15-213: Introduction to Computer Systems Written Assignment #4

This written homework covers the Memory Hierarchy and Cache Memories.

Directions

Complete the question(s) on the following pages with single paragraph answers. These questions are not meant to be particularly long! Once you are done, submit this assignment on Canvas.

Below is an example question and answer.

Q: Please describe benefits of two's-complement signed integers versus other approaches.

A: Other representations of signed integers (ones-complement and sign-and-magnitude) have two representations of zero (+0 and −0), which makes testing for a zero result more difficult. Also, addition and subtraction of two’s complement signed numbers are done exactly the same as addition and subtraction of unsigned numbers (with wraparound on overflow), which means a CPU can use the same hardware and machine instructions for both.

Grading

Assignments are graded via *peer review:*

1. Three other students will each provide short, constructive feedback on your assignment, and a score on a scale of 1 to . You will receive the maximum of the three scores.
2. You, in turn, will provide feedback and a score for three other students (not the same ones as in part 1). We will provide a *rubric*, a document describing what good answers to each question look like, to assist you. You receive five additional points for completing all of your peer reviews.

Due Date

This assignment is due on July 6 by 11:59pm Pittsburgh time (currently UTC−4). Remember to convert this time to the timezone you currently reside in.

Peer reviews will be assigned roughly 12 hours later, and are due a week after that.

Question 1

1. Explain one thing that cache can do but main memory can’t and one thing that main memory can do but a cache can’t. If comparing speed or size, be sure to give approximate quantities.
2. Explain one thing that main memory can do but local disks can’t and one thing that local disks can do but main memory can’t. If comparing speed or size, be sure to give approximate quantities.

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Question 2

How does a write-back cache handle a write hit differently than a write-through cache? What are the pros and cons of a write-through cache? What are the pros and cons of a write-back cache?

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Question 3

Consider a cache of the following configurations

Total Cache Size = 1024 bytes

Block size = 32 bytes

Number of sets = 8

16 bit address space

1. How many block, set, and tag bits are there?
2. How many lines are there per set?
3. Memory is accessed at the address 0x1A23. Write out the tag, set and block bits.
4. Next, memory is accessed at 0x1B32. Is this a hit or a miss? If it is a miss, what kind, and does it evict the other line from the cache? If it is a hit, what kind of locality does it share with the other line?
5. Following this, the next byte of data is accessed with address 0x1B33. Is this a hit or a miss? If it is a miss, what kind, and does it evict the other line from the cache? If it is a hit, what kind of locality does it share with the other line?
6. Finally, the programmer begins a program which loops, accessing 33 distinct places in memory, none of which share a cache block. What kind of misses does this pattern create? How can you differentiate this from any other kinds of misses discussed in (D) or (E)?

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