Scalable SMT Sampling for Floating-Point Formulas via Coverage-Guided Fuzzing

Manuel Carrasco, Cristian Cadar and Alastair F. Donaldson
Imperial College London

ICST 2025

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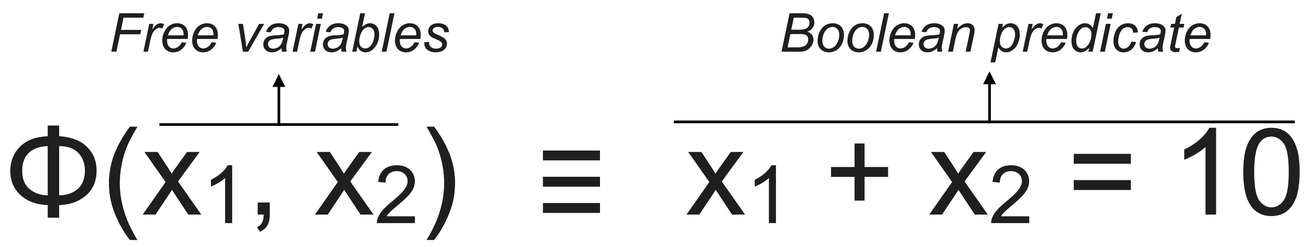

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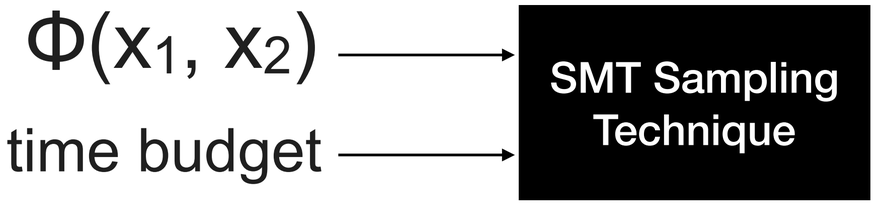
Free variables — x_1, x_2

Boolean predicate — $x_1 + x_2 = 10$



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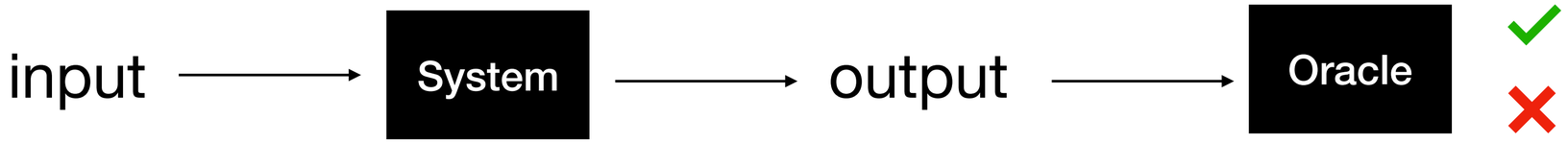

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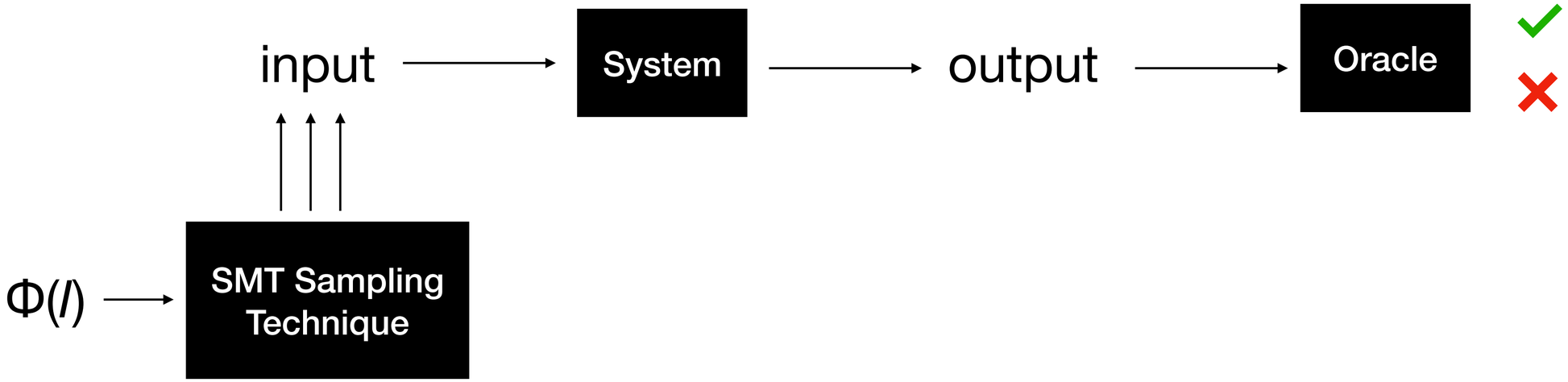

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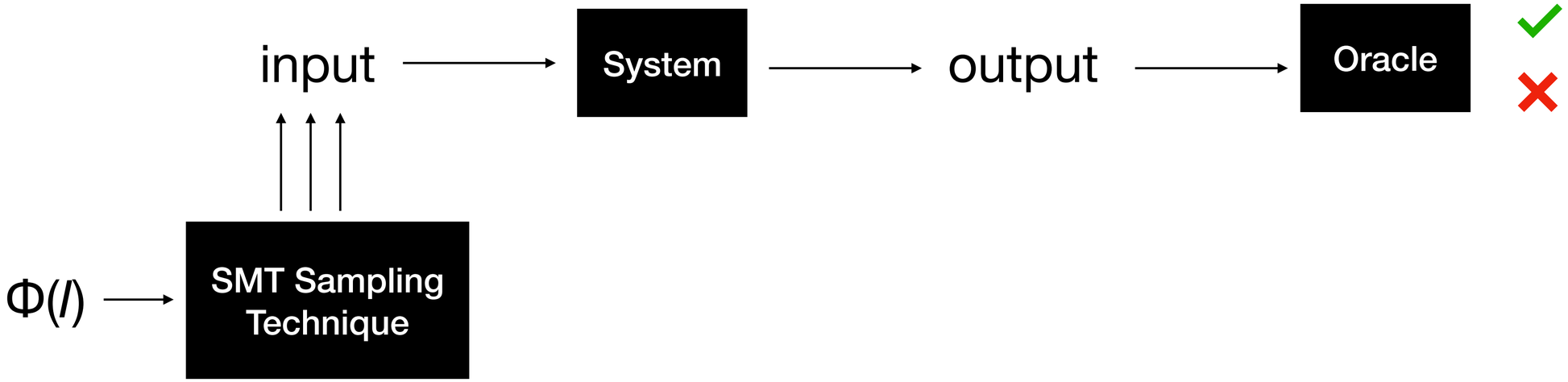

- Φ(*I*) can be an input specification or any other testing property.

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- These two metrics are in constant tension.
- They are influenced by the underlying sampling algorithm!

Related Work: SMTSampler

SMTSampler: Efficient Stimulus Generation from Complex SMT Constraints

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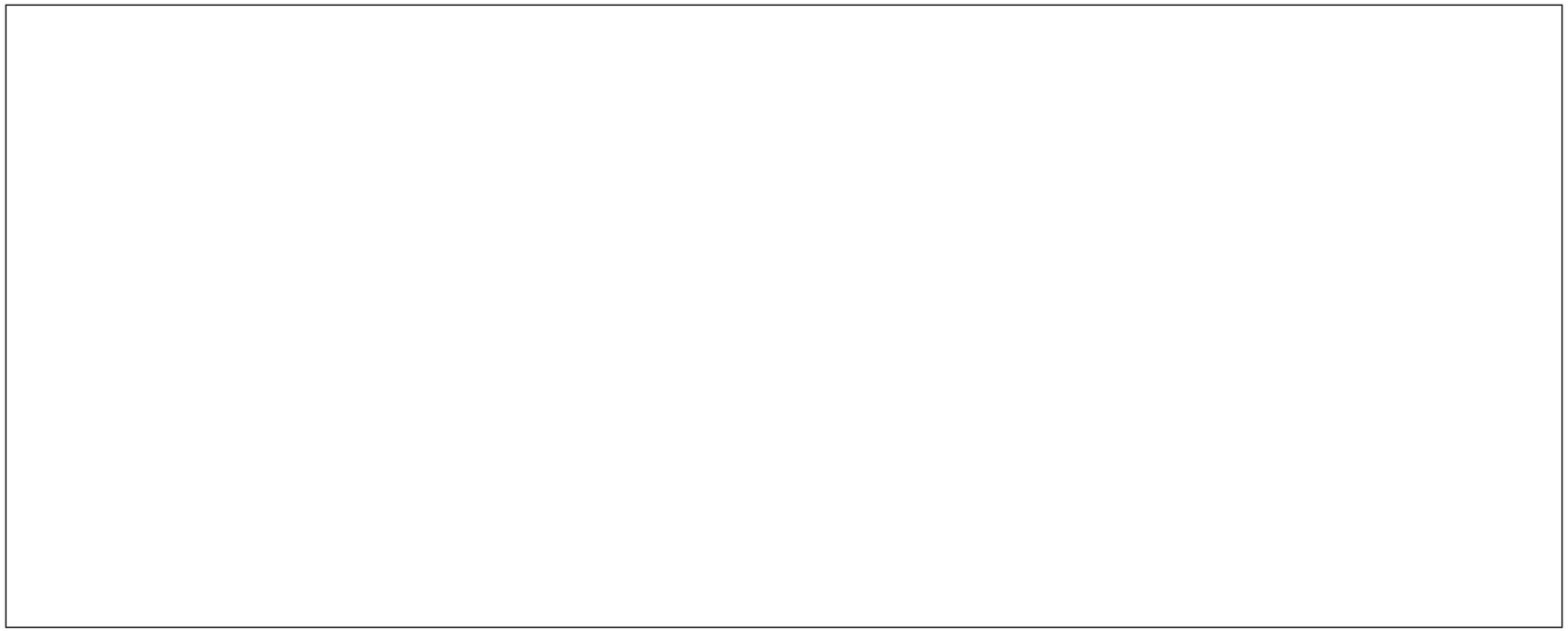
- It proved to have higher throughput when compared to other samplers.

