

EVALUATING Z3'S PERFORMANCE ON REAL NUMBER CONSTRAINTS

EMPIRICAL STRATEGIES FOR TACTIC SELECTION AND PARALLELIZATION

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01 INTRODUCTION

- **ESSENCE:** Z3 is a state-of-the-art SMT solver from Microsoft Research that checks the satisfiability of logical formulas [1]. Satisfiability Modulo Theories (SMT) extends SAT solving by allowing reasoning over domains like real numbers – an example is shown in Figure 1.
- **IMPACT:** Z3 is widely used in formal methods and supports various theories like arithmetic and arrays.

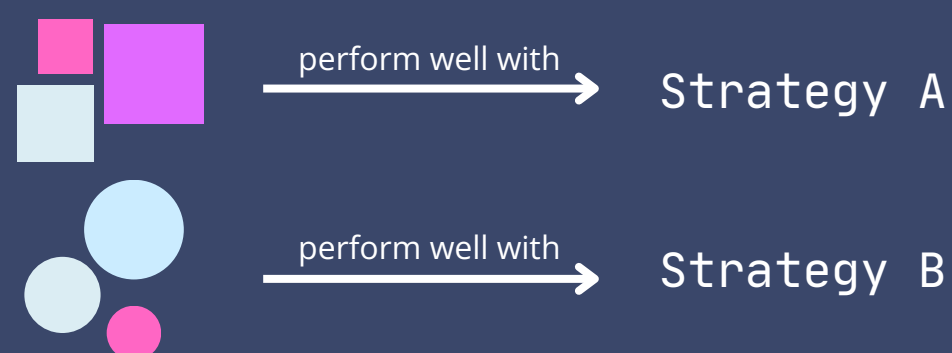
Do there exist x, y, z such that this is true:
 $(x+y+z > 2)$ AND $(10*y < 0.22)$ AND $(z = 2*x+y)$

Figure 1: Example linear arithmetic satisfiability problem

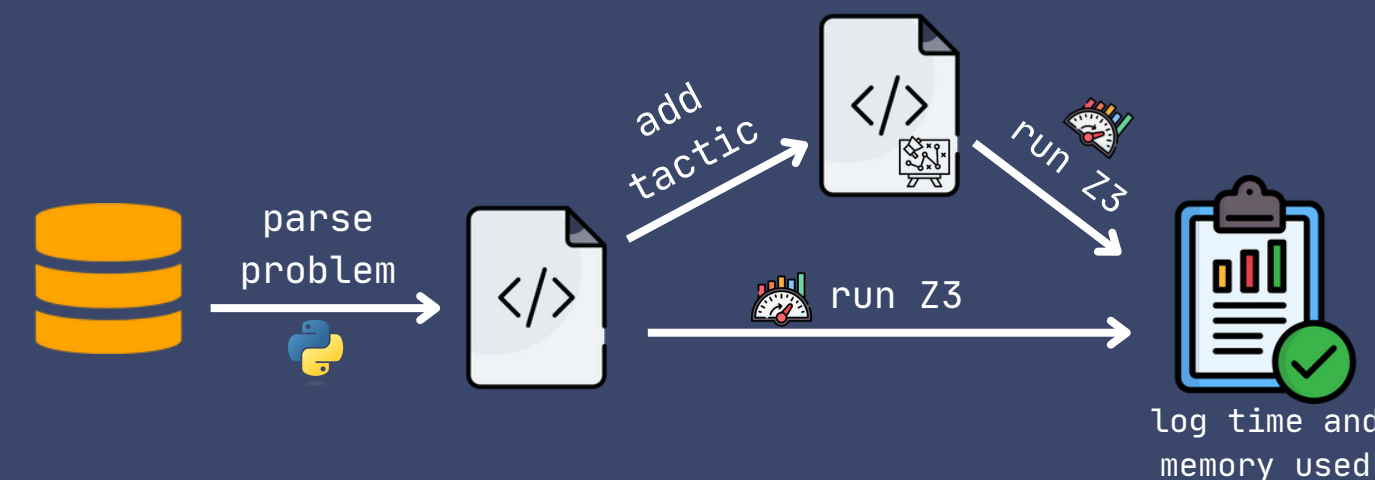
02 RESEARCH TOPIC

How do different tactics influence the performance of Z3 in solving real number arithmetic problems?

- **BACKGROUND:** Tactics in Z3 are used to “guide” the solver how to solve a certain problem and tacticals are tactic combinators [2].
- **IDEA:** Find problems where specific tactics, or pipelines significantly speed up Z3's performance and explain why that is based on the problem structure.



