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Computer Architecture - Assignment 1

Configuration attached in the zip folder by the name ‘two_level.py’.
And the cache file named ‘caches.py’

Miss Rate Data observed from the system:

1) L2 Cache Size - 4kB, L2 Associativity - 1

```
401    system.l2cache.overallMissRate::cpu.inst      0.999192
402    system.l2cache.overallMissRate::cpu.data      0.982976
403    system.l2cache.overallMissRate::total         0.983099
```

2) L2 Cache Size - 4kB, L2 Associativity - 2

```
401    system.l2cache.overallMissRate::cpu.inst      0.998384
402    system.l2cache.overallMissRate::cpu.data      0.978449
403    system.l2cache.overallMissRate::total         0.978601
```

3) L2 Cache Size - 4kB, L2 Associativity - 4

```
401    system.l2cache.overallMissRate::cpu.inst      0.996769
402    system.l2cache.overallMissRate::cpu.data      0.977093
403    system.l2cache.overallMissRate::total         0.977243
```

4) L2 Cache Size - 4kB, L2 Associativity - 8

```
401    system.l2cache.overallMissRate::cpu.inst      0.993538
402    system.l2cache.overallMissRate::cpu.data      0.977068
403    system.l2cache.overallMissRate::total         0.977194
```

5) L2 Cache Size - 8kB, L2 Associativity - 1

```
401    system.l2cache.overallMissRate::cpu.inst      0.999192
402    system.l2cache.overallMissRate::cpu.data      0.974226
403    system.l2cache.overallMissRate::total         0.974416
```

6) L2 Cache Size - 8kB, L2 Associativity - 2

```
401    system.l2cache.overallMissRate::cpu.inst      0.998384
402    system.l2cache.overallMissRate::cpu.data      0.968206
403    system.l2cache.overallMissRate::total         0.968436
```

7) L2 Cache Size - 8kB, L2 Associativity - 4

```
401    system.l2cache.overallMissRate::cpu.inst      0.991115
402    system.l2cache.overallMissRate::cpu.data      0.965674
403    system.l2cache.overallMissRate::total         0.965867
```

8) L2 Cache Size - 8kB, L2 Associativity - 8

```
401    system.l2cache.overallMissRate::cpu.inst      0.974960
402    system.l2cache.overallMissRate::cpu.data      0.966448
403    system.l2cache.overallMissRate::total         0.966512
```

9) L2 Cache Size - 16kB, L2 Associativity - 1

```
401    system.l2cache.overallMissRate::cpu.inst      0.985460
402    system.l2cache.overallMissRate::cpu.data      0.942618
403    system.l2cache.overallMissRate::total         0.942944
```

10) L2 Cache Size - 16kB, L2 Associativity - 2

```
401    system.l2cache.overallMissRate::cpu.inst      0.992730
402    system.l2cache.overallMissRate::cpu.data      0.948551
403    system.l2cache.overallMissRate::total         0.948887
```

11) L2 Cache Size - 16kB, L2 Associativity - 4

```
401    system.l2cache.overallMissRate::cpu.inst      0.972536
402    system.l2cache.overallMissRate::cpu.data      0.934815
403    system.l2cache.overallMissRate::total         0.935102
```

12) L2 Cache Size - 16kB, L2 Associativity - 8

```
401    system.l2cache.overallMissRate::cpu.inst      0.958805
402    system.l2cache.overallMissRate::cpu.data      0.930362
403    system.l2cache.overallMissRate::total         0.930579
```

13) L2 Cache Size - 32kB, L2 Associativity - 1

```
401    system.l2cache.overallMissRate::cpu.inst      0.966882
402    system.l2cache.overallMissRate::cpu.data      0.869314
403    system.l2cache.overallMissRate::total         0.870057
```

14) L2 Cache Size - 32kB, L2 Associativity - 2

```
401    system.l2cache.overallMissRate::cpu.inst      0.951535
402    system.l2cache.overallMissRate::cpu.data      0.871897
403    system.l2cache.overallMissRate::total         0.872503
```

15) L2 Cache Size - 32kB, L2 Associativity - 4

```
401    system.l2cache.overallMissRate::cpu.inst      0.949111
402    system.l2cache.overallMissRate::cpu.data      0.875049
403    system.l2cache.overallMissRate::total         0.875612
```

16) L2 Cache Size - 32kB, L2 Associativity - 8

```
401    system.l2cache.overallMissRate::cpu.inst      0.941034
402    system.l2cache.overallMissRate::cpu.data      0.876300
403    system.l2cache.overallMissRate::total         0.876792
```

