StateFuzzVis:

State-coverage Guided Fuzzer Visualizer

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Motivation

- **Fuzzing** is an **effective** and **widely-used** vulnerability detection technique

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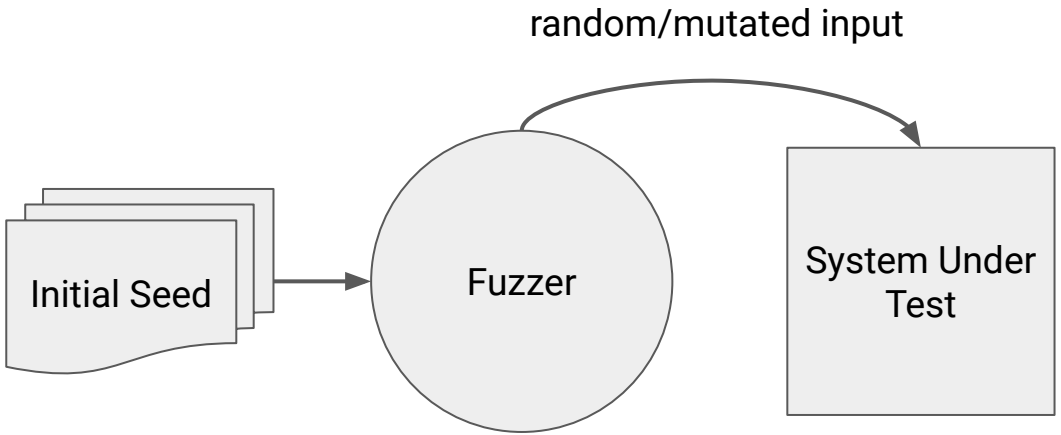

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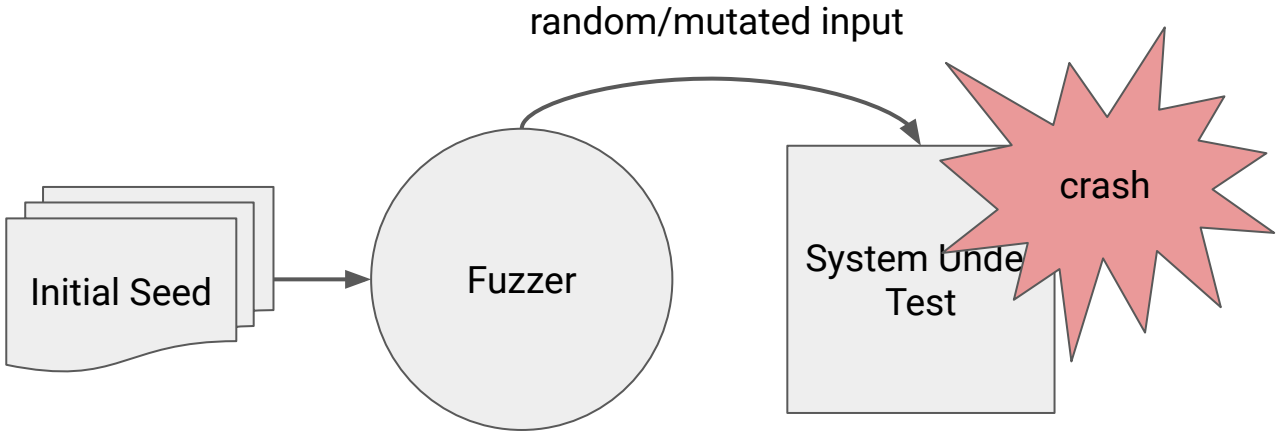

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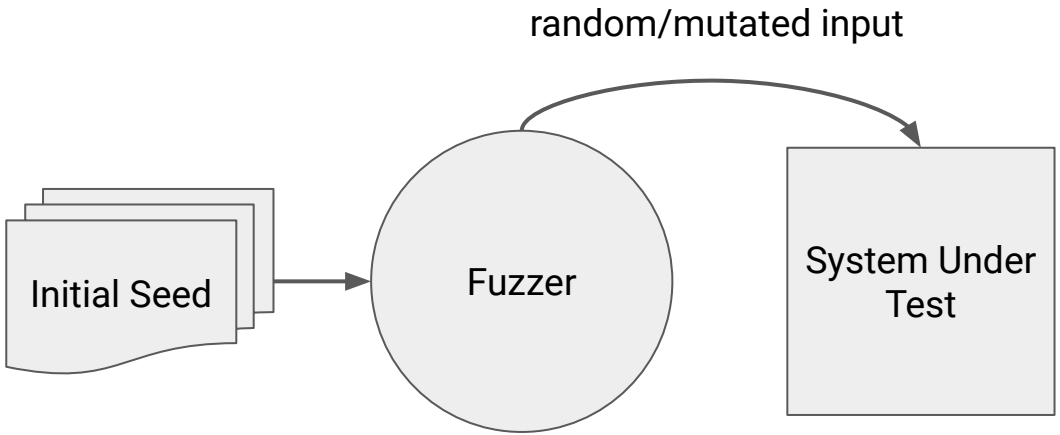
- Greybox fuzzing uses **coverage information** to guide its fuzzing process



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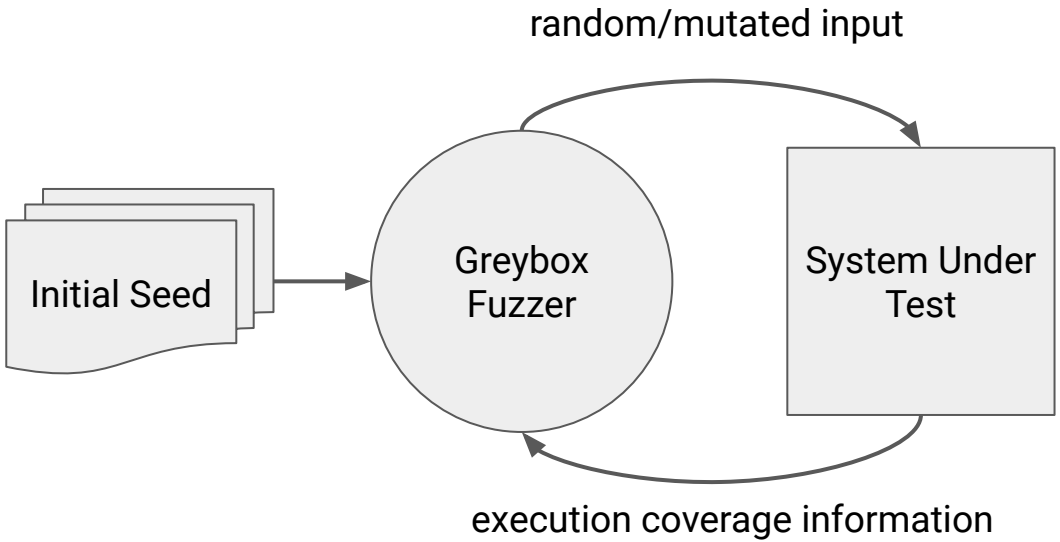

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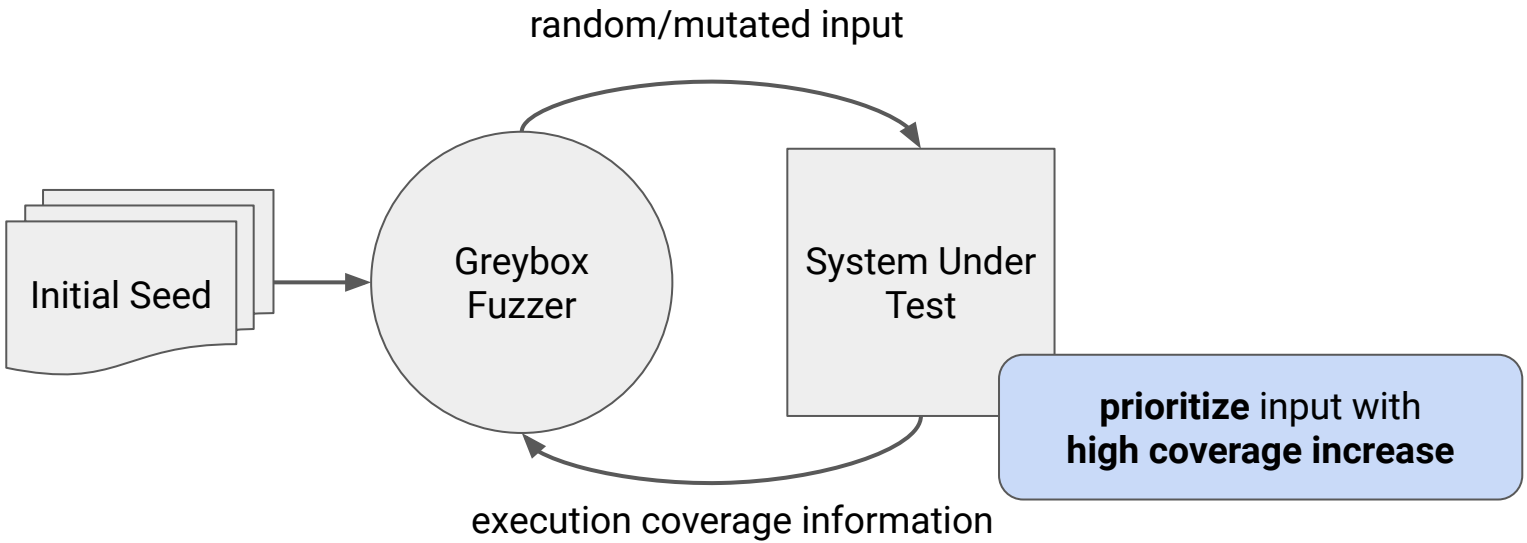

