MÄLARDALEN UNIVERSITY
SWEDEN

BOMBARDIER

USING TIMED BASE-CHOICE COVERAGE CRITERION FOR TESTING INDUSTRIAL CONTROL SOFTWARE

HENNING BERGSTRÖM AND **EDUARD ENOIU**

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COMBINATORIAL TESTING (CT)

- **CT tries to select test input values:**
  - the test goal is a combination strategy - test criteria.
- **Test Level:**
  - System: create inputs on user-level interaction
  - Unit: create inputs for method param. and variables

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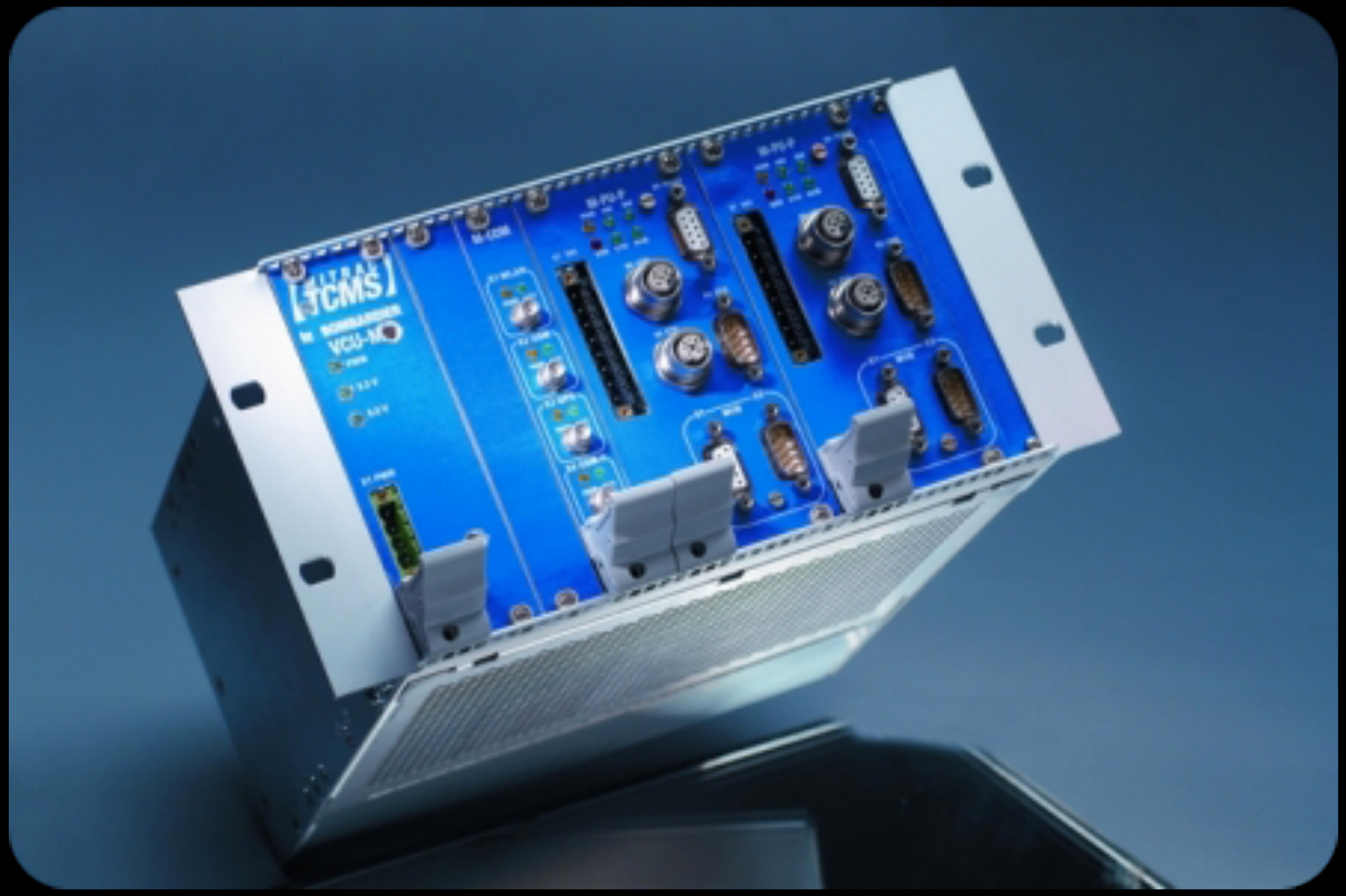
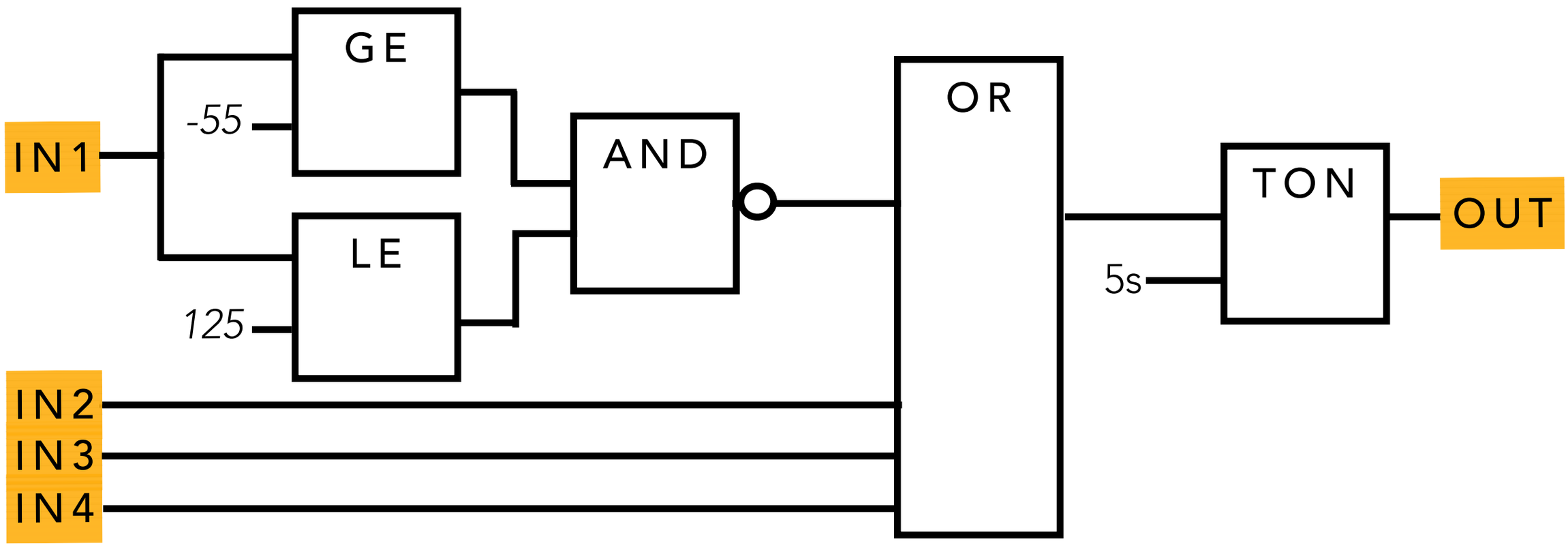
PROGRAMMABLE LOGIC CONTROLLERS (PLC)

