Snappy: Efficient Fuzzing with Adaptive and Mutable Snapshots

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Teaser

- Snappy is a speed optimization for fuzzers
- Key insight: it skips the part of the program executions that is always the same (redundant)
- It achieves:
  - up to 1.76× speed increase in FuzzBench, with no significant regressions
  - up to 31% coverage increase on real-world programs (24 hours benchmarks)

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Background - User-space application fuzzing

- Fuzzing is a trial and error process
- More attempts make success (crashes) more likely
- Speed (exec/sec) is extremely important
- Operations that do not depend on the *mutated* input are *redundant*

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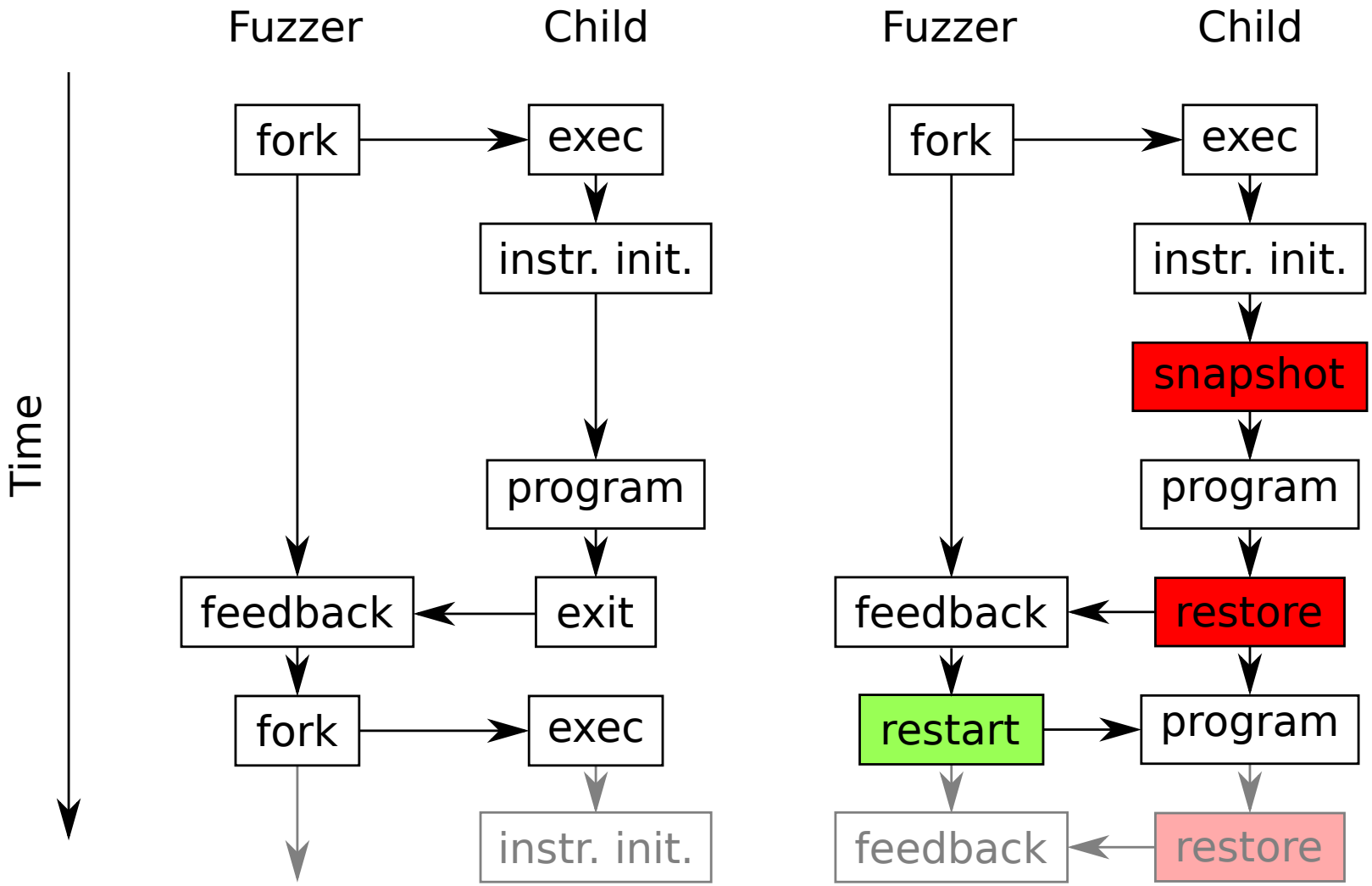
Background - Process snapshotting