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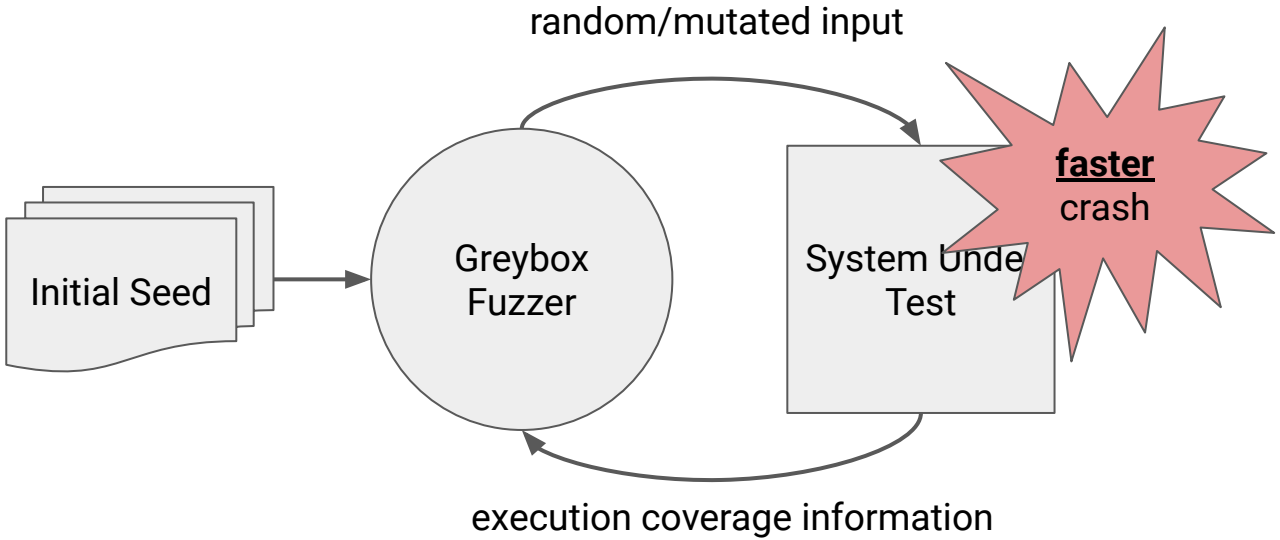

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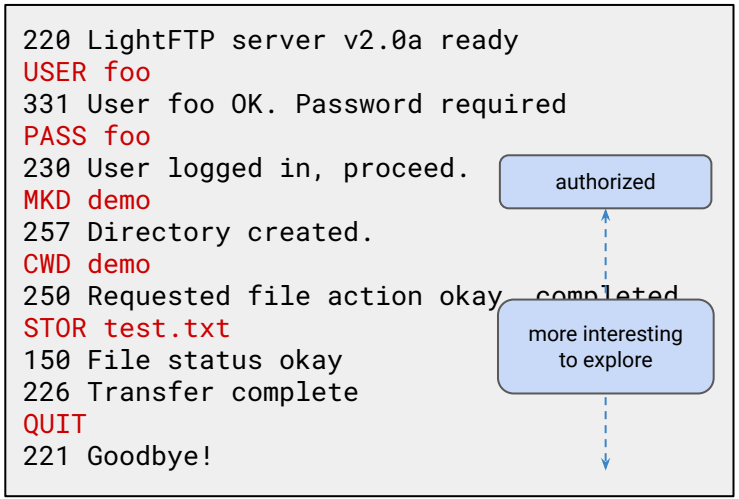

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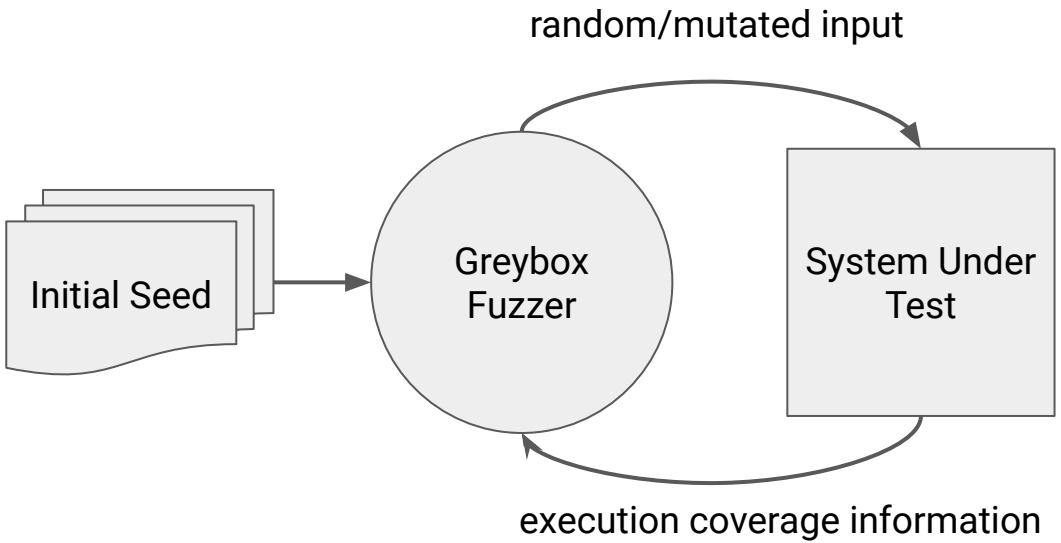
- Much research effort on **state-coverage guided fuzzers**

State-coverage Guided Fuzzers



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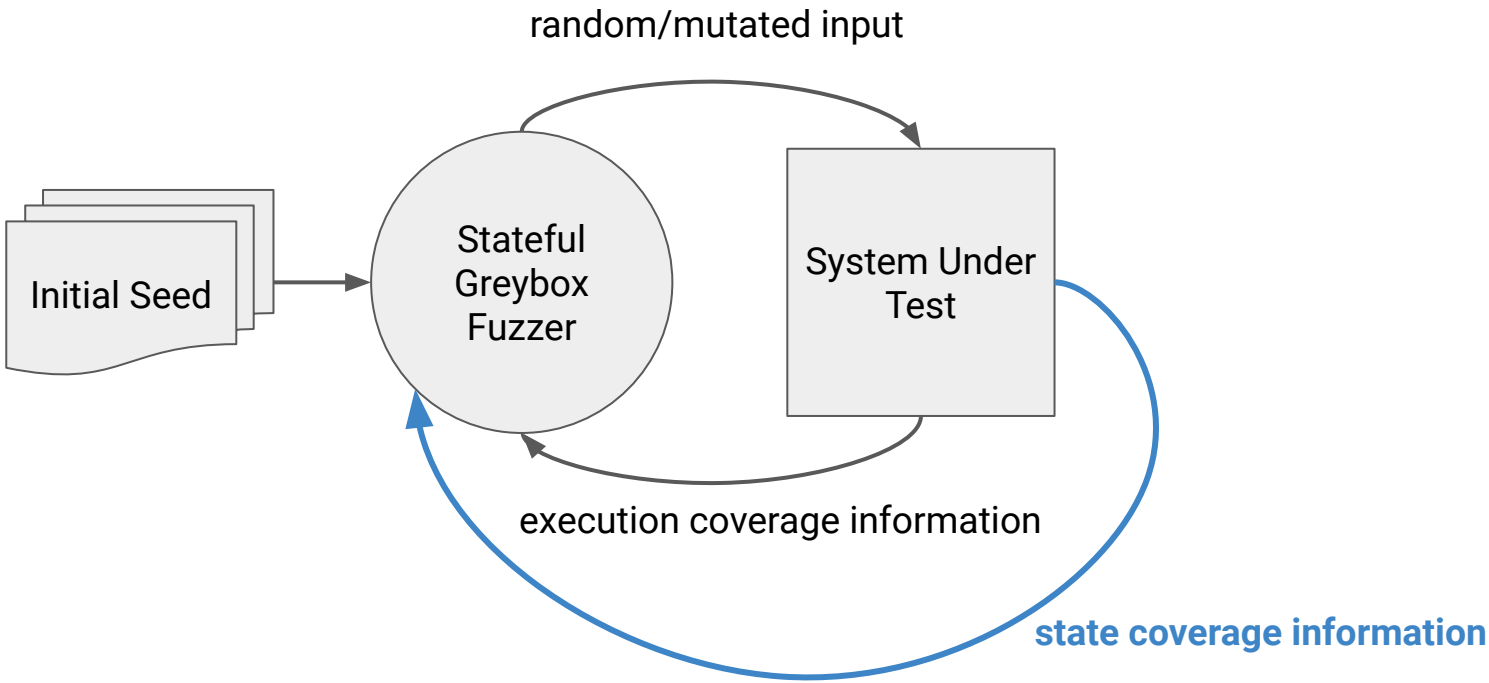

