Racket Does Dijkstra

Systems Integrity Assurance via Weakest Precondition

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Agenda

- Goal: Fault-Free Code through Systems Integrity Assurance
- Thought Leaders
- Background: Dijkstra et al.
- Approach: Weakest Precondition
- Examples
- Racket Software Demo

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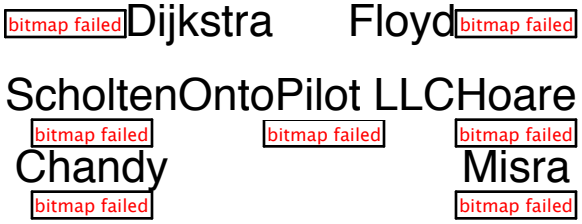
- We call this method SIA, for Systems Integrity Assurance

SIA Thought Leaders



- Floyd applied logic to programming
- Hoare invented notation for pre-condition and post-condition
- Dijkstra advocated for the predicate transformer, weakest precondition
- Scholten help him formalize the mathematics
- Chandy and Misra extended the approach to non-deterministic/parallel programs

Weakest Precondition for sequential code

- Use predicate Q to specify a postcondition on the "state space"
- Use these rules to determine the weakest precondition that will imply Q
- (wp (no-op) Q) = Q
- (wp (set! x e) Q) = (subst e x Q)
- (wp (begin e1 e2) Q) = (wp e1 (wp e2 Q))
- (wp (if B e1 e2) Q) = (or (and B e1) (and (not B) e2))
- Etc.

Summary of WP

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You need to CYA -- Check Your Assumptions

Special Case: Slicing

- Goal: figure out how the outputs depend on the inputs
- Question posed: under what conditions will this code produce these abstract values?
- Use a special post-condition of the form "var1=a and var2=b ..."

General Version: Dijkstra Guarded Commands

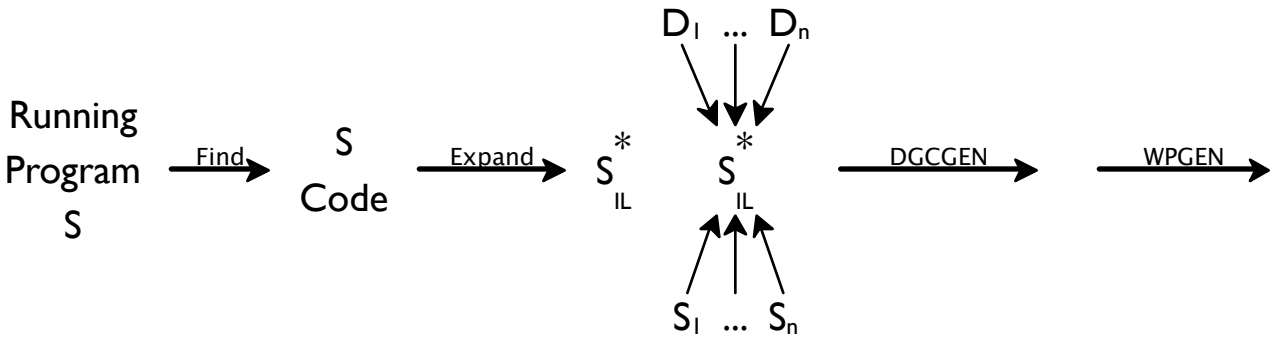
- The nondeterministic case:

```
(dgc guard-exp exp ...)

(dgc-if (dgc guard-exp exp ...) ...)

(dgc-do (dgc guard-exp exp ...) ...)

(s-assign (x ...) (exp ...))
```

Assist from Micron Automata Processor?

- http://MicronAutomata.com
- Initial SIA project: WP + AP => fault-free code, fast
- AP: Array of 48K state transition elements per chip, 1.5M/board
- Capable of recognizing many thousands of complex patterns in real-time in near-gigibit data stream
- Up for a challenge?

Tool Development
for
System Integrity Analysis



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Running
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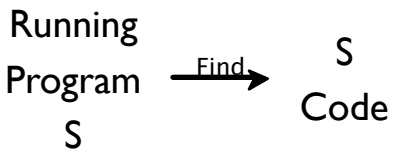

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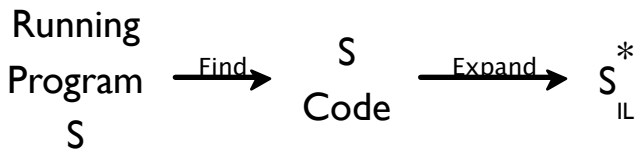

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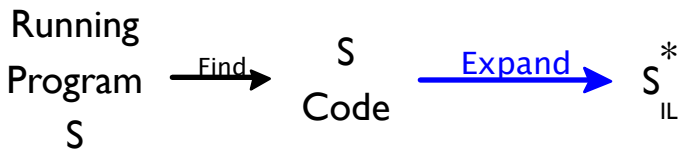

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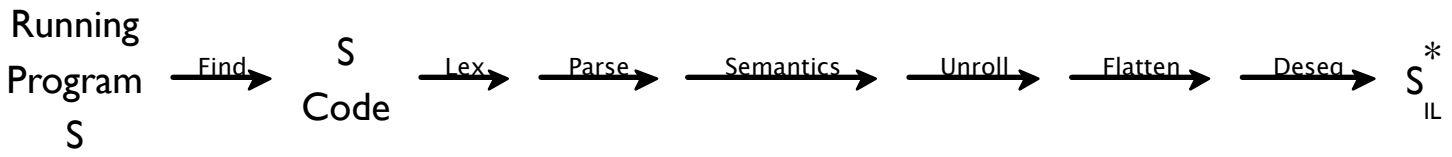

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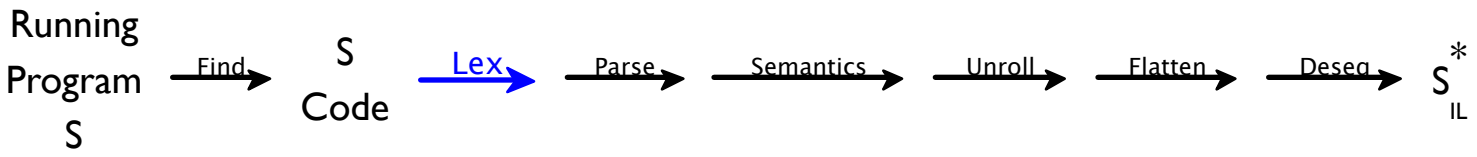