- Are real-time systems
- Found in trains, nuclear power plants, automation
- Run on domain-specific operating systems.



INDUSTRIAL CONTROL SOFTWARE (UNIT) PLC WRITTEN IN IEC 61131-3



TESTING PLC SOFTWARE

EN 50128 - RAILWAY

IEC 62304 - MEDICAL

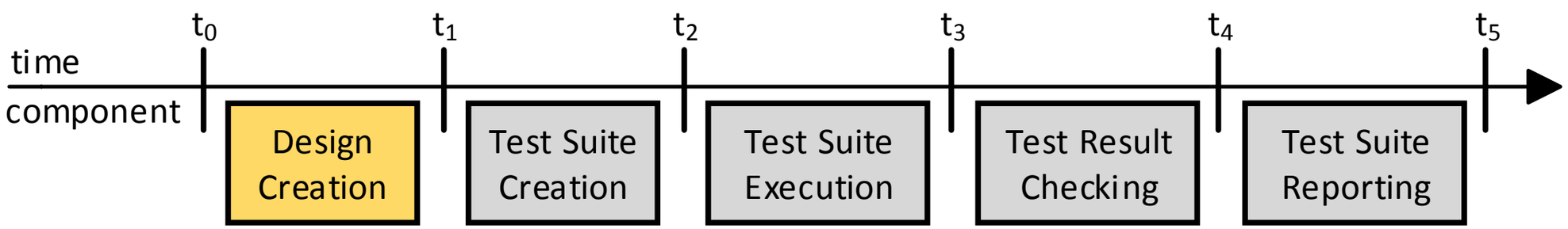
EN 62138 - NUCLEAR

DO-178B - AEROSPACE

TESTING PLC SOFTWARE

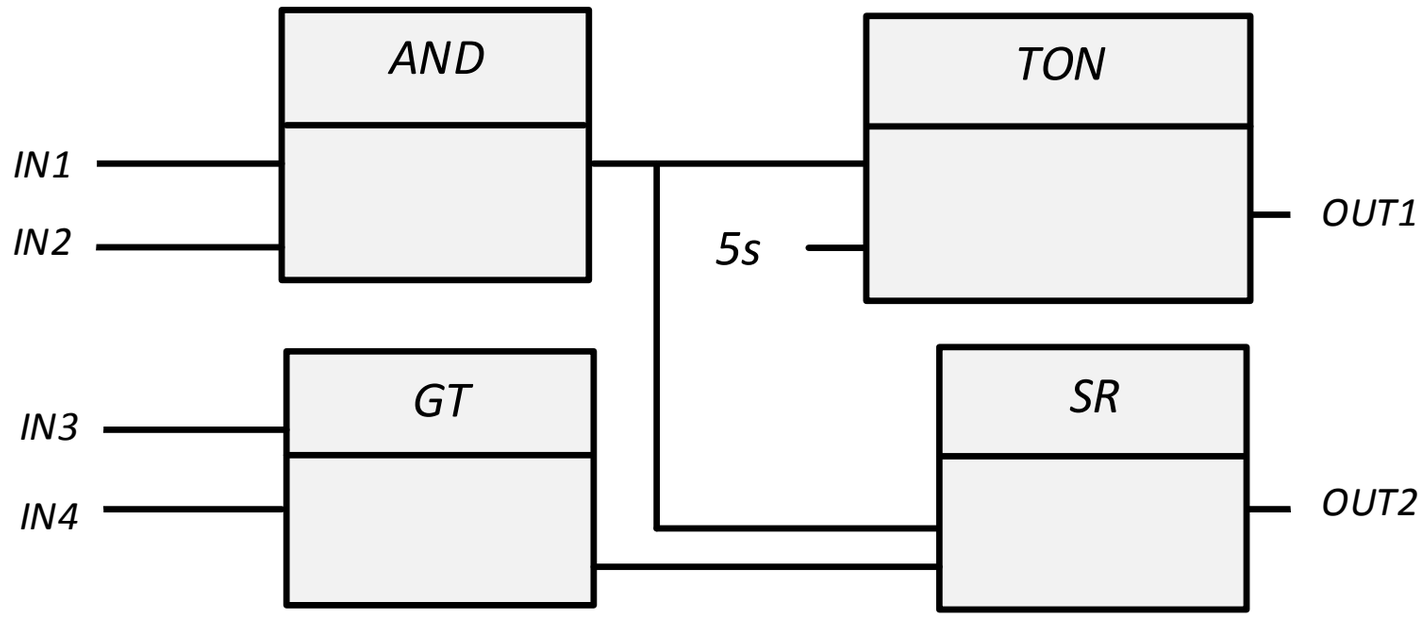
EN 50128 - RAILWAY

- Unit (component) level testing
  - A design is used as expected output (test oracle)
  - The use of functional testing is mandated
  - Some level of code coverage is recommended