SMTSampler’s Algorithm



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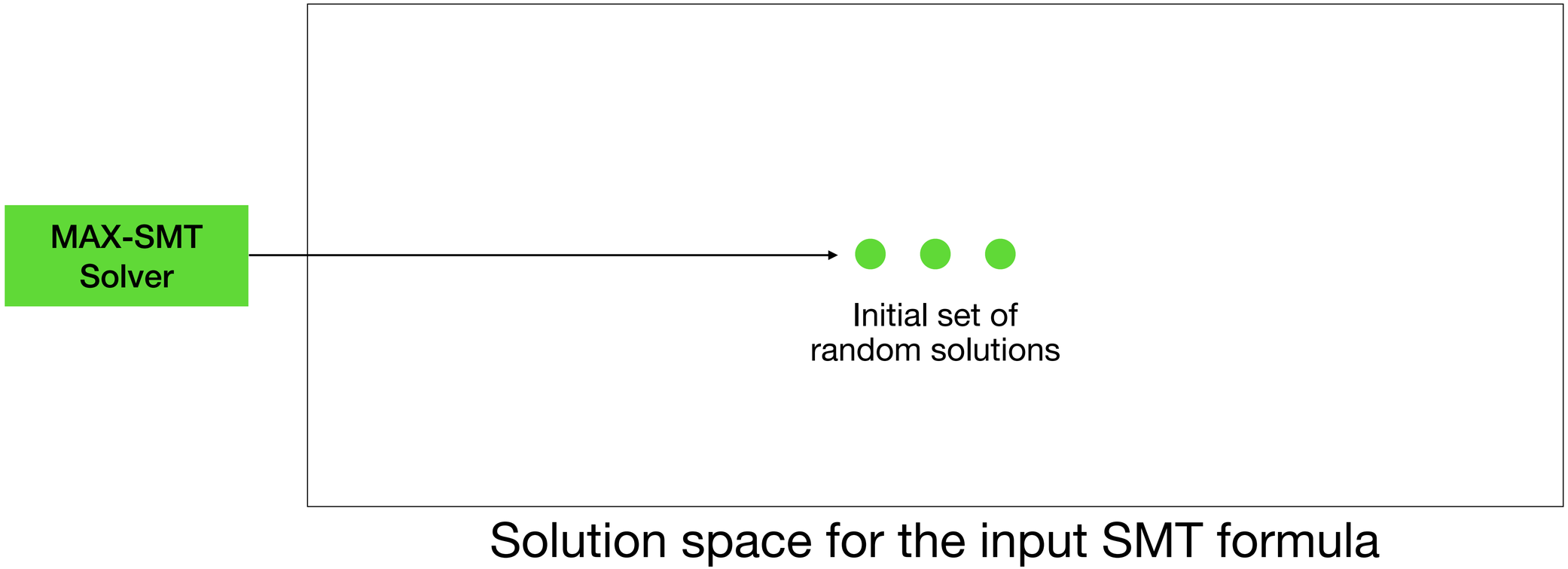

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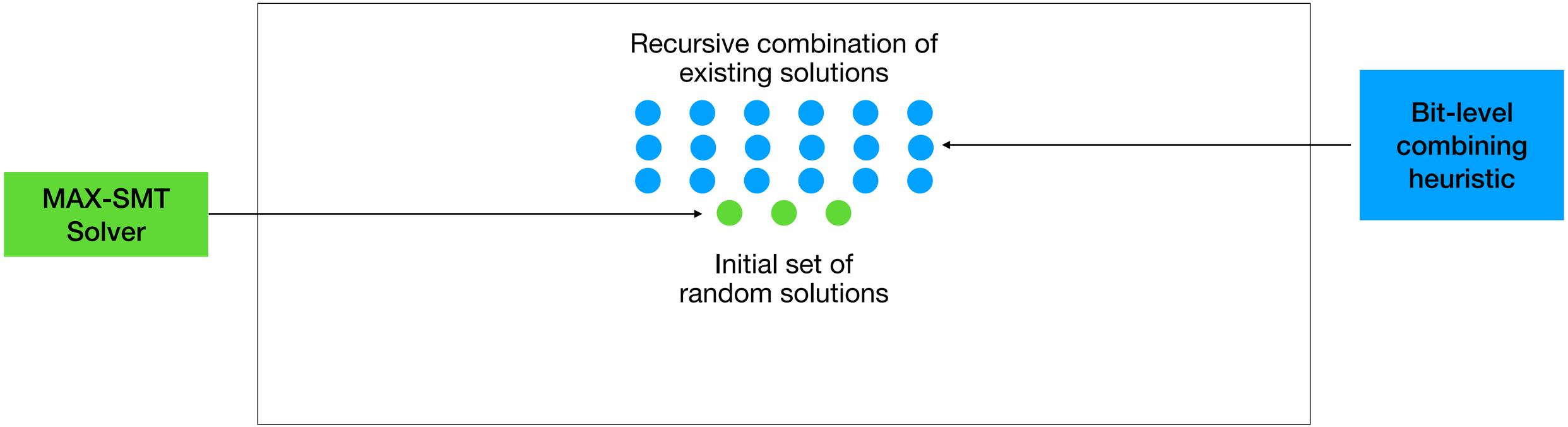

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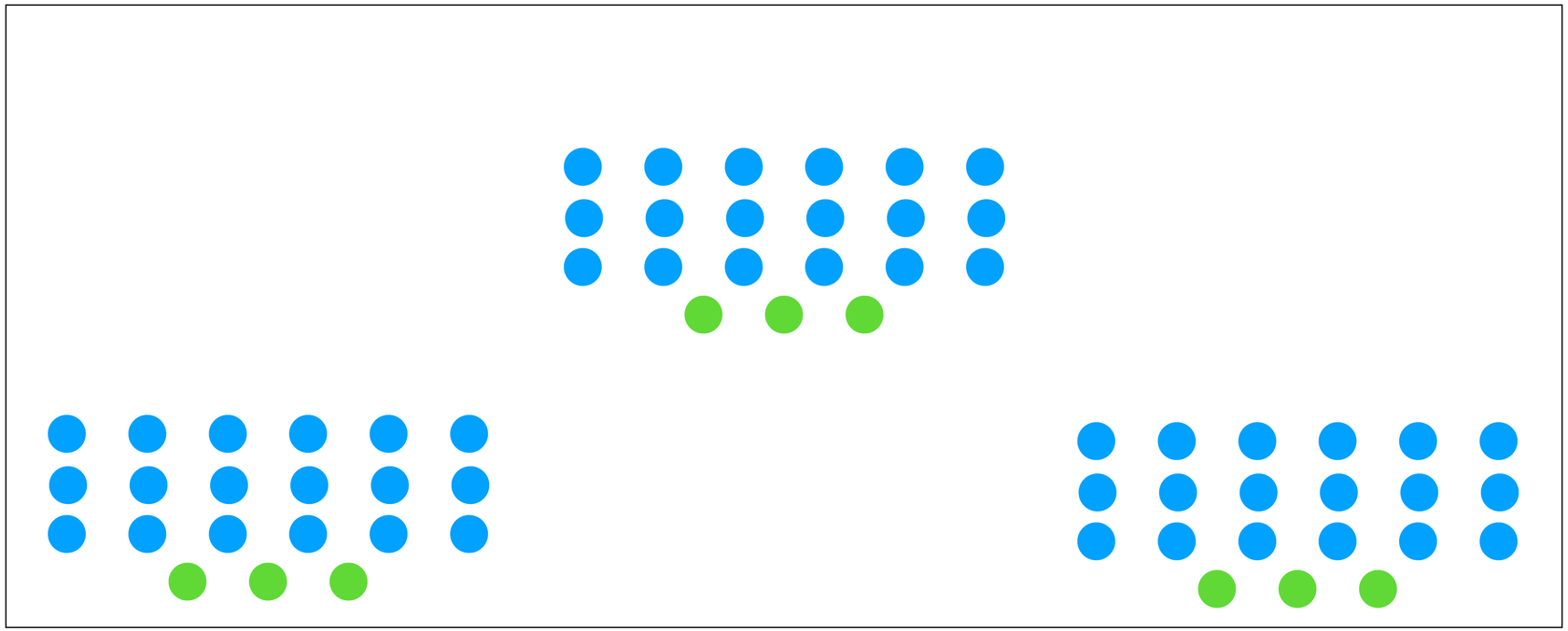