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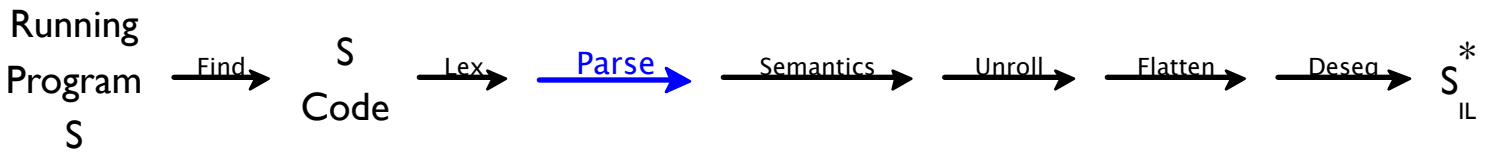

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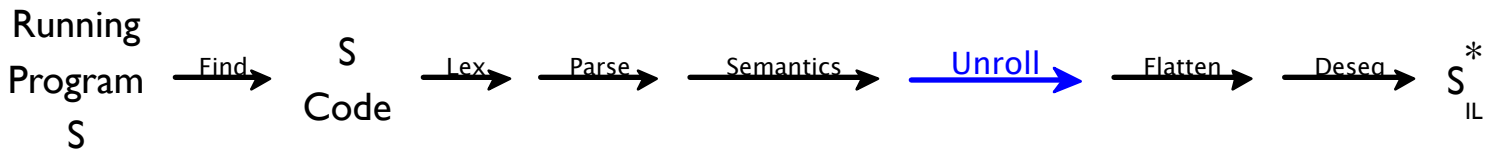

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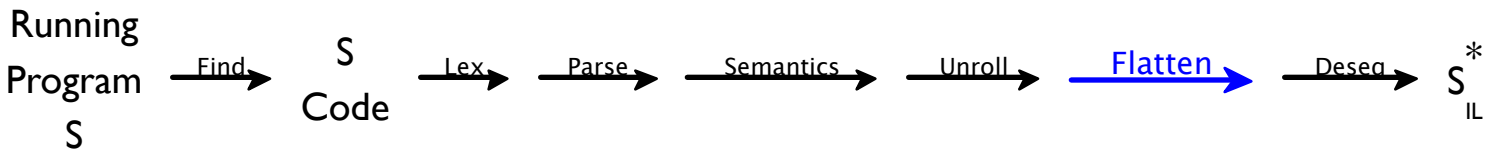

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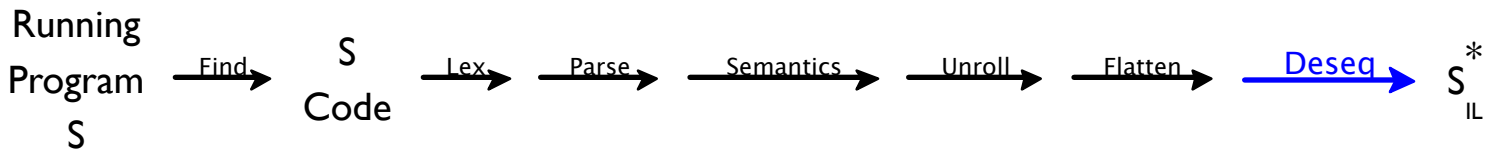

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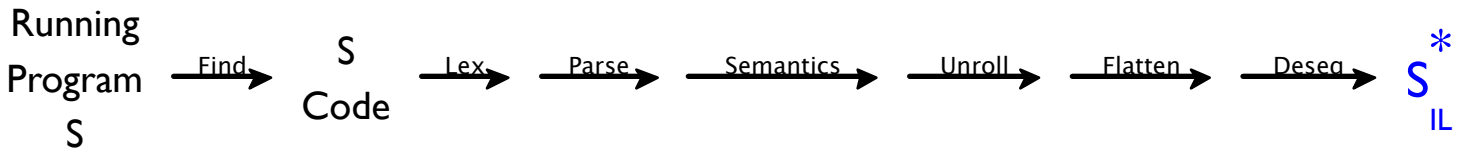

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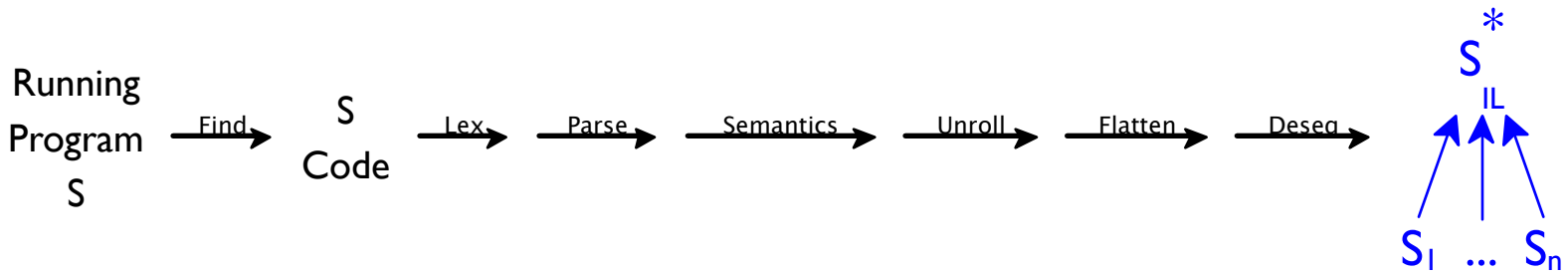