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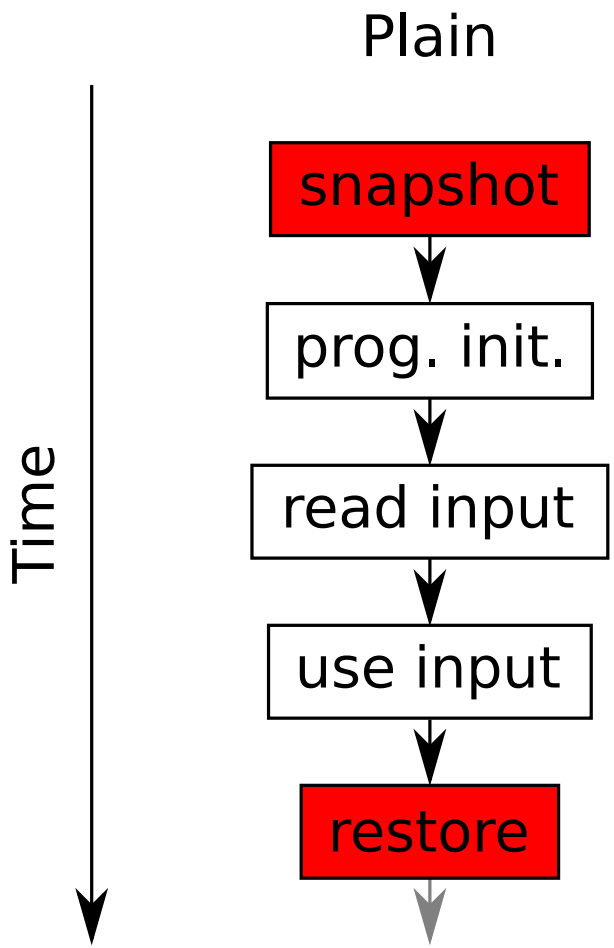
Optimization opportunities



- Program initialization is redundant
- Input data is copied before use, but does not influence the execution
- Several mutation operators leave most of the input unchanged
- Pushing the snapshot into the execution will remove redundant operations

