Exercise 3: Given a computer with a 4MB main memory, byte-addressable, with a 2-way 4KB cache, 512B blocks and a fully-associative victim cache of 1024B. In both caches, the replacement policy is a FIFO. The initial cache state is the following:

| Set | Tag | FIFO state |
|---|---|---|
| 0 | 668 | 0 |
| 0 | 008 | 1 |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

| Tag | FIFO state |
|---|---|
| 0A80 | 0 |
| 3FFF | 1 |

Given the following sequence of accesses: 0x334500, 0x14BF00, 0x150084, 0x004021, 0x0540AB y 0x0041F1. Obtain the cache evolution, showing the tags, misses and transfers among both caches.

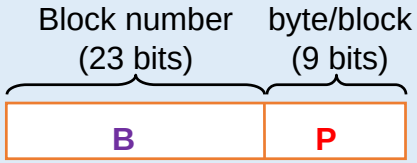
Exercise 3: Given a computer with a 4MB main memory, byte-addressable, with a 2-way 4KB cache, 512B blocks and a fully-associative victim cache of 1024B. In both caches, the replacement policy is a FIFO. The initial cache state is the following:

| Set | Tag | FIFO state |
|---|---|---|
| 0 | 668 | 0 |
| 0 | 008 | 1 |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

$$\frac{4096\ bytes}{512\ bytes/block} = 8\ blocks$$

$$\frac{8\ blocks}{2\ ways/set} = 4\ sets$$

**Fields of the memory address**



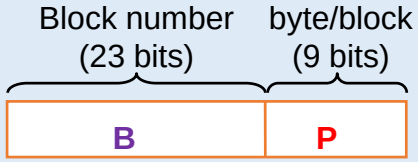


21 bits 2 bits

| Tag | FIFO state |
|---|---|
| 0A80 | 0 |
| 3FFF | 1 |

$$\frac{1024\ bytes}{512\ bytes/block} = 2\ blocks$$

**Fields of the memory address**



Given the following sequence of accesses:

| Address | Memory block (binary) | Cache tag and set |
|---|---|---|
| 0x334500 | 0011 0011 0100 010 | 0x0668, set 2 HIT |
| 0x14BF00 | 0001 0100 1011 111 | 0x0297, set 3 HIT |
| 0x150084 | 0001 0101 0000 000 | 0x02A0, set 0 MISS |
| 0x004021 | 0000 0000 0100 000 | 0x008, set 0 |
| 0x0540AB | 0000 0101 0100 000 | 0x0A8, set 0 |
| 0x0041F1 | 0000 0000 0100 000 | 0x008, set 0 |

| Set | Tag | FIFO state |
|---|---|---|
| 0 | 668 | 0 |
| 0 | 008 | 1 |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

Obtain the cache evolution, showing the tags, misses and transfers among both caches.

Given the following sequence of accesses:

| Address | Memory block (binary) | Cache tag and set |
|---|---|---|
| 0x334500 | 0011 0011 0100 010 | 0x0668, set 2 HIT |
| 0x14BF00 | 0001 0100 1011 111 | 0x0297, set 3 HIT |
| 0x150084 | 0001 0101 0000 000<br>0x0A80 | 0x02A0, set 0 Cache MISS<br>Victim cache hit: block 0x0A80 is mapped to set 0s, evicting block 0x668 (blocks are swapped). |

| Set | Tag | FIFO state |
|---|---|---|
| 0 | 668 | 0 |
| 0 | 008 | 1 |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

| Tag | FIFO state |
|---|---|
| 0A80 | 0 |
| 3FFF | 1 |

| Set | Tag | FIFO state |
|---|---|---|
| 0 | **2A0** | **1** |
| 0 | 008 | **0** |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

| Tag | FIFO state |
|---|---|
| 19A0 | 1 |
| 3FFF | 0 |

0x668, set 0: 0110 0110 1000 00

Given the following sequence of accesses:

| Address | Memory block (binary) | Cache tag and set |
|---|---|---|
| 0x334500 | 0011 0011 0100 010 | 0x0668, set 2 HIT |
| 0x14BF00 | 0001 0100 1011 111 | 0x0297, set 3 HIT |
| 0x150084 | 0001 0101 0000 000 | 0x02A0, set 0 MISS |
| 0x004021 | 0000 0000 0100 000 | 0x008, set 0 HIT |
| 0x0540AB | 0000 0101 0100 000 | 0x0A8, set 0 |
| 0x0041F1 | 0000 0000 0100 000 | 0x008, set 0 |

| Set | Tag | FIFO state |
|---|---|---|
| 0 | **2A0** | **1** |
| 0 | 008 | **0** |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

| Tag | FIFO state |
|---|---|
| 19A0 | **1** |
| 3FFF | **0** |
| | |

Obtain the cache evolution, showing the tags, misses and transfers among both caches.

Given the following sequence of accesses:

| Address | Memory block (binary) | Cache tag and set |
|---|---|---|
| 0x004021 | 0000 0000 0100 000 | 0x008, set 0 HIT |
| 0x0540AB | 0000 0101 0100 000 | 0x0A8, set 0 Cache MISS |
| | 0x02A0 | Victim cache MISS: |

block 0x008 set 0 is written in victim cache, evicting block 0x3FFF

| Set | Tag | FIFO state |
|---|---|---|
| 0 | **2A0** | **1** |
| 0 | 008 | **0** |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

| Set | Tag | FIFO state |
|---|---|---|
| 0 | **2A0** | **0** |
| 0 | 0A8 | **1** |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

| Tag | FIFO state |
|---|---|
| 19A0 | **0** |
| 0020 | **1** |

| Tag | FIFO state |
|---|---|
| 19A0 | **1** |
| 3FFF | **0** |

0x008, set 0: 0000 0000 1000 00

Given the following sequence of accesses:

| Address | Memory block (binary) | Cache tag and set |
|---|---|---|
| 0x0041F1 | 0000 0000 0100 000 | 0x008, set 0 Cache MISS |

Victim cache HIT

| Set | Tag | FIFO state |
|---|---|---|
| 0 | **2A0** | **0** |
| 0 | 0A8 | **1** |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

| Tag | FIFO state |
|---|---|
| 19A0 | 0 |
| 0020 | 1 |

| Set | Tag | FIFO state |
|---|---|---|
| 0 | **008** | **1** |
| 0 | 0A8 | **0** |
| 1 | 297 | 0 |
| 1 | 368 | 1 |
| 2 | 5FF | 0 |
| 2 | 668 | 1 |
| 3 | 297 | 1 |
| 3 | 200 | 0 |

| Tag | FIFO state |
|---|---|
| 19A0 | 0 |
| 0A80 | 1 |