Tracing Optimization for Performance Modelling and Regression Detection

Kaveh Shahedi, Heng Li
Polytechnique Montreal

POLYTECHNIQUE MONTRÉAL
TECHNOLOGICAL UNIVERSITY

01
The Problem

What is Performance Modelling?

Observe
Software Behavior

- Num. of Inputs
- Complexity of Inputs
- Functions Executions

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Performance Regression?

The performance model **MUST** be able to **DETECT** the performance **regressions**

In this study, the performance model is a regression model, functions tracing data are the inputs, and the program’s execution time is the output.

The Trade-Off

A: GOOD

Performance Model Precision

Using **functions tracing**, the **accuracy** of the **performance model** is **great**!

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Performance Model

R2 Score: > 99%
Mean Error: < 5%
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BUT

B: BAD

The Overhead of Tracing

The **added overhead** to the **system** regarding the **execution time** and **storage usage** is **massive**!

Resources

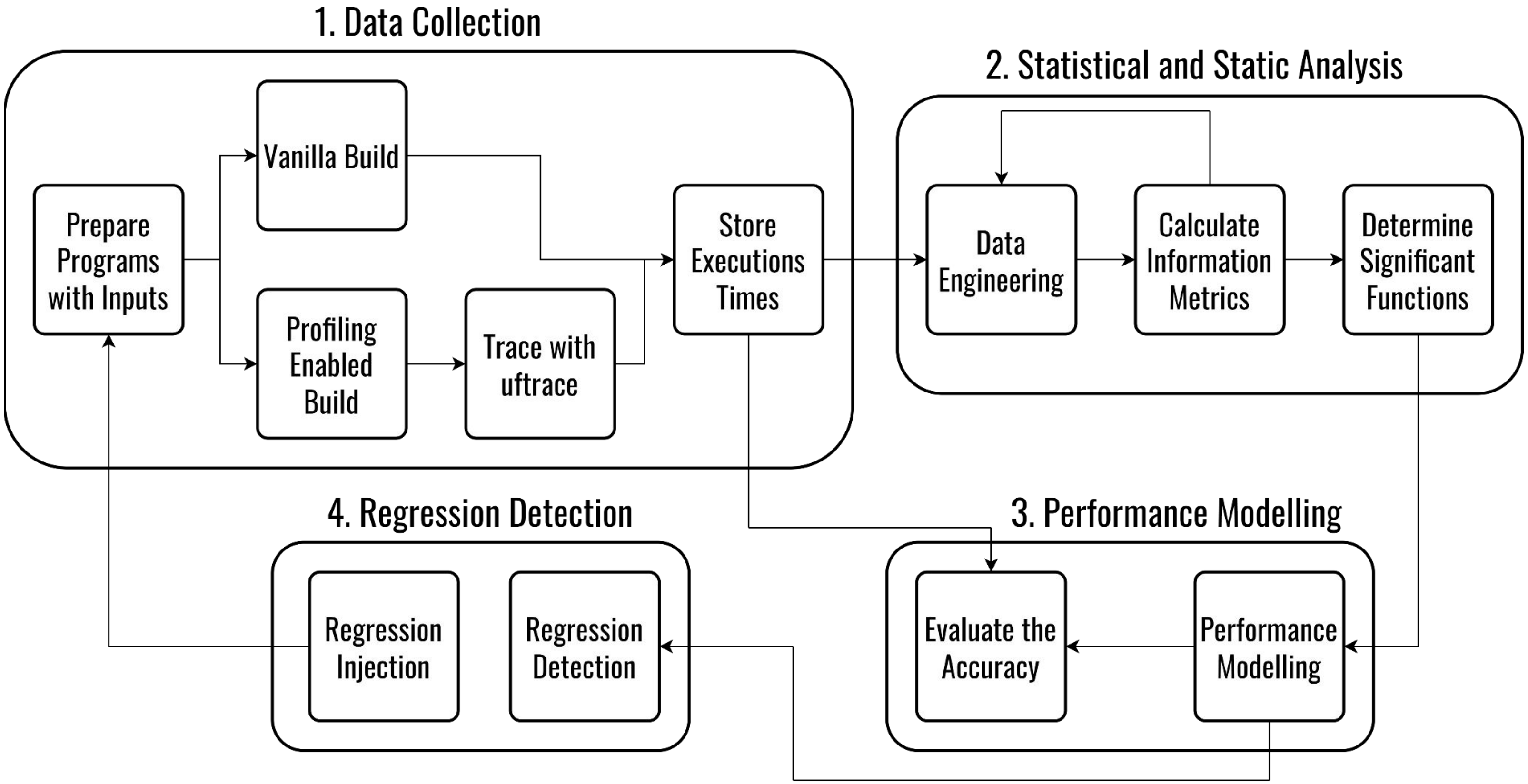
```
Mean Time Overhead: > 55%
Mean Storage Overhead: >> 1000%
```

But, **with respect to performance modelling, not all** of the **functions** have **significant impact** on the **model** and can be **removed** from **tracing**

02

The Methodology

Overall Steps



1. Data Collection

I. **Programs (Benchmarks)**
   A. SPEC CPU 2017: 631.deepsjeng_s (Int), 638.imagick_s (FP)
   B. SPEC MPI 2007: 104.milc
   C. SU2
   D. PARSEC: freqmine