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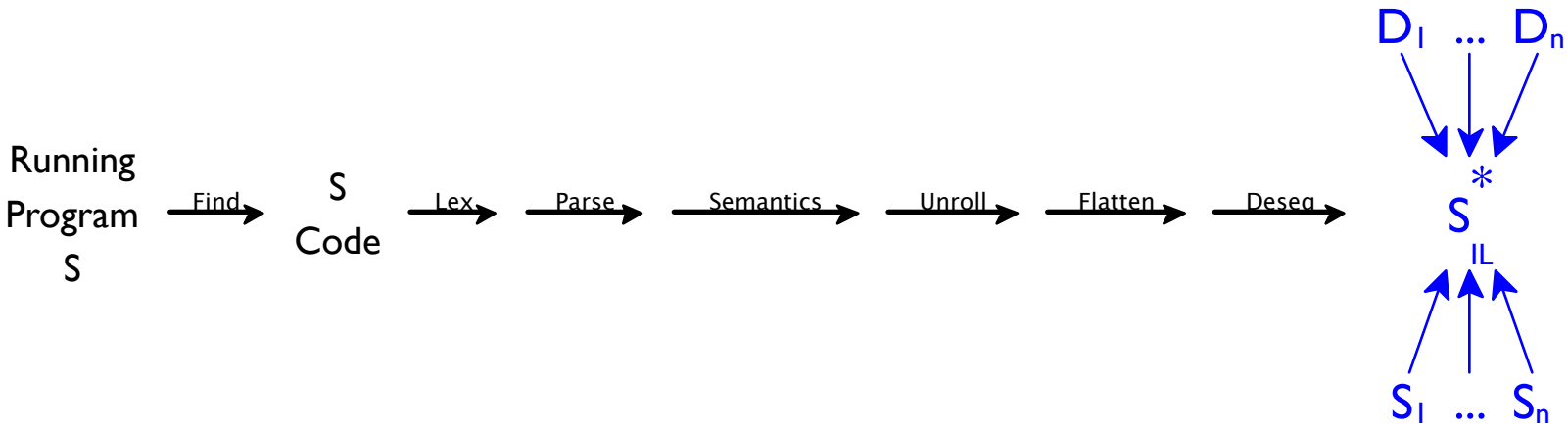

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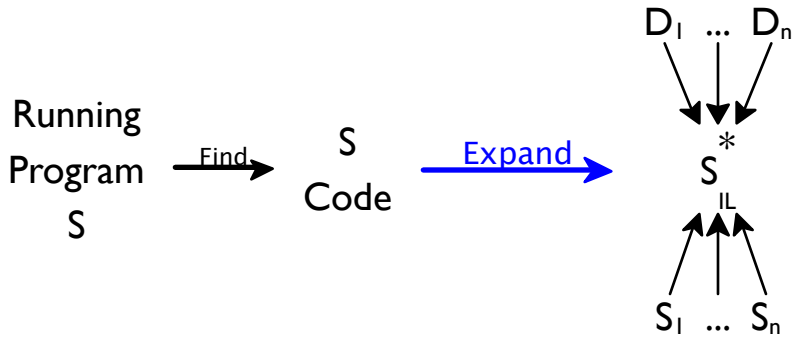

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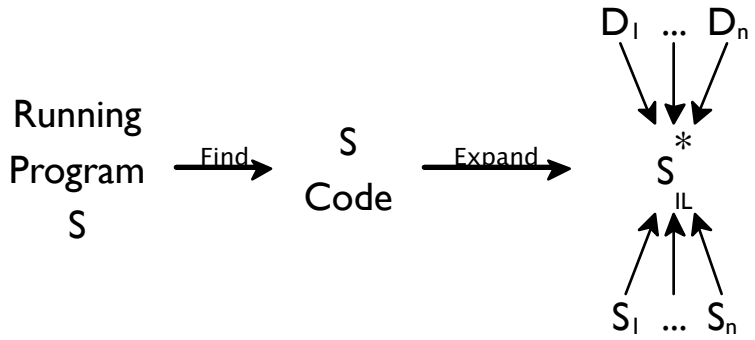

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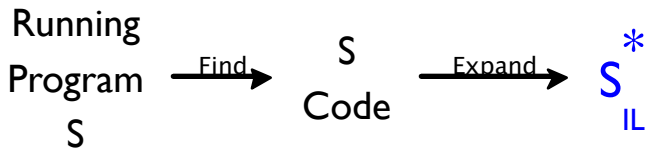

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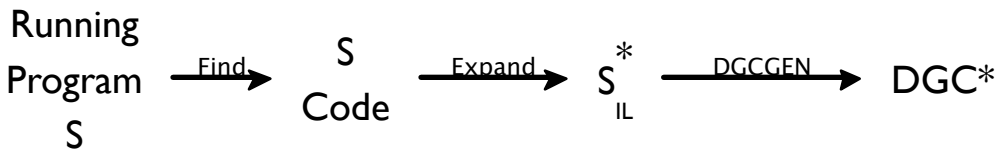

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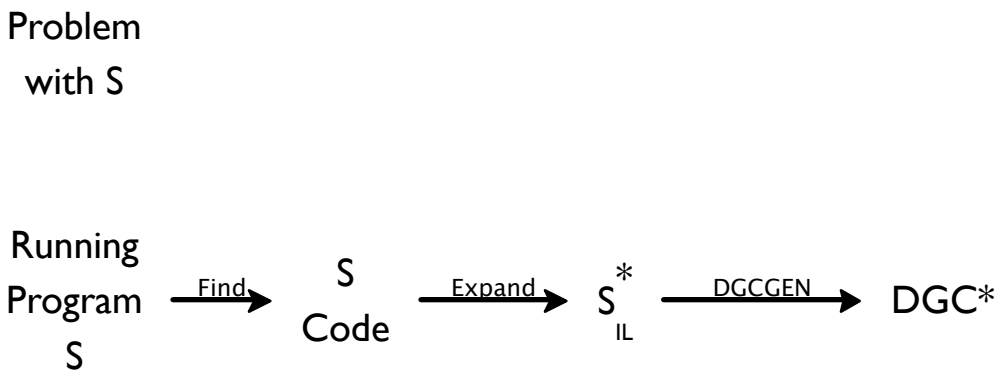