BASE CHOICE CRITERION

# Tests	IN1	IN2	IN3	IN4
1	1	1	5	4
2	0	1	5	4
3	1	0	5	4
4	1	1	5	3
5	1	1	5	5
6	1	1	4	4
7	1	1	3	4



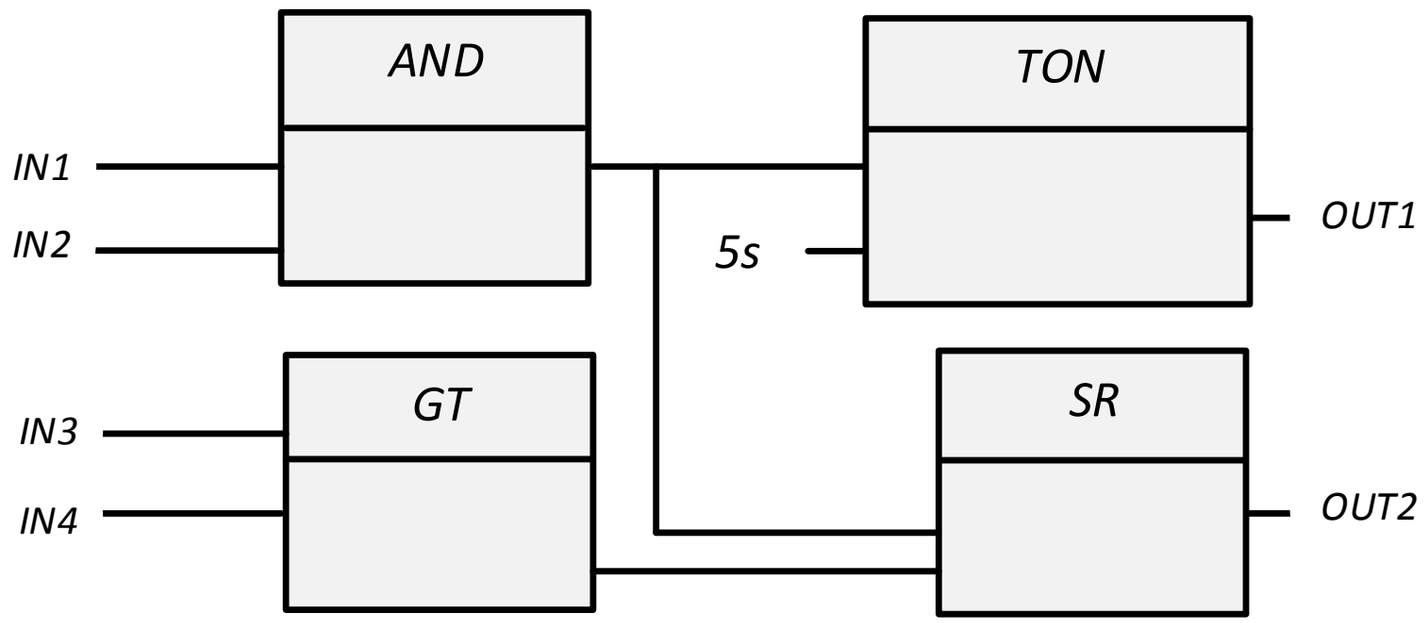
program cycle P=500ms

TIMED BASE-CHOICE CRITERION

1. Create the basic input model
2. Identify the timing constraint
3. Identify a base and time choice test.
4. Create a test suite.

# Tests	IN1	IN2	IN3	IN4
1	1	1	5	4
2	0	1	5	4
3	1	0	5	4
4	1	1	5	3
5	1	1	5	5
