ECE/CS 466 Project

(Graduate Students Only)

In this project, you are asked to learn how to use and modify the popular architectural simulator, SimpleScalar, to analyze the performance impact of different architectural designs. The project has two parts.

First, you need to download "simplesim-3v0e.tgz" from www.simplescalar.com and install the simulator on your computer. If your computer is windows-based, you need to install the simulator either under "cygwin" or a Linux-like virtual machine.

When you install the codes, please use the PISA configuration (follow the installation instruction in file "README" and use "make config-pisa"). To verify the installation, run the testing with command of "./sim-safe tests/bin.little/test-math". You should see printed results as shown in the class.

Next, you will use SimpleScalar to run a SPEC2000 benchmark program, equake. This is a floating-point application for Seismic Wave Propagation Simulation. You can download the PISA binary code of equake (equake.ss) and the input file (equake.in) from the blackboard. It's better to put the two files under the same directory of sim-outorder and sim-safe on your computer.

Now, you can begin the following experiments to see the performance impact of varying hardware parameters and implementations. Run the simulation, report and analyze the observed results. Please attach the screenshots of related statistics and starting time of the simulation as appendix of your report.

Part 1

Due: November 20, 2018

Since running the program from beginning to end using the most detailed simulator included, sim-outorder, would take too long, a widely used approach is to fast-forward the program to bypass the initialization phase and then run only a small portion of the program in details. Please use the following option "-fastfwd 350000000" to fast-forward the first 350 million instructions and then collect detailed statistics on the next 250 million instructions (using the option "-max:inst 250000000").

1. What is the performance of running the program, equake, under the default system setup (without changing any simulation parameters) using command: ./sim-outorder -fastfwd 350000000 -max:inst 250000000 equake.ss < equake.in ?

2. How much is the performance loss if the processor uses in-order execution instead of the default out-of-order execution to run the program?

3. The above experiments only perform detailed simulation on 250 million instructions. Based on the simulator running time in Question 1, estimate how long it would take to simulate the program's execution in details from beginning to end using the default configuration. Note: Do not actually run the detailed simulation from beginning to end. It may take hours or even days to finish depending on the speed of your computer.

4. An advantage of using simulator is that you can vary the processor parameters to see their performance impact. In the default configuration, the processor pipeline (fetch, decode, issue and commit) bandwidth is 4. If all the other parameters are kept the same, how much is the performance improvements when the pipeline bandwidth increases 8? Usually when the pipeline bandwidth increases, the capacity of other hardware components should also increase to have a balanced design. Which component should double its size first, RUU, LSQ, integer ALU, integer multiplier, floating-point ALU, or floating-point multiplier? Use experimental results to support your claim.

Hint:

- You need to use "sim-outorder" in order to get any performance-related statistics such as the CPI or IPC value.
- There is no program called sim-inorder for in-order execution. But sim-outorder has an option to perform in-order execution.
- The reported "sim_elapsed_time" is how fast the simulator runs on your computer instead of how fast the program runs on the simulated processor.
- For Question 3, you can use "sim-safe" to run the program till the end to get the total number of instructions of the program (it may take a few hours depending on the speed of your computer) and then do the estimation.
- If you do not the result for question 1 within one hour, it's very likely that the "max:inst" option is put on a wrong place and does not take effect. You should kill the program and restart the correct simulation.