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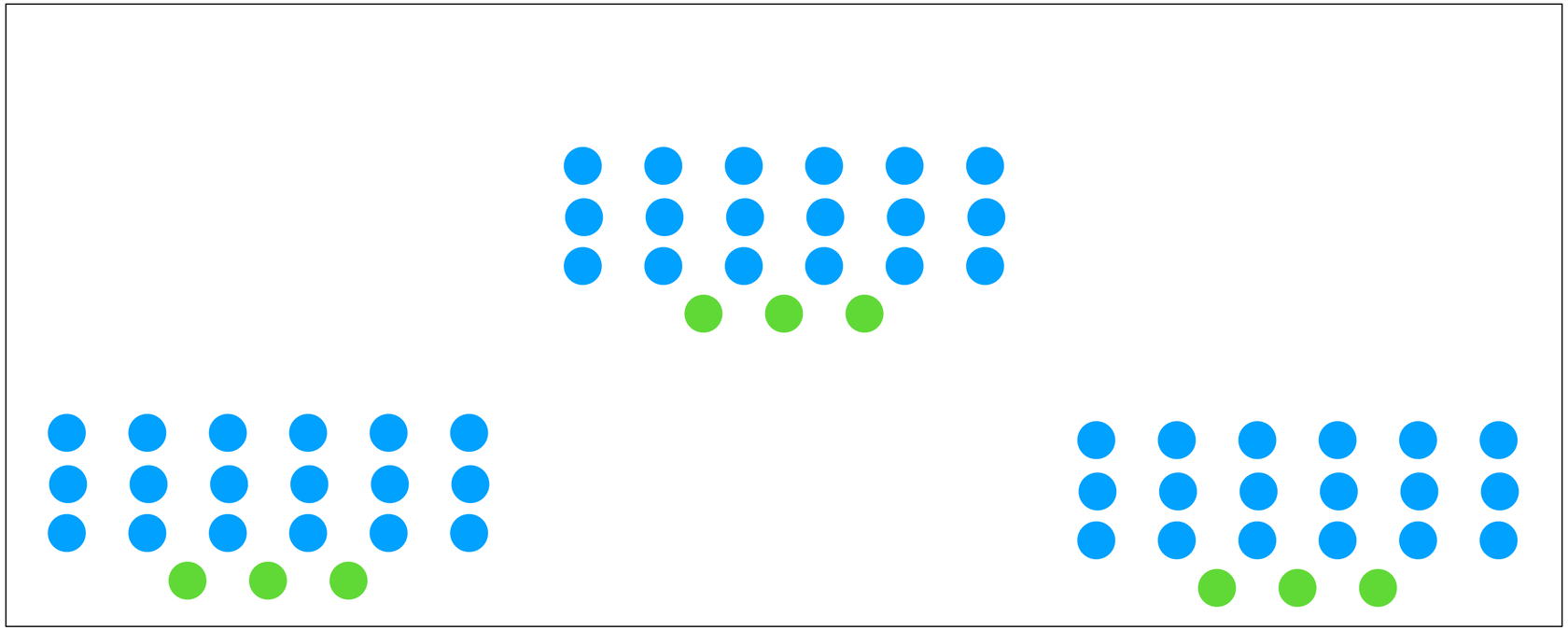

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- We want a scalable sampler for this domain.
- We leverage related work that uses coverage-guided fuzzing.

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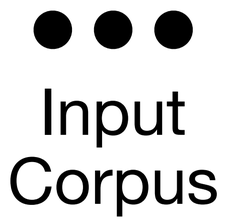

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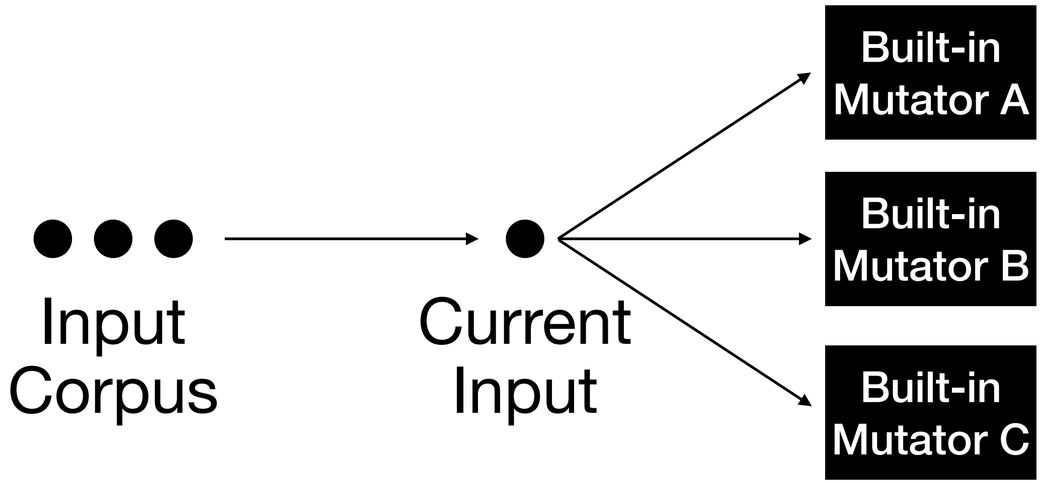

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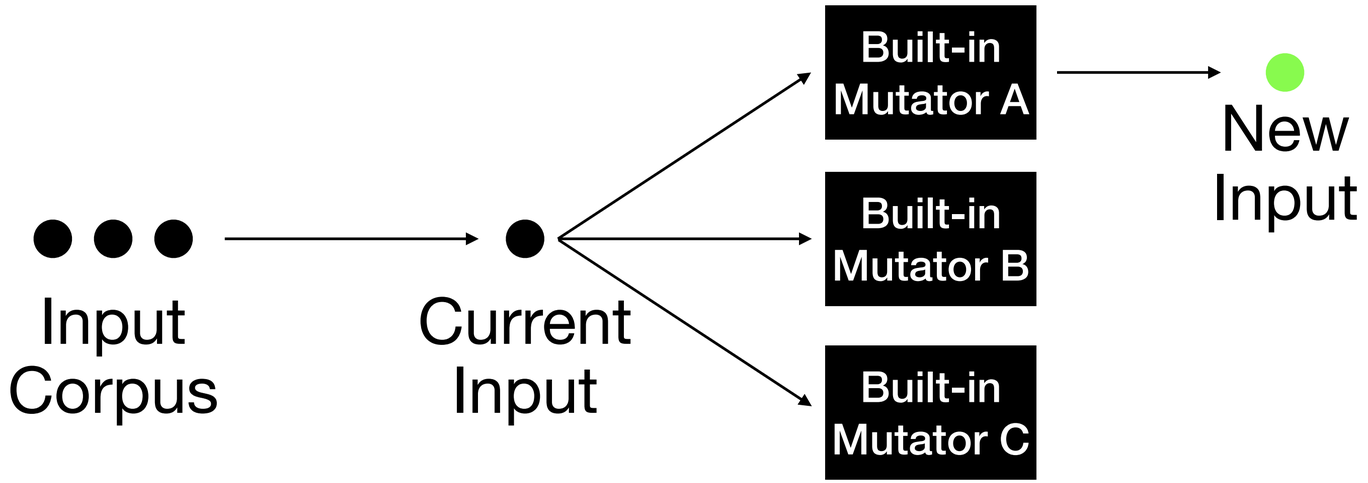