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III. **Run the Programs in Vanilla Mode and Full Tracing, and Store the Execution Times along with Storage Usage**

2. Statistical and Static Analysis

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   A. Entropy, Coefficient of Variant, and Ridge Regression Coefficients
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III. **Extracting Functions Characteristics**
   A. Complexity, LoC, Number of loops, Number of calls, etc.
   B. These characteristics will be used for the further steps of this study

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   A. Building a performance model with the fully instrumented data
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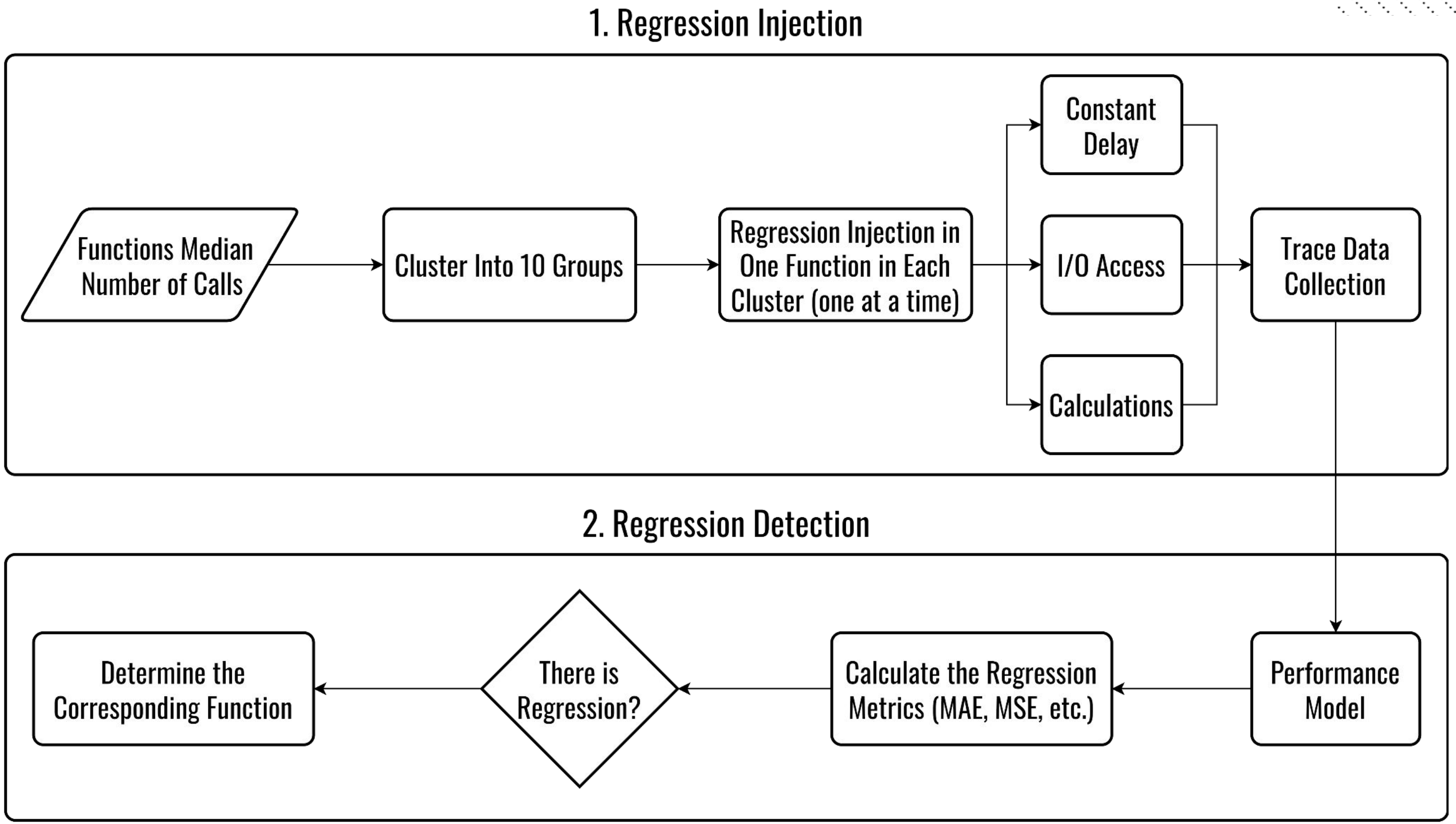
III. **Evaluating the Optimized Performance Model**
   A. The accuracy of the performance model itself
   B. Performance regression detection

4. Regression Detection



03
The Results

1. Data Collection

Programs Collected Data

- 631.deepsjeng_s: 9,000 executions
- 638.imagick_s: 2,350 executions
- 104.milc: 4,650 executions
- SU2: 4,700 executions
- Freqmine: 4,200 executions

Times	Storage Usage	Parameters	Functions
Total execution times of the program (vanilla, fully traced)	The overhead of used storage by tracing	The input parameters for that specific execution	Self time, cumulative time, number of calls

