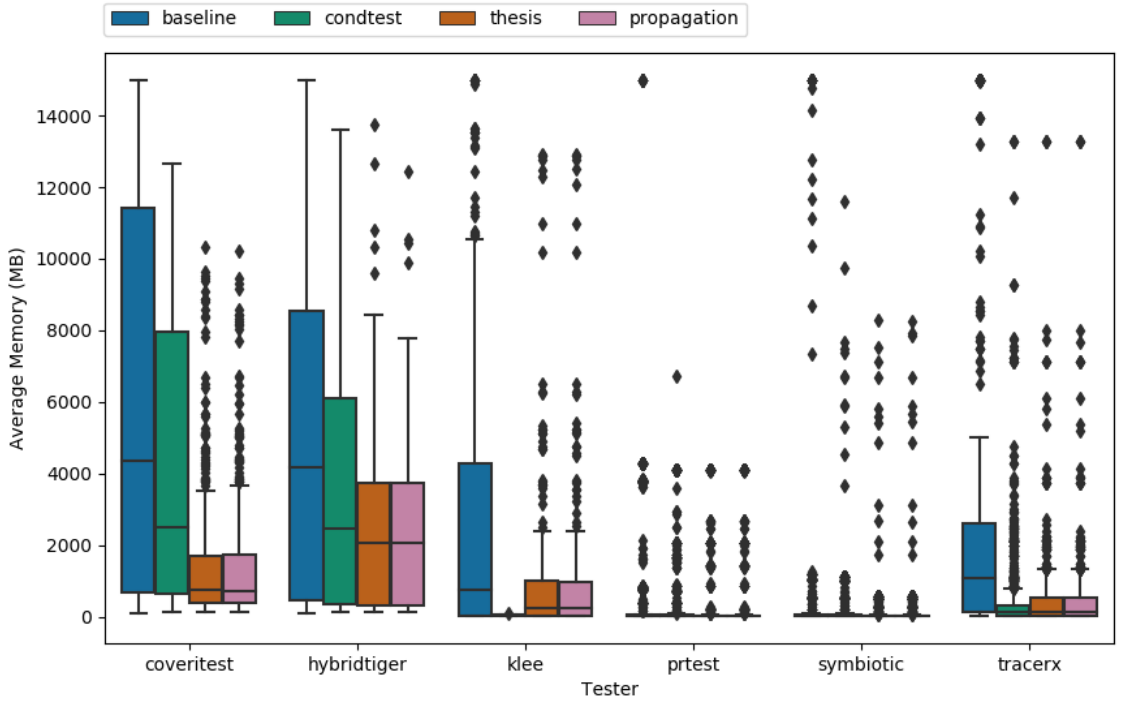


One Tester

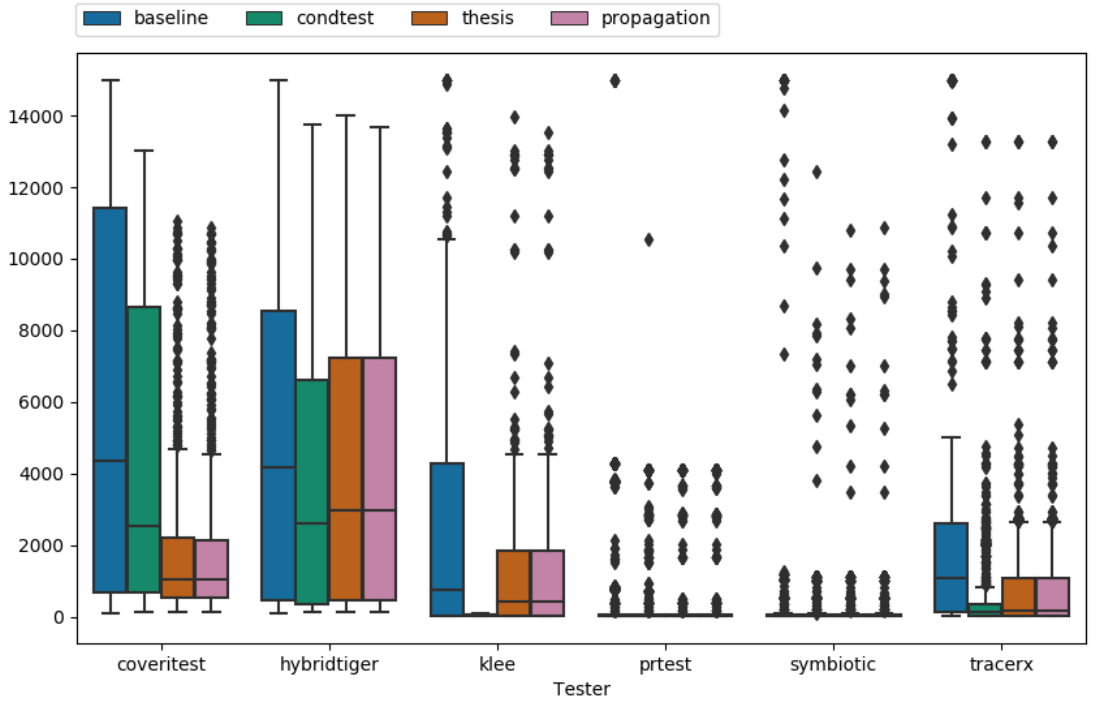
- One Tester, applied sequentially
- Baseline: Tester à 15min
- CondTest: Using CondTest’s reducer