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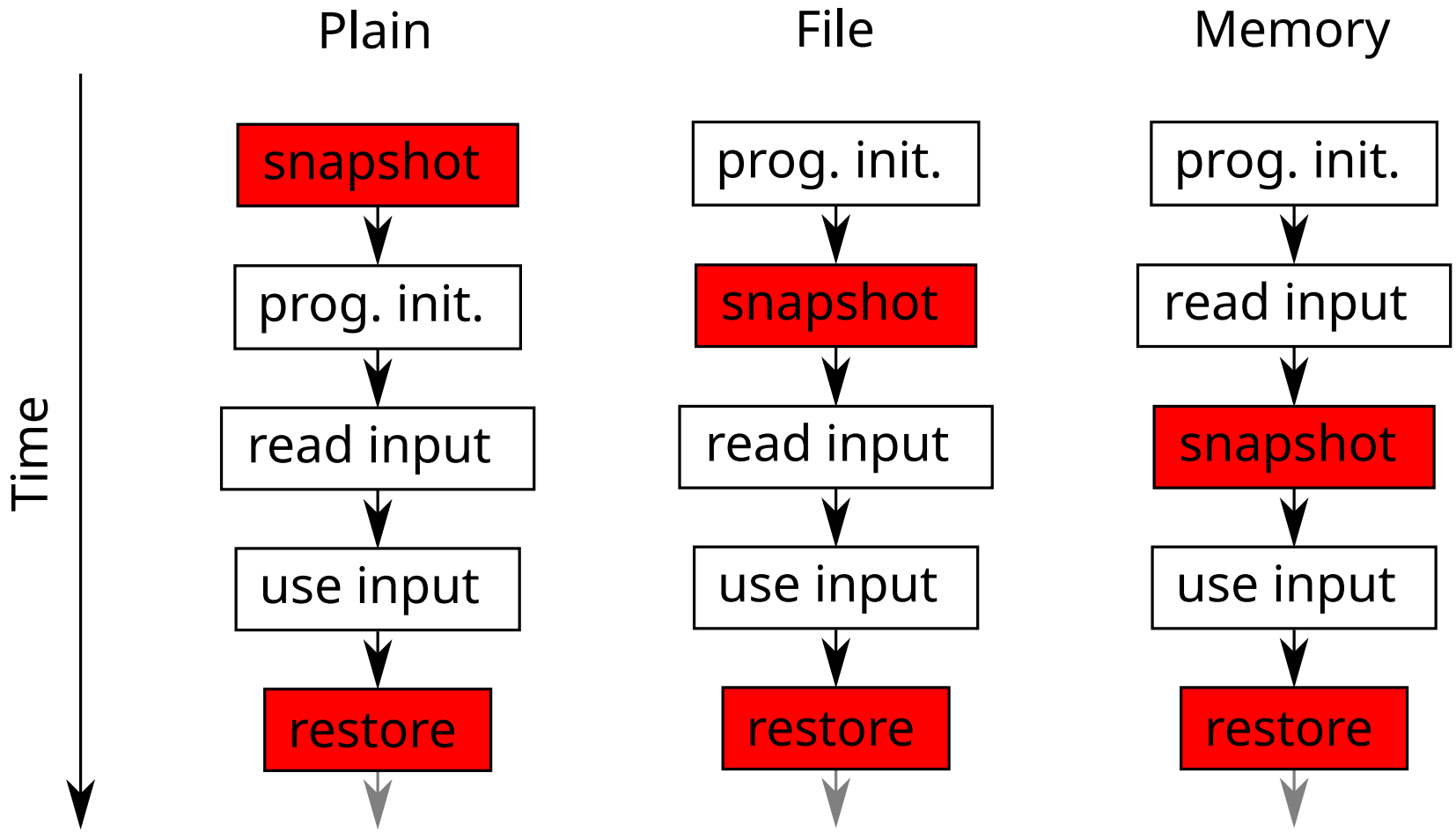
Snapshot positioning policies



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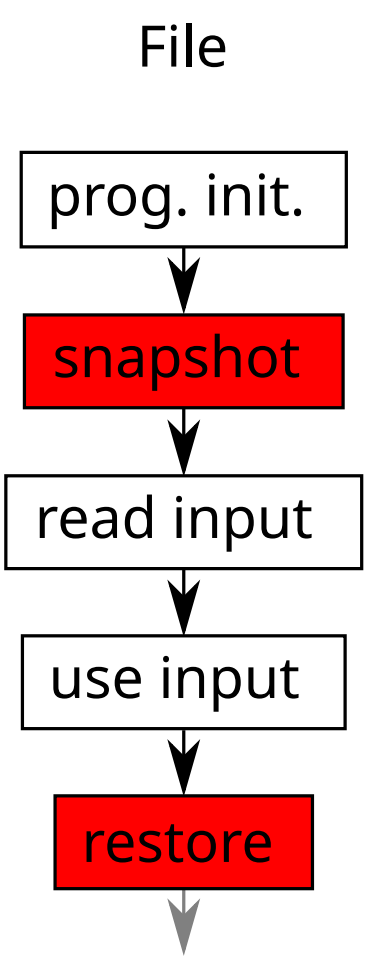
Example - File policy