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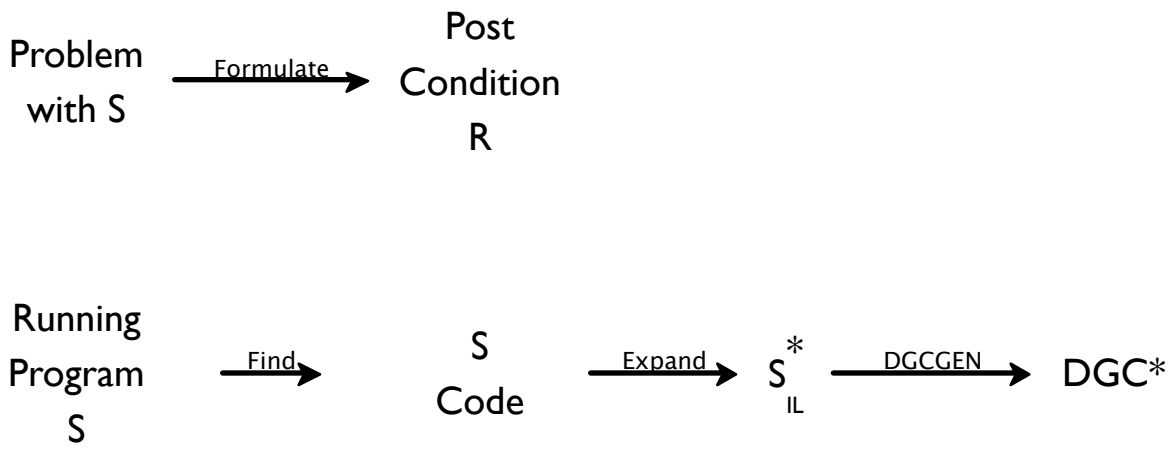

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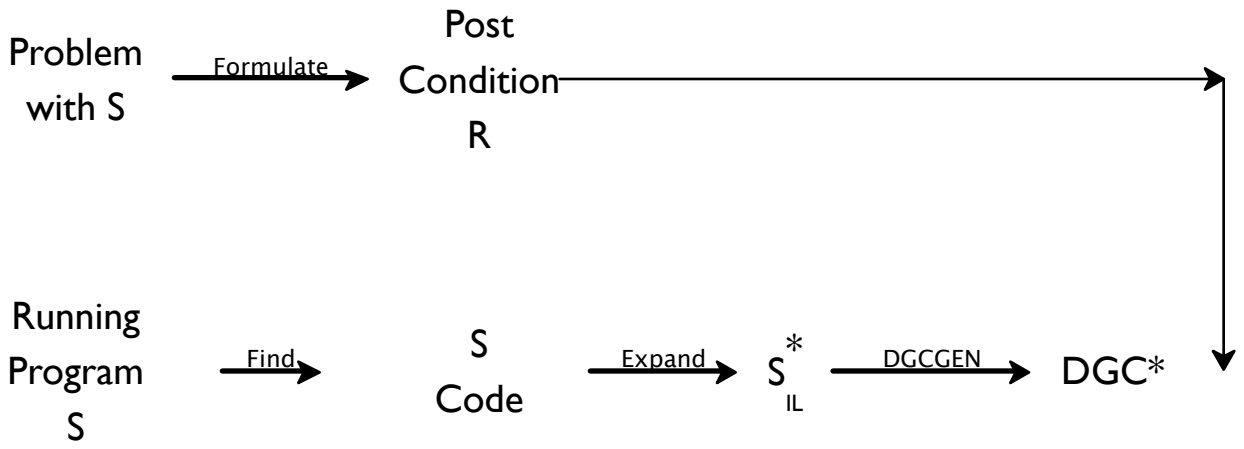

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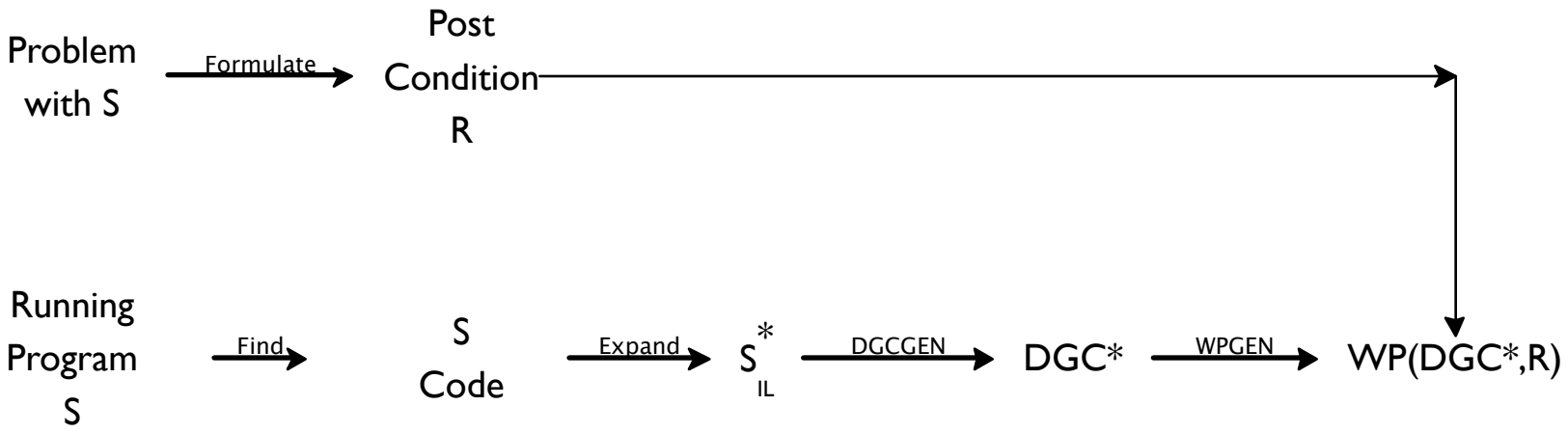