baseline
condtest
thesis
propagation
1000
800
600
400
200
0
CPU time (s)
coveritest
hybridtiger
klee
prtest
symbiotic
tracerx
Tester

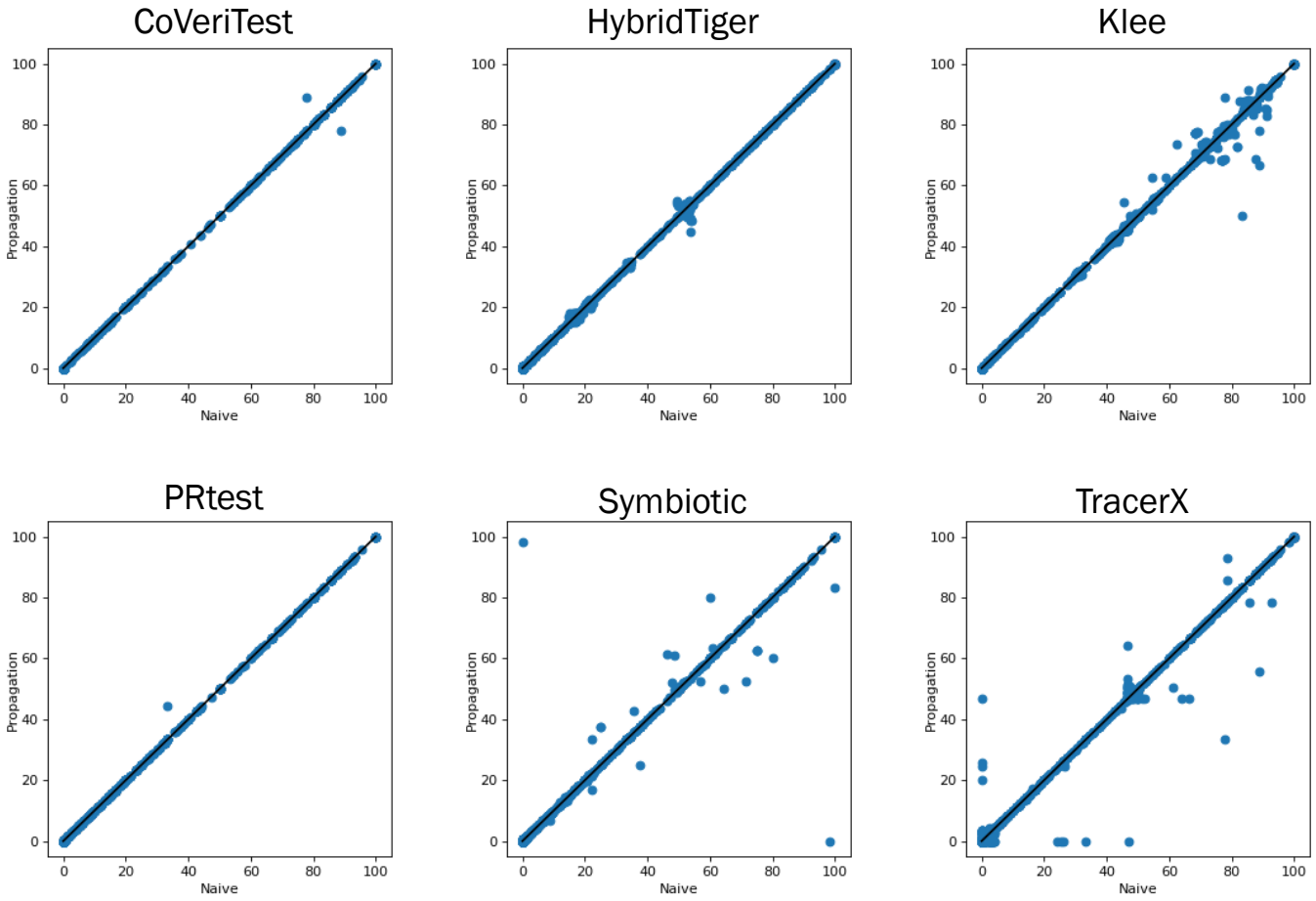
Memory (Average)