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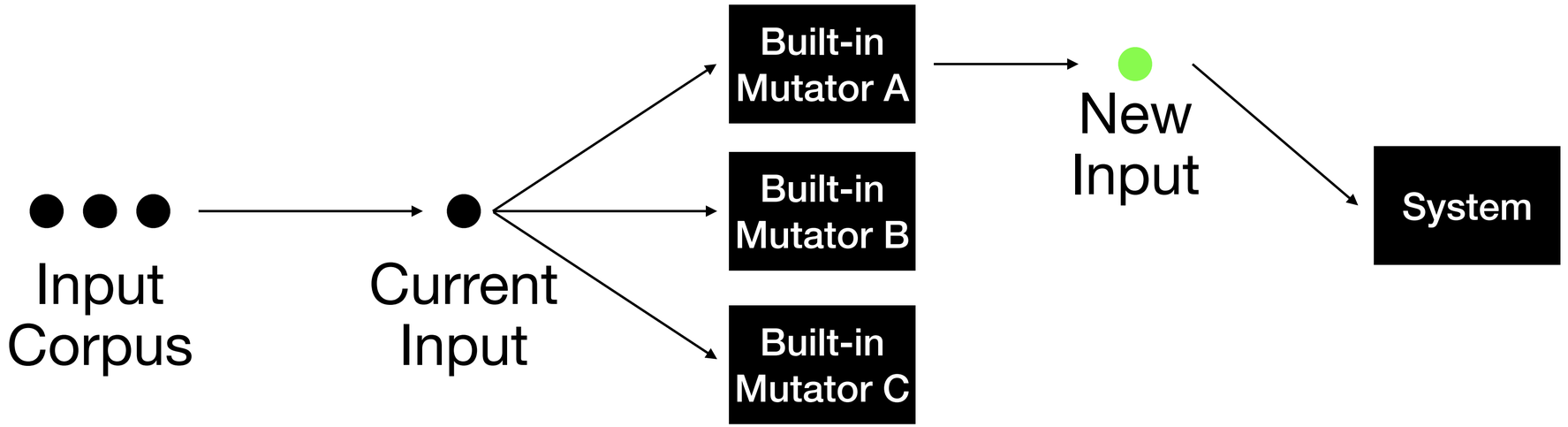

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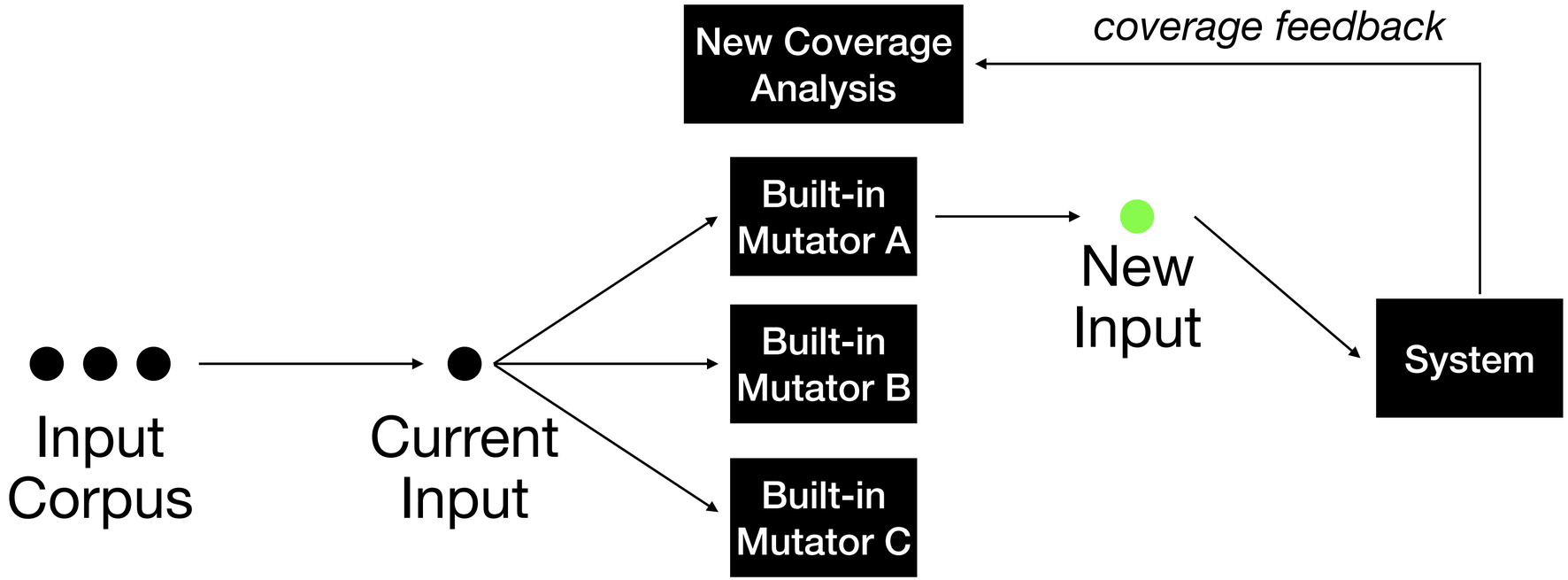

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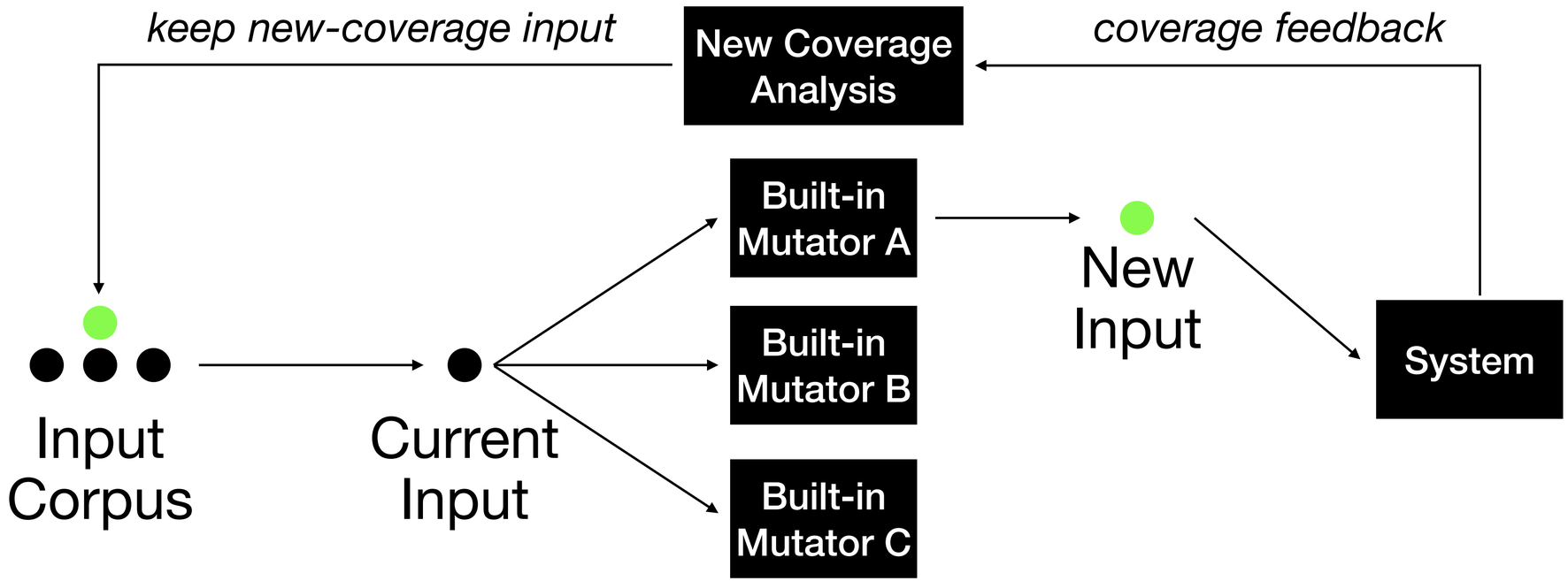

