

Read me file for Computer Organisation End Semester Assignment

Note :

The folder contains files which have codes for bonus assignment files in them. So basically 2 caches are made in each of the 3 bonus .py files and only one cache in the remaining normal .py files

6 files being -

2019306_HARSHAL_DEV_bonus_direct_mapping.py
2019306_HARSHAL_DEV_bonus_fully_associative.py
2019306_HARSHAL_DEV_bonus_k_way_associative.py

2019306_HARSHAL_DEV_direct_mapping.py
2019306_HARSHAL_DEV_fully_associative.py
2019306_HARSHAL_DEV_k_way_associative.py

The readme file is more of documentation for the bonus files as the bonus files/ codes are a larger subset, which means that if someone/anyone can do the bonus files then he/she can easily do the normal files/codes too!

Assumptions:

1. Both the cache are mapped with same mapping i.e, both the cache is either directly mapped (part1), fully associative mapped (part2), k-way mapped (part3).
- 2a. Block size and cache line are in the power of 2!
- 2b. Cache size = Block size* no of cache line has to manually inputted along with block size and no of cache lines
3. It is assumed that address is being loaded instead of any data and similarly for searching for any file of the assignment.
4. All the input in the functions ie “searching” and “loading” is to be given in integer format. For eg - searching(17) or loading(17)
5. For a better understanding of the output/processes, it is expected that the user after every function call will write “print(badi_cache)” and “print(choti_cache)”, which will print both the cache of size S and S/2 in respective order, as the print command needs to given/written, else none of the cache would be printed using the searching() or loading() function!

6. By doing `print(badi_cache)` and `print(choti_cache)` respectively after every `loading()/searching()` function, the bigger cache(of size S) will be printed first and then the smaller cache(of size $S/2$).
7. If by calling the `searching()` function results in a cache miss/hit, then both the cache will be loaded again.
8. If any assumption is left or is unclear, I will explain it in the demo itself.
9. Main memory size must be larger than the cache size itself
10. Main memory must be in the power of 2

Input format

-In this code, you won't be asked to give inputs, rather you have to hardcode all your inputs , ie you have to first manually input the required inputs and then run the code. So the required inputs are:-

- 1)Cache lines
- 2)Block size
- 3)An extra input ie k-way set input is taken in k-way assignment alongside above mentioned two.
- 4)Loading or searching function, as many times as you but remember to write `print(badi_cache)` and `print(choti_cache)` so that both the caches are printed out.
(for more info refer to Common assumptions 5th point)

-In the case of Loading, you will have to give the command as `loading(integer)` , where integer means the address of the "Word" (which is in the assumed main memory) which you want to load in the cache, For example, if you wish to load 17, then you would input `loading(17)`

In the case of Searching, you will have to give the command as `searching(integer)` , where integer means the address of the "Word" (which is in the assumed main memory) which you want to search in the cache, For example, if you wish to search 17, then you would input `searching(17)`

Output

During output, first, the bigger cache and then the smaller cache will be printed, given you type "print(badi_cache)" and "print(choti_cache)". (for more info refer to Common assumptions 5th point)

While using the searching() function,

- if it's a hit, then the output is " *Word* is a hit". For eg for searching(17), if it's a hit, then the output is " 17 is a hit"
- if it's a miss, then the output is " *Word* is a miss". For eg for searching(17) , if it's a miss, then the output is " 17 is a miss"

Warning

For K way assignment, the code will not work if any of the cache's cache line is less than k.

Error handling:

Python will automatically deal with any error shortcomings if any. If not, refer assumptions.

Code explanation/ working/ algorithm

In direct mapping, the block number is calculated using "(Word address)//block_size" and then the cache line of the same is calculated using "blocknumber%number of cache lines)

In Fully associative mapping, the block number is calculated using "(Word address)//block_size". Then searching()/loading() is done on the basis of LRU, which can be found in lecture slides.

In K-way set associative mapping, the block number is calculated using "(Word address)//block_size", along with the number of sets which is calculated by using " number of cache line // value of k ", where k is inputted from the user, and then the words are placed accordingly in their set(aka set number) using the formula "block number % number of sets". In short, this mapping is a combination of the above two mappings.