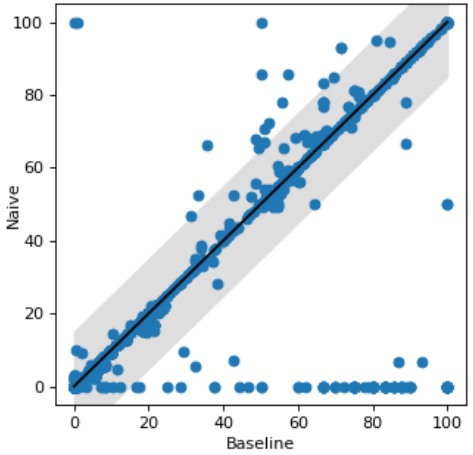
Memory (Maximum)



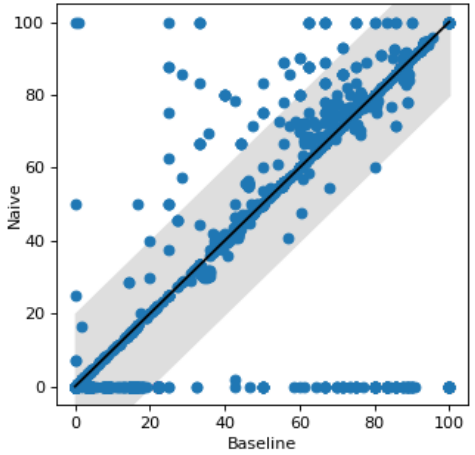
Naïve vs optimized version

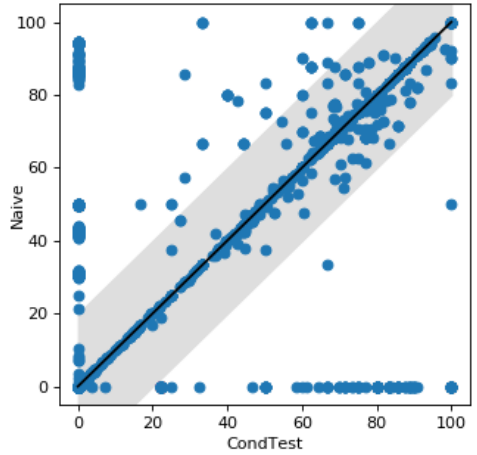


HybridTiger

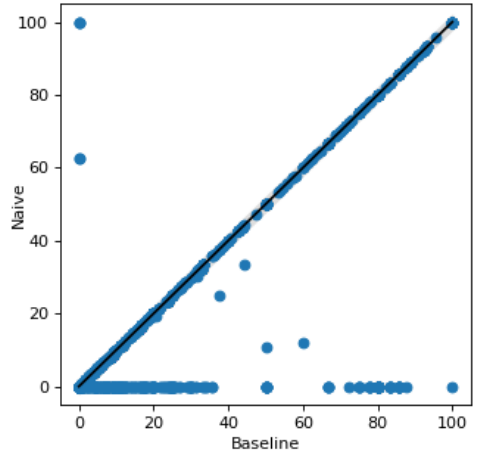


Klee