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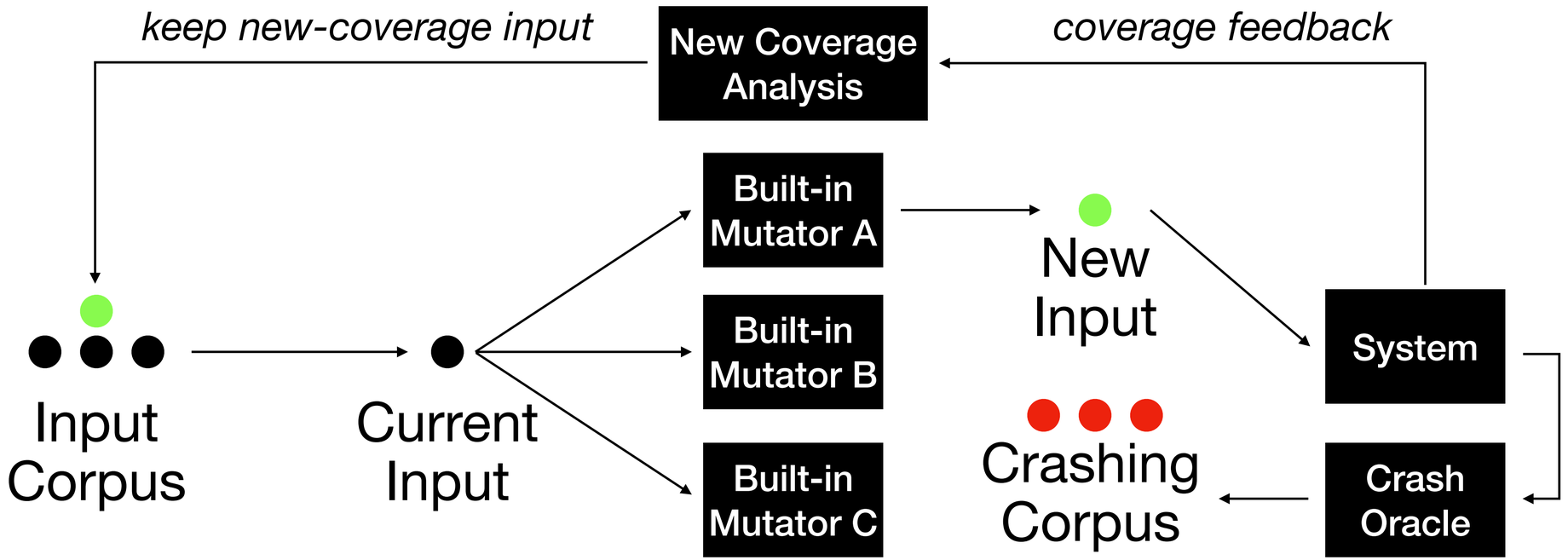

Related Work: JFS (Just Fuzz-It Solver)

Just Fuzz It: Solving Floating-Point Constraints using Coverage-Guided Fuzzing

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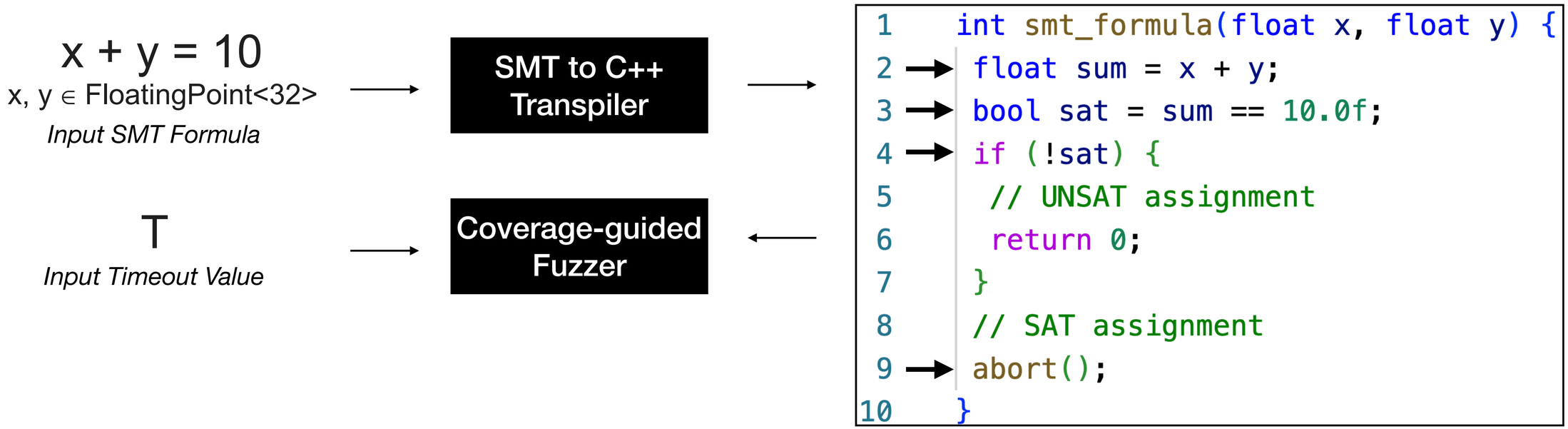

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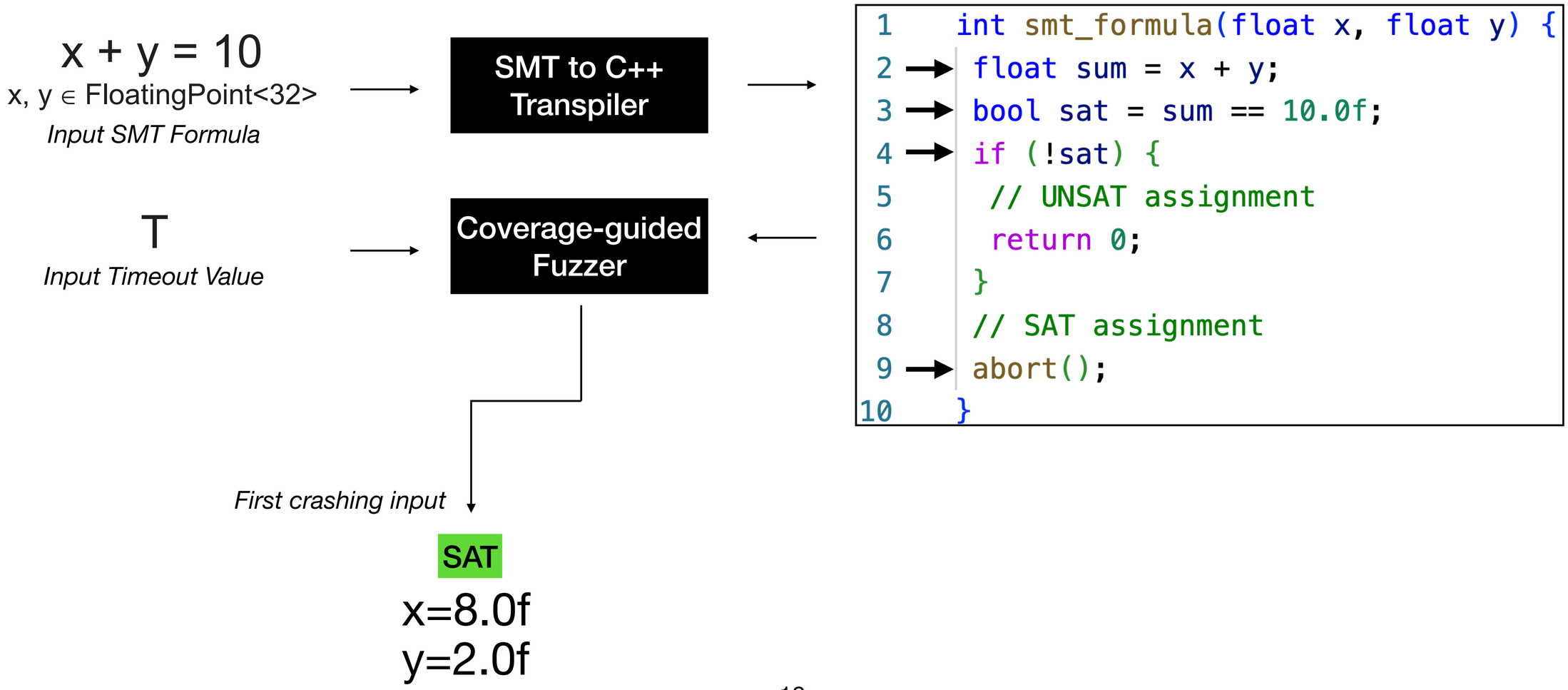

