

Computer Architecture

Assignment-3 Report

I have done this assignment in Java Language. I have implemented the Direct Mapped cache in one file and Set Associative cache in another file. I have implemented the set-associative cache by using LRU principle. I have implemented all the required classes for those caches in the respective files.

To run the files, open the terminal and go to the respective directory. Make sure that you have all the required files in the directory. The files are IMT2019025_Direct_mapped.java and the trace files gcc.trace, gzip.trace, mcf.trace, swim.trace, twolf.trace for running the Direct Mapped cache. The commands are

```
$javac IMT2019025_Direct_Mapped.java
```

```
$java IMT2019025_Direct_Mapped
```

The first command will create the .class files. The second file will execute them. The output will be printed in the terminal.

For running the Set Associative You need to have the files in the directory like IMT2019025_Set_Associative.java and the .trace files like files gcc.trace, gzip.trace, mcf.trace, swim.trace, twolf.trace. The commands are

```
$javac IMT2019025_Set_Associative.java
```

```
$java IMT2019025_Set_Associative
```

For the trace files given, the outputs of the hit and miss rates are:

Trace files	Direct Mapped	Set Associative
gcc.trace	Total Count : 515683 Hit : 483504 Miss : 32179 Hit Rate : 0.937599 Miss Rate : 0.062401 Hit to Miss rate : 15.025451	Total count : 515683 Hit : 483871 Miss : 31812 Hit Rate : 0.938311 Miss Rate : 0.061689 Hit to Miss rate : 15.210329
gzip.trace	Total Count : 481044 Hit : 320883 Miss : 160161 Hit Rate : 0.667055 Miss Rate : 0.332945 Hit to Miss rate : 2.003503	Total count : 481044 Hit : 320883 Miss : 160161 Hit Rate : 0.667055 Miss Rate : 0.332945 Hit to Miss rate : 2.003503
mcf.trace	Total Count : 727230 Hit : 7505 Miss : 719725 Hit Rate : 0.010320 Miss Rate : 0.989680 Hit to Miss rate : 0.010428	Total count : 727230 Hit : 7508 Miss : 719722 Hit Rate : 0.010324 Miss Rate : 0.989676 Hit to Miss rate : 0.010432
swim.trace	Total Count : 303193 Hit : 280738 Miss : 22455 Hit Rate : 0.925938 Miss Rate : 0.074062 Hit to Miss rate : 12.502249	Total count : 303193 Hit : 280825 Miss : 22368 Hit Rate : 0.926225 Miss Rate : 0.073775 Hit to Miss rate : 12.554766
twolf.trace	Total Count : 482824 Hit : 476770 Miss : 6054 Hit Rate : 0.987461 Miss Rate : 0.012539 Hit to Miss rate : 78.752891	Total count : 482824 Hit : 476844 Miss : 5980 Hit Rate : 0.987615 Miss Rate : 0.012385 Hit to Miss rate : 79.739799

I have attached the snapshots of the terminal.

```
manohar@manohar-Inspiron-5580:~/Desktop/proj1-traces/traces$ javac IMT2019025_Direct_Mapped.java
manohar@manohar-Inspiron-5580:~/Desktop/proj1-traces/traces$ java IMT2019025_Direct_Mapped
Trace : gcc.trace
Total Count : 515683
Hit : 483504
Miss : 32179
Hit Rate : 0.937599
Miss Rate : 0.062401
Hit to Miss rate : 15.025451

Trace : gzip.trace
Total Count : 481044
Hit : 320883
Miss : 160161
Hit Rate : 0.667055
Miss Rate : 0.332945
Hit to Miss rate : 2.003503

Trace : mcf.trace
Total Count : 727230
Hit : 7505
Miss : 719725
Hit Rate : 0.010320
Miss Rate : 0.989680
Hit to Miss rate : 0.010428

Trace : swin.trace
Total Count : 303193
Hit : 280738
Miss : 22455
Hit Rate : 0.925938
Miss Rate : 0.074062
Hit to Miss rate : 12.502249

Trace : twolf.trace
Total Count : 482824
Hit : 476770
Miss : 6054
Hit Rate : 0.987461
Miss Rate : 0.012539
Hit to Miss rate : 78.752891
manohar@manohar-Inspiron-5580:~/Desktop/proj1-traces/traces$
```

```

manohar@manohar-Inspiron-5580:~/Desktop/proj1-traces/traces$ javac IMT2019025_Set_Associative.java
manohar@manohar-Inspiron-5580:~/Desktop/proj1-traces/traces$ java IMT2019025_Set_Associative
Trace : gcc.trace
Total count : 515683
Hit : 483871
Miss : 31812
Hit Rate : 0.938311
Miss Rate : 0.061689
Hit to Miss rate : 15.210329

Trace : gzip.trace
Total count : 481044
Hit : 320883
Miss : 160161
Hit Rate : 0.667055
Miss Rate : 0.332945
Hit to Miss rate : 2.003503

Trace : mcf.trace
Total count : 727230
Hit : 7508
Miss : 719722
Hit Rate : 0.010324
Miss Rate : 0.989676
Hit to Miss rate : 0.010432

Trace : swim.trace
Total count : 303193
Hit : 280825
Miss : 22368
Hit Rate : 0.926225
Miss Rate : 0.073775
Hit to Miss rate : 12.554766

Trace : twolf.trace
Total count : 482824
Hit : 476844
Miss : 5980
Hit Rate : 0.987615
Miss Rate : 0.012385
Hit to Miss rate : 79.739799

```

This Direct Mapped Cache have 4 bytes in each block, so the byte offset is 2 bits. Since the size of the Cache is 256KB, and each block contains 4 bytes, no.of indexes is 2^{16} which is 65536, so the no.of index bits is 16. Hence the no.of tag bits is 14.

Similarly, the Set Associative Cache has 4 ways in it each having 4 bytes of data. So, the offset bits is 2. The index bits is 14. Hence the tag bits are 16.

For a given index, a Direct Mapped Cache can store only 1 unit of data whereas a 4-way Set Associative Cache can store 4 units of data, 1 in each way. So, there will be higher probability of a hit in the set-associative cache than the direct mapped cache.

From the implementation, we can clearly see that the Hit rates of the set-associative cache is never worse than the direct mapped cache. It is either better or equal to the direct mapped. For the traces gcc.trace, mcf.trace, swim.trace and twolf.trace the hit rate in set-associative cache is better than the direct mapped cache. In the gzip.trace file, the hit rate is same in both the caches.

So, for better performance, we will prefer the set-associative cache instead of the direct mapped cache.

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