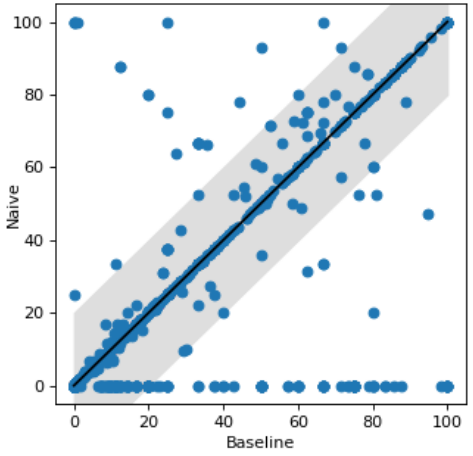




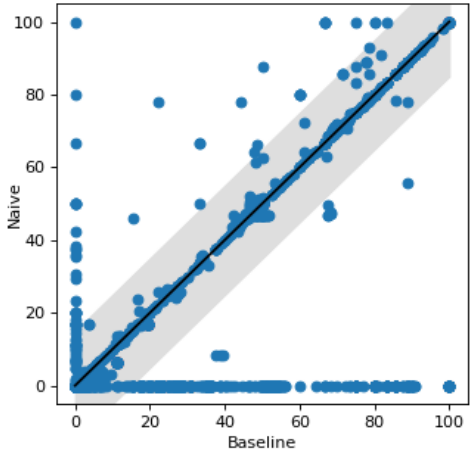
PRtest

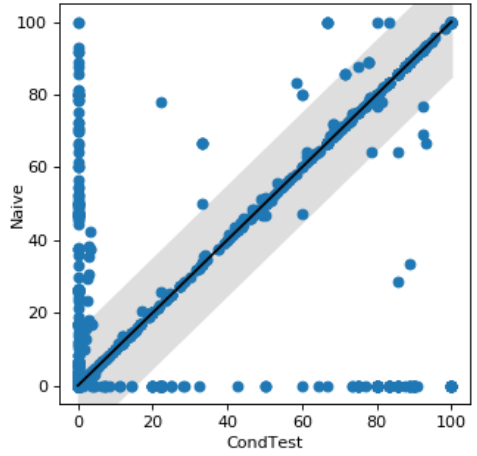


Symbiotic

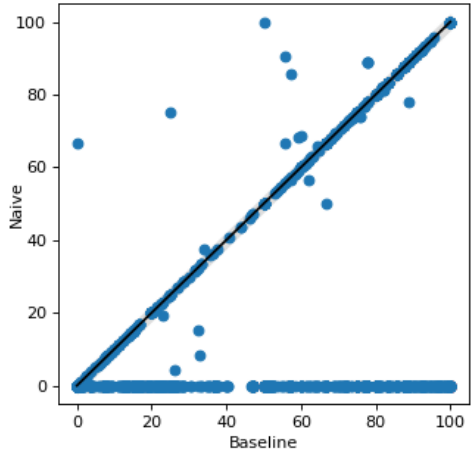


TracerX





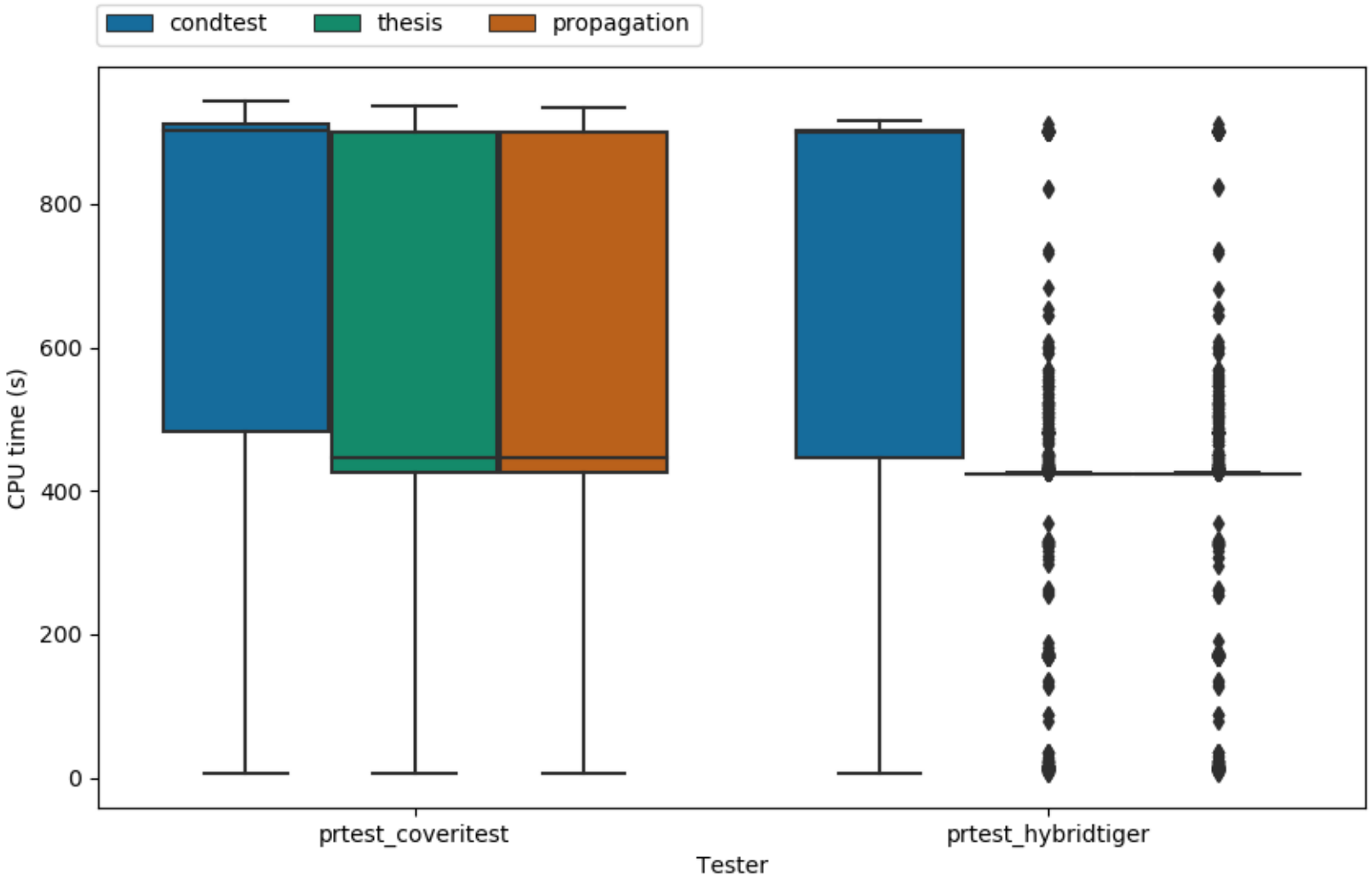
CoVeriTest