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3    FILE* file = fopen(argv[1], "rb");
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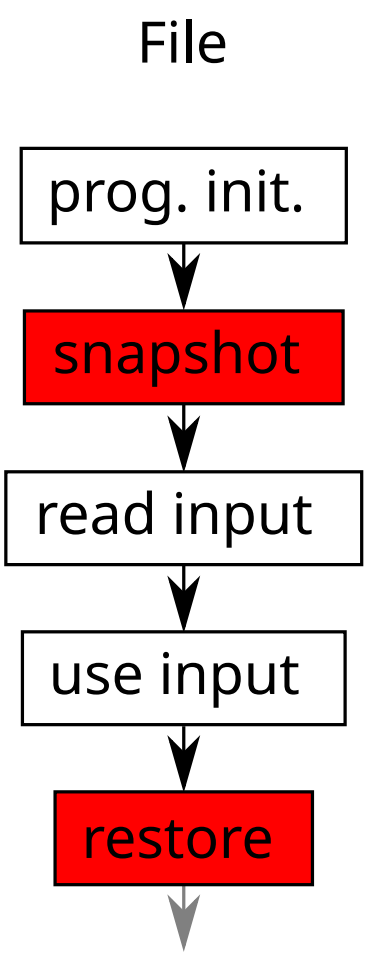


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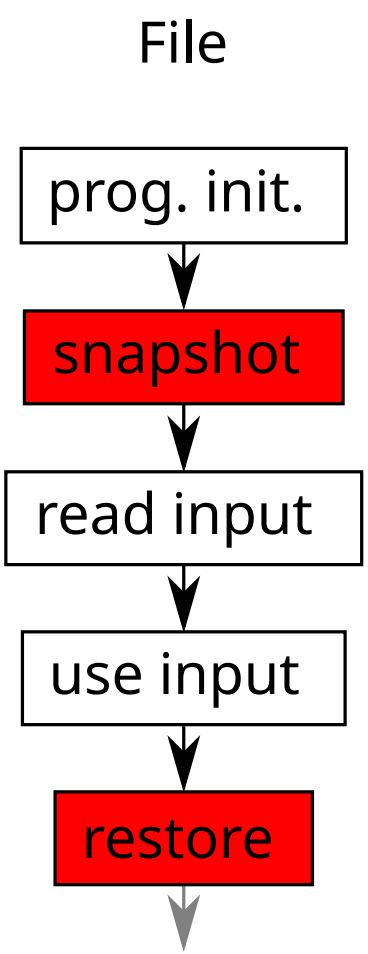


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Memory policy

- Input bytes that will be modified are tainted
- Find first tainted load from memory through Dynamic Taint Analysis *(adaptive snapshots)*
- Record a snapshot keeping track of all tainted bytes in memory with DTA
- On restore, replace all tainted bytes with mutated ones *(mutable snapshots)*

Each new parent test case requires a new snapshot

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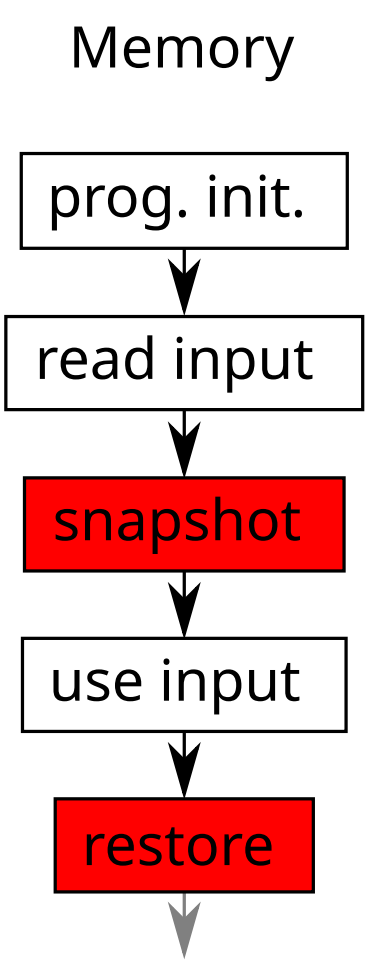
Example - Memory policy