Loading function calls two functions in order ie loading_in_badi_cache(address) to load the address in the bigger cache and loading_in_choti_cache(address) to load the address in the smaller cache.

Similarly for searching, it calls two functions ie `searching_in_badi_cache(address)` to search the address in the bigger cache and `searching_in_choti_cache(address)` to search the address in the smaller cache

General overview

For loading,

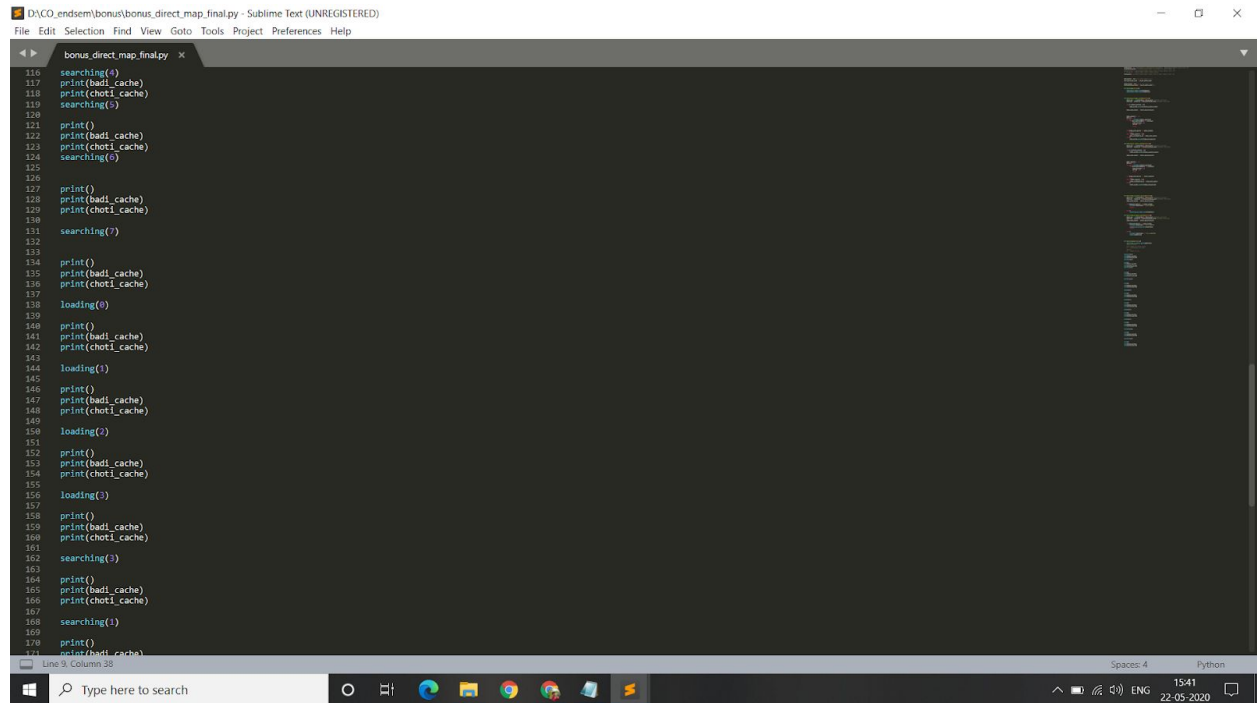
The `loading(address)` function is called which in calls the `loading_in_badi_cache(address)` function which loads the address in the bigger cache and then `loading_in_choti_cache(address)` function is called which loads in the smaller cache

For searching,

The `searching(address)` is called which first calls the `searching_in_choti_cache(address)` to check in the smaller cache. If it hits the desired address, it prints "it's a hit ", it loads the same in the bigger cache too (except for the case of direct mapping). If it doesn't hit the address, then it checks in the bigger cache by calling the `searching_in_badi_cache(address)`. If found, it then prints ("it's a hit") and also simultaneously loads it in the smaller cache (by calling the `loading_in_smaller_cache(address)`). If the address is not found in both the caches, ie bigger and smaller caches, then it loaded in both the caches by calling the `loading(address)` which loads the address first in the bigger cache and then the smaller cache!