Two Testers

- Two combinations:
  - PRTest/ CoVeriTest
  - PRTest/ HybridTiger

- Idea: PRTest “dumb” random tester, eliminates the easy paths


condtest
thesis
propagation
CPU time (s)
800
600
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200
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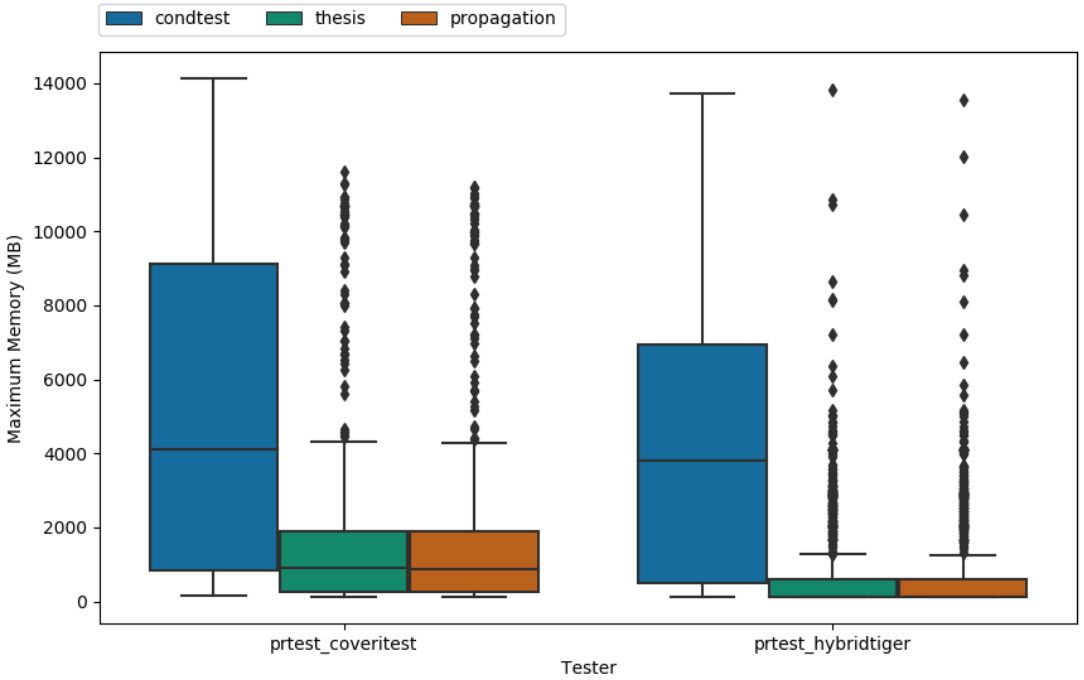
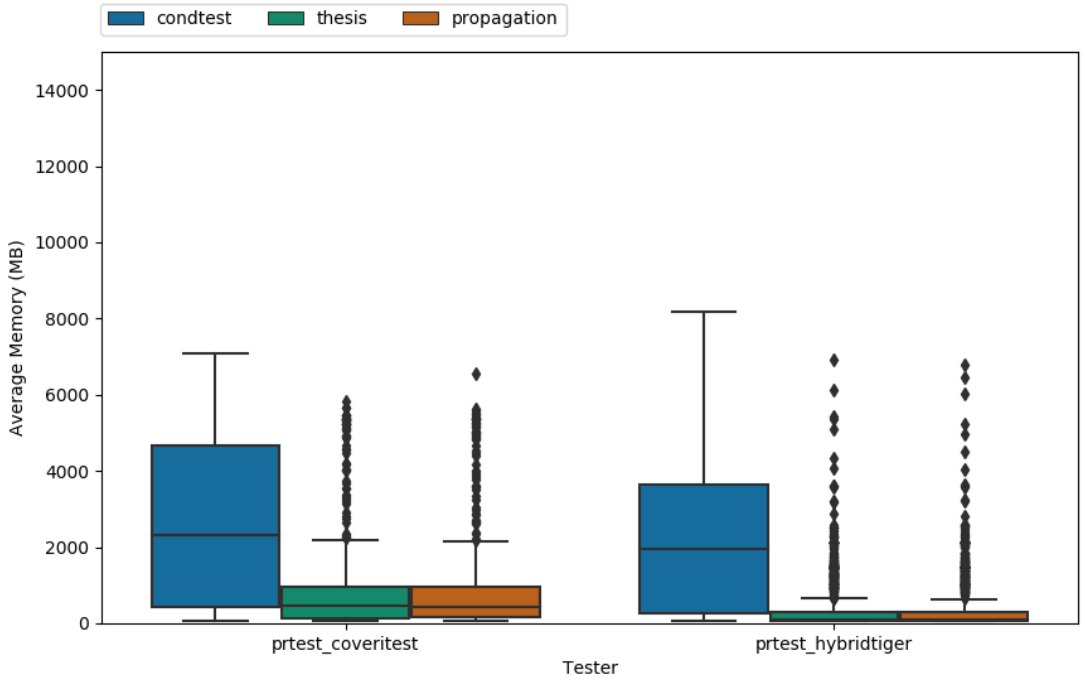
prtest_coveritest
prtest_hybridtiger
Tester

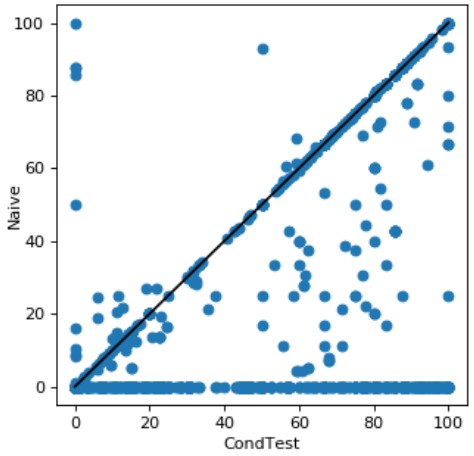
Memory (Maximum)