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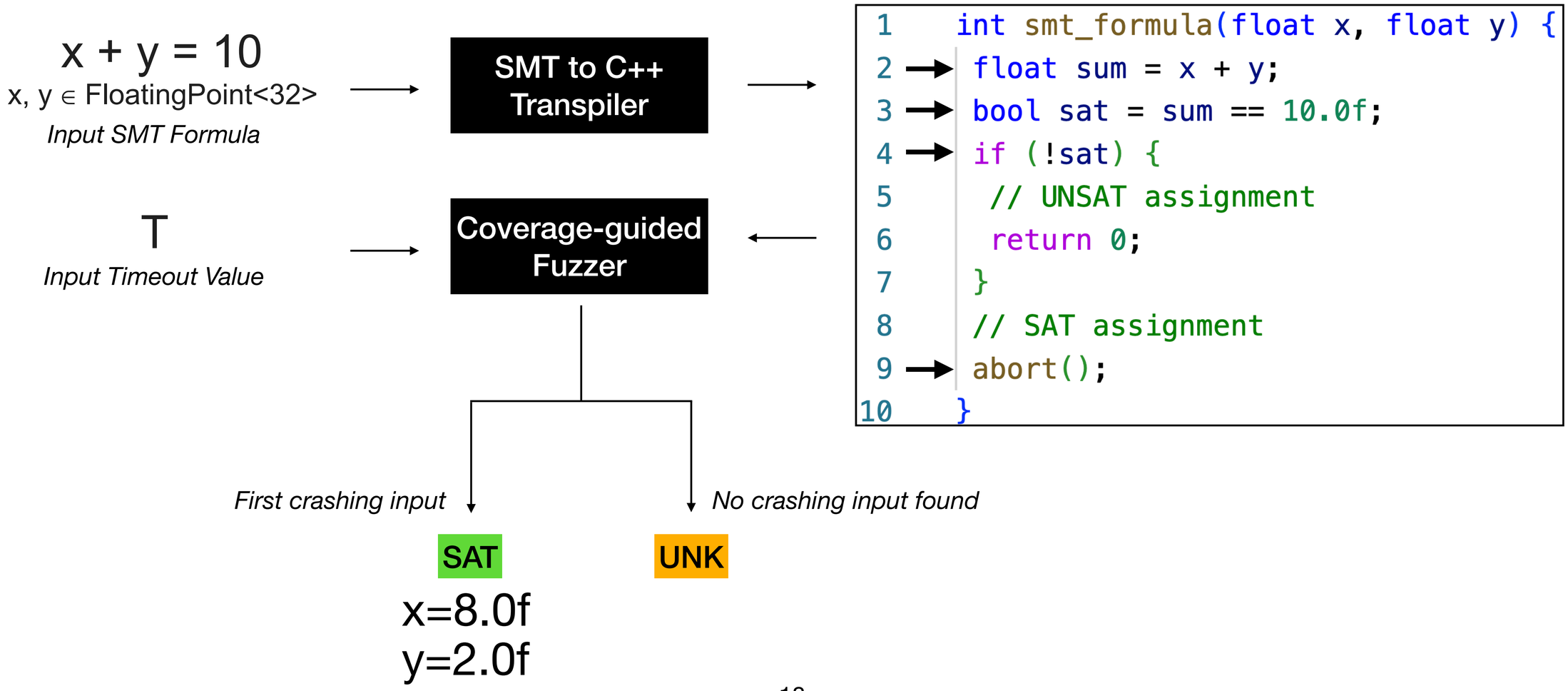

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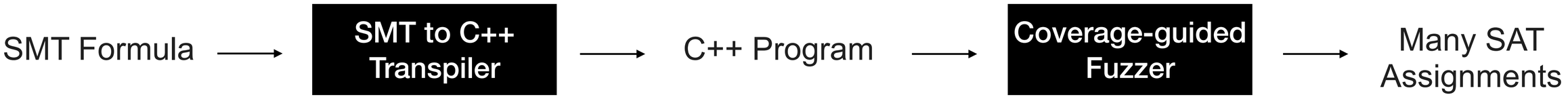

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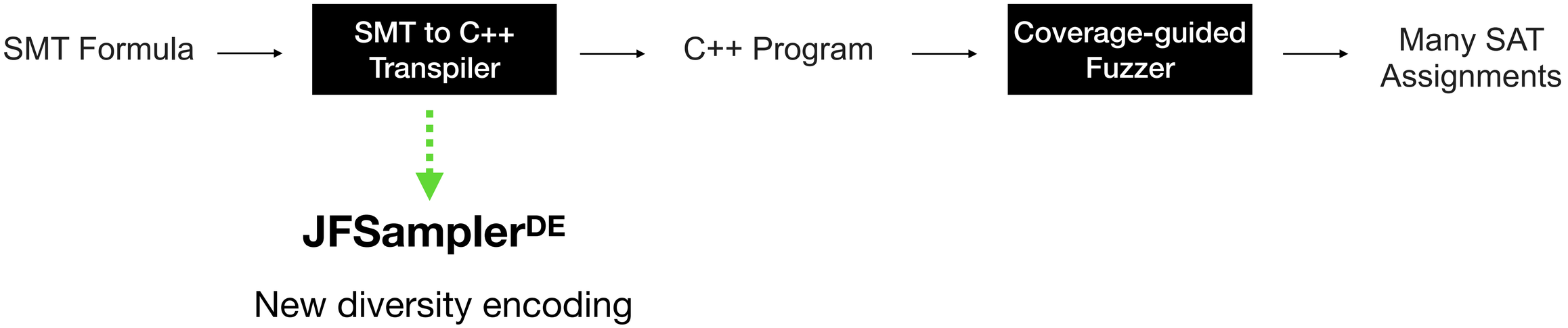

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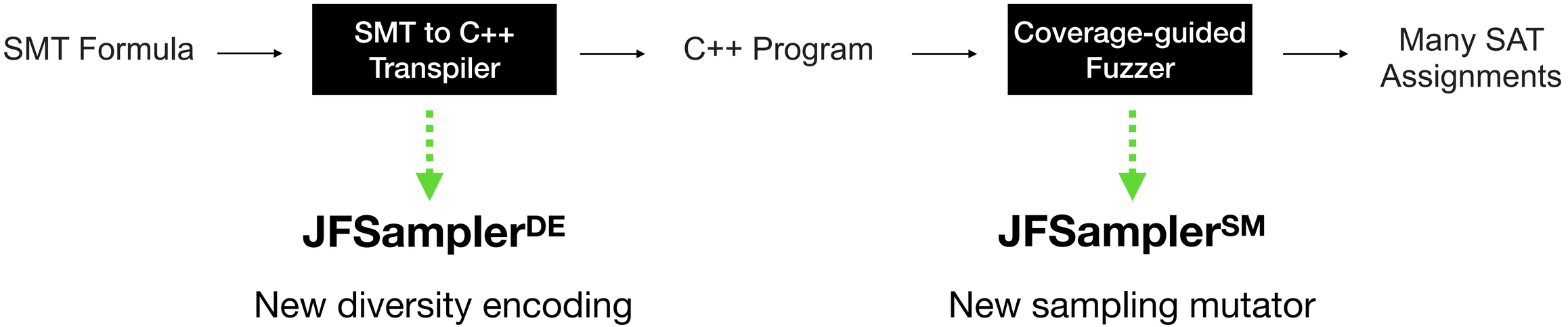

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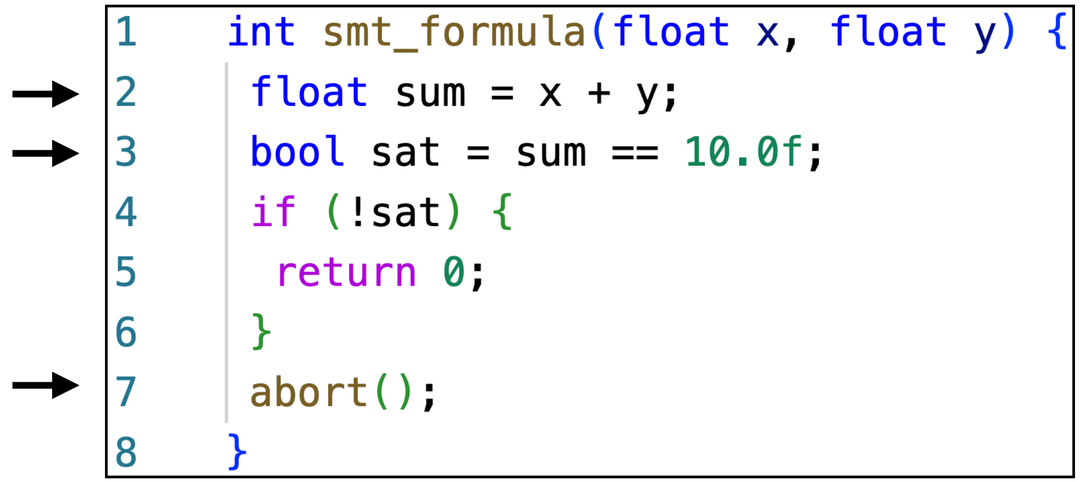

- If coverage saturates for satisfying assignments, the fuzzer cannot distinguish them.

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- **SMTSampler** defined it to measure sample diversity, used for evaluation but not part of the algorithm.

