Effective Test Generation for Worst-Case Execution Time

Samuel Jiménez Gil, Ph.D. Candidate

Supervised by Iain Bate

Real-Time Systems Group

RTS York

UNIVERSITY of York

Outline

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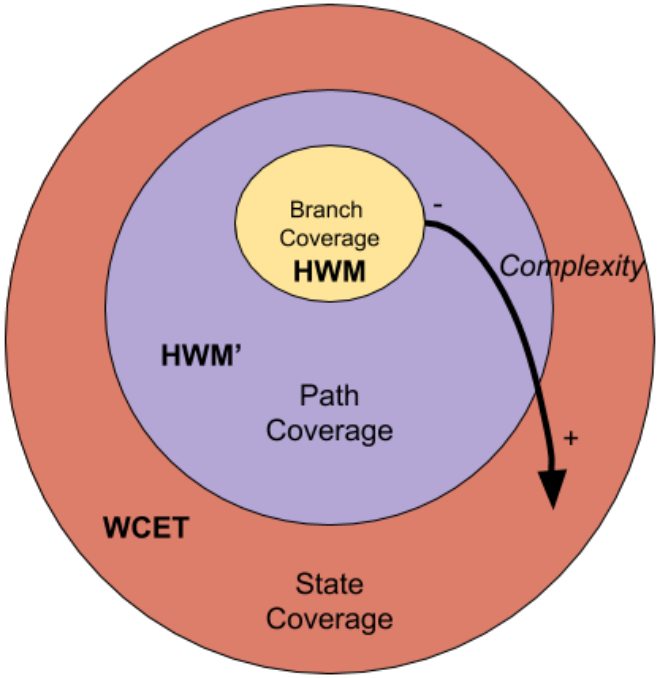
WCET



1. WCET problem is generally an **intractable** problem and therefore the **WCET is generally unknown**.
2. In its absence any method to derive it must gives confidence that its results are close to it. *Underestimation* is normally deemed a more **hazardous** situation whereas a non-overly pessimistic upper-bound is considered ideal.

Measurement-Based or Hybrid Approach

- It collects end-to-end measurements from the actual hardware or an equivalent simulator.
- It is prone to underestimate although it doesn't need to model hardware.

☞ *This approach is only applicable if proper test data* are supplied to evaluate the performance

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Research Question

☞ **How do we generate test data for the WCET automatically?**

Outline

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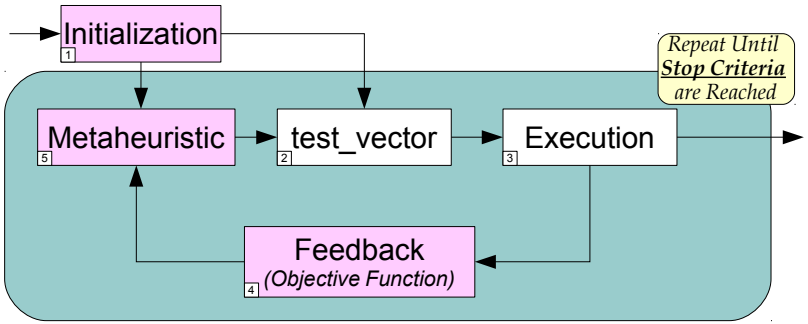
- Manually generated test data is often the practice in the industry.
- From a certain point of view the WCET can be considered an optimization problem
- Artificial Intelligence offers promising areas to address such a problems: **Meta-heuristics, Constraint-Satisfaction Problems**

Search-Based Testing




```
1  procedure test_foo
2     (x, y : in My_Int)
3     is
4     begin
5
6        if x - y = 0 then
7           Status := Still;
8        end if;
9
10    end test_foo;
```

Listing 1: Pathological case of Search-Based Testing

Constraint-Based Testing

1. It is able to handle **discrete search space**.
2. Industrial Cases of successful application, e.g., SAGE, Microsoft [2].
3. NP-hard solving algorithms

