TOGETHER. TOMORROW. EWHA

# Computer Architecture Homework #04

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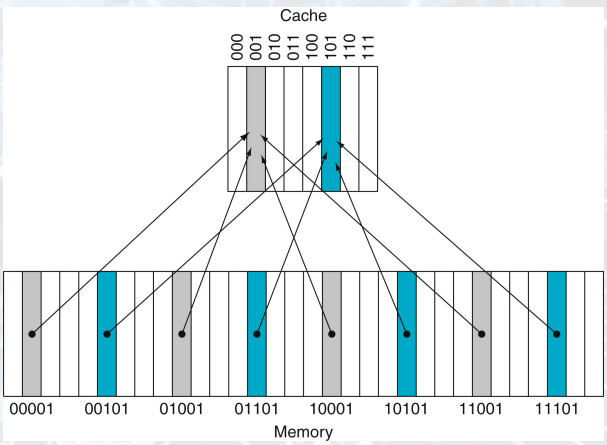
## Direct Mapped Cache

- **Location determined by address**
- **Direct mapped: only one choice**
  - (Block address) modulo (#Blocks in cache)



## Tags and Valid Bit

- **Each cache location can contain the contents of a number of different memory locations**
  - How do we know whether a requested word is in the cache or not?
- ***Tags:***
  - Contain the address information required to identify whether a word in the cache corresponds to the requested word.
  - It only contains upper portion of the address, corresponding to the bits that are not used as an index into the cache
- ***Valid bit:***
  - Indicates whether an entry contains a valid address



## Cache Example

- **8-blocks, 1 word/block, direct mapped**
- **Initial state**

| Index | V | Tag | Data |
|---|---|---|---|
| 000 | N | | |
| 001 | N | | |
| 010 | N | | |
| 011 | N | | |
| 100 | N | | |
| 101 | N | | |
| 110 | N | | |
| 111 | N | | |

# Cache Example

| Word Addr | Binary Addr | Hit/Miss | Cache Block |
|---|---|---|---|
| 22 | 10 110 | Miss | 110 |

| Index | V | Tag | Data |
|---|---|---|---|
| 000 | N | | |
| 001 | N | | |
| 010 | N | | |
| 011 | N | | |
| 100 | N | | |
| 101 | N | | |
| **110** | **Y** | **10** | **Mem[10 110]** |
| 111 | N | | |



# Cache Example

| Word Addr | Binary Addr | Hit/Miss | Cache Block |
|---|---|---|---|
| 26 | 11 010 | Miss | 010 |

| Index | V | Tag | Data |
|---|---|---|---|
| 000 | N | | |
| 001 | N | | |
| **010** | **Y** | **11** | **Mem[11 010]** |
| 011 | N | | |
| 100 | N | | |
| 101 | N | | |
| 110 | Y | 10 | Mem[10 110] |
| 111 | N | | |

# Cache Example

| Word Addr | Binary Addr | Hit/Miss | Cache Block |
|---|---|---|---|
| 22 | 10 110 | Hit | 110 |
| 26 | 11 010 | Hit | 010 |

| Index | V | Tag | Data |
|---|---|---|---|
| 000 | N | | |
| 001 | N | | |
| 010 | Y | 11 | Mem[11 010] |
| 011 | N | | |
| 100 | N | | |
| 101 | N | | |
| 110 | Y | 10 | Mem[10 110] |
| 111 | N | | |



# Cache Example

| Word Addr | Binary Addr | Hit/Miss | Cache Block |
|---|---|---|---|
| 16 | 10 000 | Miss | 000 |
| 3 | 00 011 | Miss | 011 |

| Index | V | Tag | Data |
|---|---|---|---|
| 000 | Y | 10 | Mem[10 000] |
| 001 | N | | |
| 010 | Y | 11 | Mem[11 010] |
| 011 | Y | 00 | Mem [00 011] |
| 100 | N | | |
| 101 | N | | |
| 110 | Y | 10 | Mem[10 110] |
| 111 | N | | |