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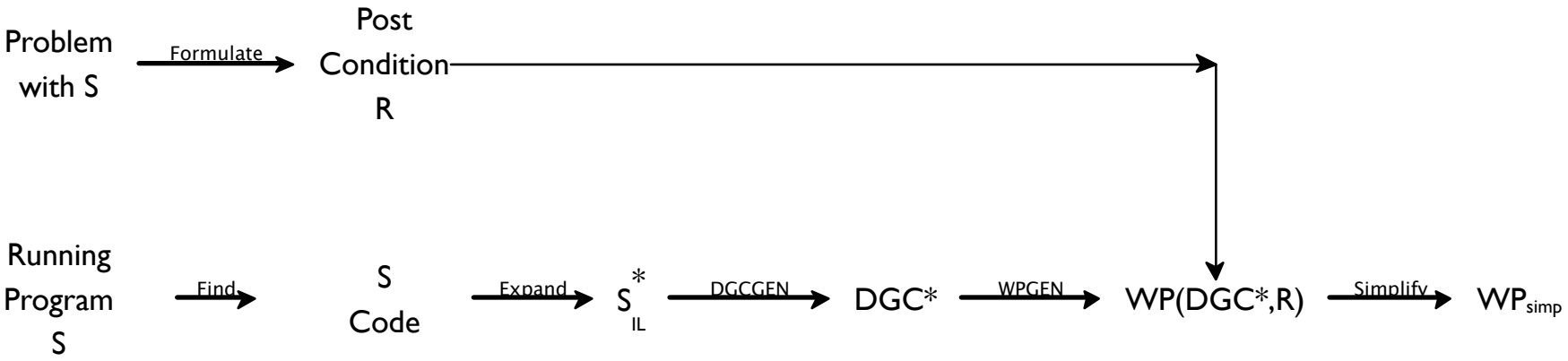

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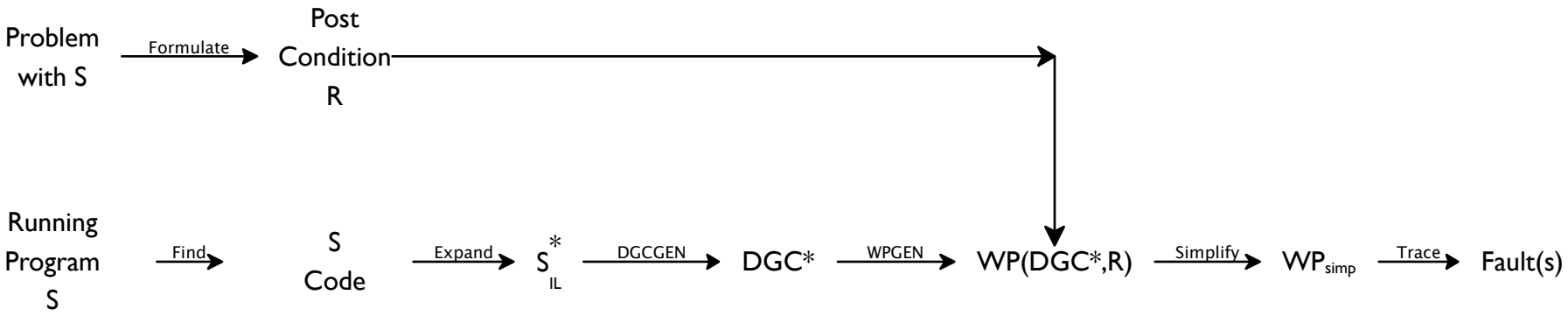

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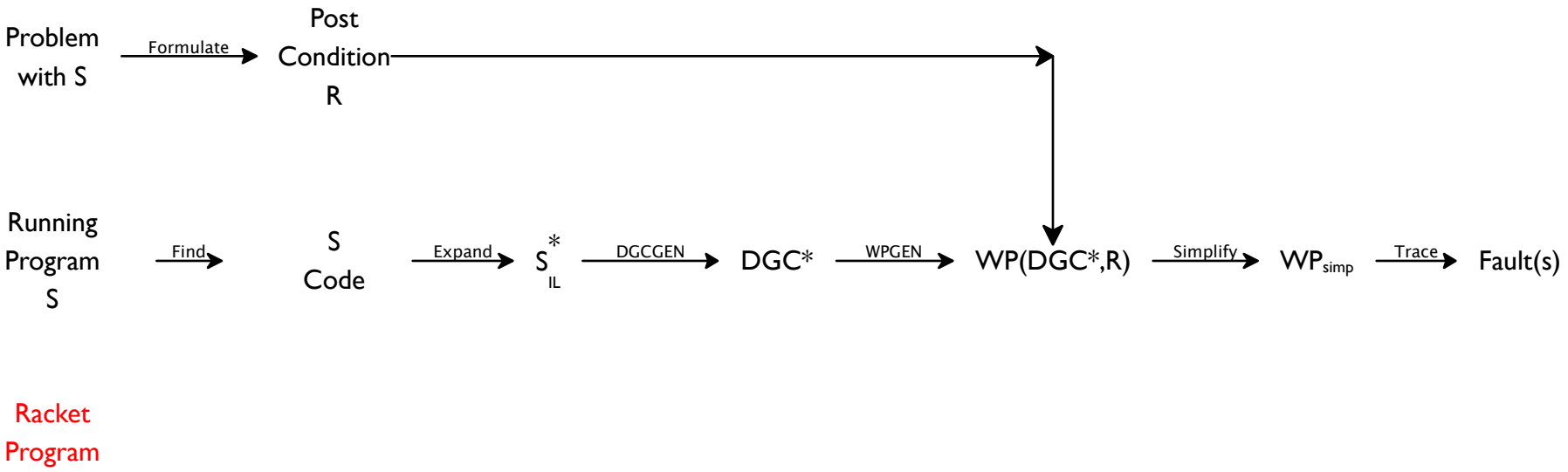