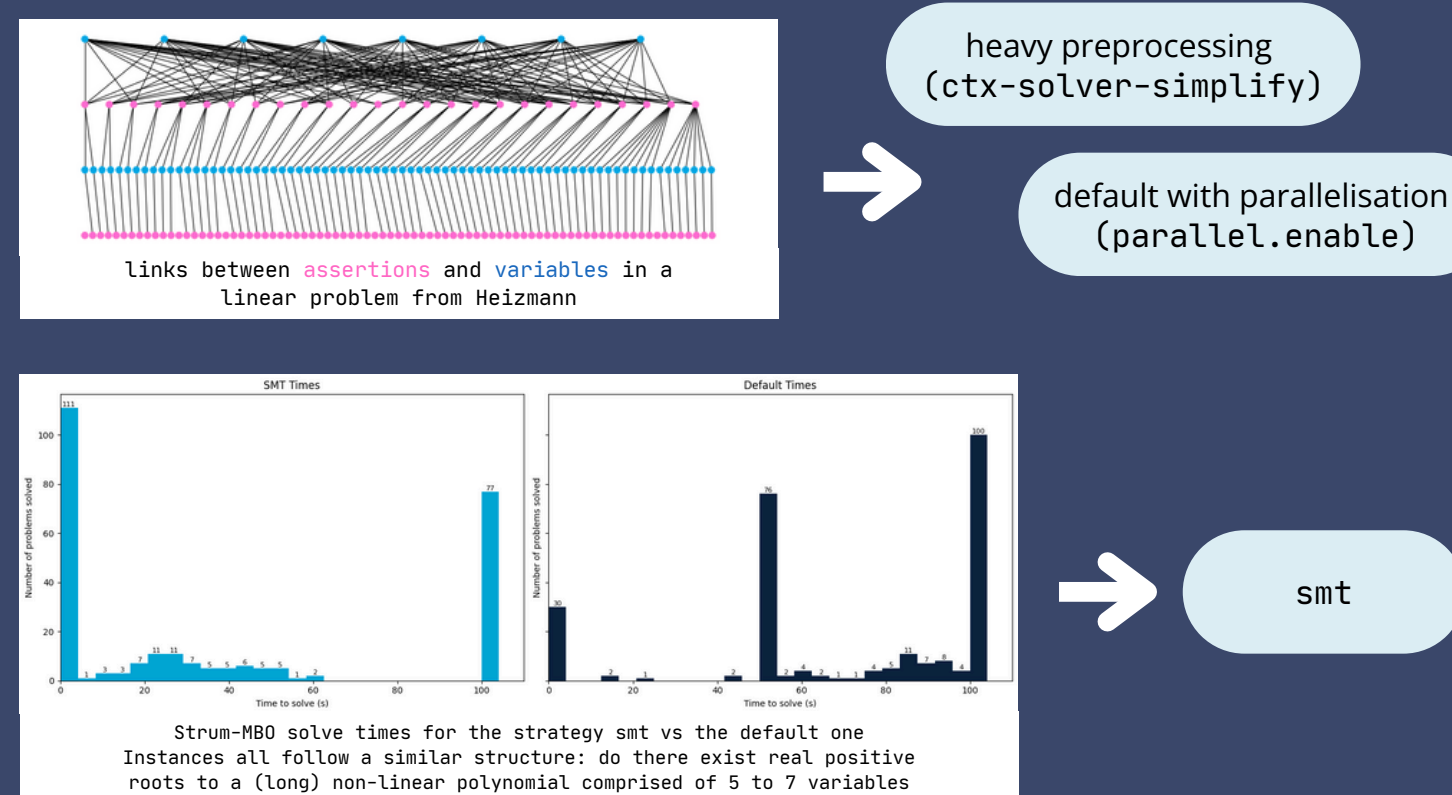
03 METHODOLOGY



*A Z3 Solver instance is ran from the Python API as a subprocess
**Logs are later analysed in a separate pipeline

04 RESULTS & CONCLUSIONS

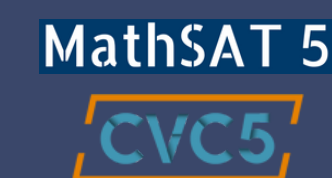
- We confirm that tactic selection can indeed have an impact on solver time and there is no single custom strategy that works well across all problem types.
- We identify two key patterns for which we notice a different behaviour in problem solving time based on the strategy:



05 FUTURE WORK



Add user-defined means of parallelization.



Experiment with other SMT solvers, data, or strategy configurations.



Fine tune or train existing models with the data [4].

REFERENCES

- [1] "Introduction," Online Z3 Guide, Microsoft, 2025. [Online]. Available: <https://microsoft.github.io/z3guide/docs/logic/intro/>
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- [3] M. Preiner, Schurr, Hans-Jörg, Barrett, Clark, Fontaine, Pascal, Niemetz, Aina, and Tinelli, Cesare, 'SMT-LIB release 2024 (non-incremental benchmarks)'. Zenodo, Apr. 2024. doi: 10.5281/zenodo.11061097.
- [4] Mislav Balunović, Pavol Bielik, and Martin Vechev. Learning to solve smt formulas. In S. Bengio, H. Wallach, H. Larochelle, K. Grauman, N. Cesa-Bianchi, and R. Garnett, editors, *Advances in Neural Information Processing Systems 31*, pages 10337–10348. Curran Associates, Inc., 2018.