# Cache Example

| Word Addr | Binary Addr | Hit/Miss | Cache Block |
|---|---|---|---|
| 16 | 10 000 | Hit | 000 |

| Index | V | Tag | Data |
|---|---|---|---|
| 000 | Y | 10 | Mem[10 000] |
| 001 | N | | |
| 010 | Y | 11 | Mem[11 010] |
| 011 | Y | 00 | Mem [00 011] |
| 100 | N | | |
| 101 | N | | |
| 110 | Y | 10 | Mem[10 110] |
| 111 | N | | |

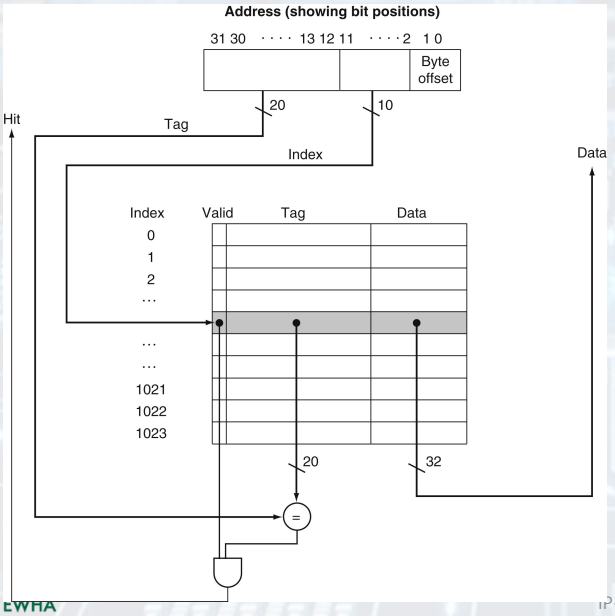


# Cache Example

| Word Addr | Binary Addr | Hit/Miss | Cache Block |
|---|---|---|---|
| 18 | 10 010 | Miss | 010 |

| Index | V | Tag | Data |
|---|---|---|---|
| 000 | Y | 10 | Mem[10 000] |
| 001 | N | | |
| **010** | **Y** | **10** | **Mem[10 010]** |
| 011 | Y | 00 | Mem [00 011] |
| 100 | N | | |
| 101 | N | | |
| 110 | Y | 10 | Mem[10 110] |
| 111 | N | | |

# Address Subdivision




A *cache index*, which is used to select the block

A *tag field*, which is used to compare with the value of the tag field of the cache



# Guide

```
/*
* ********** Please read the instructions below carefully **********
* Your name and student ID must be printed when this project is executed
* Do not print anything other than your name and student ID (Delete printf functions used for debugging when submitting this homework)
* - If not, there will be 20% penalty
* Run make clean command before submitting your homework
* Change this project folder name to studentID_yourname (EX: 1234567_myungkukyoon)
* You must compress this project folder (not the files in this folder)
* - If not, there will be 20% penalty
* - Use ZIP compression utility (DO NOT USE TAR COMMAND)
* The name of ZIP file must be studentID_yourname.zip (EX: 1234567_myungkukyoon.zip)
* All the tests must be done in 5 seconds
* - If not, you will get 0%
*/
```