Outline

InsertionSort Algorithm with an array of 100 items

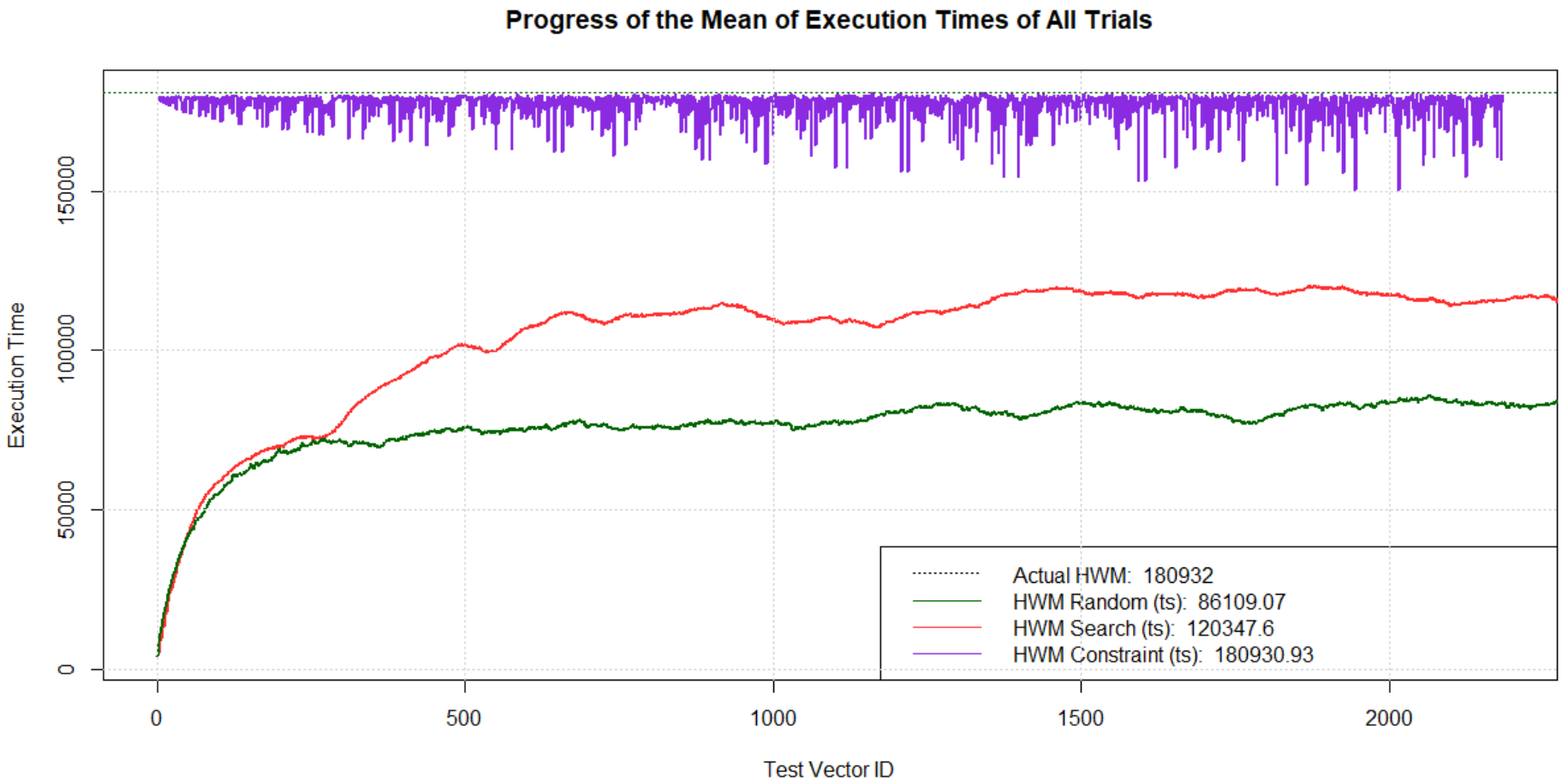


Figure 2: Time series displaying the average of each test generator in each trial. HWM denotes High Water Mark (Maximum observed execution time)