- Test cases of size 12 which differ only by their 2nd byte

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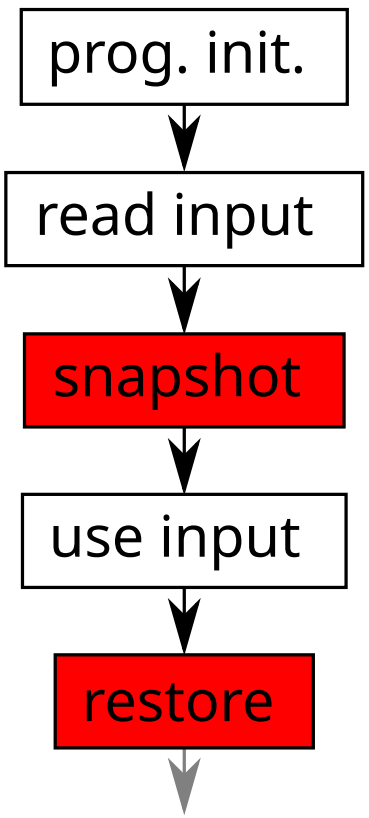


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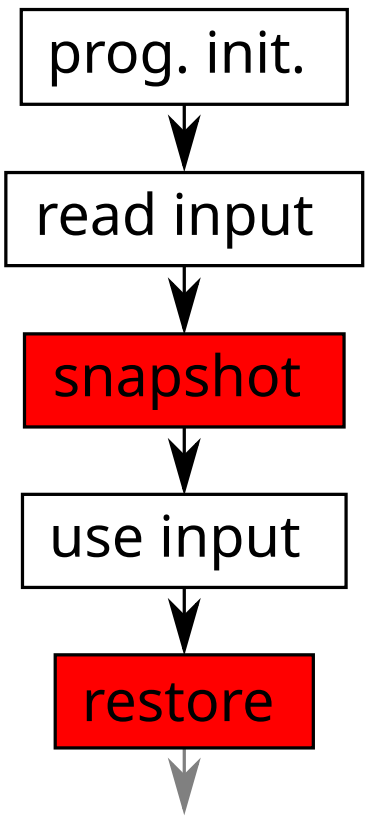


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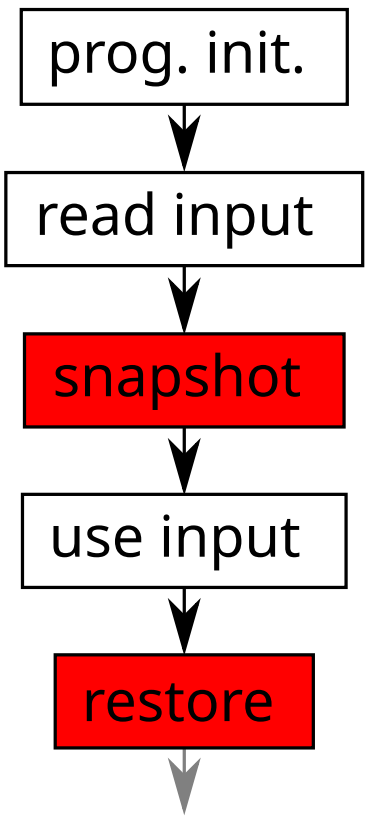


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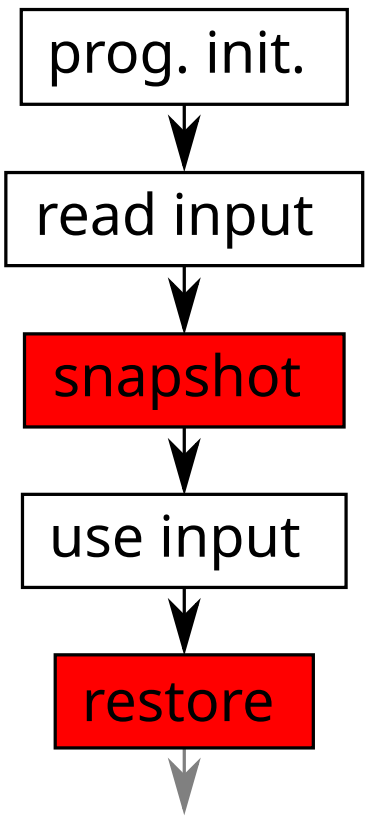