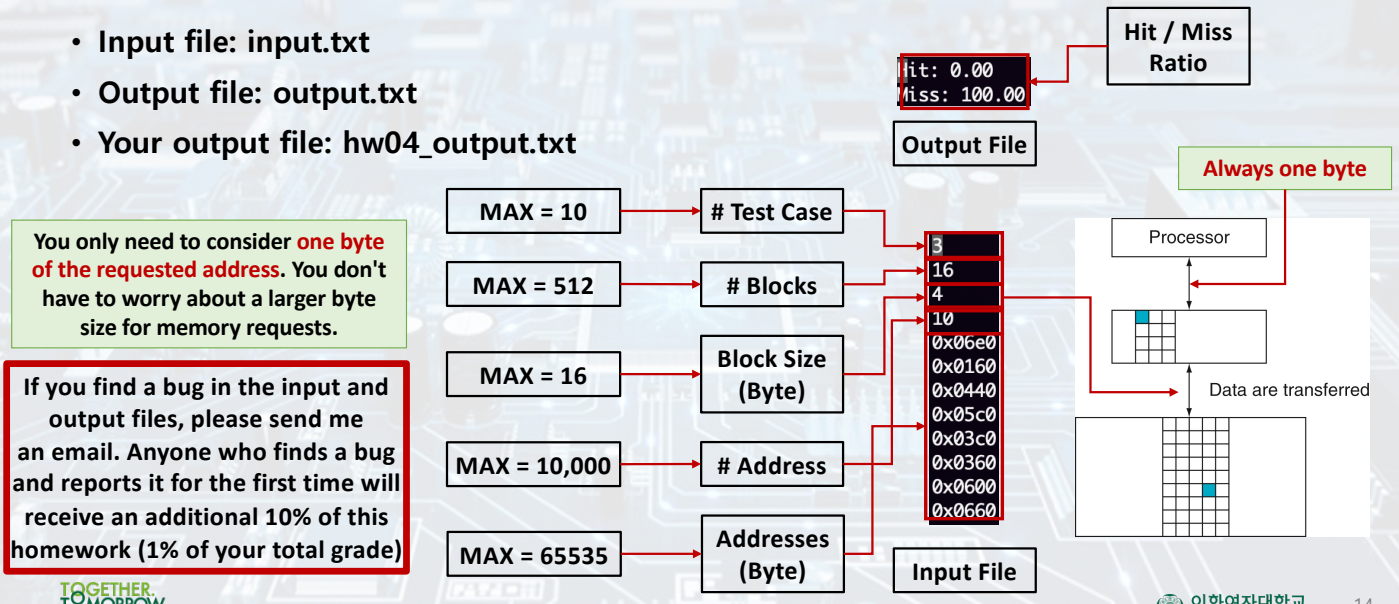
# Guide

- **Grading: 0% ~ 100%**
  - Based on the corrected number of values (HIT and MISS)
  - If the program doesn't run, you'll get 0 points (such as Segmentation Fault!!)
- **Due date: 2022-12-09 (11:59 PM)**
  - Late homework is not allowed
  - A compressed file must be uploaded to the cyber campus
  - Folder name must be studentID_YourName (Ex: 1234567_MyungKukYoon)
  - The compressed file name must be studentID_YourName.zip (Ex: 1234567_MyungKukYoon.zip)
- **Q/A**
  - I will be happy to answer your questions about homework #04 until **December 7th**. After December 7th, I will not answer your questions about homework #04
- **Execution time: less than 5 seconds**



# Input and Output Files & Max Size

- **Input file: input.txt**
- **Output file: output.txt**
- **Your output file: hw04_output.txt**




You only need to consider one byte of the requested address. You don't have to worry about a larger byte size for memory requests.

If you find a bug in the input and output files, please send me an email. Anyone who finds a bug and reports it for the first time will receive an additional 10% of this homework (1% of your total grade)

