Part 1: Research Paper Exploration

URL: https://ieeexplore.ieee.org/document/8718630

1. Summary

The key objective of this paper was to provide researchers with more information on simulators since there was not enough documentation on simulators. They did this by comparing, analyzing, and even categorizing the simulators which would help in understanding the simulators and their use.

Methodologies

There were two methodologies mentioned in the paper:

A. The Target System
    a. Used for experiments based on Intel's Haswell microarchitecture.
    b. Relied on other sources to configure the simulation to match this target
    c. As the simulators did not support micro-operation fusion, the width of the pipeline stages was set to a comparable number of simple micro-operation
    d. Simulators were configured to match the chosen reference system
    e. Purpose: compare the simulators absolute and relative accuracy with each other and not to validate simulators
    f. Despite configuring the predictors as close as possible, some specifications of the simulators were not exactly the same
B. Experimental Workloads and Performance Measurement on Real Hardware
    a. Used SPEC-CPU2006 and a subset of MiBench embedded benchmarks
    b. Embedded benchmarks complete their execution in a realistic time on a simulated system whereas SPEC benchmarks can take a long time
    c. Real hardware:
        i. PAPI was used to measure the instructions per cycle (IPC), cache misses, branch mispredictions values for the entire execution of embedded benchmarks
        ii. SPEC-CPU2006 benchmarks: measured the same parameters for the same 500 million simulated instructions

Findings of the Study

- Sniper provides the minimum absolute error and the ZSim is the fastest for single-core simulations

- How it is important to validate simulators as there are some sources of inaccuracies within computer architecture simulators

2. Critical Analysis:

Three major advantages of computing applications:

- Helpful for new researchers which makes it easier for them to select and use the right simulators for their projects
- Recognizes how important accurate simulation results are by comparing the simulator outputs with real hardware
- There are in-depth comparisons of multiple simulators which help the researchers in knowing which one they need.

Two potential limitations:

- To accurately provide a sampling point with the architectural state's starting image (ASSI)
- Simulators that are functional require ASSI in order to achieve a correct output
- The issue with working with sampling techniques

3. Application

- Through the article I was able to understand how important simulators accuracy is and was also able to take a good look at the overview of a computer's components and the most important parts of a computer's architecture.

Part 2: Evaluating emulsiV

Link: https://eseo-tech.github.io/emulsiV/

Overview:

It is a visual simulator that is designed to teach architecture concepts using RISC-V instructions step-by-step. Its purpose is to make understanding computer architecture easier and more interactive through real-time visualizations.

Advantages of Using emulsiV:

- Interactive
    - As it is an interactive interface it makes it easier for students to understand complex computer architecture concepts
- Real-Time Visualization
    - There is a real-time visualization of how data transfers and how instructions are executed which helps understanding processors dynamic behaviour.
- Customization and flexibility
    - There are a range of customization options like animation speed and different views along with examples and it makes it easier for different learning scenarios.

Disadvantages or limitations of using emulsiV:

1. Limited to RISC-V architecture: emulsiV is designed for the RISC-V instruction set which limits usability for other users who want to learn other architectures.
2. Learning: It may be hard to learn for beginners who are not familiar with functions of the architectures or instruction sets. They may need to use other resources to understand all of its features.

Comparison with Traditional Tools

emulsiV vs. gem5:

- Both have a big learning curve because you require a deeper understanding of computer architecture
- emulsiV has an educational focus which makes it easier for beginners to interact with
- emulsiV provides real-time visualizations of data flow and instruction execution whereas gem5 offers detailed and cycle-accurate simulations

Practical Application

emulsiV would be a simulator for IT or computer science students who want to develop a different educational module. You can create interactive tutorials which explain each part of the simulator such as the instruction execution, pipeline processing, memory hierarchy and more. Students would also be able to experiment with the sequences and actually understand the different architectural designs on performance. It would enhance learning outcomes and make it easier for students to understand.