Computer Architecture Explorer

Members: Ben Endara, Tianfang Guo, Cordell Mazzetti, Jackson Schilling
Faculty Mentor: Professor Mattan Erez
April 29th, 2024

The University of Texas at Austin
Chandra Department of Electrical and Computer Engineering
Cockrell School of Engineering

Abstract

Computer Architecture is sometimes difficult for students to visualize the effects of certain design decisions on the overall system. We wish to mitigate this issue in student learning by providing a tool to create these visualizations.

Design Problem

The goal of this project was to build an educational web-based tool for students taking Computer Architecture courses to assist them as they learn the material throughout the semester.

The main phases of the project were split into three segments:

1. Identifying the parameters to simulate, benchmarks to be run, and receiving performance output data from the simulator
2. Storing only the required simulator output data in an online database
3. Designing a website to access the database and display simulator output data to users

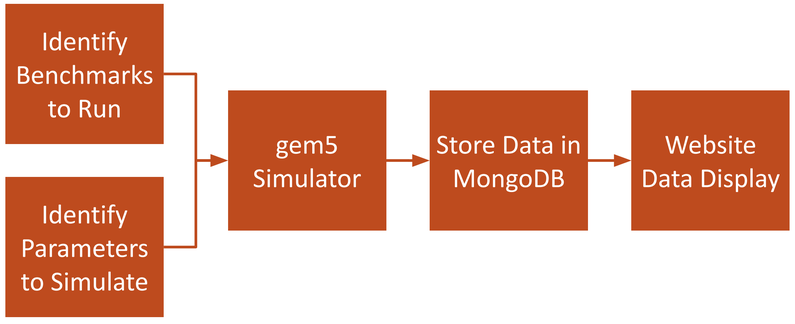

Figure 1. Data Flow Block Diagram

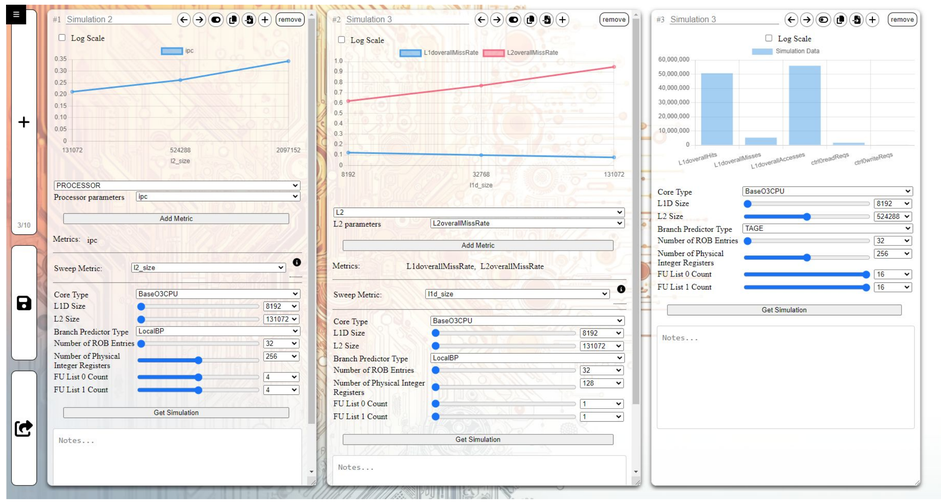

Figure 2. Website

Design Solution

The SPEC CPU 2017 benchmark was selected since it is an industry standard.

The parameters were chosen based on what is learned in the class that this tool is meant to be used alongside.

The gem5 simulator was chosen due to its flexibility and previous use in research.

Valgrind and SimPoint were used to create checkpoints from SPEC for detailed simulation.

These checkpoints were simulated varying across each value of each parameter to create the database of results, which was stored using MongoDB due to its ease of use and familiarity.

The website is structurally sound using a single frontend web server which interfaces with the database. It was built with flexibility and simplicity in mind for the user.

Simulation Parameters

The user configures these aspects of the system:

Architectural
- Execution Order
- Branch Predictor
- RAS Size

L1/L2 Cache
- Size
- Associativity

Out of Order
- ROB Size
- Register Count
- ALU Count
- Mult/Div Unit Count

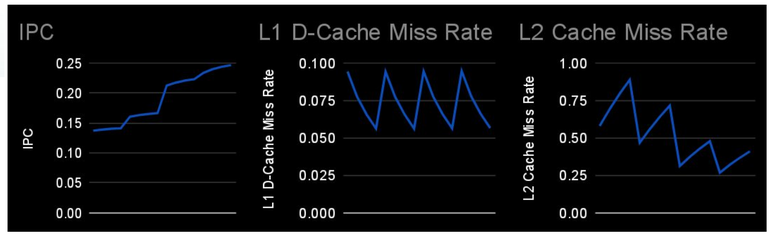

Figure 3. Simulation Parameter Data Graphing

Testing and Evaluation

Thorough testing was performed on all three major phases of the project:

Simulator
- Customizability
- Simulation Speed

Database
- Access Efficiency
- Correct Data Storage
- Correct Data Reads

Website
- Unit Testing
- Edge Case Testing

Conclusion

The final product was a helpful online tool for students to view and compare simulations. Possible future work would include adding more parameter and benchmark options, simulator data outputs, and visual aids.