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```
11  #define SMT_COVERAGE(F) {
12    // New C++ code that, if covered,
13    // means an increase in diversity
14
15
16
17
18
19
20
21
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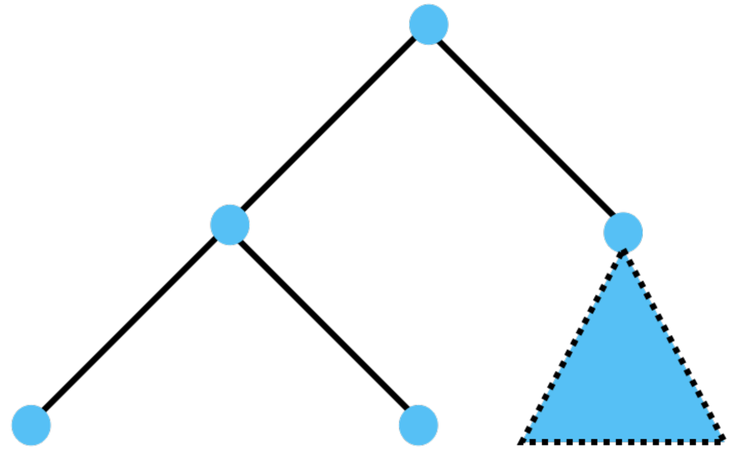

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- **SMTSampler** blindly applies the heuristic without any feedback; it could combine uninteresting satisfying assignments.

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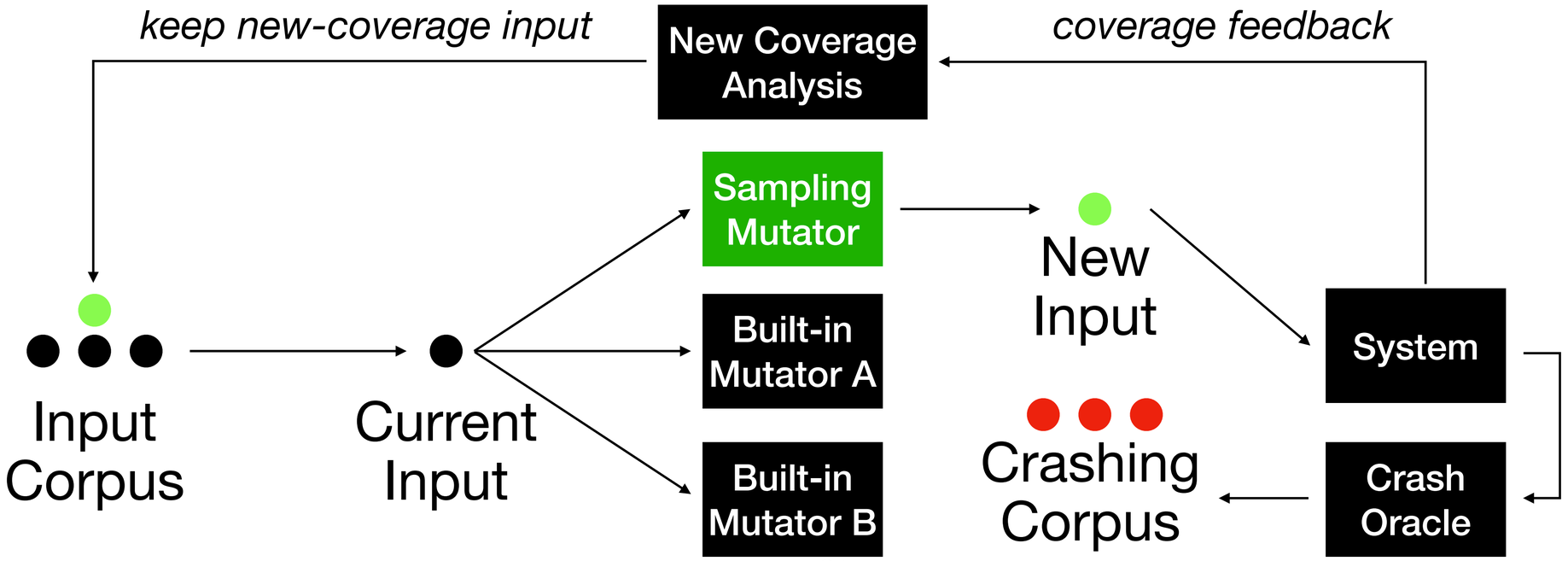

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- We expect this mode to perform the best in terms of diversity and throughput.

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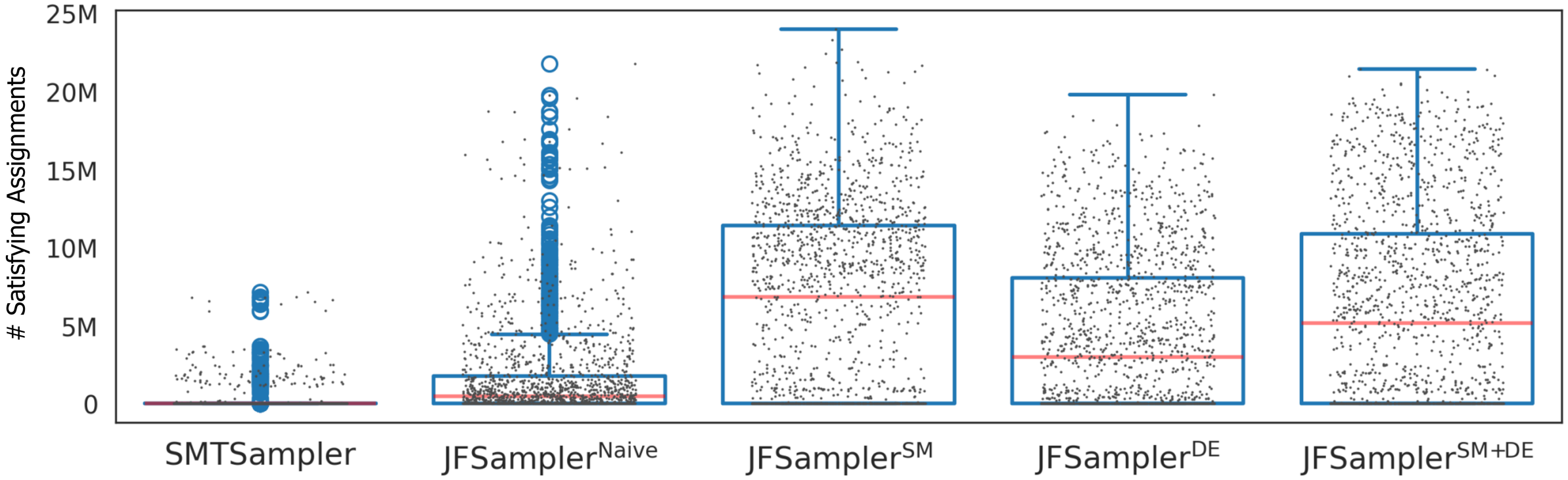
- We evaluated the FP and FP+BV suites (total of 862 formulas).

FP Suite

Throughput (the higher, the better)



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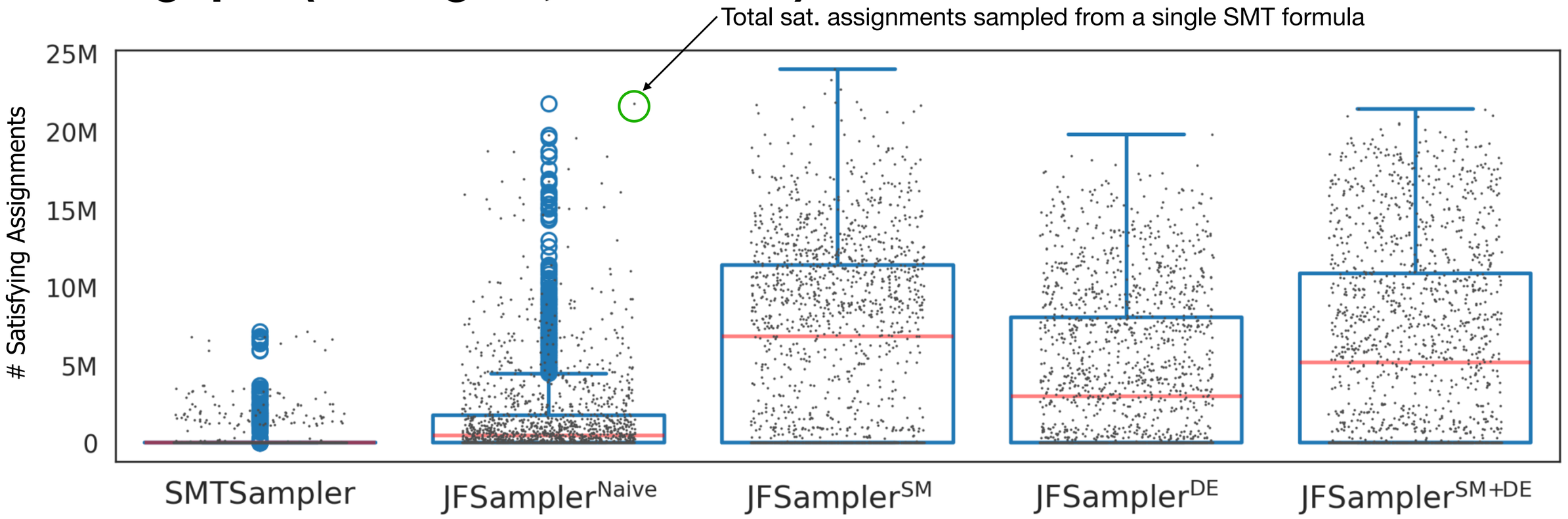