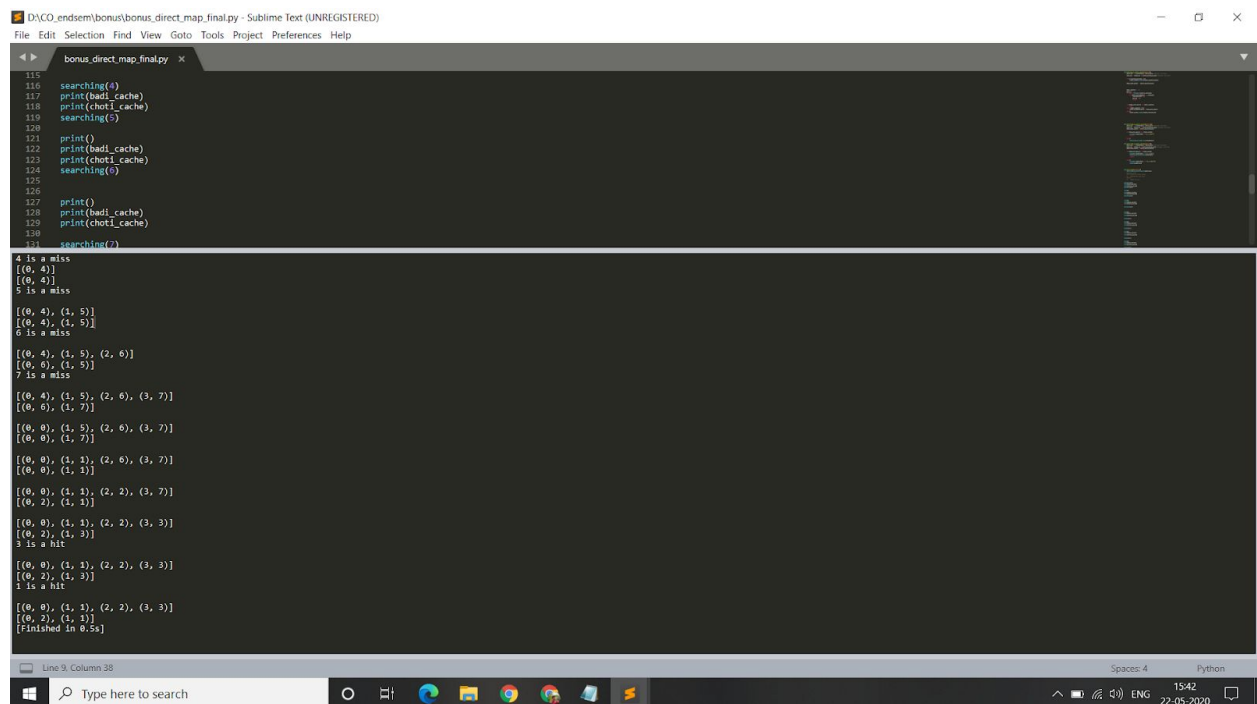
Photographs of the code working.