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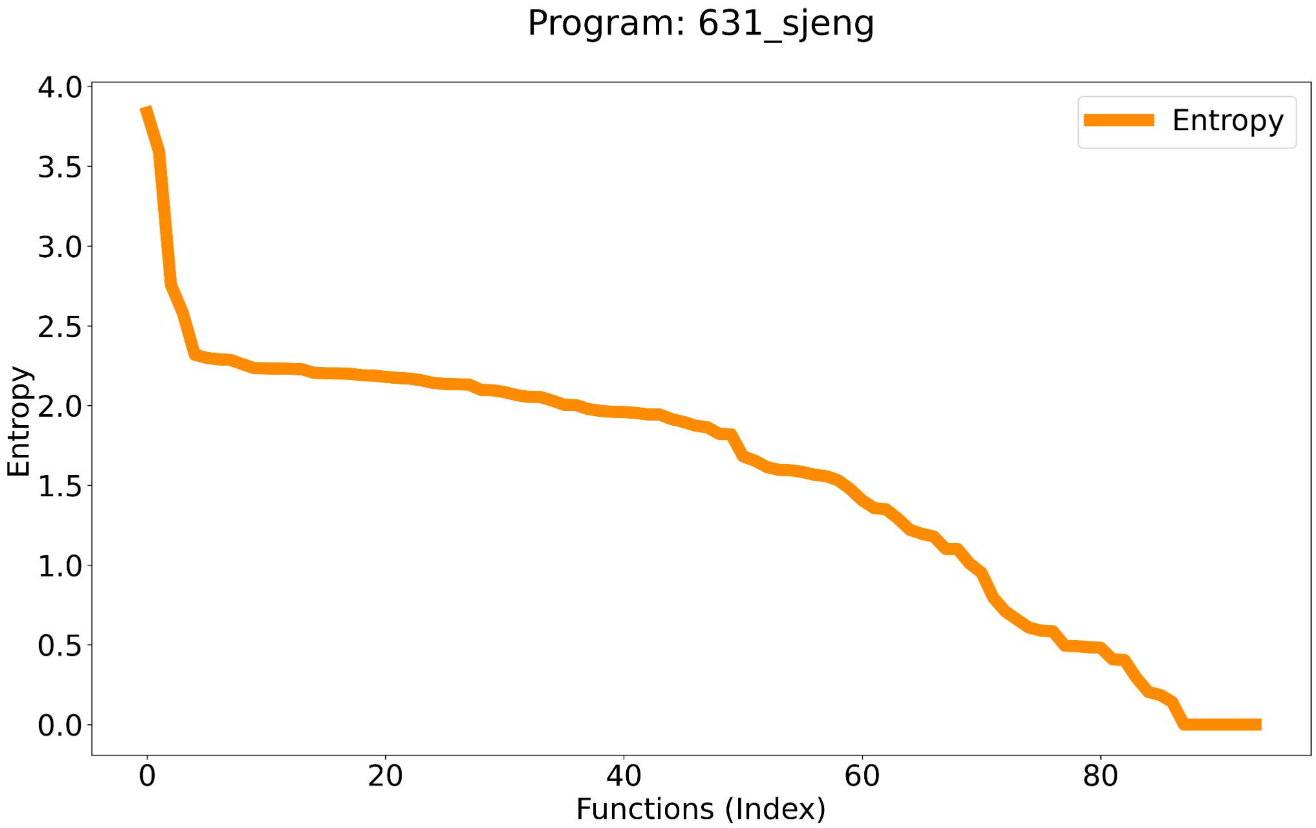

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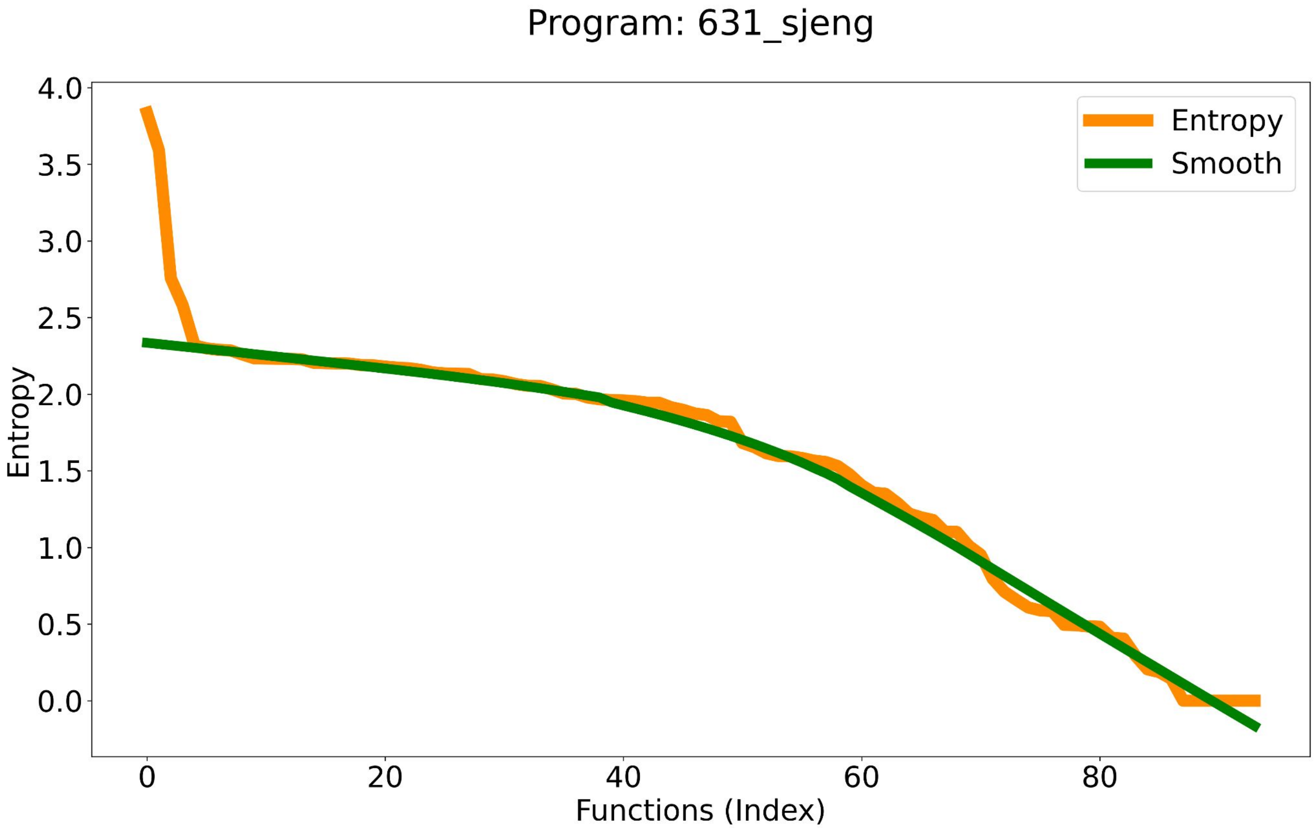