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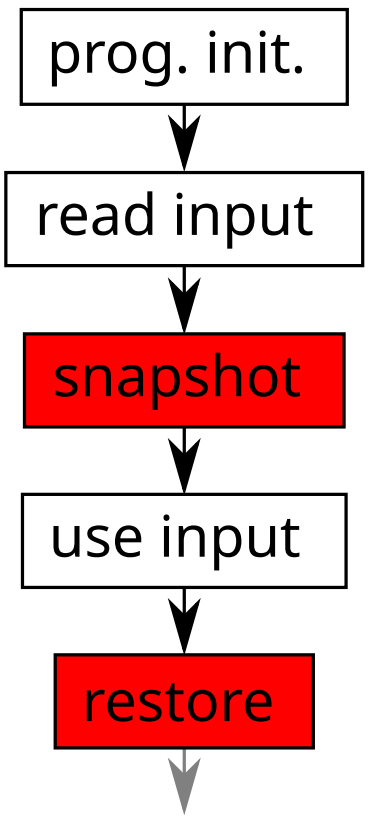


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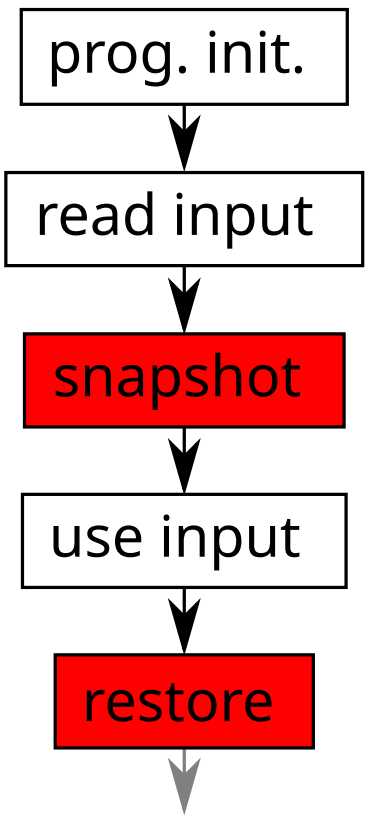


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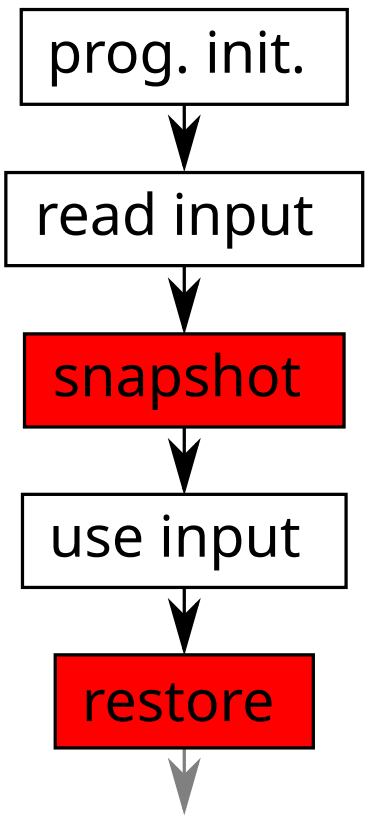


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Other optimizations

- Dynamic switching between File and Memory policies
- Exit optimization for error handling code
- Other low level optimizations