6	1	1	4	4
7	1	1	3	4

- time choice T = 6s
- (1,1,5,4) is fixed for 6s.
- Tests 1 to 7 are fixed for 6s each



CASE STUDY

- Compare timed base-choice with base choice in terms of code coverage and fault detection.

INDUSTRIAL CASE STUDY

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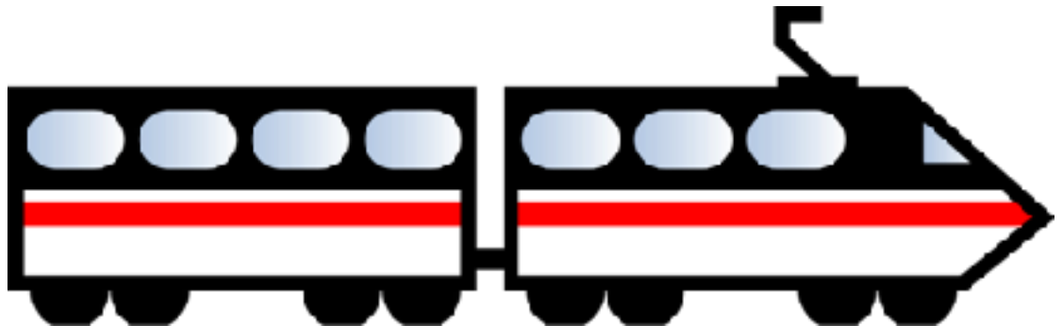
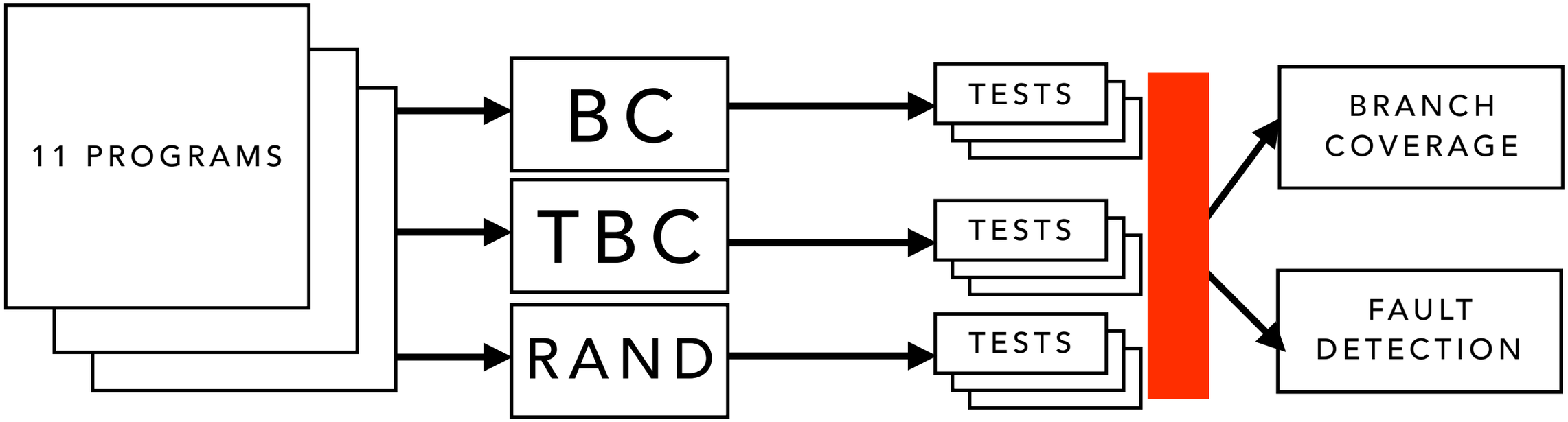
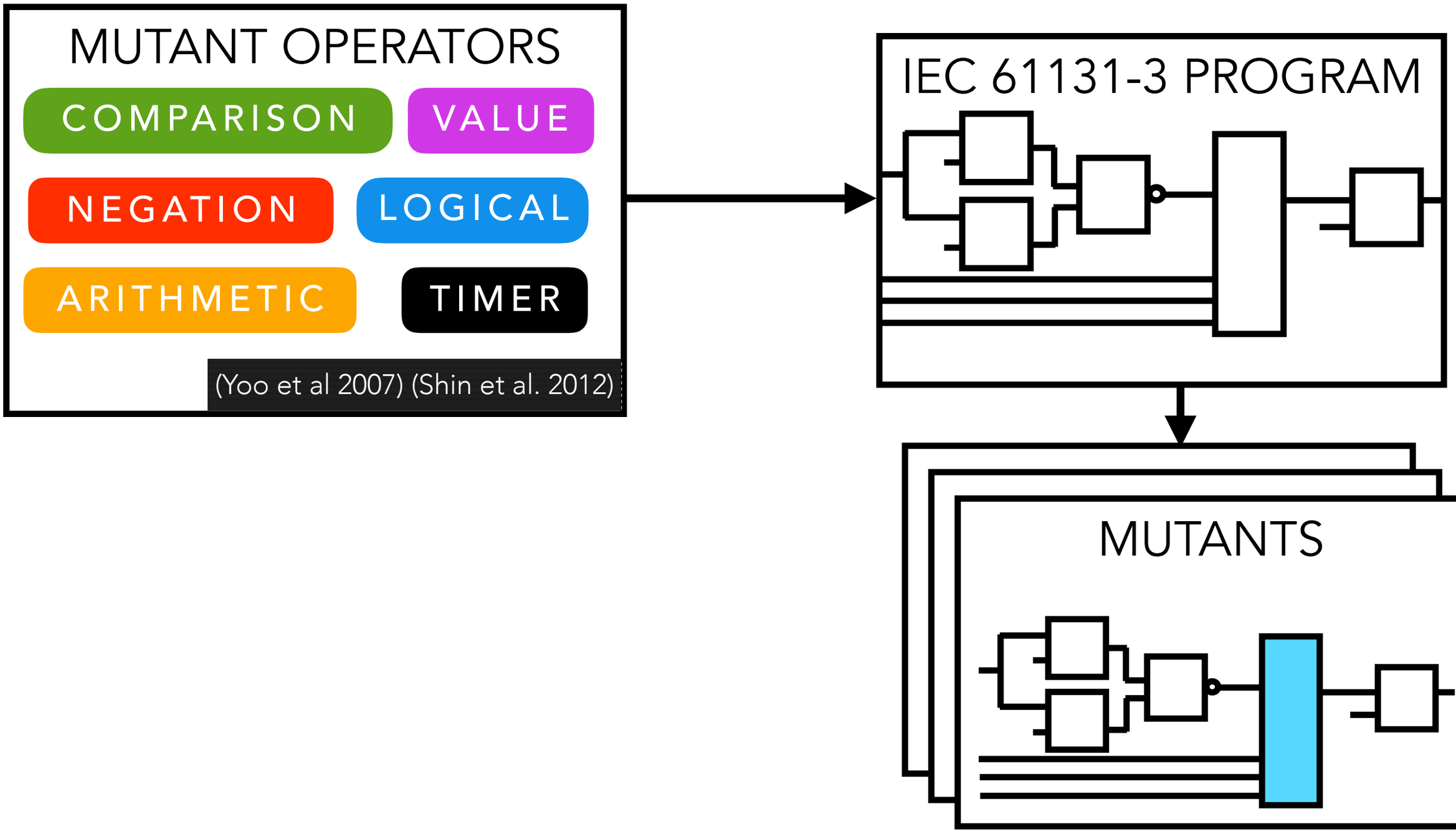


