Modeling System Behaviour from Log Analysis Using Meta-Heuristic Search

Calin Georgescu[@], Annibale Panichella[*], Mitchell Olsthoorn[*]

[@]c.a.georgescu@student.tudelft.nl, [*]The Software Engineering Research Group, TU Delft

1. Introduction

Behaviour Modeling

- Used in program comprehension, test case generation, property verification etc.
- Limited alternatives: source code analysis, instrumentation (profiling)
- No scalable approaches
- Benchmark: XRP Ledger Consensus Algorithm

Meta-Heuristic Search

- FSM minimization is an NP-Hard problem
- Meta-heuristics generate *good* solutions while exploring a fraction of the search space
- STOA results for many combinatorial optimization problems

2. Approach

Model Inference Algorithm

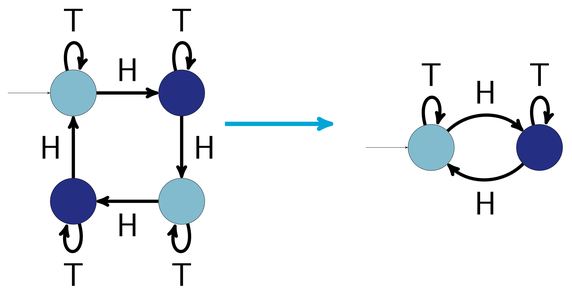
- Input **config** and **log traces** for the system
- Greedily build an initial **naive** model
- **Minimize** the naive model using meta-heuristic search

Minimization Algorithms

- **RSSHC**: Random Selection Stochastic Hill Climber
- **TSSHC**: Tournament Selection Stochastic Hill Climber
- **SA**: Simulated Annealing
- **PSA**: Pareto Simulated Annealing

3. Research Questions

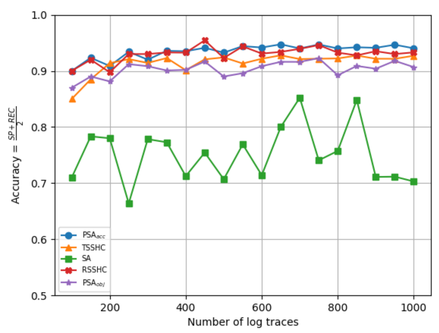
- ***RQ1:*** How effective are RSSHC, TSSHC, SA, and PSA at inferring a **concise** and **accurate** state model for the XRP Ledger Consensus Algorithm?
- ***RQ2:*** How efficiently do RSSHC, TSSHC, SA, and PSA **scale** in terms of runtime with regard to the number of traces used as input?



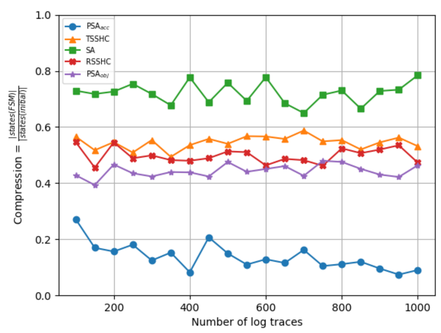
4. Evaluation

- **Accuracy** in terms of **specificity** and **recall**
- **Conciseness** in terms of the number of states removed from the initial model
- **Scalability** in terms of runtime over the number of log traces in the input

5. Results



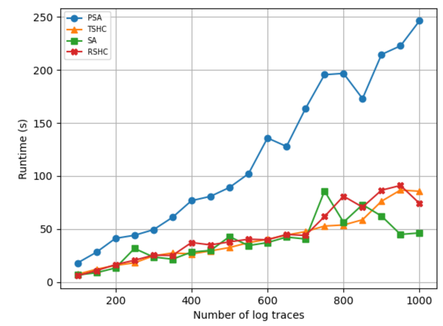
(a) Accuracy comparison



(b) Compression comparison

6. Conclusion

- Each algorithm excels in different ways:
  - **PSA**: trade-offs and accuracy
  - **SA**: conciseness
  - **RSSHC** and **TSSHC**: optimizing the objective function
- All algorithms **scale linearly** and produce results **within minutes**



(c) Scalability comparison

Github Repository

TU Delft Delft University of Technology

Faculty of Electrical Engineering, Mathematics and Computer Science