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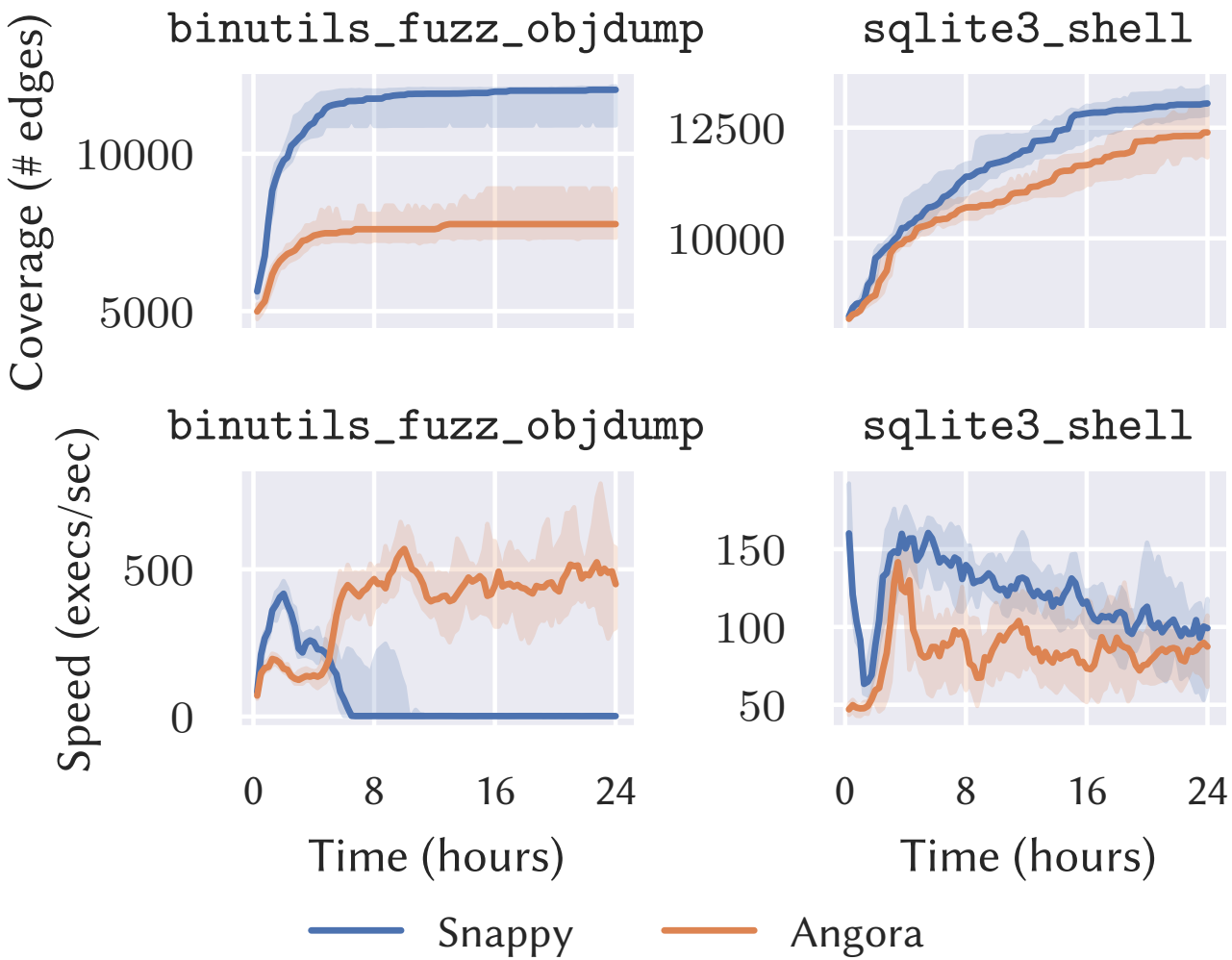
Evaluation



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Conclusion

- Snappy increases fuzzing speed by moving snapshots further into the program trace
- It does so with two policies: File (simpler) and Memory (more complex)
- It produces:
  - up to 1.76× speed increase in FuzzBench, with no significant regressions
  - up to 31% coverage increase on real-world programs (24 hours benchmarks)