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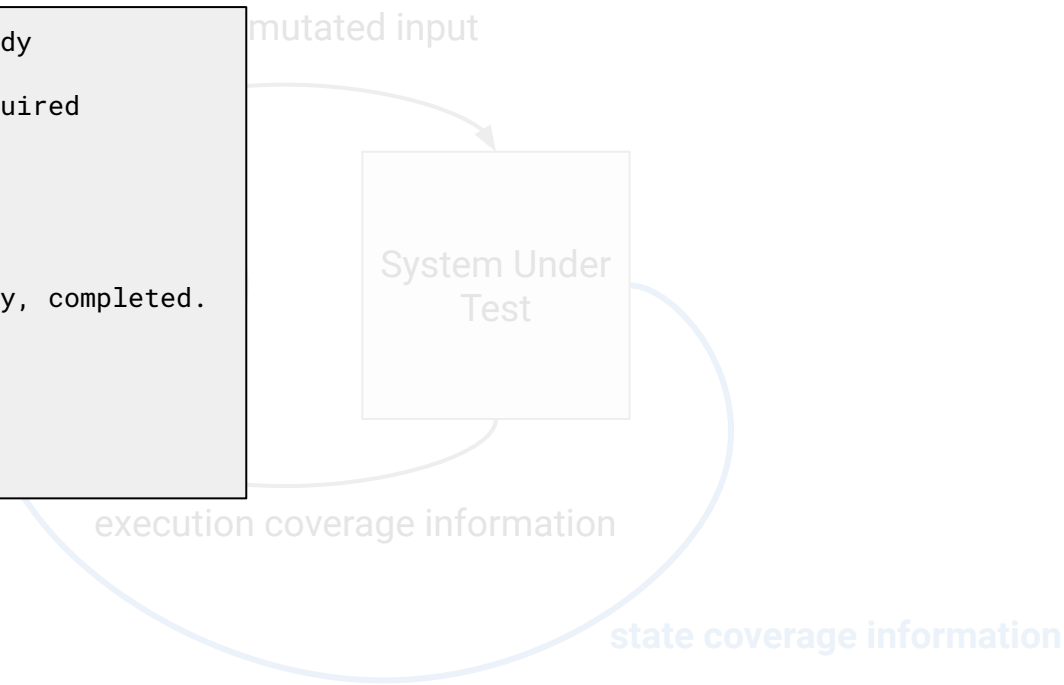

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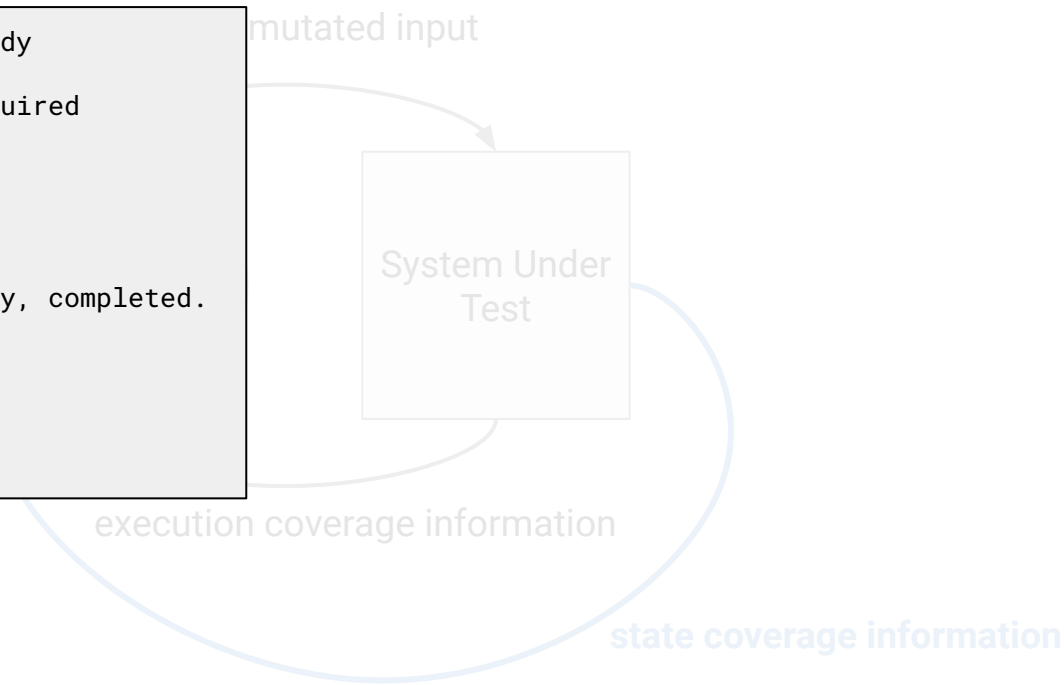

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AFLNet

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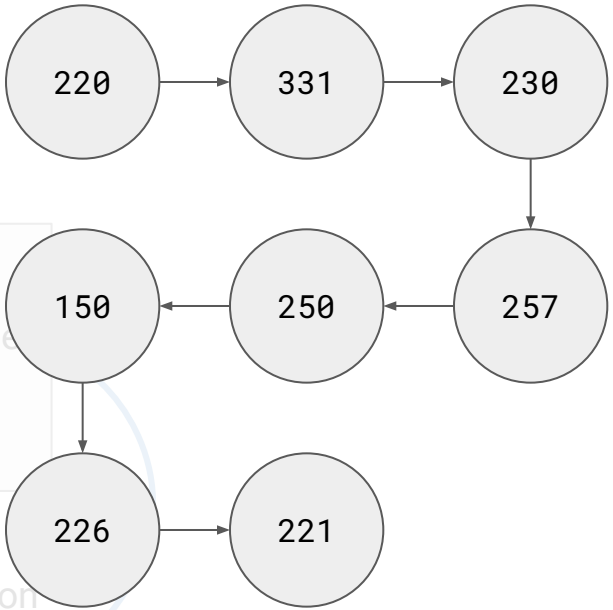

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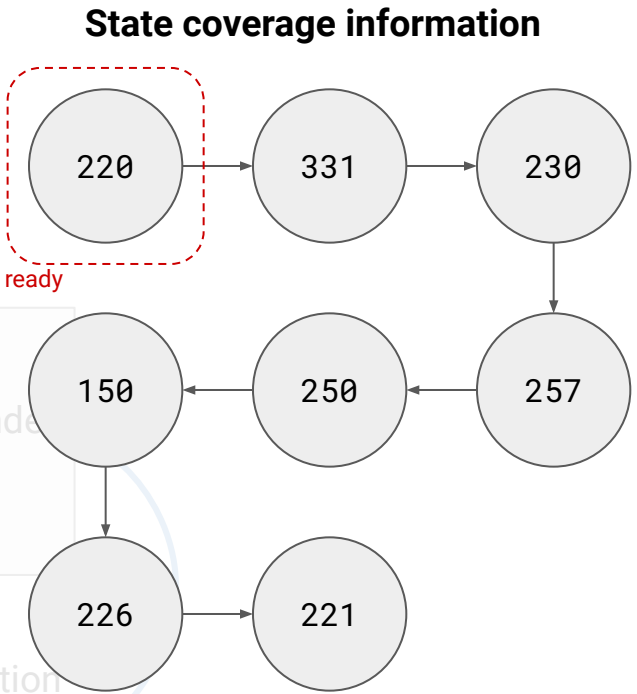

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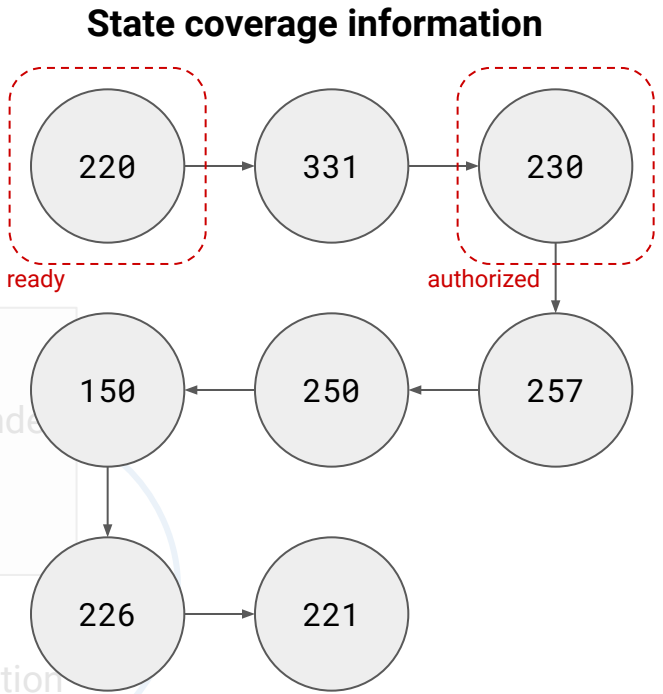