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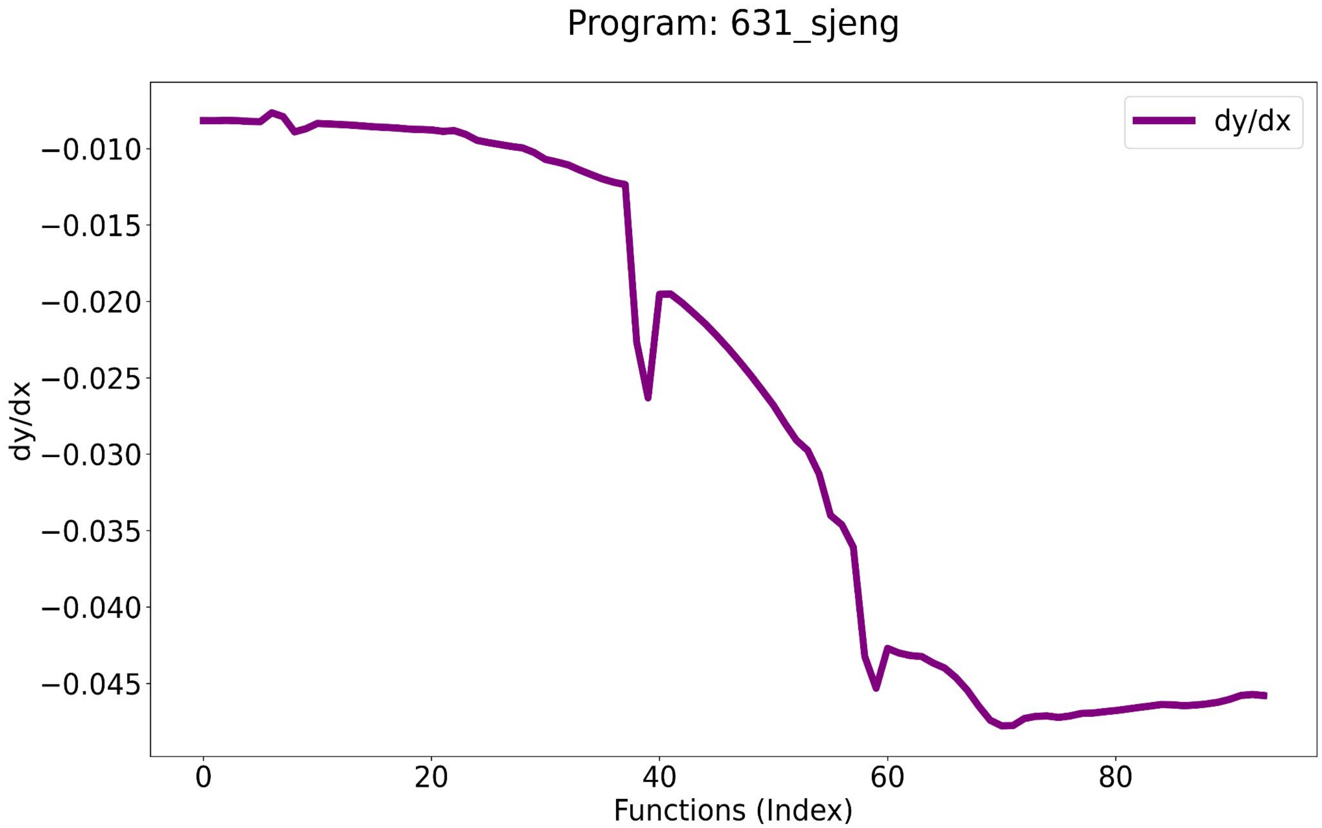

