

Homework 5

Friday, November 19, 2021

6:04 PM

#1 (A) $16 \times 8 = 128$ $\frac{128}{8} = 2 \text{ integers}$

(B) the last line of code repeatedly access I and J, so keeping the values of I & J would speed up the operation through Temporal Locality

(C) I & J are accessed by incrementation, so this would also be an example of Spatial Locality since the values referenced by I and J will be next to each other in memory

#2

(A)

| | | | | |
|------|-----------|---|---|------|
| 0x03 | 0000 0011 | 0 | 3 | Miss |
| 0x84 | 1011 0100 | 8 | 4 | Miss |
| 0x2B | 0010 1011 | 2 | B | Miss |
| 0x02 | 0000 0010 | 0 | 2 | Miss |
| 0xBF | 1011 1111 | B | F | Miss |
| 0x58 | 0101 1000 | 5 | 8 | Miss |
| 0xBE | 1011 1110 | 6 | E | Miss |
| 0x0E | 0000 1110 | 0 | E | Miss |
| 0xB5 | 1011 0101 | 6 | 5 | Miss |
| 0x2C | 0010 1100 | 2 | C | Miss |
| 0xBA | 1011 1010 | B | A | Miss |
| 0xFD | 1111 1101 | F | D | Miss |

(B)

| | | | | |
|------|-----------|---|---|------|
| 0x03 | 0000 0011 | 0 | 1 | Miss |
| 0x84 | 1011 0100 | B | 2 | Miss |
| 0x2B | 0010 1011 | 2 | 5 | Miss |
| 0x02 | 0000 0010 | 0 | 1 | Hit |
| 0xBF | 1011 1111 | B | 7 | Miss |
| 0x58 | 0101 1000 | 5 | 4 | Miss |
| 0xBE | 1011 1110 | B | 7 | Hit |
| 0x0E | 0000 1110 | 0 | 7 | Miss |
| 0xB5 | 1011 0101 | B | 2 | Hit |
| 0x2C | 0010 1100 | 2 | 6 | Miss |
| 0xBA | 1011 1010 | B | 5 | Miss |
| 0xFD | 1111 1101 | F | 6 | Miss |

(C) L2 with two word blocks results in fewer misses so it is the best cache design

#3 (A) Cache size $\rightarrow 2^5 = 32 \text{ words}$

(B) 9-5 bits index $\rightarrow 2^5 = 32 \text{ blocks}$

(C) 54 bit tag 32 words size n

$$\frac{54 + (32 \times n)}{32 \times n}$$

(D)

| | Index | |
|-----|-------|------|
| 00 | 00000 | Miss |
| 04 | 0000 | Hit |
| 10 | 00000 | Hit |
| 84 | 00100 | Miss |
| E8 | 00111 | Miss |
| A0 | 00101 | Miss |
| 400 | 00000 | Miss |
| 1E | 00000 | Miss |
| 8C | 00100 | Hit |
| C1C | 00000 | Miss |
| B4 | 00101 | Hit |
| 884 | 00100 | Miss |

(e) $\frac{4}{12}$ hit ratio

(F) 4,2 Mem[0x880]-Mem[0x89F]
0,3 Mem[0xc00]-Mem[0xc1F]
5,0 Mem[0xA0]-Mem[0xBF]
7,0 Mem[0xE0]-Mem[0xFF]

(4) (A) P1 $\rightarrow \frac{1}{.66} = 1.515 \text{ GHz}$

P2 $\rightarrow \frac{1}{.9} = 1.11 \text{ GHz}$

(B) P1 $\rightarrow [.92 \times .66] + [.08 \times 70] = 5.6 \text{ nanoseconds}$

P2 $\rightarrow [.94 \times .9] + [.06 \times 70] = 4.2 \text{ nanoseconds}$

(C) P1 $\rightarrow [.36 \times .08] \times [70 / .66] = (3.054) \times (\text{Instruction Count})$

P2 $\rightarrow [.36 \times .06] \times [70 / .90] = (1.68) \times (\text{Instruction Count})$

P1 $\rightarrow \frac{\text{Total Cycles}}{\text{Instruction Count}} = \text{CPI} = 3.054$

P2 $\rightarrow \text{CPI} = 1.68$

#5 (A) Block $\rightarrow 2 \text{ words}$

Cache $\rightarrow 48 \text{ words}$

Word Addr. Size $\rightarrow 8 \text{ bits}$

| Tag | Index | Offset |
|-----|-------|--------|
| 4 | 3 | 1 |

(B)

| | Tag | Index | Offset | |
|----|------|-------|--------|------|
| 03 | 0000 | 1 | 1 | Miss |
| 84 | 1011 | 2 | 0 | Miss |
| 2B | 0010 | 5 | 1 | Miss |
| 02 | 0000 | 1 | 0 | Hit |
| BE | 1011 | 7 | 0 | Miss |
| 58 | 0101 | 4 | 0 | Miss |
| BF | 1011 | 7 | 1 | Hit |
| 0E | 0000 | 7 | 0 | Miss |
| 1F | 0001 | 7 | 1 | Hit |
| B5 | 1011 | 2 | 1 | Hit |
| BF | 1011 | 7 | 1 | Hit |
| BA | 1011 | 5 | 0 | Miss |
| 2E | 0010 | 7 | 0 | Miss |
| CE | 1100 | 7 | 0 | Miss |

(C)

| | | |
|----|----|------|
| 03 | 03 | Miss |
| 84 | 64 | Miss |
| 2B | 2B | Miss |
| 02 | 02 | Miss |
| BE | BE | Miss |
| 58 | 58 | Miss |
| BF | BF | Miss |
| 0E | 0E | Miss |
| 1F | 1F | Miss |
| B5 | B5 | Miss |
| BF | BF | Hit |
| BA | BA | Miss |
| 2E | 2E | Miss |
| CE | CE | Miss |

6 $\frac{\left(\frac{32}{2}\right)}{\left(\frac{2}{2^{13}}\right)} = 2^{17}$

4 Bytes $\rightarrow 2^{32} \text{ pages}$ 2^{13} per page $2^{32} \times 2^{13} = 2^{45} \text{ B}$

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| | | index | valid | page # |
|------|------------|-------|-------|--------|
| 123D | Miss | 0 | 1 | 5 |
| 08B3 | Hit | 1 | 0 | 13 |
| 365D | Hit | 2 | 0 | 14 |
| 871B | Hit | 3 | 1 | 6 |
| 8EE6 | Page Fault | 4 | 1 | 9 |
| 3146 | Hit | 5 | 1 | 11 |
| C099 | Page Fault | 6 | 0 | 9 |
| | | 7 | 1 | 4 |
| | | 8 | 0 | 2 |
| | | 9 | 0 | 5 |
| | | A | 1 | 3 |
| | | B | 1 | 12 |

TLB

| | | | |
|---|-----|----|---|
| 1 | 0x1 | 13 | 1 |
| 1 | 0x7 | 4 | 7 |
| 1 | 0x3 | 6 | 4 |
| 1 | 0x2 | 14 | 3 |