CASE STUDY

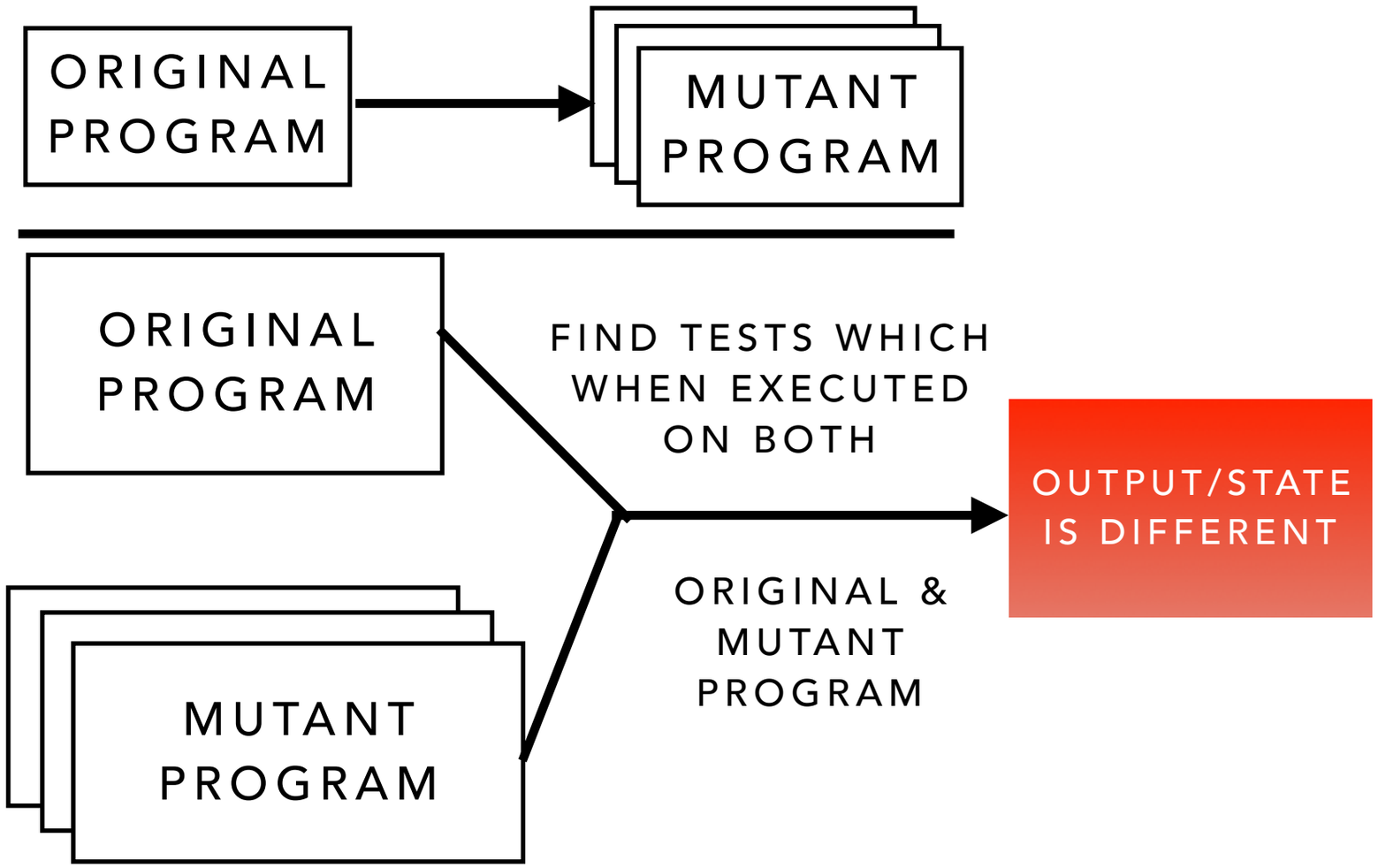
METHOD



MUTATION ANALYSIS

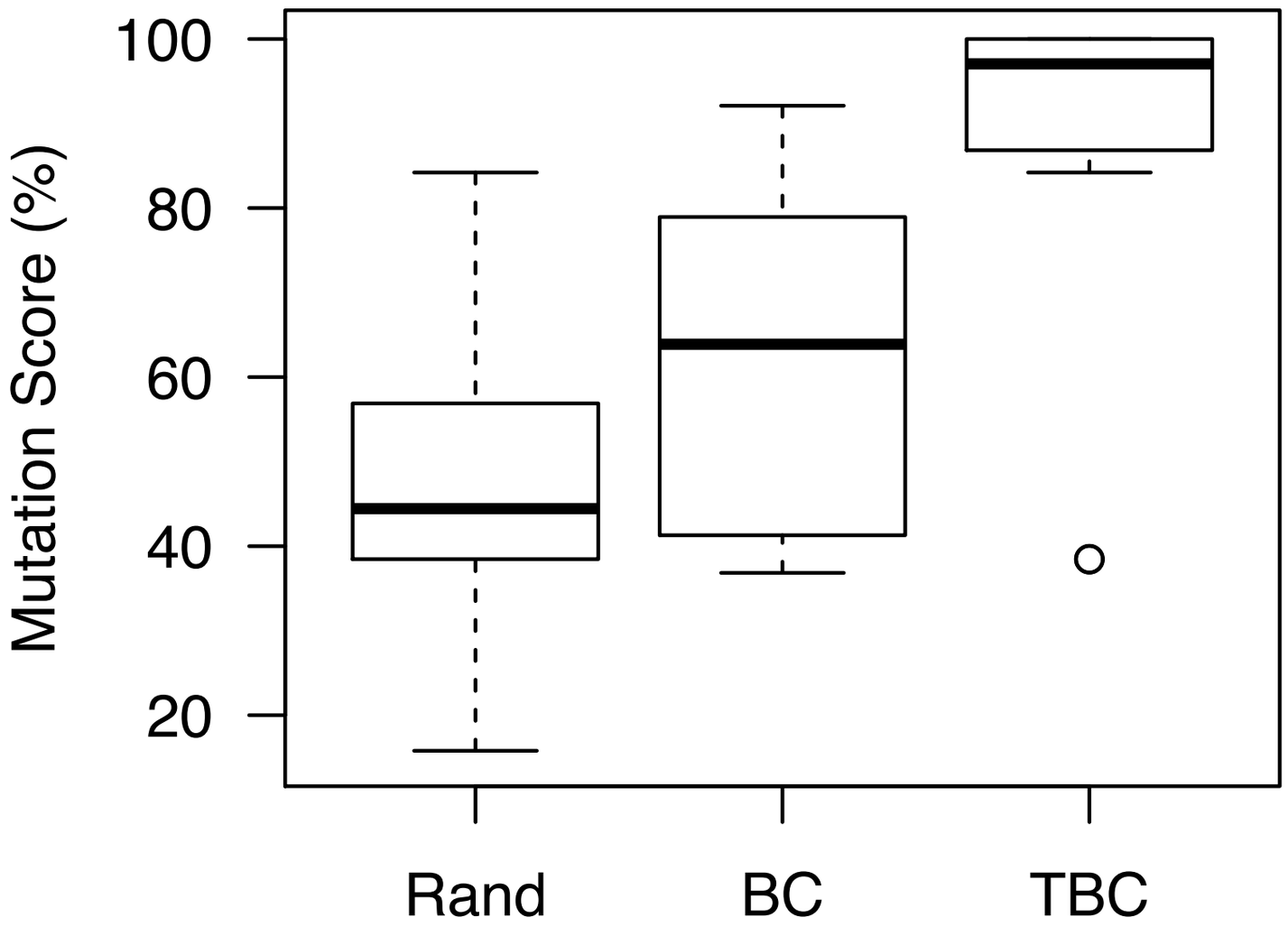


MUTATION ANALYSIS



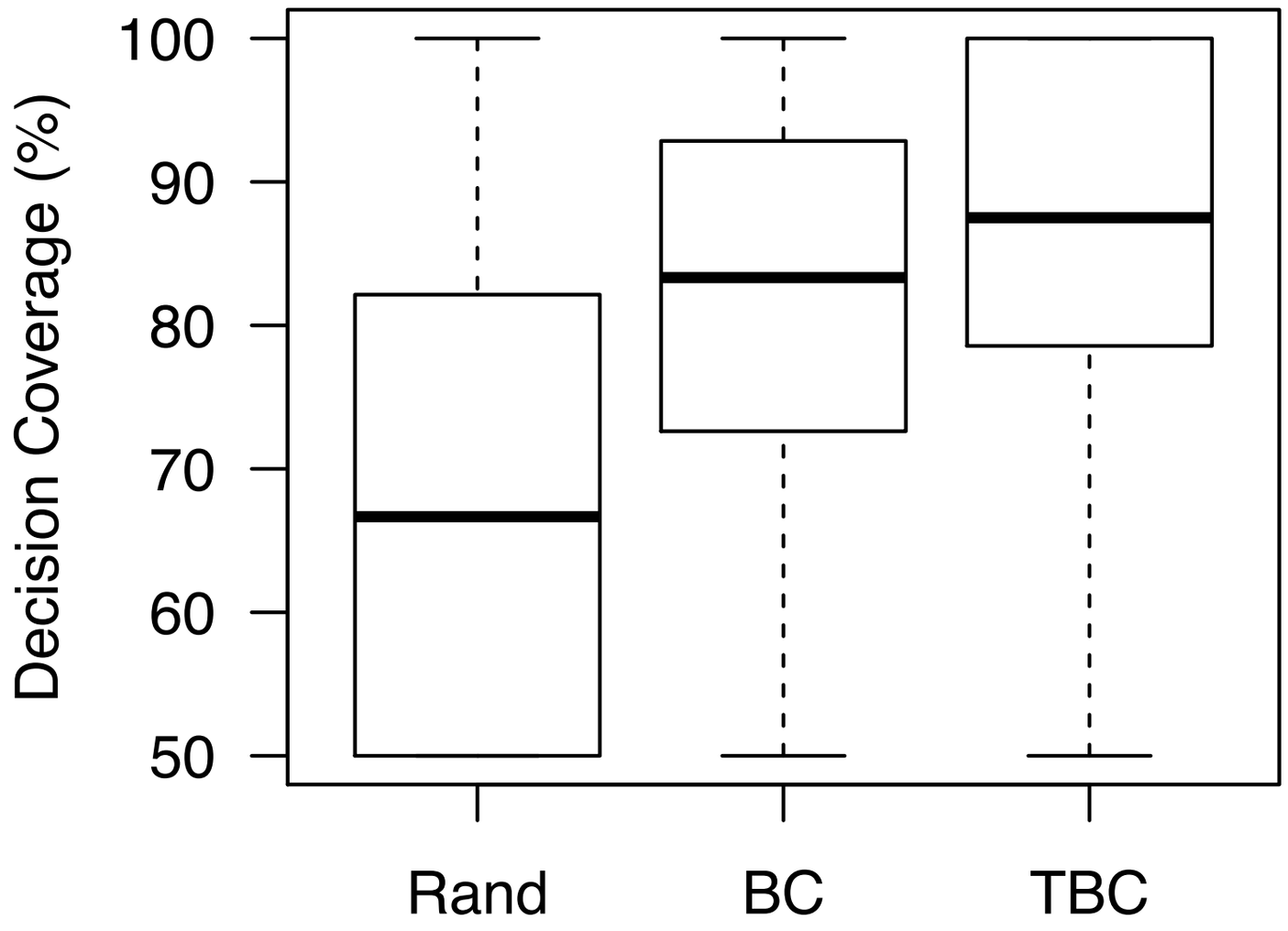
RESULTS