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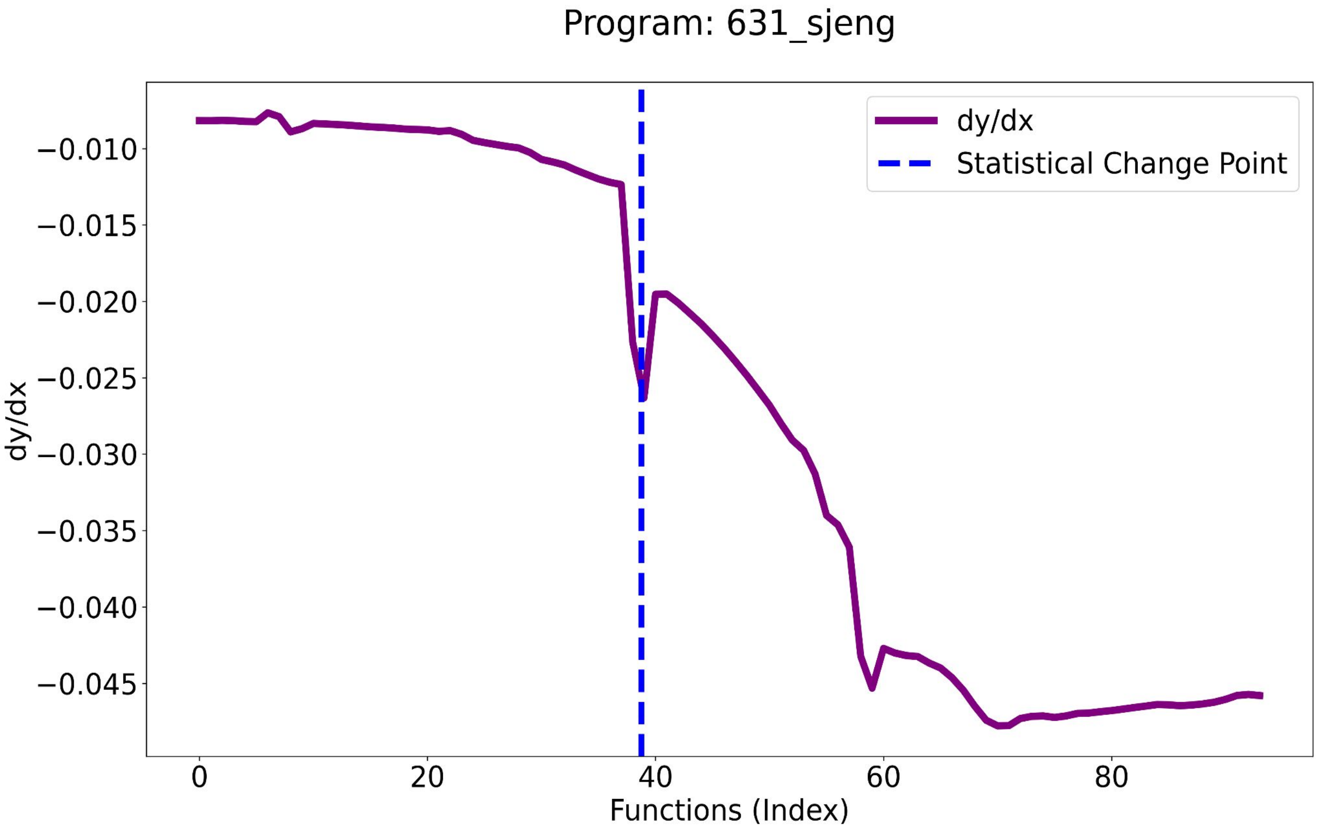

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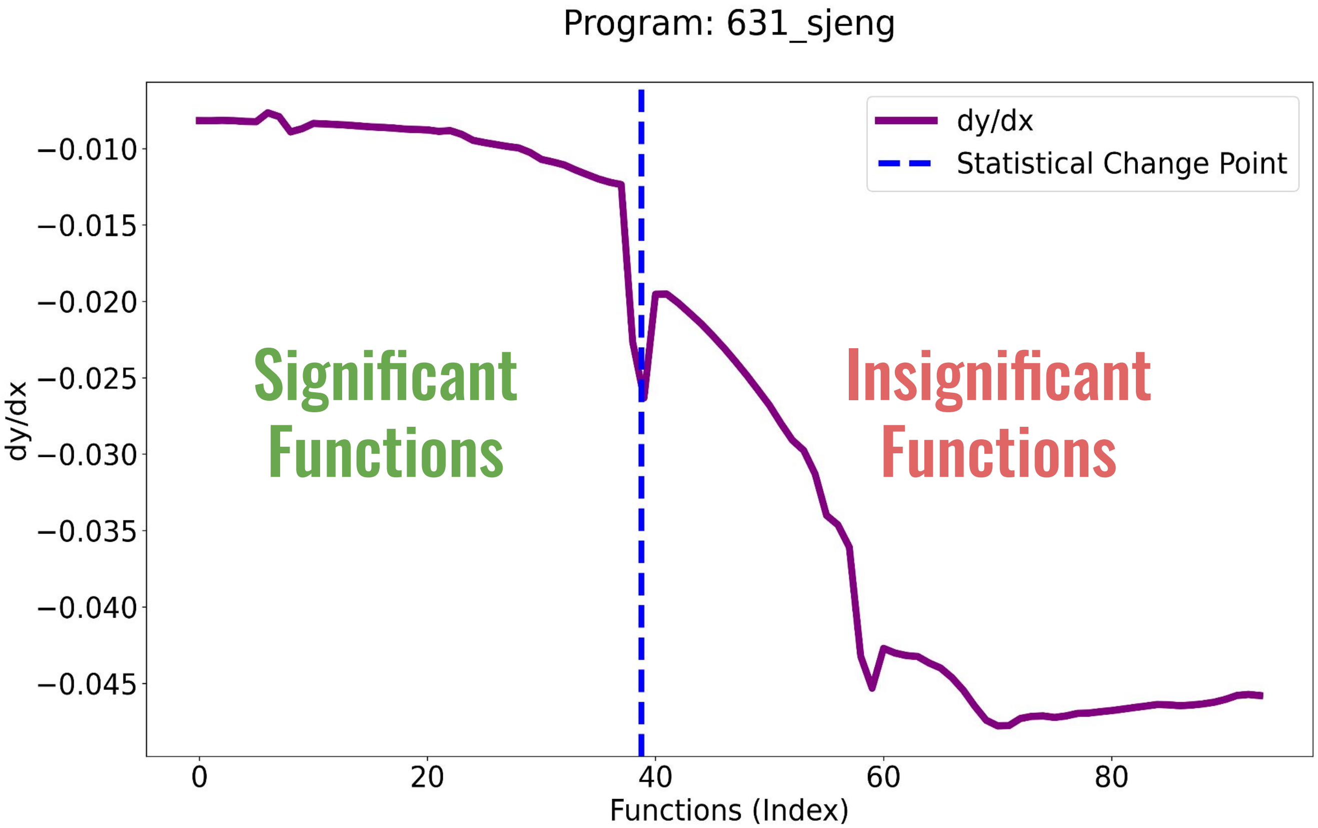