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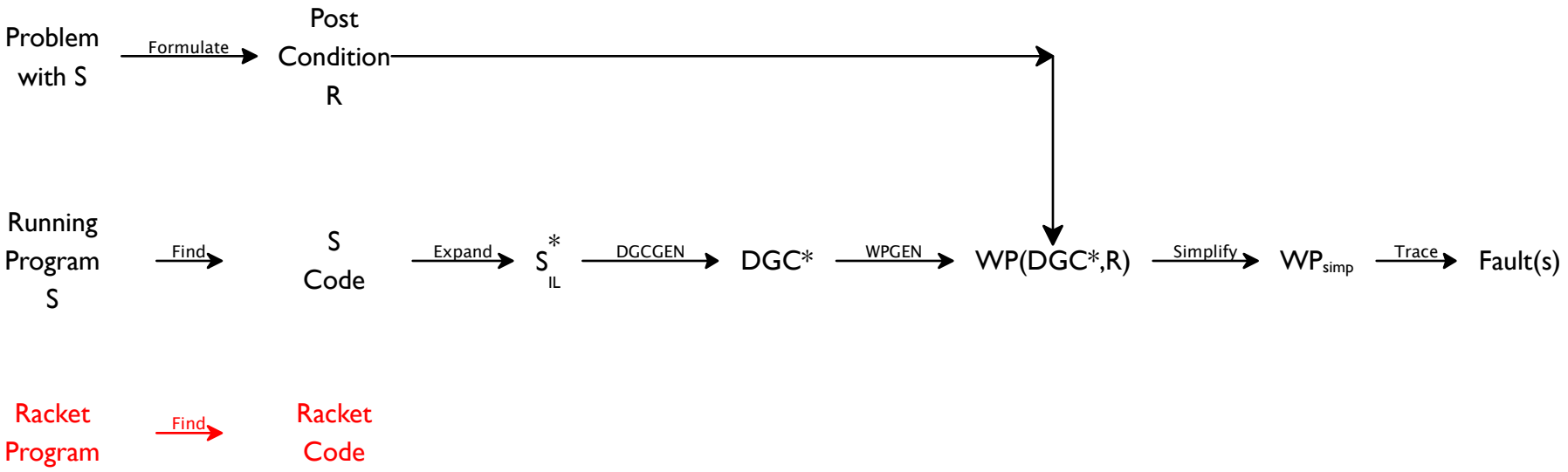

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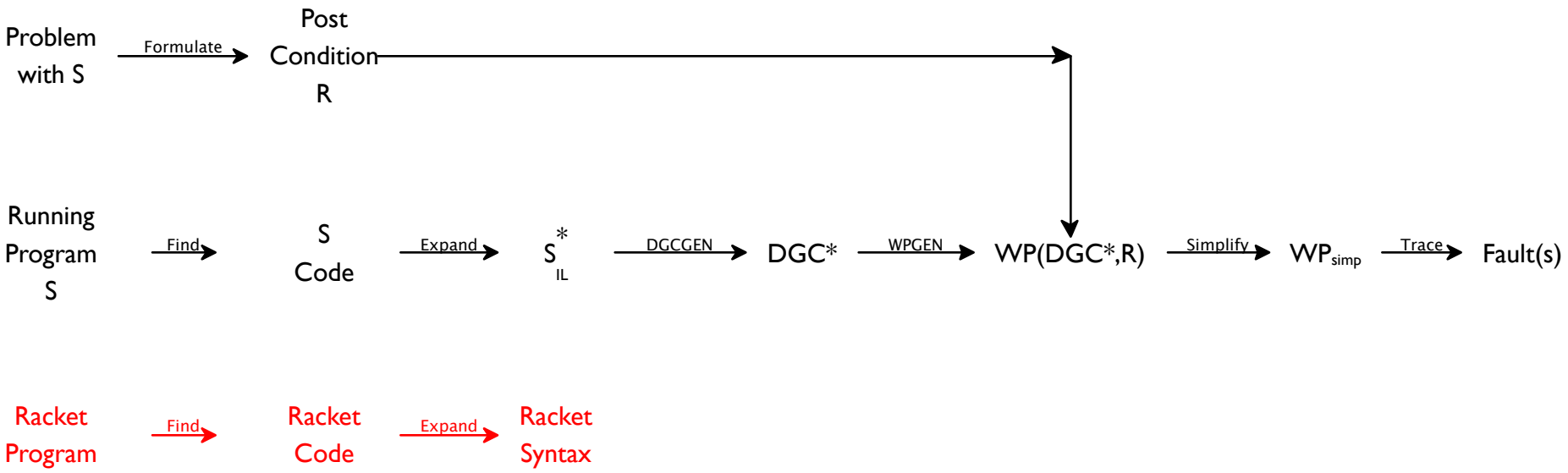

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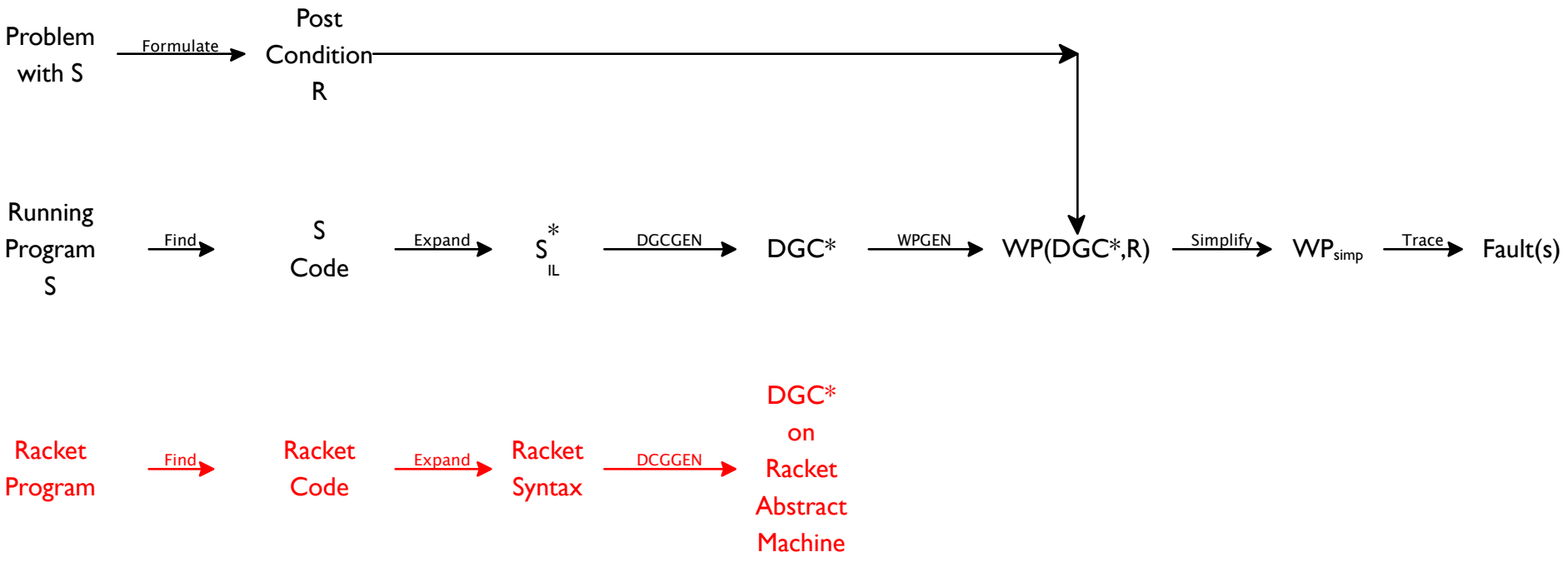