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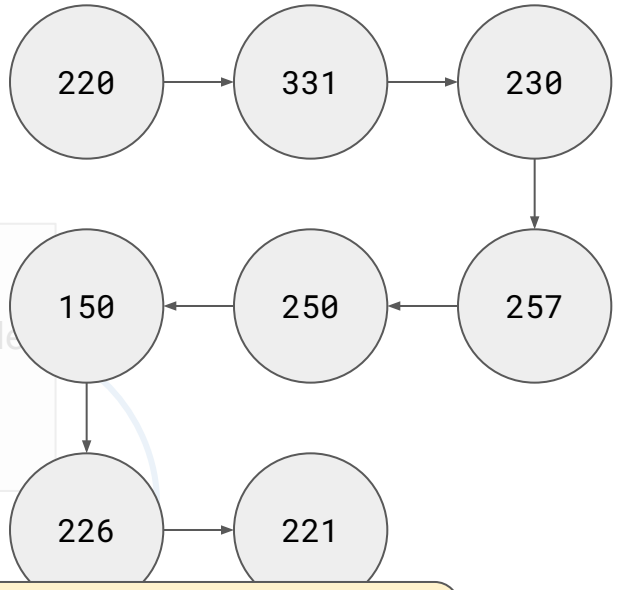

other fuzzers may use different state identification strategy

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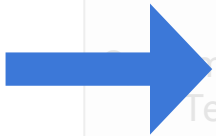

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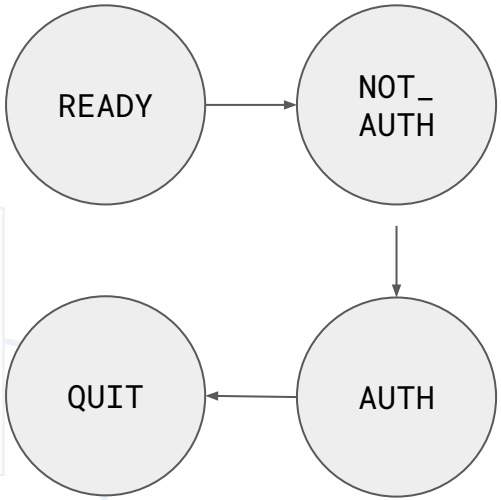

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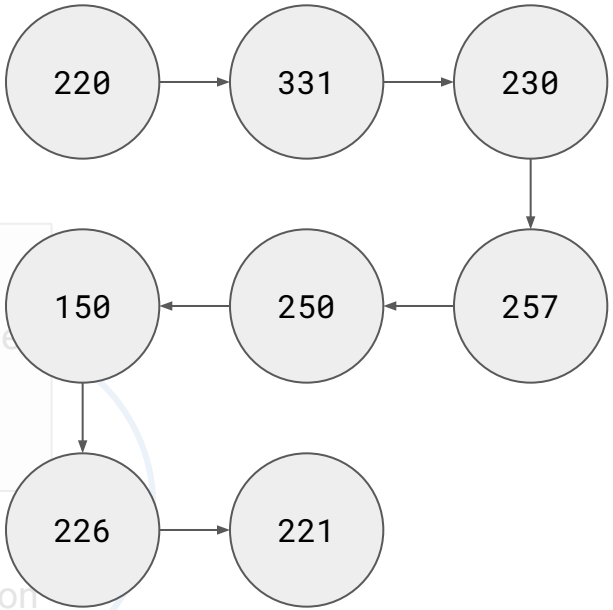

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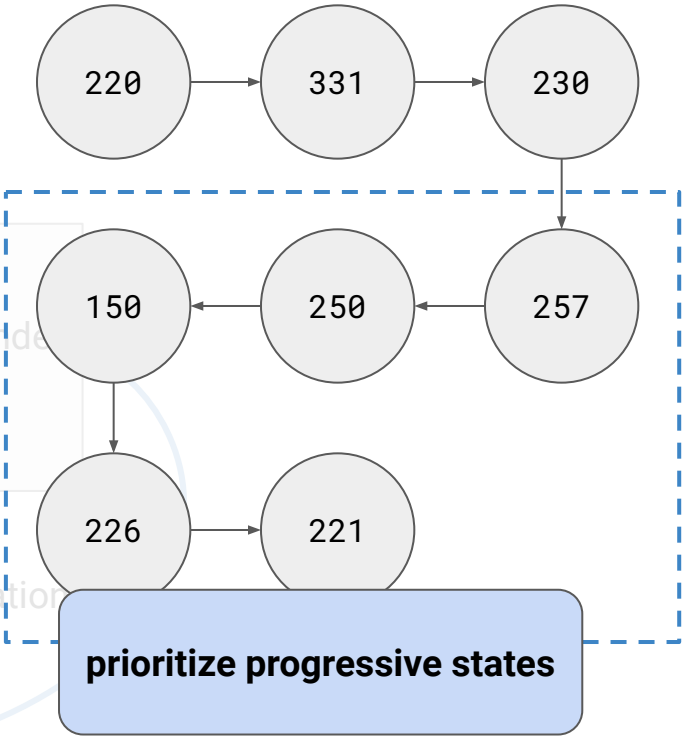

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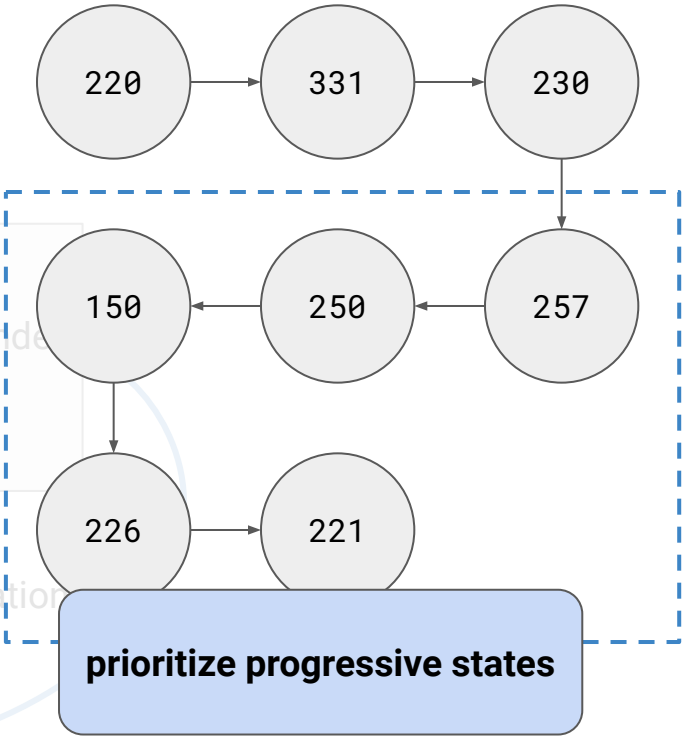

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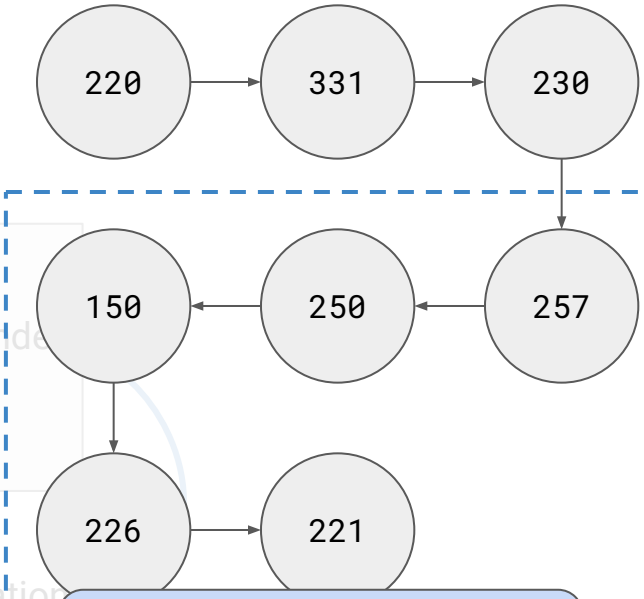

other fuzzers may use different prioritization strategy

state identification strategy also affects decision

prioritize progressive states

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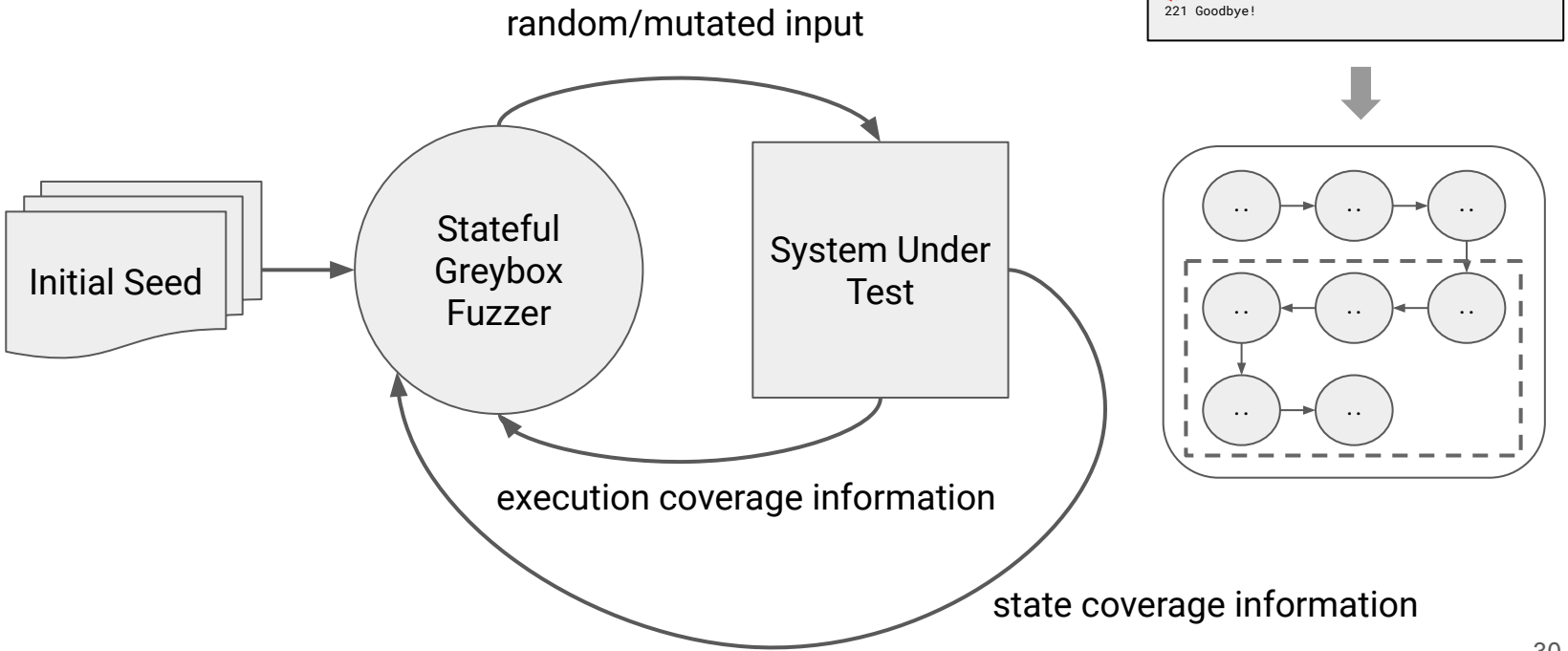

