BenchPAL

Systematic Benchmarking Test Case Generation

Motivation

- Proof assistants are critical tools in formal verification used to ensure the correctness of mathematical theorems, software, and hardware systems.
- Lean, Idris, Agda, and Rocq are functional programming languages commonly used as proof assistants.
- Current user experience suggests that there are many low-level deficiencies.
- BenchPAL systematically tests these proof assistant languages (PALs) to highlight areas for improving their performance.

System Design

1. **CI Pipeline**
   Allows users to run the system utilizing Docker and Vercel.
2. **Test generator**
   Uses MHPG to dynamically generate scalable test modules based on size input.
3. **Translators**
   Translates the generated tests into each PAL.
4. **Tracking**
   Tests are type-checked, and both time and memory usage are recorded.
5. **Calculations**
   Startup times subtracted from runtimes, and log values are calculated if log interval selected.
6. **Visualization**
   Graphs are plotted using Matplotlib from JSON file and served in Flask backend.
7. **Future development**
   Test suite can be expanded by adding tests to Tests module (Tests.hs).

Structure of BenchPAL

1 → 2 → 3

1 — CI [GitHub Actions]

The user interacts with our project through a CI implemented in GitHub Actions or locally.

2 — Automated Code Generator

Automated code generator creates tests of increasing size and translates them to the four proof assistant languages.

3 — Webpage Generation

Test complexities visualized using Python's matplotlib in a Flask backend and hosted on Vercel to display results.

Example: Let Bindings Test Case

Agda

```
module LetExample where
open import Agda.Builtin.Nat
n : Nat
n = let
    x1 = 1
 in
    let
    x2 = x1
 in
    let
    x3 = x2
 in
    x3
```

Idris

```
module Main
n : Nat
n = let
    x1 = 1 in
    let
    x2 = x1 in
    let
    x3 = x2 in
    x3
main : IO()
main = putStrLn ""
```

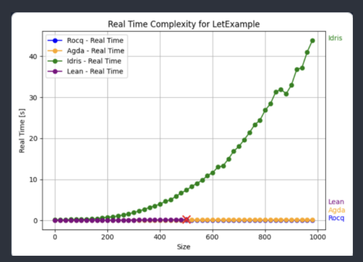
Lean

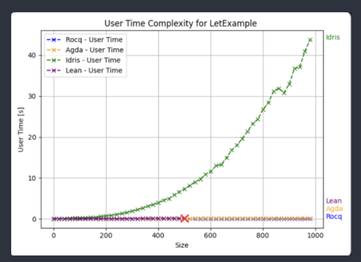
```
def n : Nat := let x1 := 1
let x2 := x1
let x3 := x2
x3
```

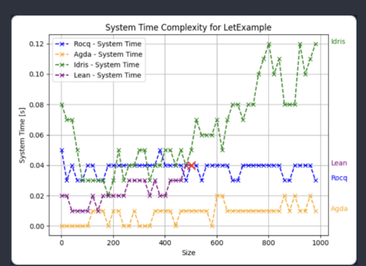
Rocq

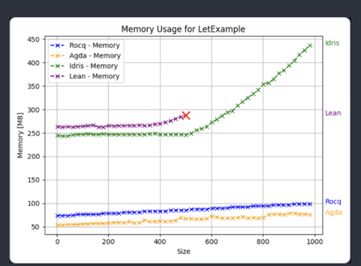
```
Module LetExample.
Definition n : nat := let x1 := 1 in
    let x2 := x1 in
    let x3 := x2 in
    x3.
End LetExample.
```

Results

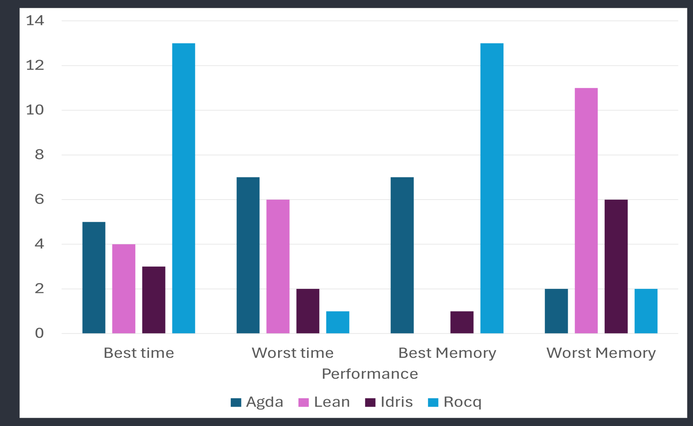








Conclusions

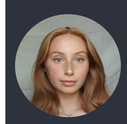


Best Time: Rocq
Best Memory: Rocq
Worst Time: Agda
Worst Memory: Lean

Technology Stack

Flask · Vercel

Team



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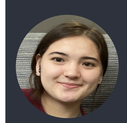

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