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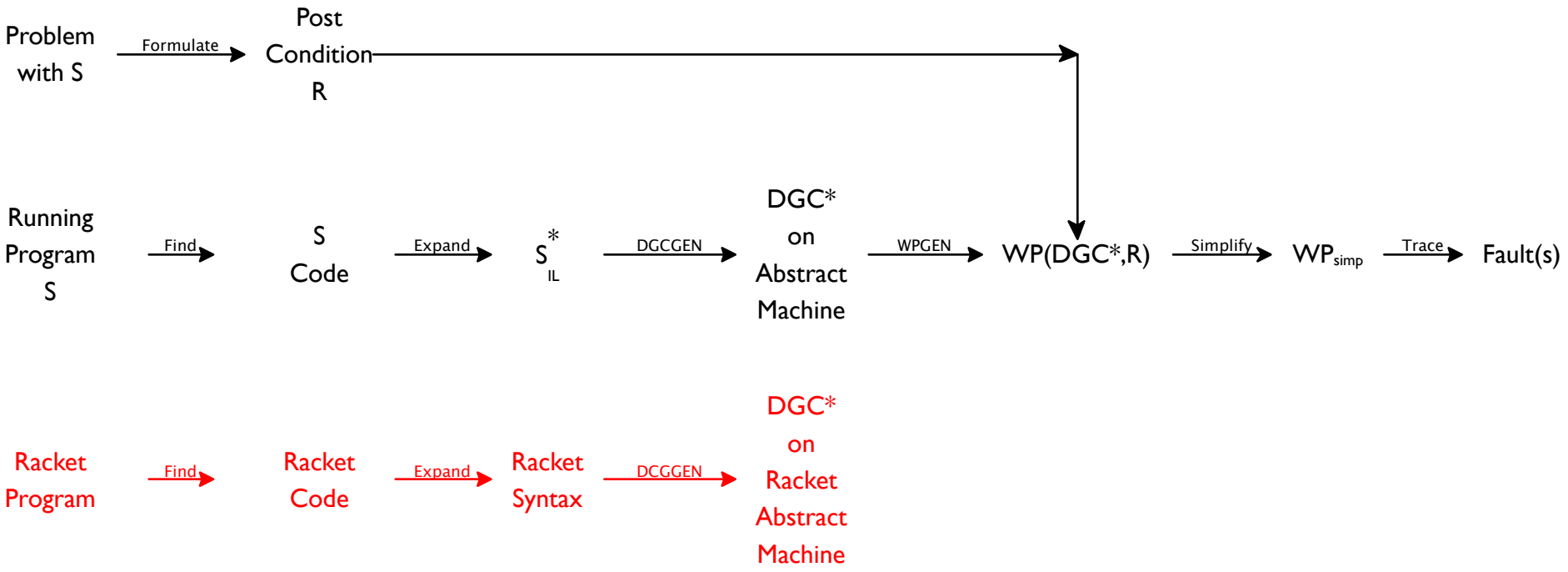

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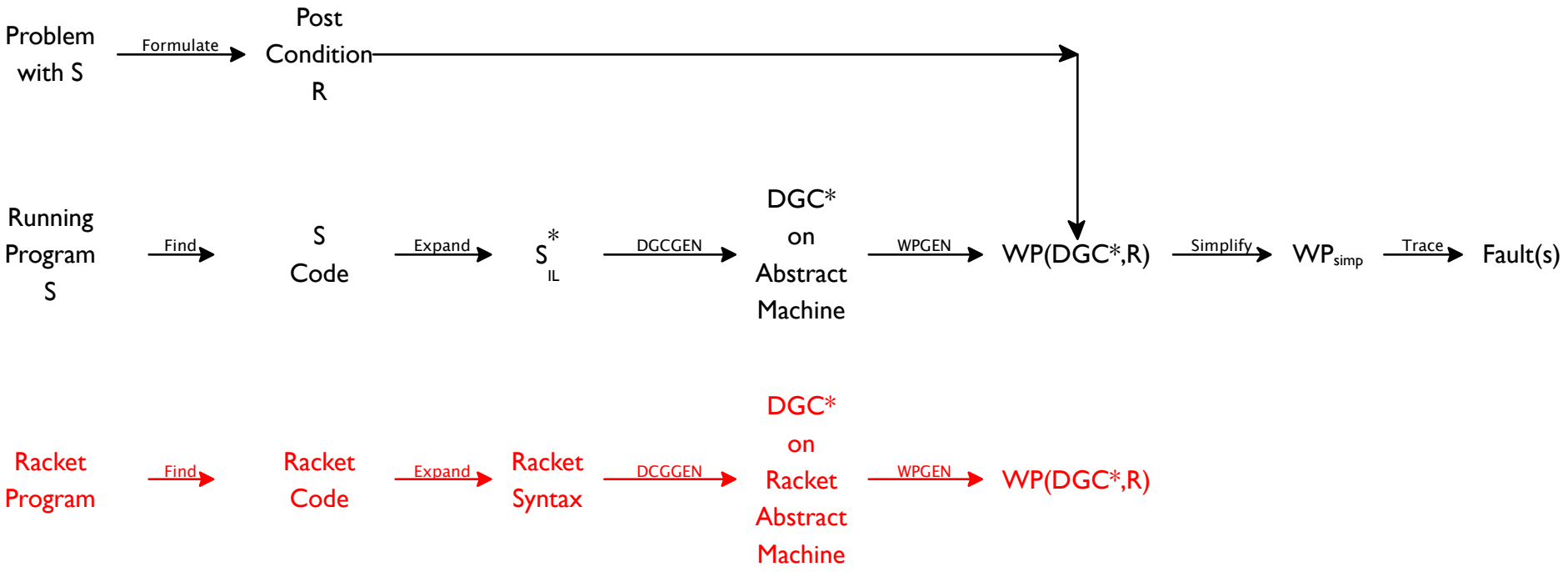

