ECE571: Advanced Microprocessor Design – Homework 1

Due: Thursday 1 February 2018, 3:30pm

1. **Background**

   - For this assignment, log into the Haswell/Quadro machine as described on the account slip that I handed out in class.
   - On Linux or OSX you will do the following (replace `username` with the one on the slip):
     ```
     ssh -p 2600 username@weaver-lab.eece.maine.edu
     ```
   - On a Windows machine you'll want to get a program such as `putty`, some directions can be found here:
     `http://web.eece.maine.edu/~vweaver/classes/ece571_2013s/using_ssh.html`
     Be sure you are connecting to port 2600 (not the default ssh port).
   - Be sure to change your password using the `passwd` command once you log in.
   - We will use the `401.bzip2` benchmark from the SPEC CPU 2006 benchmark suite.
   - Create a document that contains the data described in the Analysis sections below. A `.pdf` or `.txt` file is preferred but I can accept MS Office format if necessary.

2. **Aggregate Event Counts**

   (a) perf tool

   - First copy the input file to your local directory:
     ```
     cp /opt/ece571/401.bzip2/input.source .
     ```
   - Use the perf tool to gather user instruction counts for bzip2:
     ```
     perf stat -e instructions:u /opt/ece571/401.bzip2/bzip2 -k -f ./input.source
     ```

   i. Run the benchmark 5 times.
   Report the instruction count for each, as well as the overall average.

   ii. Run the benchmark 5 more times, but this time measure user cycles rather than instructions. Report the cycle count for each, as well as the overall average.

   iii. Now gather and report the results for `bzip2.reverse` which is the same benchmark, but compiled with the link order reversed (reverse alphabetical rather than alphabetical).
   ```
   perf stat -e instructions:u,cycles:u /opt/ece571/401.bzip2/bzip2.reverse -k -f ./input.source
   ```
   Gather results for instructions and cycles (5 times) and report the individual and overall average results.

   (b) Questions to Answer

   i. Are the instruction counts deterministic, or do they vary? How large is the variation?

   ii. Are the cycle counts deterministic, or do they vary? How large is the variation?

   iii. Does changing the link order change the instructions or cycle metrics?

3. **Sampled Results**

   (a) perf

      i. Use perf to gather sampled data on the benchmark:

         ```
         time perf record -e instructions /opt/ece571/401.bzip2/bzip2 -k -f ./input.source
         ```

         Note how long this took to run.

      ii. Use `perf report` and report the top 5 most used functions.

      iii. Use `perf annotate` to report which assembly instruction caused the most CPU use, as well as a few instructions on either side.

   (b) Valgrind DBI tool

      i. Use valgrind to gather sampled data.

         ```
         time valgrind --tool=callgrind /opt/ece571/401.bzip2/bzip2 -k -f ./input.source
         ```

         Note how long it takes (note: it may take a while).

      ii. Use `callgrind_annotate` for a report on the most used functions; report the top 5.

   (c) gprof

      i. The bzip2.gprof binary was compiled with -pg profiling support. (Note, using gcc-5 as gprof seems to be broken on gcc-6 and gcc-7). Gather profiling data with it, note how long it took to run.

         ```
         time /opt/ece571/401.bzip2/bzip2.gprof -k -f ./input.source
         ```

      ii. Get a report on the most used functions, report the top 5

         ```
         gprof /opt/ece571/401.bzip2/bzip2.gprof
         ```

   (d) Questions to Answer

      i. Did the three different methods of gathering function CPU use return the same results?

      ii. What were the relative speeds of the various methods of gathering the information?

4. **Skid**

   - Re-run the perf record / perf annotate results, but use the event `instructions:ppp` instead of `instructions`
   - Questions to Answer:

     (a) Which instruction was reported as taking the most time for the two cases?

     (b) Which do you think is more likely?

     (c) What is the cause of this difference?

5. Submitting your work.

   - Create the document containing the data as well as answers to the questions asked. (Text of pdf is best, Word/LibreOffice if you must).
   - Please make sure your name appears in the document.
   - e-mail the file to me by the homework deadline.