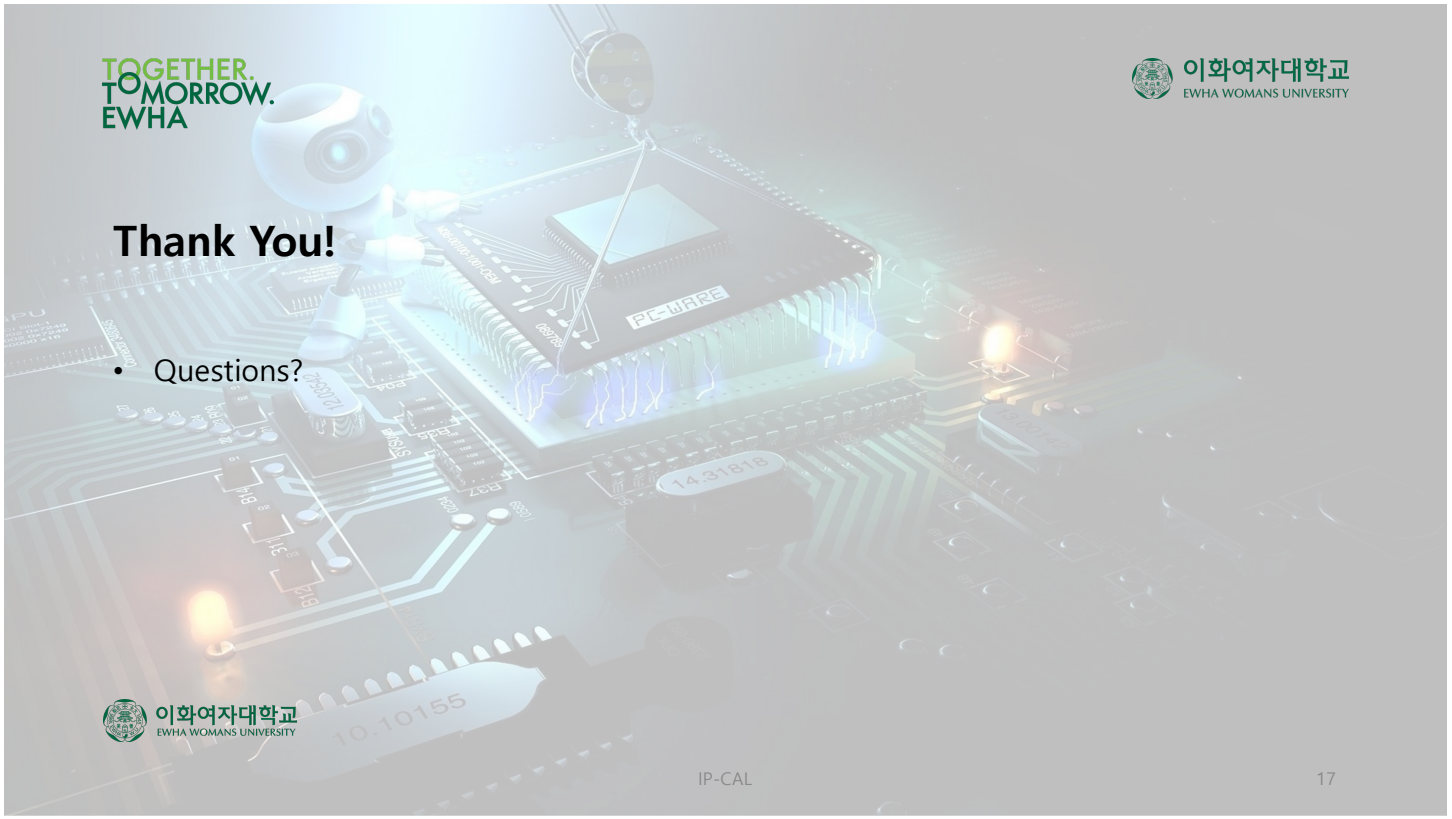
## Additional information

- **Changing directory**
  - $cd FOLDER_NAME
  - $cd ..
- **Printing the path of the working directory**
  - $pwd
- **Listing files or directoris**
  - $ls



## Additional information

- **Build/Clean/Run**
  - $make
  - $make clean
  - $./hw04
- **Diff (this command will be used to check your answer)**
  - $diff hw04_output.txt output.txt
- **ZIP & UNZIP**
  - $zip FILE_NAME.zip FOLDER_NAME/*
  - $unzip FILE_NAME.zip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Thank You!
• Questions?
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