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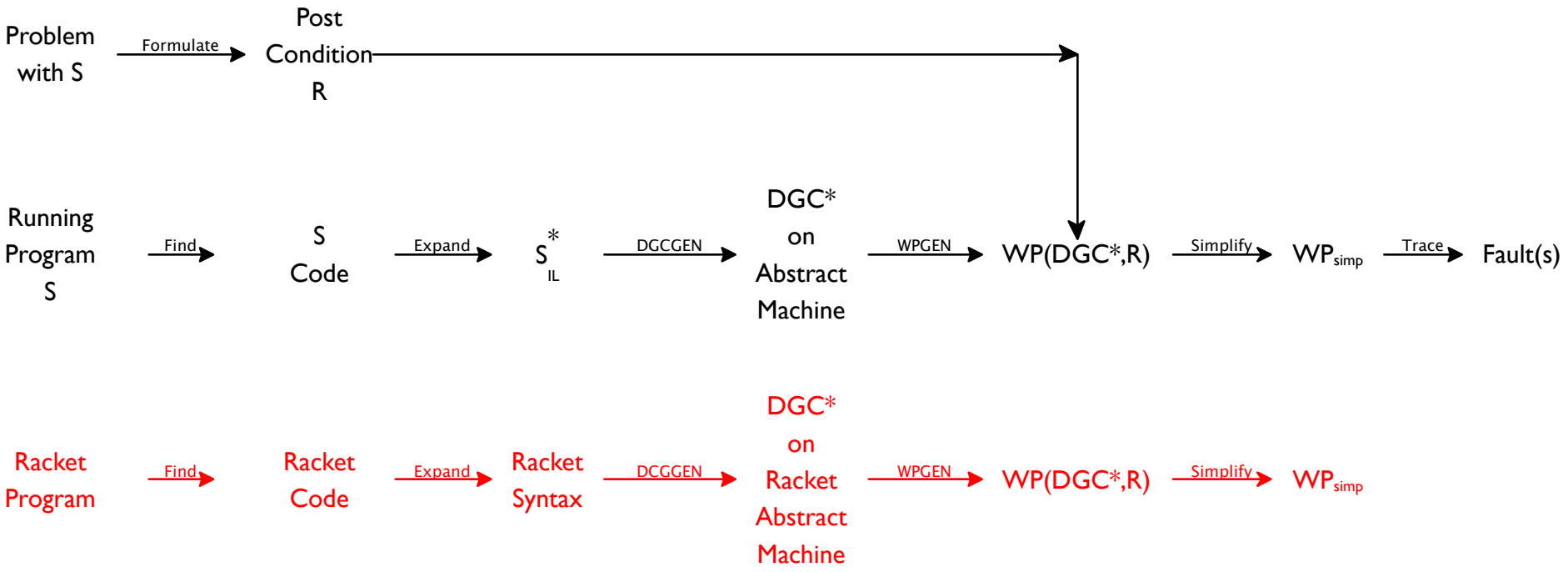

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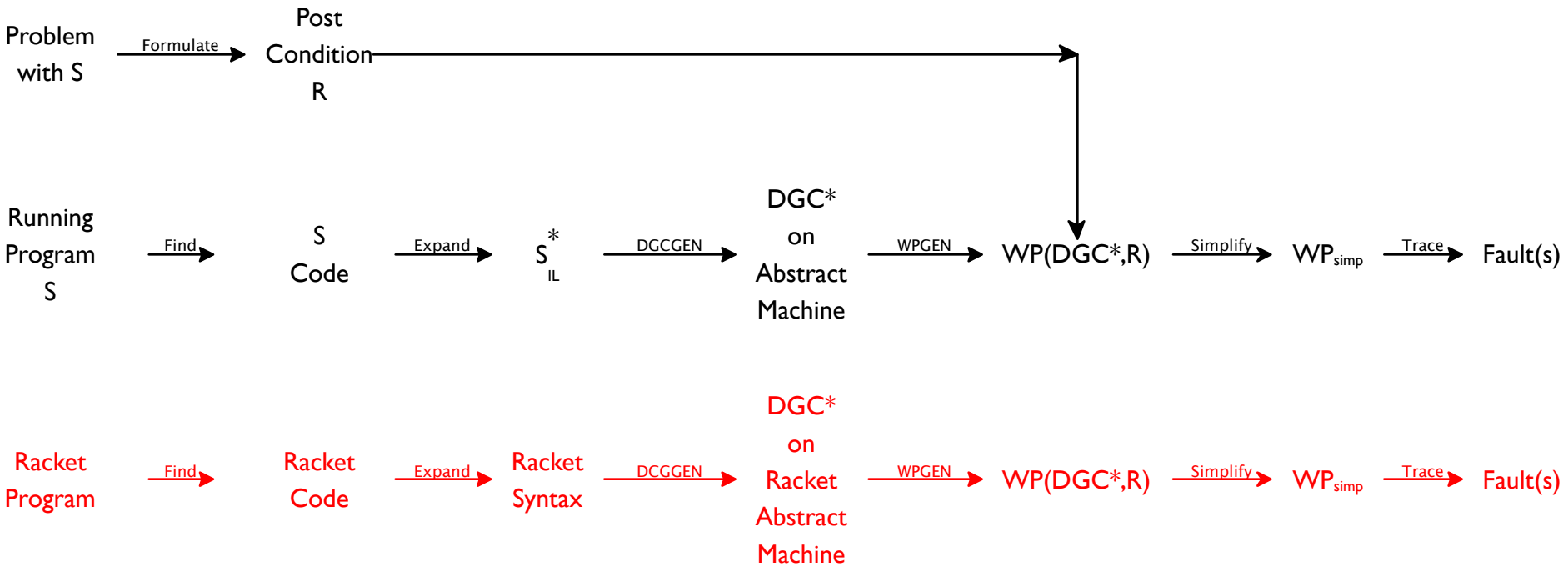

Demo

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- We would love to share with the research community to take it to the next level