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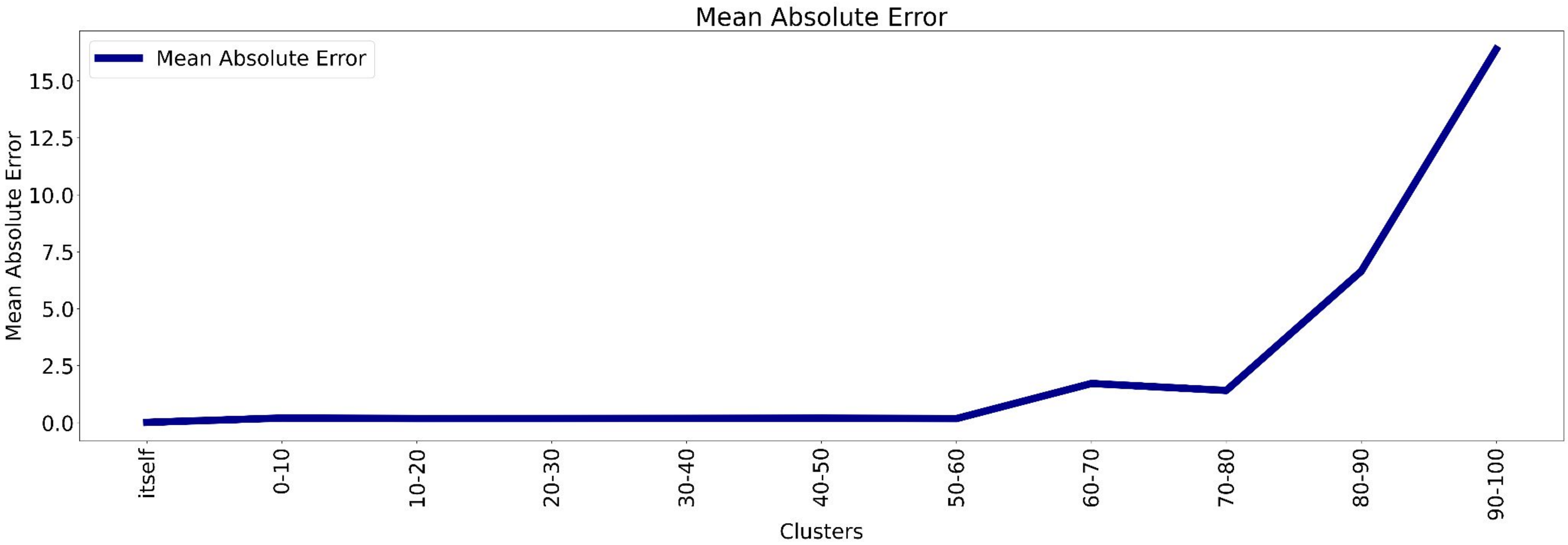