Below is the code photograph for bonus direct map with input and output and functions in them!



```
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bonus_direct_map_final.py x
116 searching(4)
117 print(badi_cache)
118 print(choti_cache)
119 searching(5)
120
121 print()
122 print(badi_cache)
123 print(choti_cache)
124 searching(6)
125
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127 print()
128 print(badi_cache)
129 print(choti_cache)
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131 searching(7)
132
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134 print()
135 print(badi_cache)
136 print(choti_cache)
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138 loading(0)
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140 print()
141 print(badi_cache)
142 print(choti_cache)
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144 loading(1)
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146 print()
147 print(badi_cache)
148 print(choti_cache)
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150 loading(2)
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152 print()
153 print(badi_cache)
154 print(choti_cache)
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156 loading(3)
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158 print()
159 print(badi_cache)
160 print(choti_cache)
161
162 searching(1)
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164 print()
165 print(badi_cache)
166 print(choti_cache)
167
168 searching(1)
169
170 print()
171 print(badi_cache)
```



```
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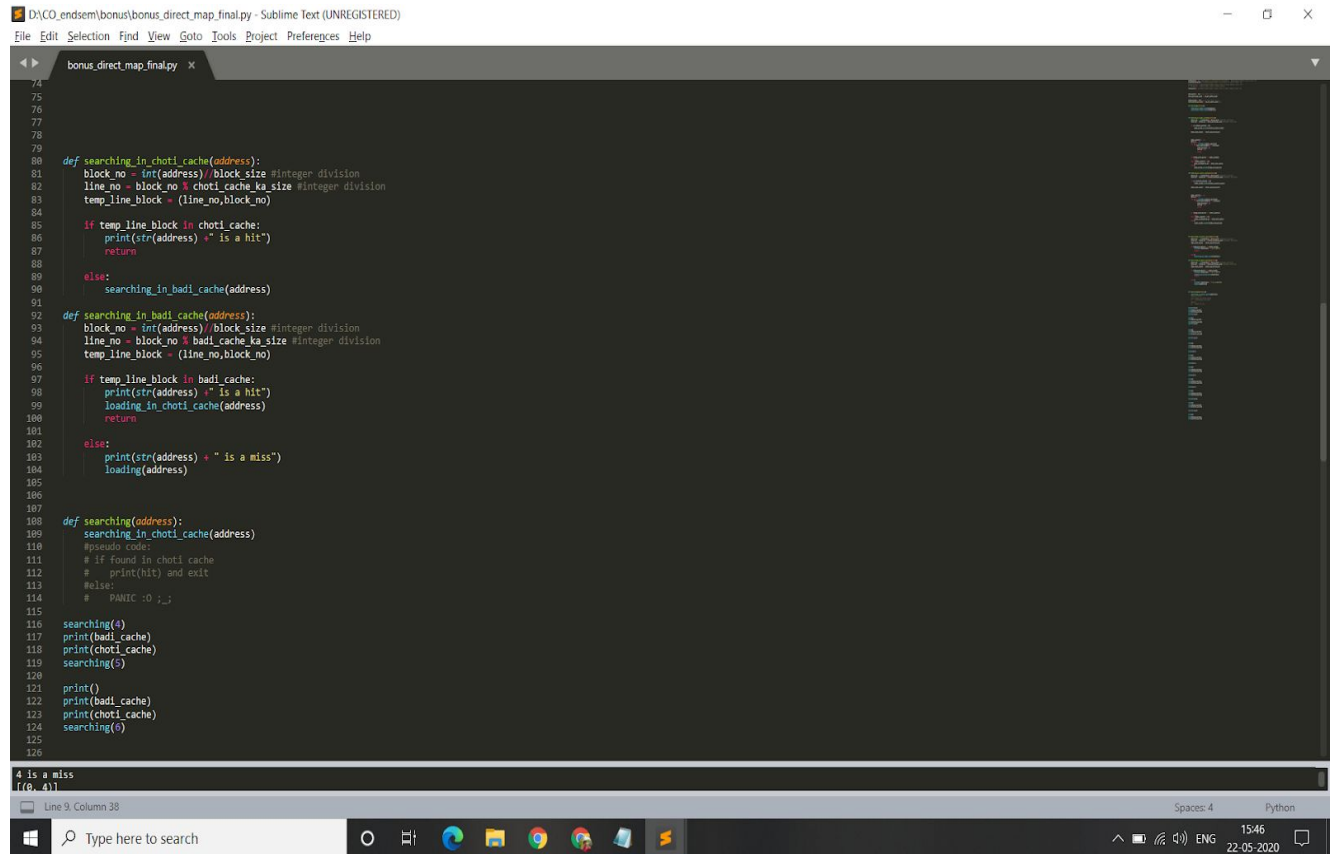
bonus_direct_map_final.py x
116 searching(4)
117 print(badi_cache)
118 print(choti_cache)
119 searching(5)
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121 print()
122 print(badi_cache)
123 print(choti_cache)
124 searching(6)
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127 print()
128 print(badi_cache)
129 print(choti_cache)
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131 searching(7)
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134 print()
135 print(badi_cache)
136 print(choti_cache)
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138 loading(0)
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140 print()
141 print(badi_cache)
142 print(choti_cache)
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144 loading(1)
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146 print()
147 print(badi_cache)
148 print(choti_cache)
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150 loading(2)
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152 print()
153 print(badi_cache)
154 print(choti_cache)
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156 loading(3)
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158 print()
159 print(badi_cache)
160 print(choti_cache)
161
162 searching(1)
163
164 print()
165 print(badi_cache)
166 print(choti_cache)
167
168 searching(1)
169
170 print()
171 print(badi_cache)

4 is a miss
[[0, 4]]
[[0, 4]]
5 is a miss
[[0, 4], (1, 5)]
[[0, 4], (1, 5)]
6 is a miss
[[0, 4], (1, 5), (2, 6)]
[[0, 6], (1, 5)]
7 is a miss
[[0, 4], (1, 5), (2, 6), (3, 7)]
[[0, 6], (1, 7)]
[[0, 0], (1, 5), (2, 6), (3, 7)]
[[0, 0], (1, 7)]
[[0, 0], (1, 1), (2, 6), (3, 7)]
[[0, 0], (1, 1)]
[[0, 0], (1, 1), (2, 2), (3, 7)]
[[0, 2], (1, 1)]
[[0, 0], (1, 1), (2, 2), (3, 3)]
[[0, 2], (1, 3)]
3 is a hit
[[0, 0], (1, 1), (2, 2), (3, 3)]
[[0, 2], (1, 3)]
1 is a hit
[[0, 0], (1, 1), (2, 2), (3, 3)]
[[0, 2], (1, 1)]
[Finished in 0.5s]
```

```
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bonus_direct_map_final.py x
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14 def loading(address):
15     loading_in_badi_cache(address)
16     loading_in_choti_cache(address)
17
18
19
20 def loading_in_badi_cache(address):
21     block_no = int(address) / block_size #integer division
22     line_no = block_no % badi_cache_ka_size #integer division
23
24     if (len(badi_cache)==0):
25         badi_cache.append((line_no,block_no))
26
27     temp_line_block = (line_no,block_no)
28
29
30
31     temp_counter = -5
32     mera_i = -5
33     for i in range(len(badi_cache)):
34         if badi_cache[i][0] == line_no:
35             temp_counter=-10
36             mera_i = i
37             break
38
39
40     if (temp_line_block in badi_cache):
41         pass
42     elif (temp_counter > 0):
43         badi_cache[mera_i] = temp_line_block
44     else:
45         badi_cache.append(temp_line_block)
46
47
48 def loading_in_choti_cache(address):
49     block_no = int(address) / block_size #integer division
50     line_no = block_no % choti_cache_ka_size #integer division
51
52     if (len(choti_cache)==0):
53         choti_cache.append((line_no,block_no))
54
55     temp_line_block = (line_no,block_no)
56
57
58
59     temp_counter = -5
60     mera_i = -5
61     for i in range(len(choti_cache)):
62         if choti_cache[i][0] == line_no:
63             temp_counter=-10
64             mera_i = i
65             break
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```

Similarly for searching, it calls two functions ie `searching_in_badi_cache(address)` to search the address in the bigger cache and `searching_in_choti_cache(address)` to search the address in the smaller cache