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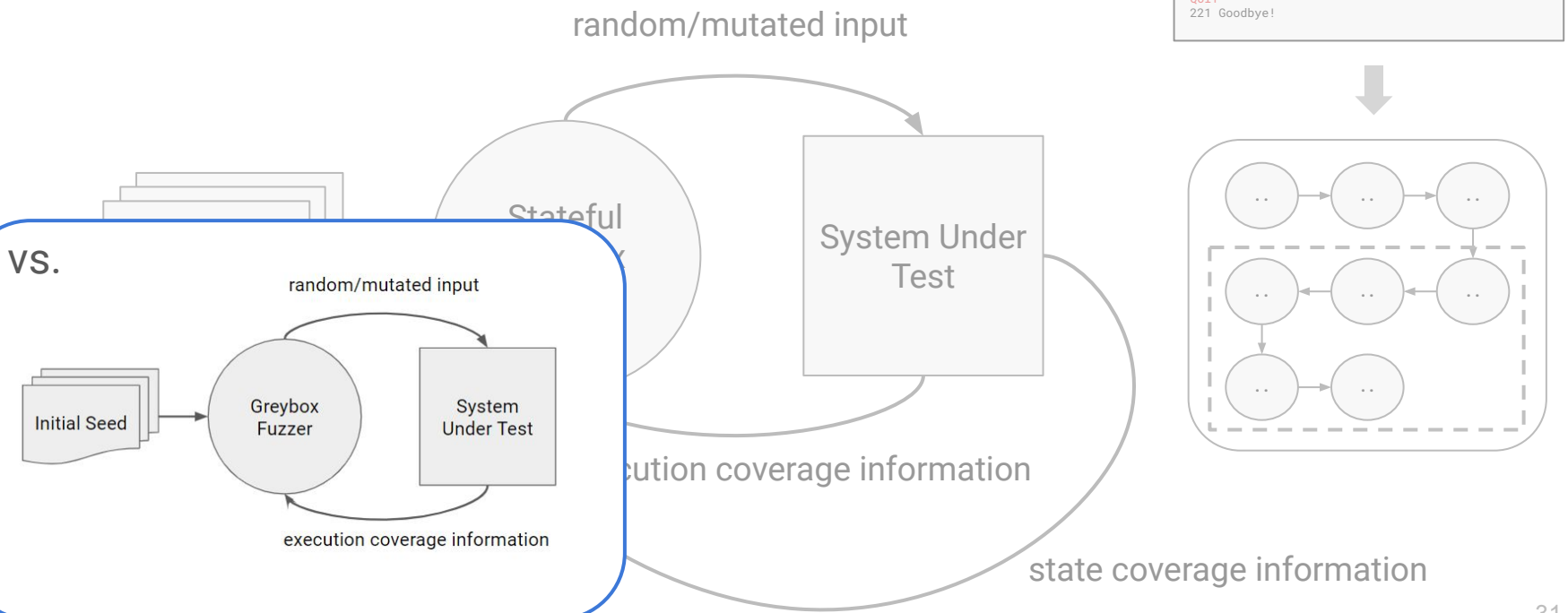

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american fuzzy lop 1.86b (test)

process timing                    overall results
       run time : 0 days, 0 hrs, 0 min, 2 sec      cycles done : 0
  last new path : none seen yet                    total paths : 1
 last uniq crash : 0 days, 0 hrs, 0 min, 2 sec     uniq crashes : 1
  last uniq hang : none seen yet                    uniq hangs : 0
cycle progress                    map coverage
  now processing : 0 (0.00%)          map density : 2 (0.00%)
 paths timed out : 0 (0.00%)       count coverage : 1.00 bits/tuple
stage progress                    findings in depth
  now trying : havoc              favored paths : 1 (100.00%)
 stage execs : 1464/5000 (29.28%)  new edges on : 1 (100.00%)
 total execs : 1697               total crashes : 39 (1 unique)
  exec speed : 626.5/sec            total hangs : 0 (0 unique)
fuzzing strategy yields           path geometry
   bit flips : 0/16, 1/15, 0/13       levels : 1
   byte flips : 0/2, 0/1, 0/0         pending : 1
  arithmetics : 0/112, 0/25, 0/0     pend fav : 1
   known ints : 0/10, 0/28, 0/0     own finds : 0
   dictionary : 0/0, 0/0, 0/0        imported : n/a
        havoc : 0/0, 0/0             variable : 0
         trim : n/a, 0.00%
                                                  [cpu: 92%]
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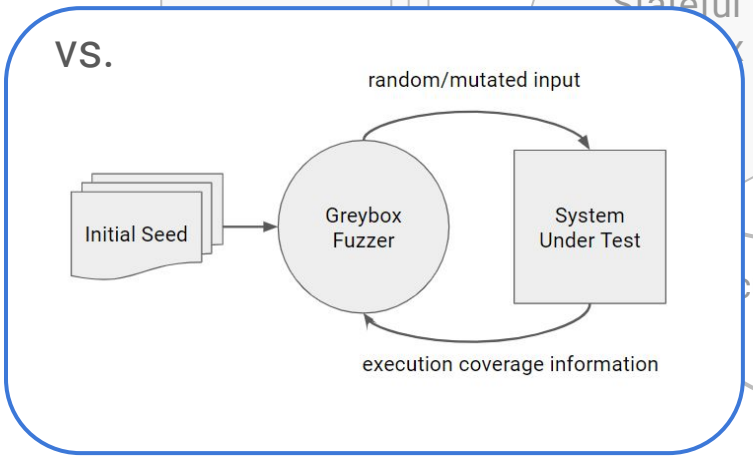

state coverage information

https://en.wikipedia.org/wiki/American_Fuzzy_Lop_%28software%29#/media/File:American_fuzzy_lop's_afl-fuzz_running_on_a_test_program.png

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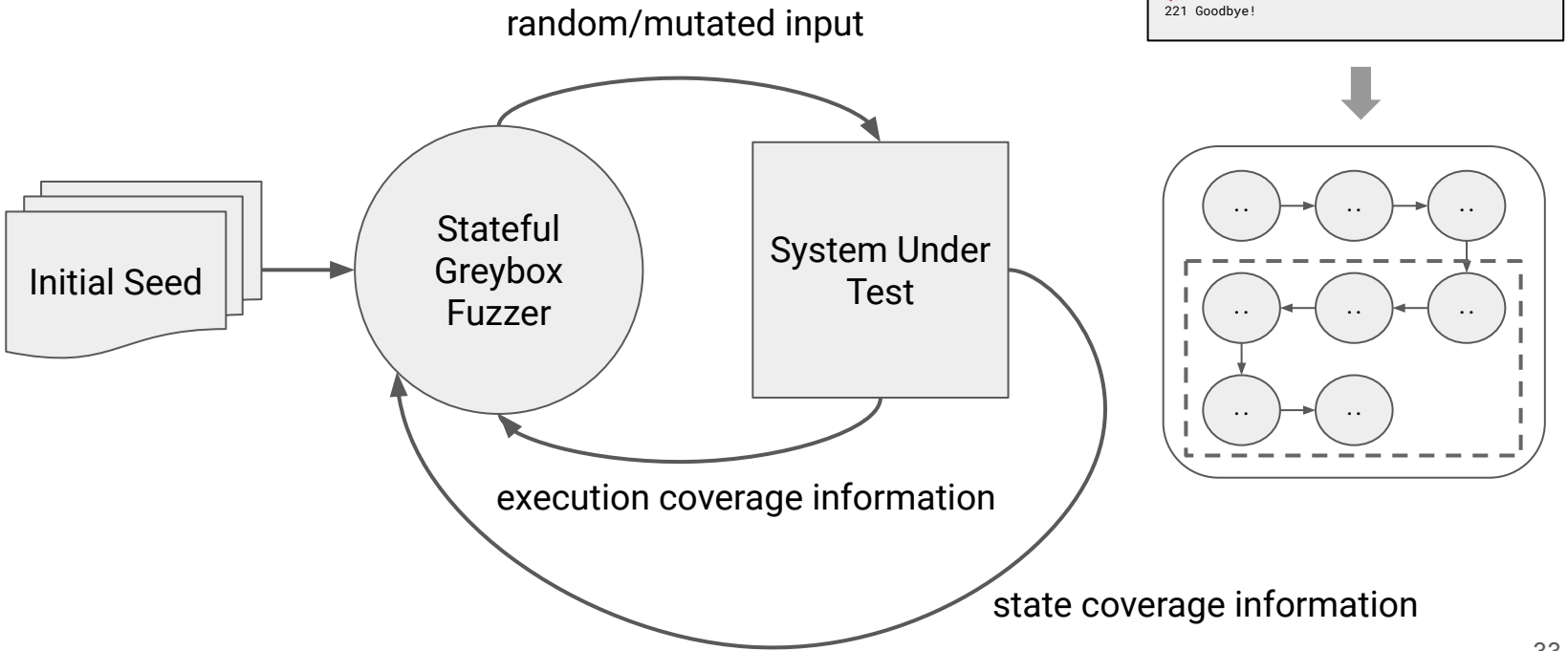