TBC ACHIEVES BETTER FAULT DETECTION SCORES THAN BC OR RAND.

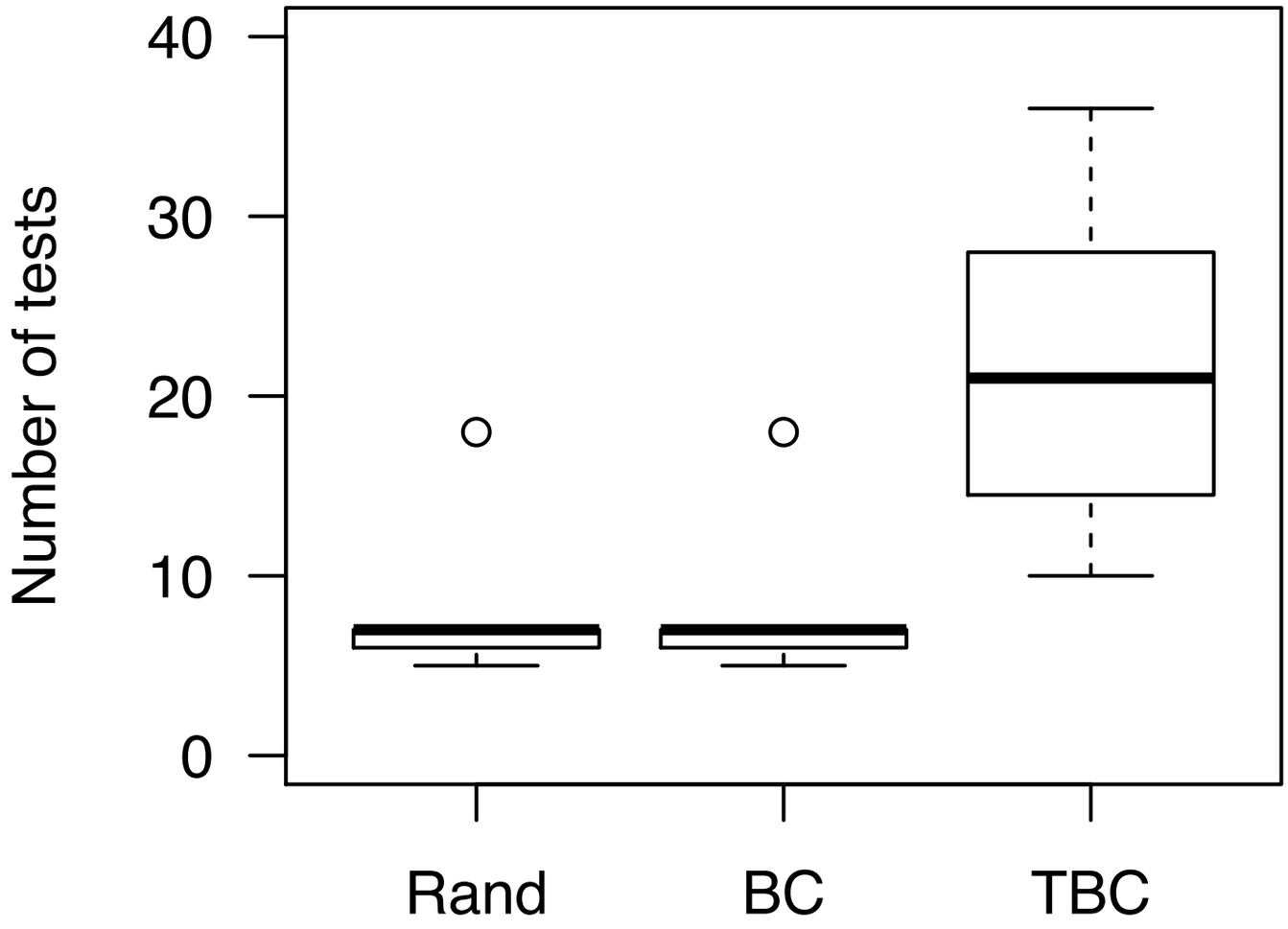


RESULTS

TBC ACHIEVES BETTER DECISION COVERAGE SCORES THAN BC OR RAND.



RESULTS



THE FUTURE

- multiple base and time choices
- evaluate the use of stronger criteria
- Use naturally-occurring faults
- Use other systems from other domains

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