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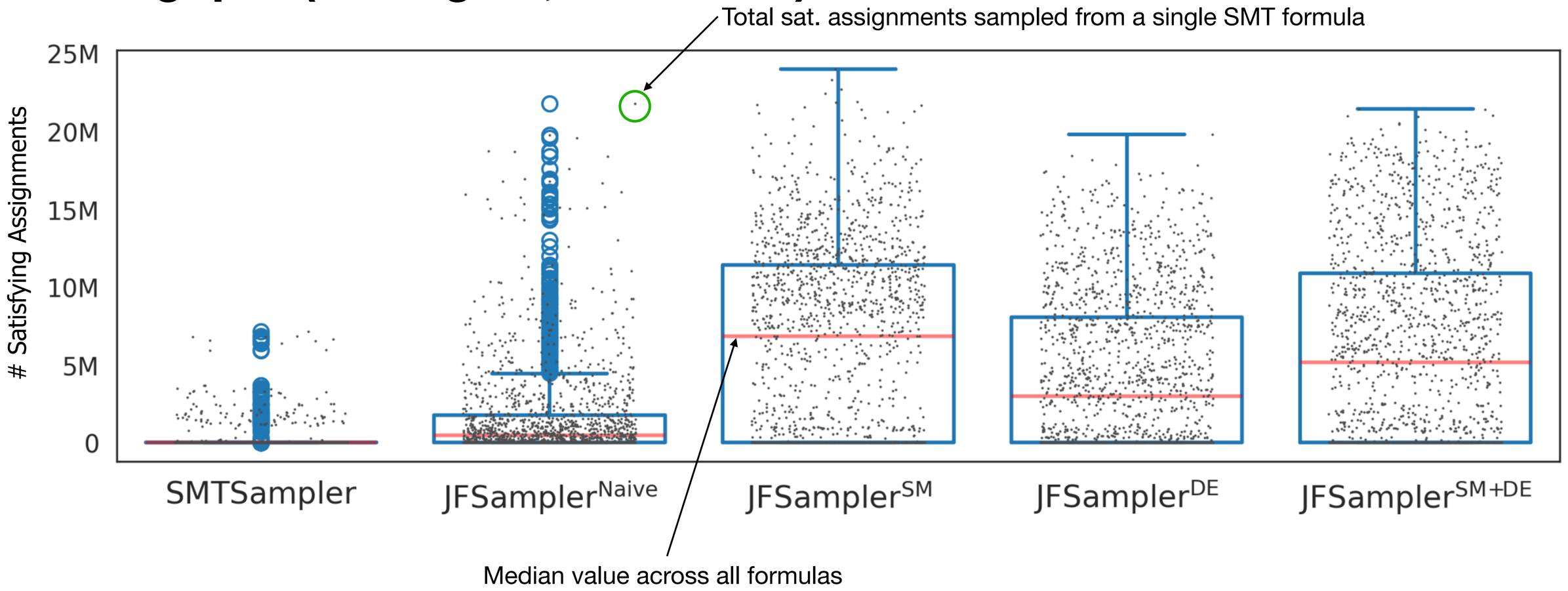
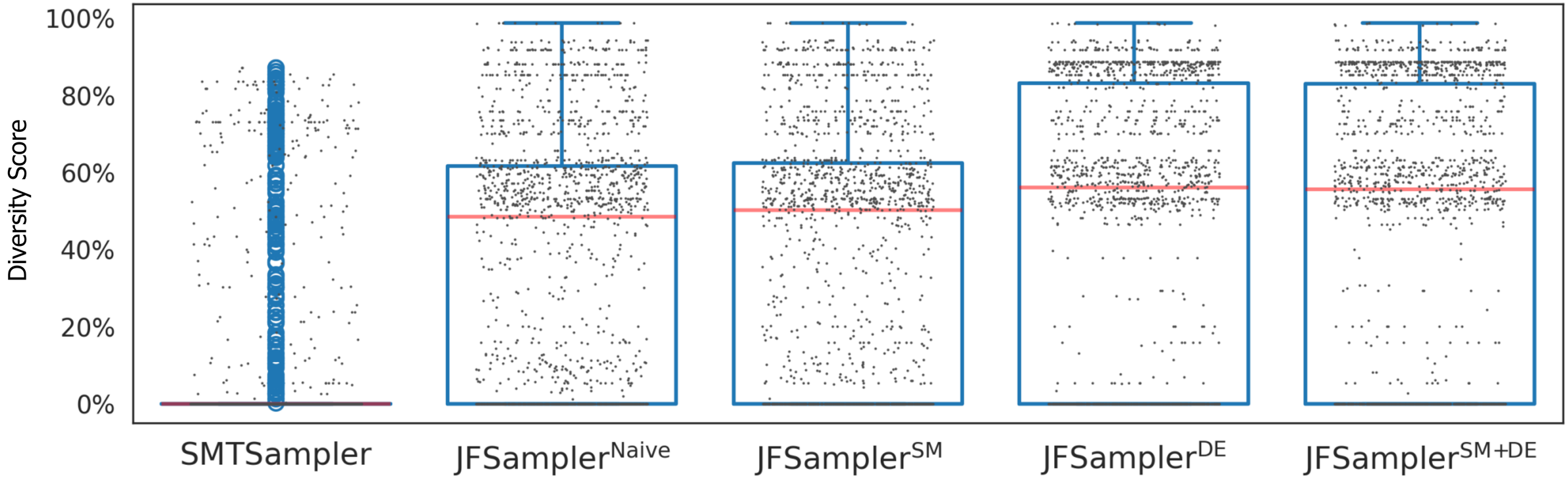


FP Suite

Diversity (the higher, the better)



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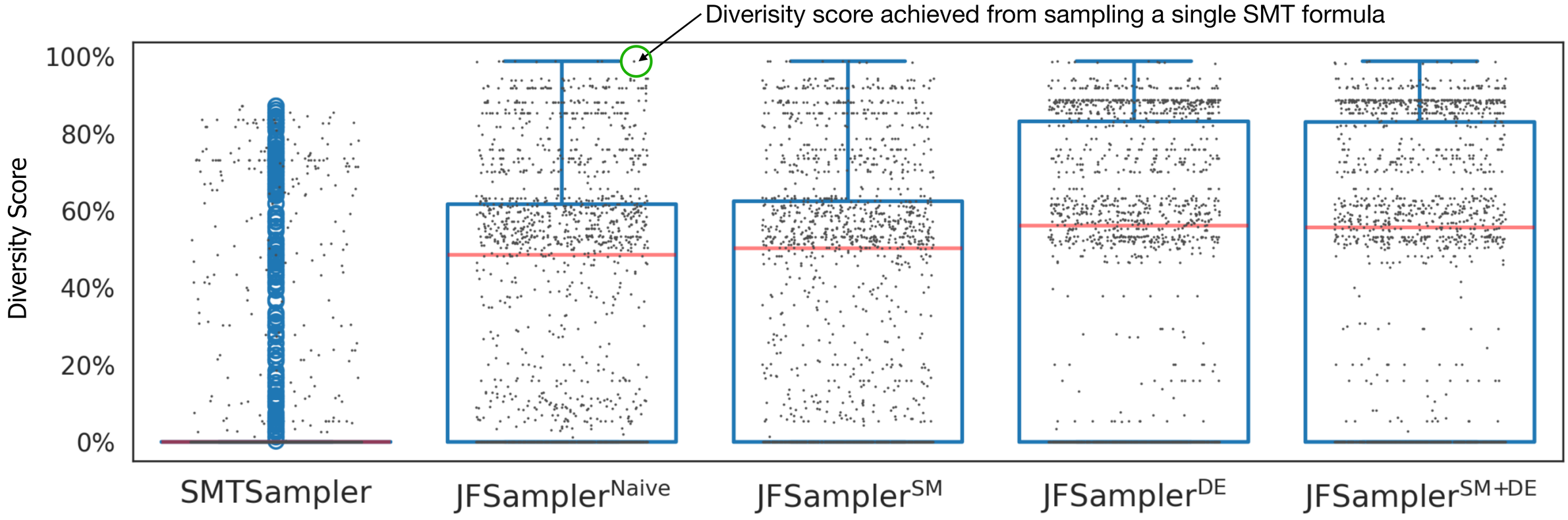

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- Our tool: https://srg.doc.ic.ac.uk/projects/jfs/