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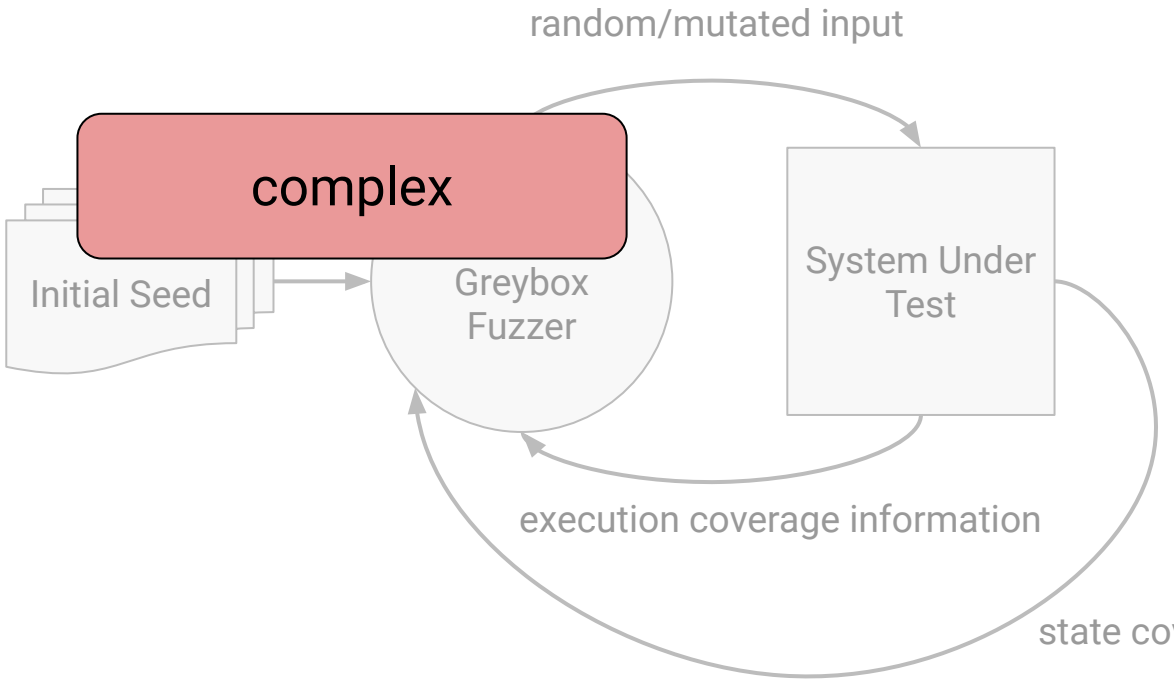

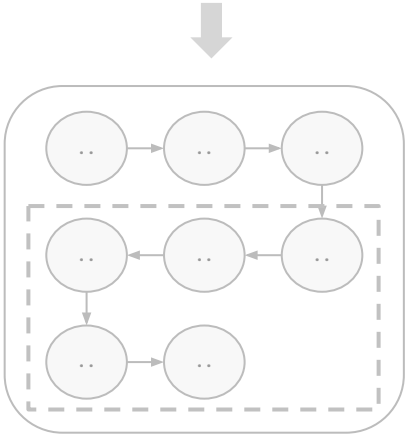

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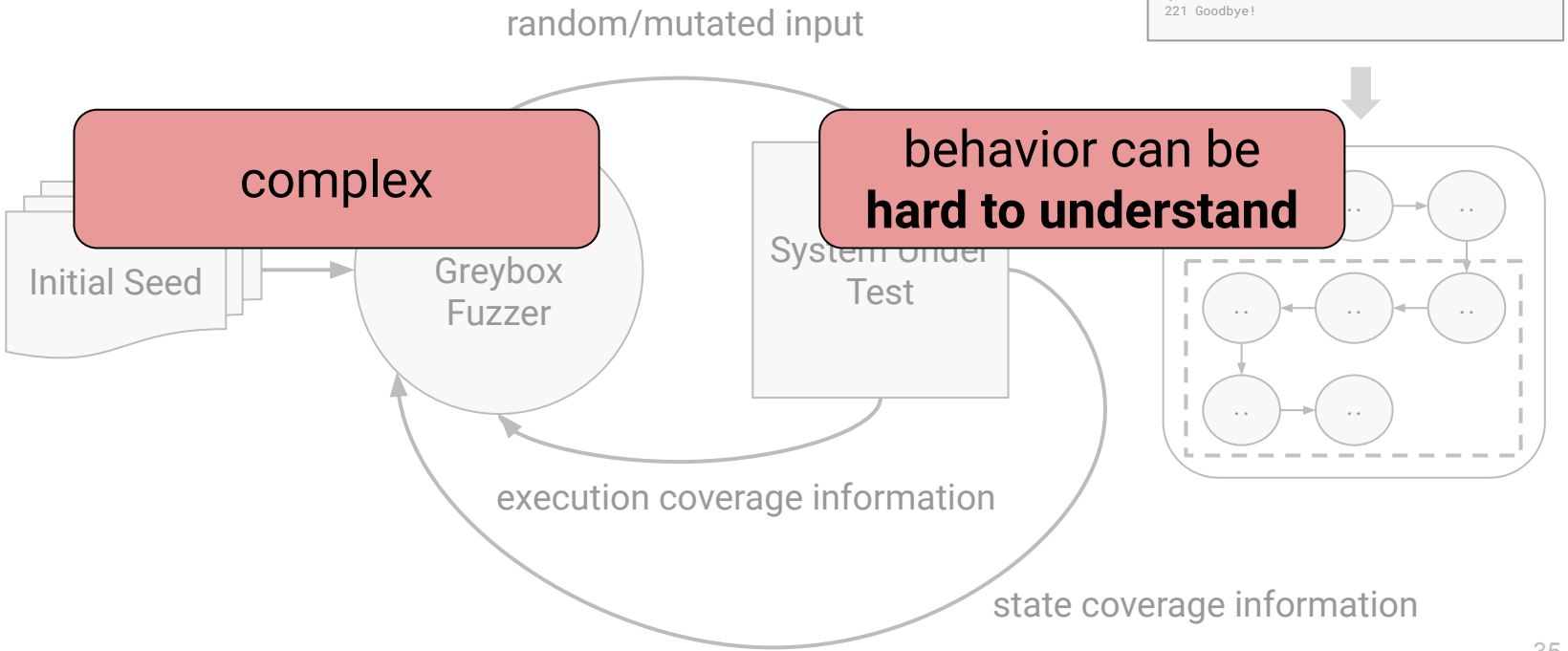

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  - Visualize the **states** and **state transitions exercised** during fuzzing
- Make it easier for developers/testers to **monitor** fuzzing process
- Aim to **gain insight** on state-coverage guided fuzzers through **real-time observation**
  - Answer questions:
    - What states are there? How to transition between states?
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- Nodes = States
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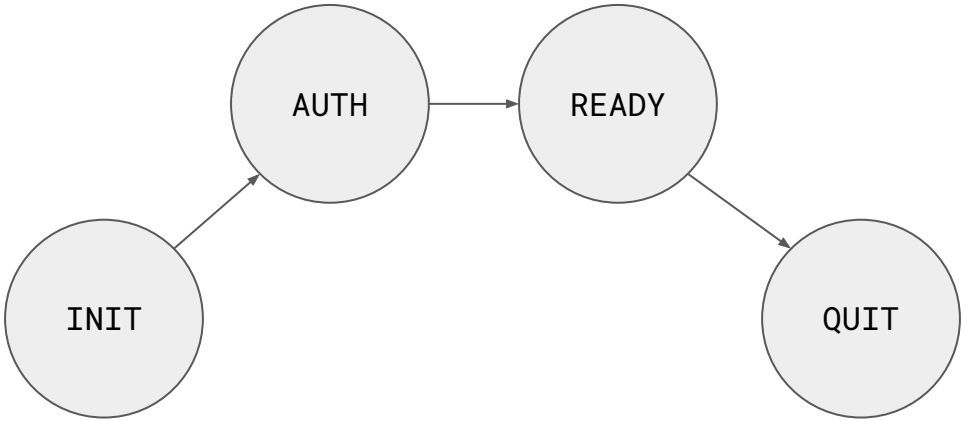

