

ECE571: Advanced Microprocessor Design – Homework 6
Prefetching
Fall 2022

Due: Friday 28 October 2022, 5:00pm

Create a document that contains the data and answers described in the sections below. A .pdf or .txt file is preferred but I can accept MS Office or Libreoffice format if necessary.

1. Bzip2 prefetch behavior on the x86 Haswell-EP Machine

For this section, log into the Haswell-EP machine just like in previous homeworks.

Run the bzip2 benchmark on the Haswell machine.

- (a) Measure (in one command) bzip using the following events: `l2_rqsts.all_demand_references` which is total L2 cache accesses, `l2_rqsts.demand_data_rd_miss` which is total demand L2 cache misses, and `l2_rqsts.all_pf` which is total prefetches into the L2 cache.

```
perf stat -e l2_rqsts.all_demand_references:u,\
l2_rqsts.demand_data_rd_miss:u,\
l2_rqsts.all_pf:u \
/opt/ece571/401.bzip2/bzip2 -k -f ./input.source
```

Note, if the program finishes instantly with an error message, be sure you have `input.source` in your current directory. You can recopy it with

```
cp /opt/ece571/401.bzip2/input.source .
```

Calculate the L2 cache miss rate from the first two results (misses/total), the third event is just informational, it in theory tracks total number of prefetches.

Note all 3 values, the rate, and total time.

2. Software Prefetching and bzip2 on Haswell-EP

- (a) Re-run the previous prefetch results on Haswell, but instead of running `bzip2` run `bzip2.swprefetch` which was compiled with `-fprefetch-loop-arrays` which enables sw prefetch instructions.

Record the miss rate and total time.

```
perf stat -e l2_rqsts.all_demand_references:u,\
l2_rqsts.demand_data_rd_miss:u,\
l2_rqsts.all_pf:u \
/opt/ece571/401.bzip2/bzip2.swprefetch -k -f ./input.source
```

3. **equake_1 prefetch behavior on the x86 Haswell-EP Machine**

Run `equake_1`:

```
(a) perf stat -e l2_rqsts.all_demand_references:u,\
    l2_rqsts.demand_data_rd_miss:u,\
    l2_rqsts.all_pf:u \
/opt/ece571/equake_1.speccomp/equake_1 < \
/opt/ece571/equake_1.speccomp/inp.in
```

Calculate the L2 cache miss rate from the first two results, also note the total time.

4. **equake_1 software prefetch behavior on the x86 Haswell-EP Machine**

Run `equake_1` with software prefetch enabled:

```
(a) perf stat -e l2_rqsts.all_demand_references:u,\
    l2_rqsts.demand_data_rd_miss:u,\
    l2_rqsts.all_pf:u \
/opt/ece571/equake_1.speccomp/equake_1.swprefetch < \
/opt/ece571/equake_1.speccomp/inp.in
```

Calculate the L2 cache miss rate from the first two results, also note the total time.

5. **Hardware Prefetch Disabled**

It is possible to disable hardware prefetch on modern Intel processors.

See:

<https://software.intel.com/en-us/articles/disclosure-of-hw-prefetcher-control-on-some-intel-processors> for details.

It requires root permissions, so I have re-run the four experiments above with the results summarized in the table below.

L2 extended results, HW Prefetch Disabled, Haswell-EP

| benchmark | L2-total | L2-miss | L2-prefetches | time |
|---------------------|----------------|----------------|---------------|-------|
| bzip2 | 295,148,679 | 130,346,668 | 62,885 | 4.00 |
| bzip2.swprefetch | 295,348,496 | 131,765,612 | 59,583 | 4.00 |
| equake_1 | 29,939,302,233 | 20,929,001,917 | 9,241,889 | 62.94 |
| equake_1.swprefetch | 29,829,058,607 | 20,921,333,239 | 9,168,505 | 59.29 |

6. Short Answer Questions

- (a) Did enabling software prefetch help on bzip2? (i.e. compare the results in question 1 and question 2?)
- (b) Did enabling software prefetch help on equake_1? (i.e. compare the results in question 3 and question 4?)
- (c) How did turning off the prefetcher affect the bzip2 results (i.e. question 1 vs question 5?)
- (d) How did turning off the prefetcher affect the equake_1 results (i.e. question 3 vs question 5?)
- (e) With the hardware prefetcher disabled, did enabling software prefetch help at all? (question 5)
- (f) Why do you think the software prefetch performance is so underwhelming?

7. Submitting your work.

- Create the document containing the data as well as answers to the questions asked.
- Please make sure your name appears in the document.
- e-mail the file to me by the homework deadline.