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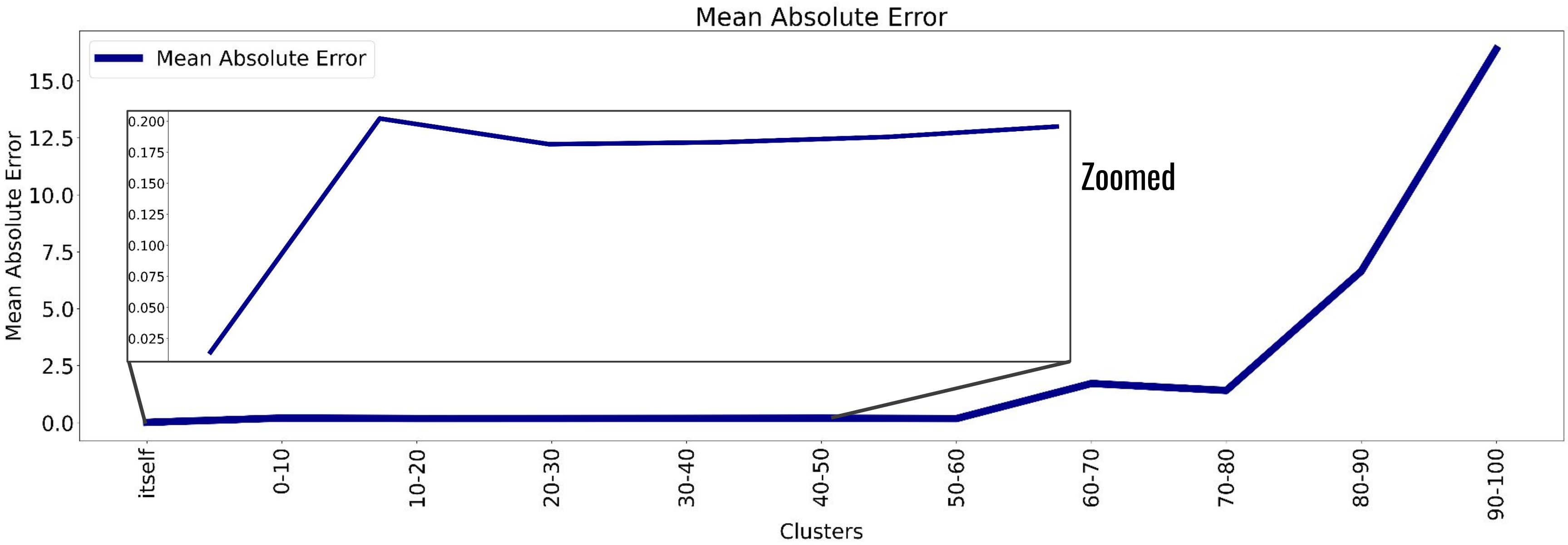

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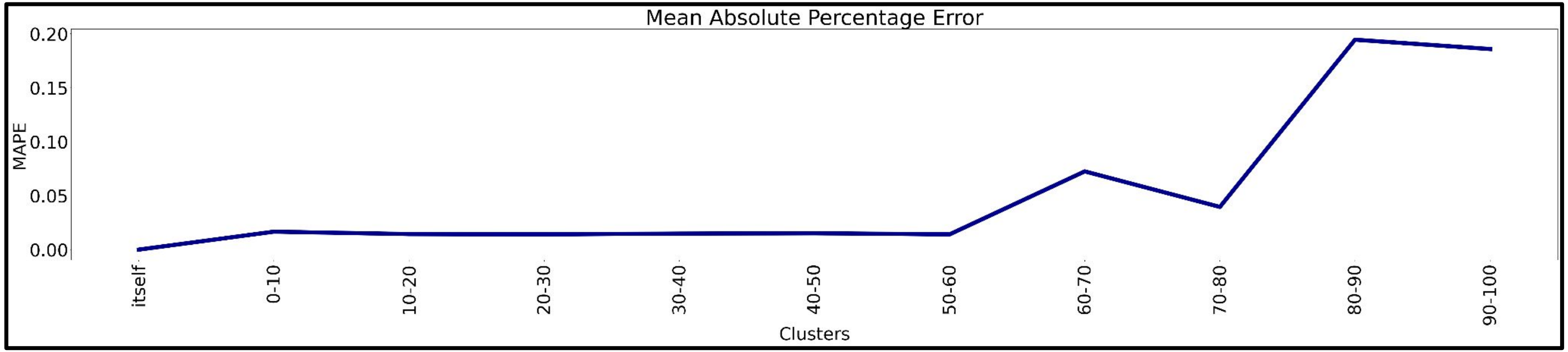

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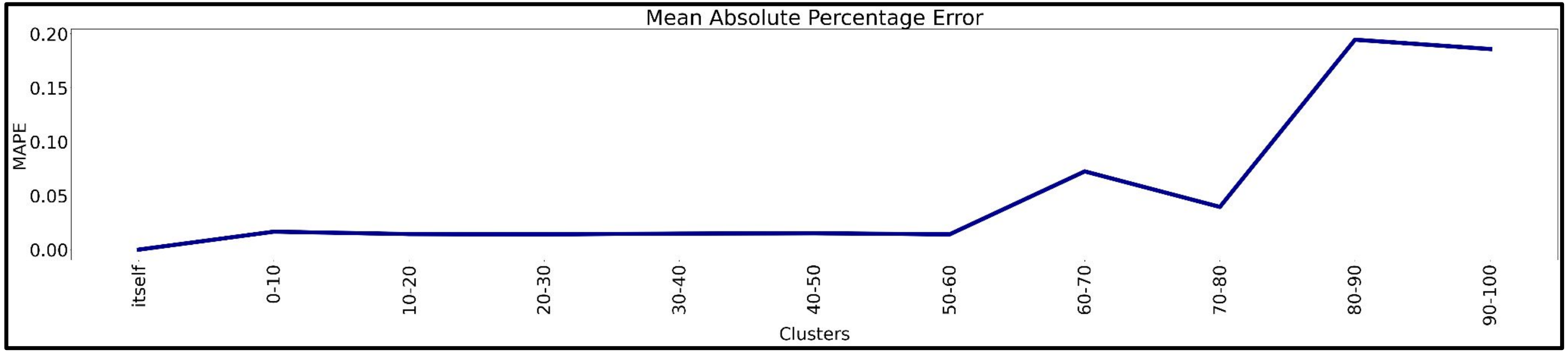