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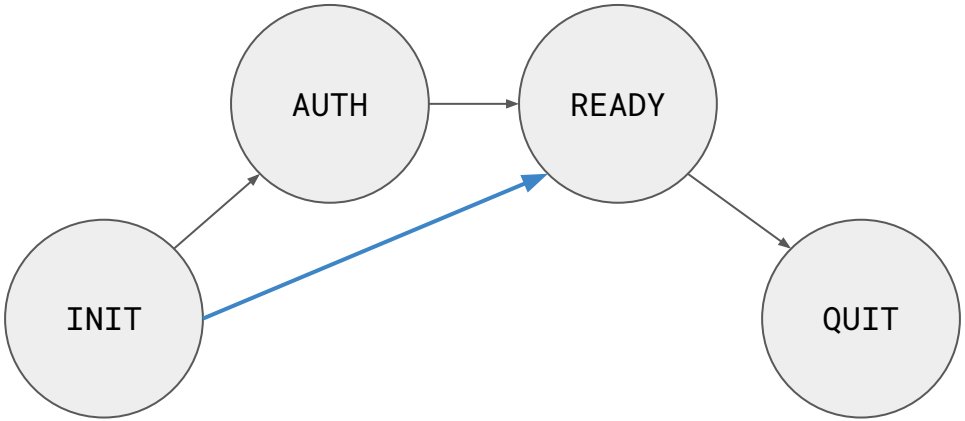

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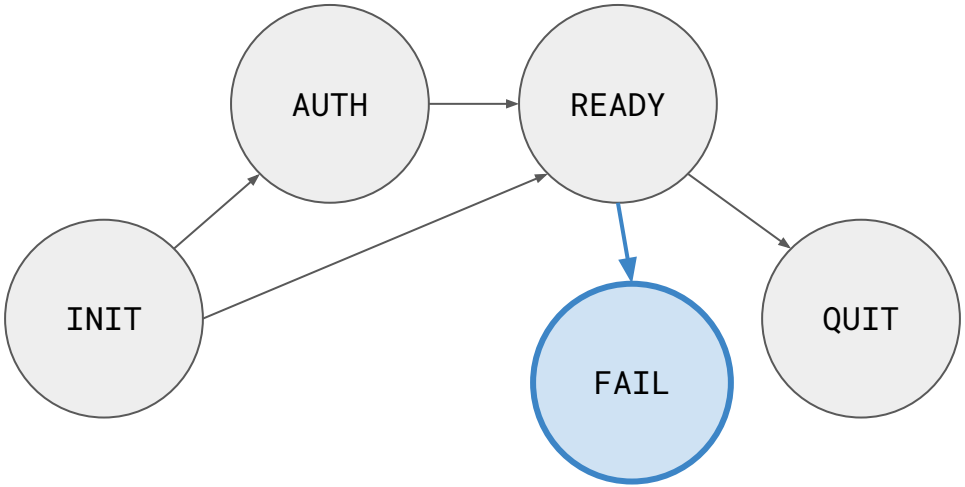

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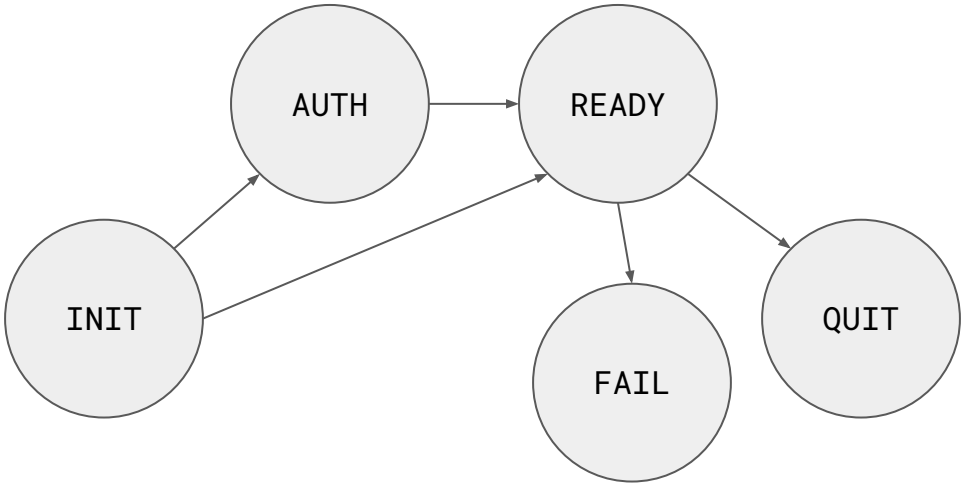

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```
INIT -> AUTH -> READY -> FAIL
```