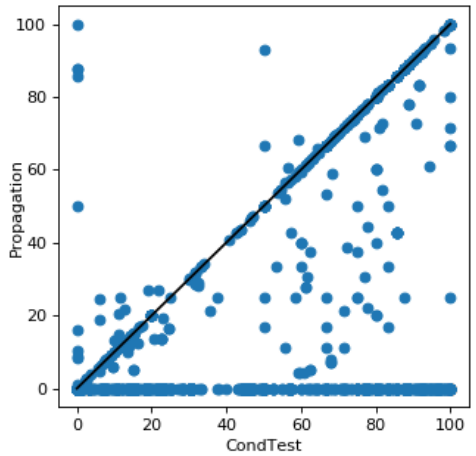


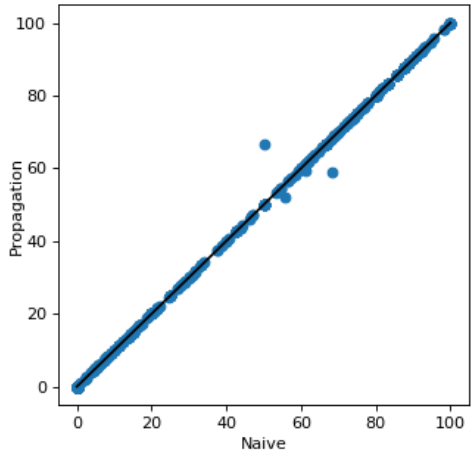
Memory (Average)



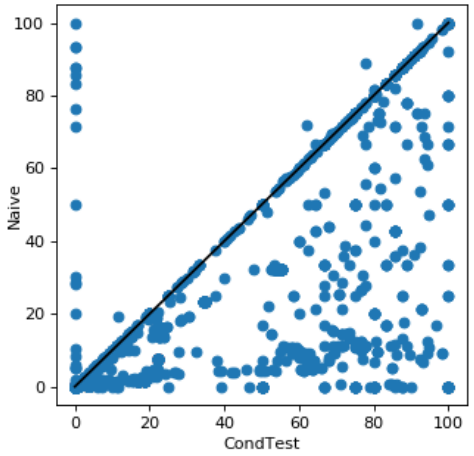
PRtest and CoVeriTest

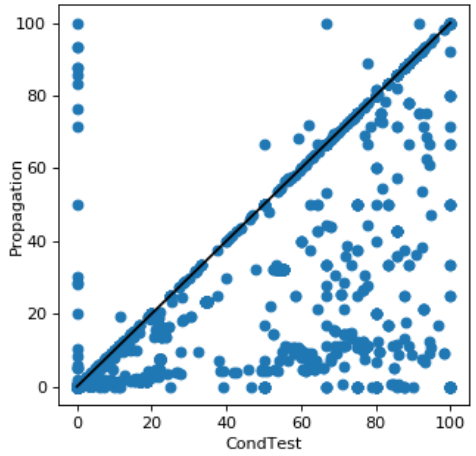


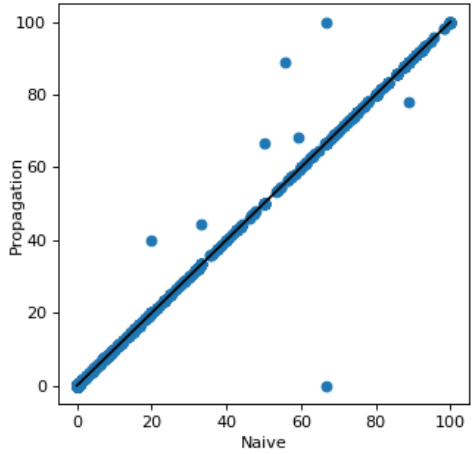




PRtest and Hybridtiger







Conclusion

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- We have shown two approaches that generate condition automata from test goals
- The approaches work well for a single tester (comparable to both baseline and CondTest)
- They suffer when being used with pairs of different testers
- There is some evidence that there is a bug in the implementation
  - Resource usage indicates most of the time only one tester is running

- What are “good” combinations for testers? How to find them?
- Play around with the time limits
- What happens if we use other testers?