```
74
75
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79
80 def searching_in_choti_cache(address):
81     block_no = int(address)/block_size #integer division
82     line_no = block_no % choti_cache_ka_size #integer division
83     temp_line_block = (line_no,block_no)
84
85     if temp_line_block in choti_cache:
86         print(str(address) + " is a hit")
87         return
88     else:
89         searching_in_badi_cache(address)
90
91
92 def searching_in_badi_cache(address):
93     block_no = int(address)/block_size #integer division
94     line_no = block_no % badi_cache_ka_size #integer division
95     temp_line_block = (line_no,block_no)
96
97     if temp_line_block in badi_cache:
98         print(str(address) + " is a hit")
99         loading_in_choti_cache(address)
100        return
101    else:
102        print(str(address) + " is a miss")
103        loading(address)
104
105
106
107
108 def searching(address):
109     searching_in_choti_cache(address)
110     #pseudo code:
111     # if found in choti cache
112     #   print(hit) and exit
113     #else:
114     #   PANIC :D ;,;
115
116     searching(4)
117     print(badi_cache)
118     print(choti_cache)
119     searching(5)
120
121     print()
122     print(badi_cache)
123     print(choti_cache)
124     searching(6)
125
126
127
128
```

4 is a miss
[(0, 4)]

Line 9, Column 38 Spaces: 4 Python

Similar is the case for the other code files too!

Credits -
Lecture slides
GATE Smashers youtube channel

Made by -
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2019306 (CSD)