```
INIT -> AUTH -> READY -> QUIT
```

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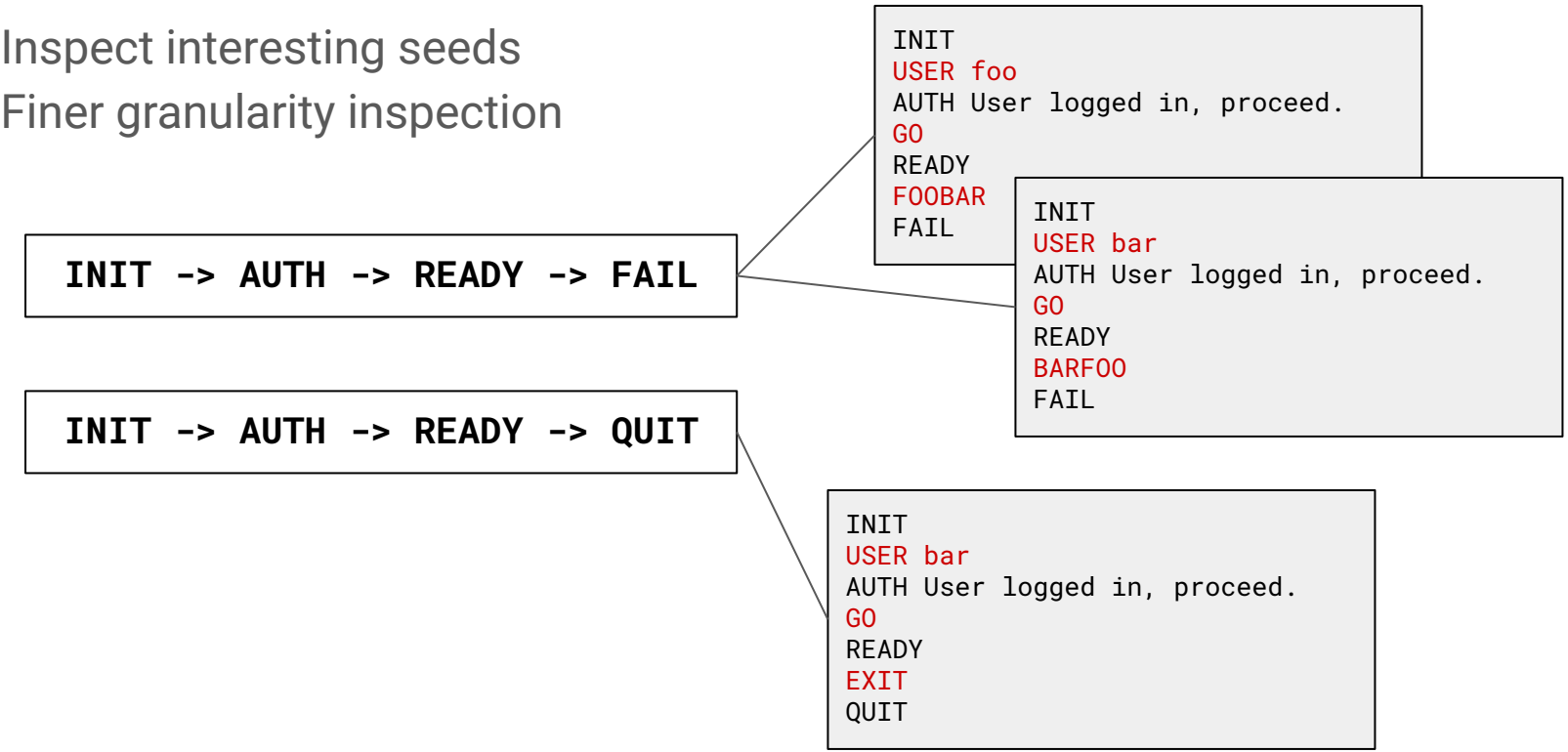

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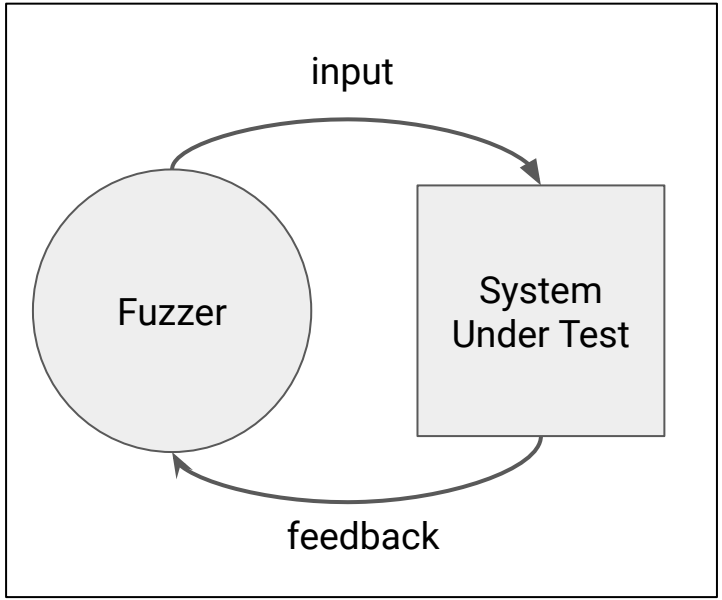

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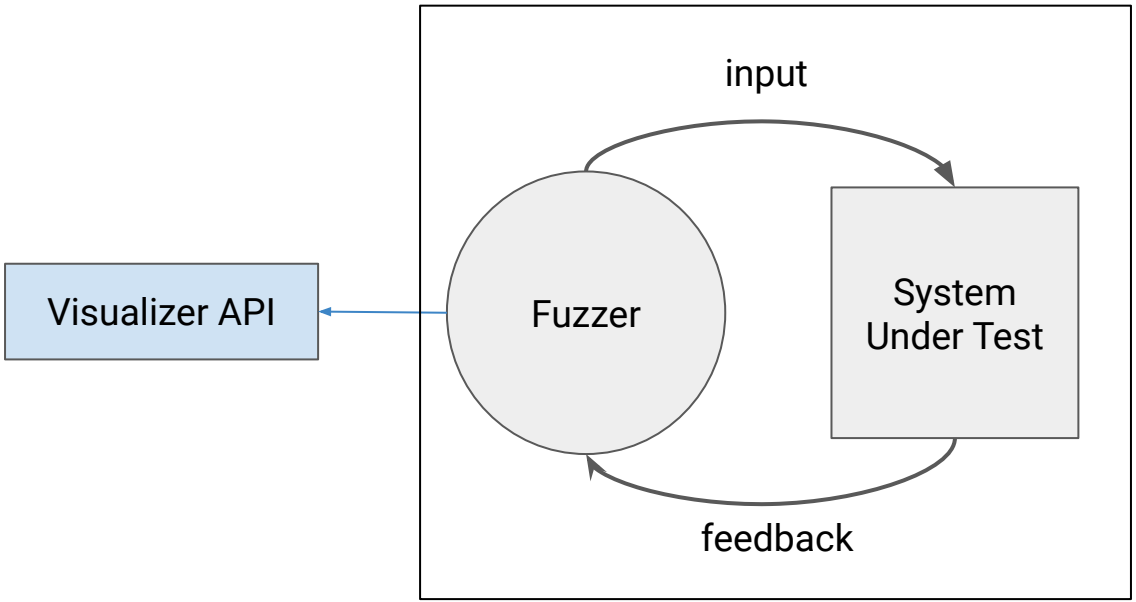

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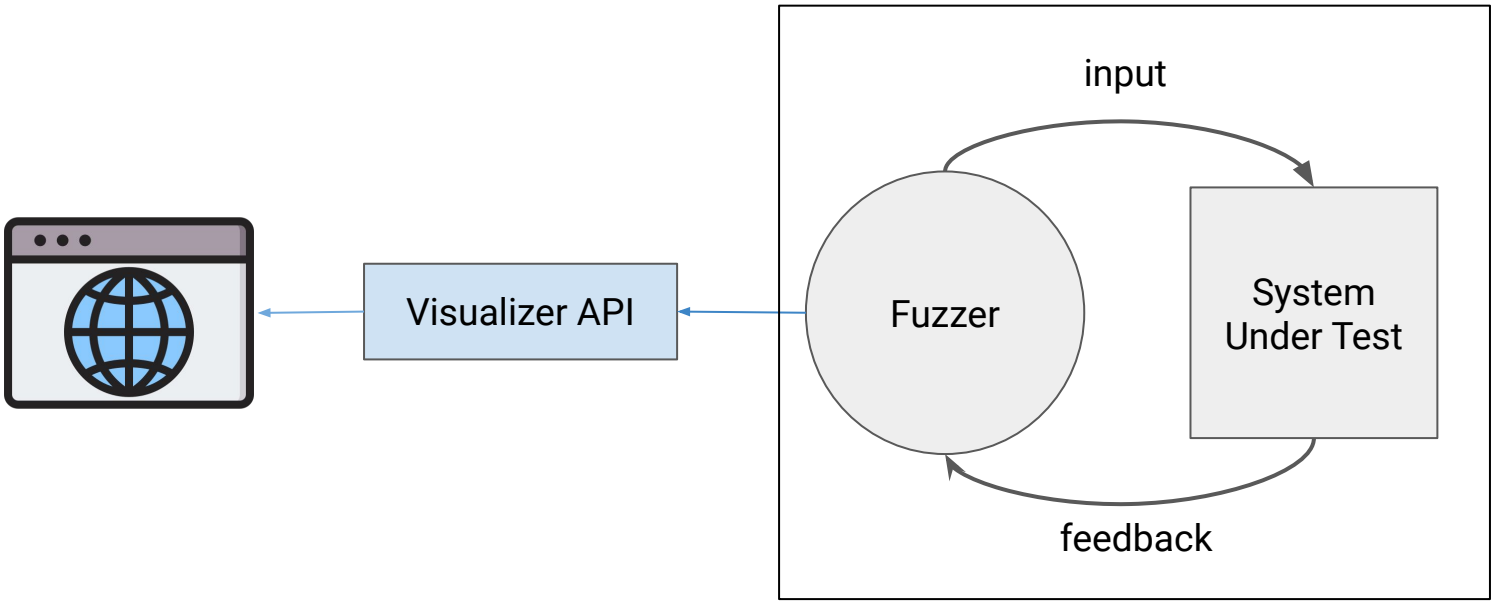

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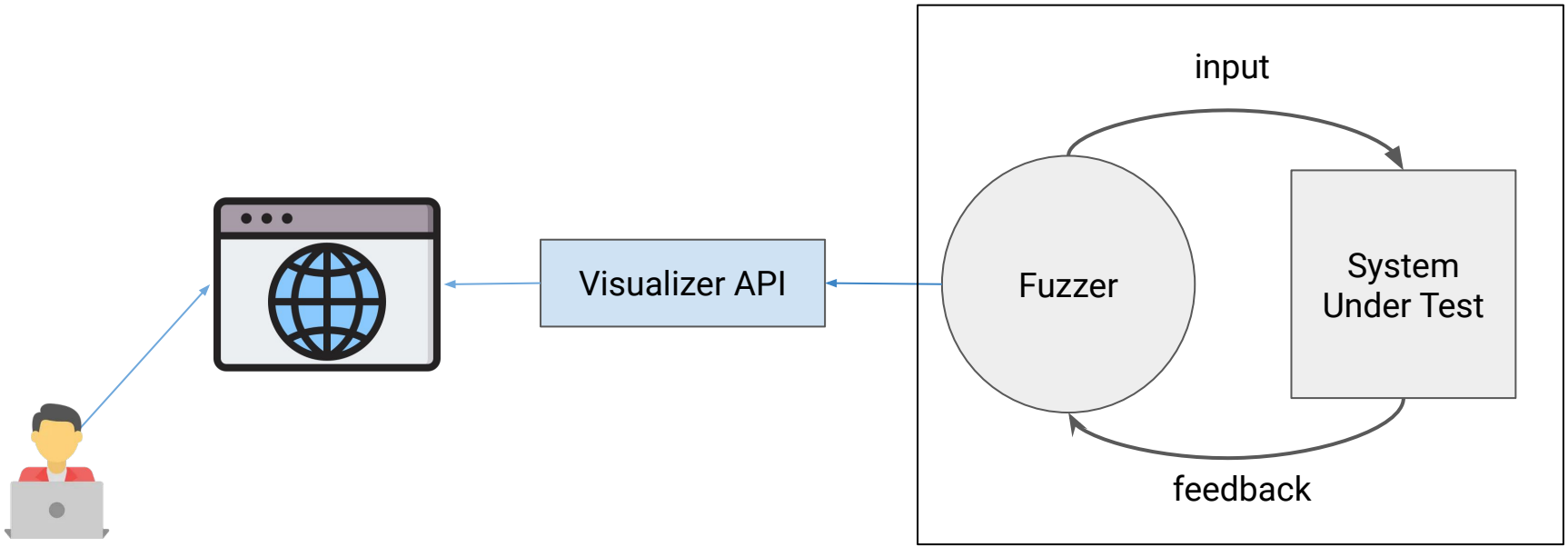

Evaluation Plan

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- ProFuzzBench for protocol benchmarks
- AFLNet, SGFuzz, StateAFL, etc. for fuzzers

What’s next?

- In-depth analysis of existing state-coverage guided fuzzers
- User-assisted fuzzing

Thank you

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Real World Scenario

- In its repo tutorial, AFLNet patches target program manually to decompose states for Live555 RTSP Server*

- State **200** is too large

```
SETUP       -> 200 OK
PLAY        -> 200 OK
TEARDOWN    -> 200 OK
```

```
SETUP       -> 201 OK
PLAY        -> 202 OK
TEARDOWN    -> 203 OK
```

*) https://github.com/aflnet/aflnet/blob/master/tutorials/live555/ceeb4f4_states_decomposed.patch