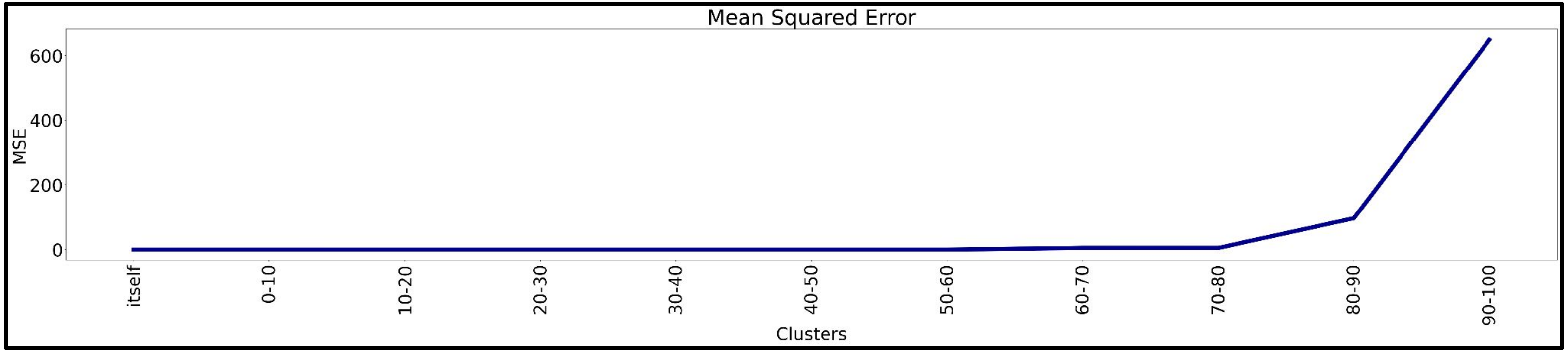

04 The Next Steps

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   A. Investigate further the performance model's accuracy
   B. Change the injected regressions types

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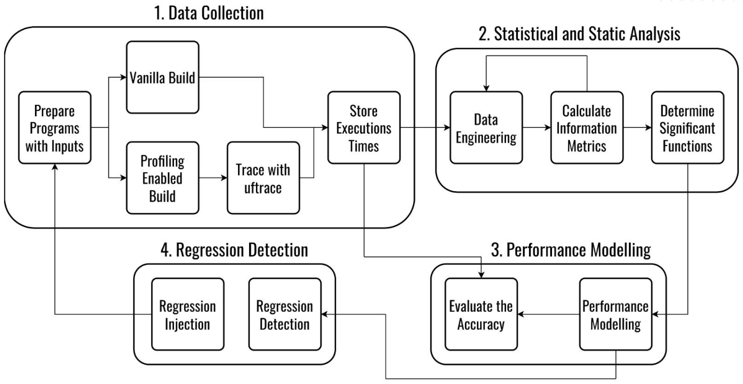
II. **Statistical and Static Analysis of the Characteristics of the Functions**
   A. Check whether it is possible (and accurate) to build an optimized performance model just through a statistical analysis of the program's source code
   B. Compare the impact of each function metric (LoC, Loops, etc.) on the performance model's accuracy

Overall Steps



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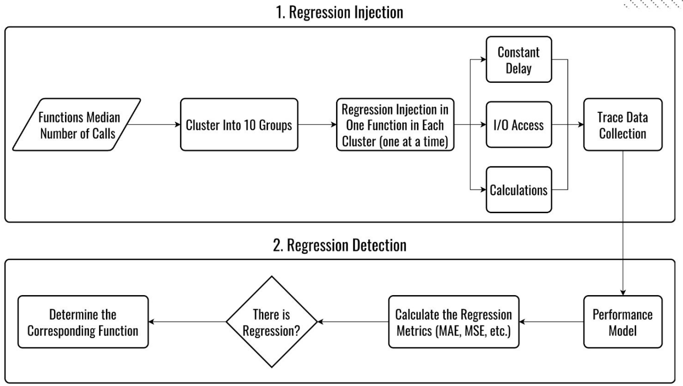

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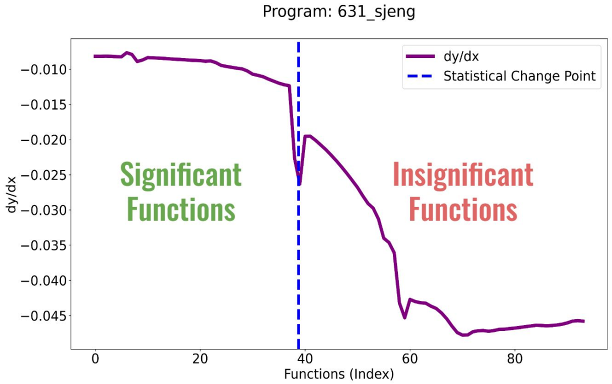

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linkedin.com/in/**kavehshahedi**

kaveh.shahedi@polymtl.ca