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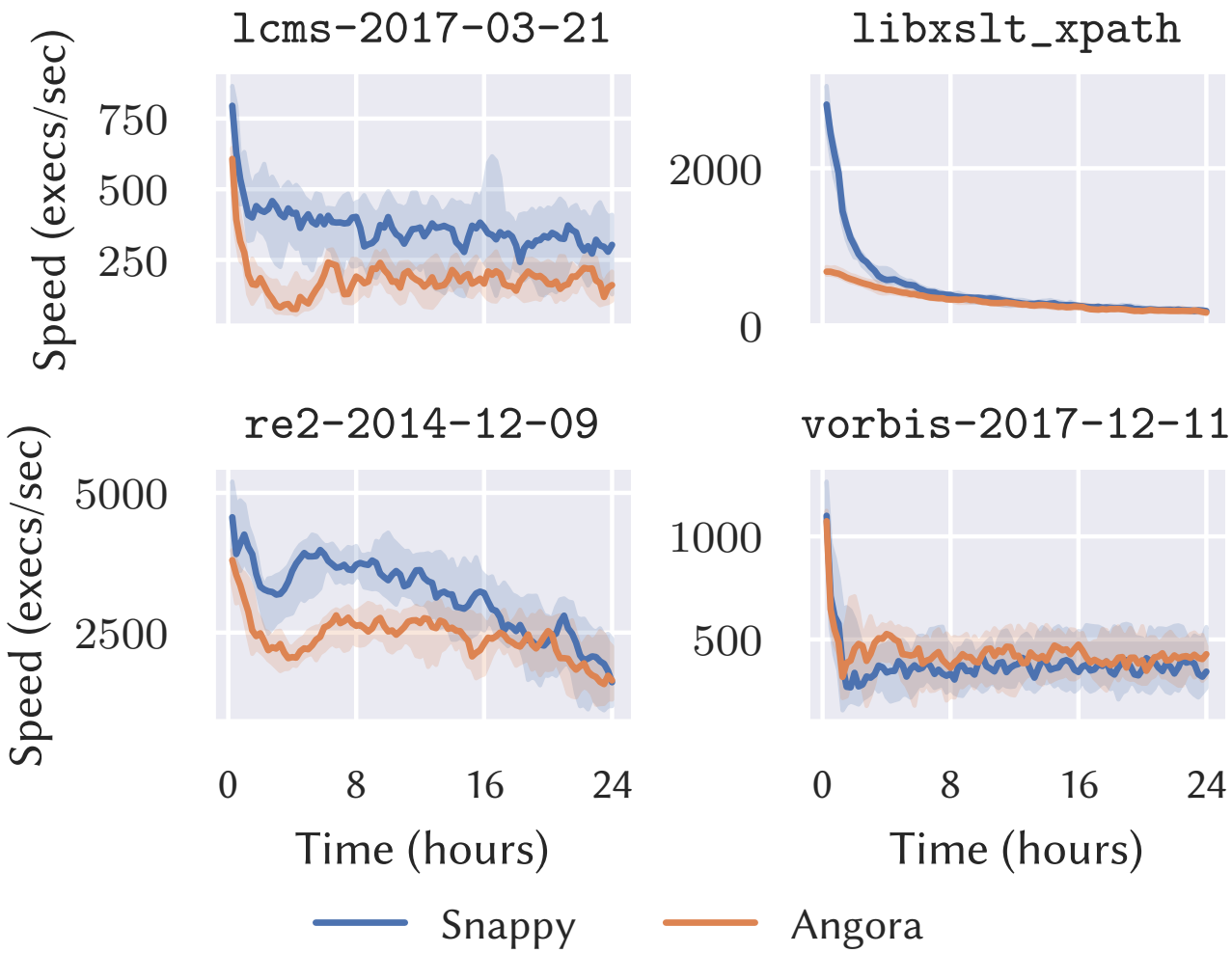
FuzzBench



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