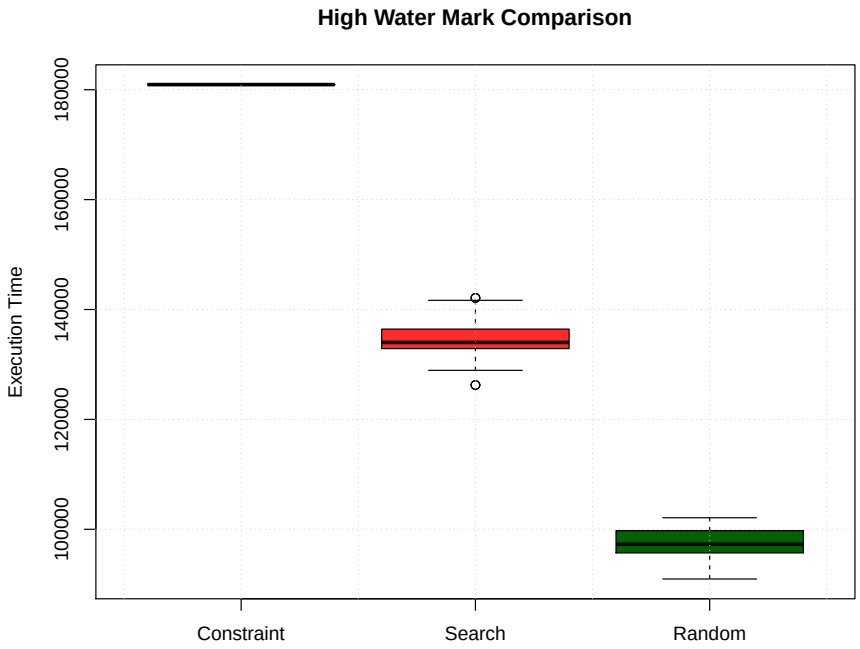


Figure 3: Comparison of the distribution of the HWM of each test generator and trial

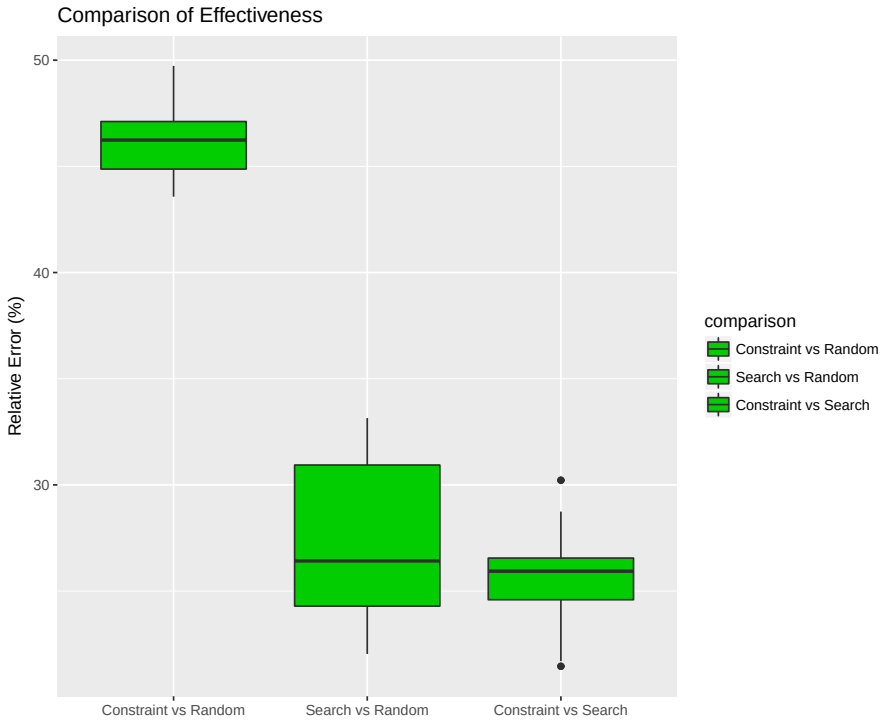


Figure 4: Comparison of the *difference* in HWM distribution of previous plot. Green plot indicates statistical significance from the Wilcoxon-Nemenyi-McDonald-Thompson test

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What I may offer

- Framework to test new meta-heuristics (test generators) and/or objective functions for a real-world intractable problem with a discrete search space.
- Spark Ada benchmarks for case of study.
- Help with SCIP: An open source constraint solver.
- Help with R environment and application of Statistics of Extremes.

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What I'd be interesting in collaborating with

- Test case generation and other ways of extrapolating Constraint-Based Testing to functional testing. This includes ways of reading formal specifications.
- Test generation for cyber security.
- More sophisticated meta-heuristic application., e.g., hyper-heuristics.
- Ada, C, and C++ Abstract Interpretation and parsing.

☞ samuel.jimenez york.ac.uk

Any questions?

Outline


Reinhard Wilhelm, Jakob Engblom, Andreas Ermedahl, Niklas Holsti, Stephan Thesing, David Whalley, Guillem Bernat, Christian Ferdinand, Reinhold Heckmann, Tulika Mitra, et al.
The worst-case execution-time problem—overview of methods and survey of tools.
ACM Transactions on Embedded Computing Systems (TECS), 7(3):36, 2008.


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Queue, 10(1):20:20–20:27, January 2012.