17) L2 Cache Size - 64kB, L2 Associativity - 1

```
401    system.l2cache.overallMissRate::cpu.inst      0.947496
402    system.l2cache.overallMissRate::cpu.data      0.773698
403    system.l2cache.overallMissRate::total         0.775020
```

18) L2 Cache Size - 64kB, L2 Associativity - 2

```
401    system.l2cache.overallMissRate::cpu.inst      0.924879
402    system.l2cache.overallMissRate::cpu.data      0.769970
403    system.l2cache.overallMissRate::total         0.771149
```

19) L2 Cache Size - 64kB, L2 Associativity - 4

```
401    system.l2cache.overallMissRate::cpu.inst      0.928918
402    system.l2cache.overallMissRate::cpu.data      0.780814
403    system.l2cache.overallMissRate::total         0.781940
```

20) L2 Cache Size - 64kB, L2 Associativity - 8

```
401    system.l2cache.overallMissRate::cpu.inst      0.928918
402    system.l2cache.overallMissRate::cpu.data      0.783631
403    system.l2cache.overallMissRate::total         0.784737
```

21) L2 Cache Size - 128kB, L2 Associativity - 1

```
401    system.l2cache.overallMissRate::cpu.inst      0.914378
402    system.l2cache.overallMissRate::cpu.data      0.660965
403    system.l2cache.overallMissRate::total         0.662893
```

22) L2 Cache Size - 128kB, L2 Associativity - 2

```
401    system.l2cache.overallMissRate::cpu.inst      0.908724
402    system.l2cache.overallMissRate::cpu.data      0.659268
403    system.l2cache.overallMissRate::total         0.661166
```

23) L2 Cache Size - 128kB, L2 Associativity - 4

```
401    system.l2cache.overallMissRate::cpu.inst      0.899838
402    system.l2cache.overallMissRate::cpu.data      0.666731
403    system.l2cache.overallMissRate::total         0.668504
```

24) L2 Cache Size - 128kB, L2 Associativity - 8

```
401    system.l2cache.overallMissRate::cpu.inst      0.891761
402    system.l2cache.overallMissRate::cpu.data      0.668917
403    system.l2cache.overallMissRate::total         0.670612
```

25) L2 Cache Size - 256kB, L2 Associativity - 1

```
401    system.l2cache.overallMissRate::cpu.inst      0.906300
402    system.l2cache.overallMissRate::cpu.data      0.558766
403    system.l2cache.overallMissRate::total         0.561410
```

26) L2 Cache Size - 256kB, L2 Associativity - 2

```
401    system.l2cache.overallMissRate::cpu.inst      0.886914
402    system.l2cache.overallMissRate::cpu.data      0.552487
403    system.l2cache.overallMissRate::total         0.555031
```

27) L2 Cache Size - 256kB, L2 Associativity - 4

```
401    system.l2cache.overallMissRate::cpu.inst      0.880452
402    system.l2cache.overallMissRate::cpu.data      0.559001
403    system.l2cache.overallMissRate::total         0.561447
```

28) L2 Cache Size - 256kB, L2 Associativity - 8

```
401    system.l2cache.overallMissRate::cpu.inst      0.878029
402    system.l2cache.overallMissRate::cpu.data      0.559454
403    system.l2cache.overallMissRate::total         0.561877
```

29) L2 Cache Size - 512kB, L2 Associativity - 1

```
401    system.l2cache.overallMissRate::cpu.inst      0.877221
402    system.l2cache.overallMissRate::cpu.data      0.450628
403    system.l2cache.overallMissRate::total         0.453874
```

30) L2 Cache Size - 512kB, L2 Associativity - 2

```
401    system.l2cache.overallMissRate::cpu.inst      0.881260
402    system.l2cache.overallMissRate::cpu.data      0.451557
403    system.l2cache.overallMissRate::total         0.454826
```

31) L2 Cache Size - 512kB, L2 Associativity - 4

```
401    system.l2cache.overallMissRate::cpu.inst      0.876414
402    system.l2cache.overallMissRate::cpu.data      0.458815
403    system.l2cache.overallMissRate::total         0.461992
```

32) L2 Cache Size - 512kB, L2 Associativity - 8

```
401    system.l2cache.overallMissRate::cpu.inst      0.876414
402    system.l2cache.overallMissRate::cpu.data      0.460648
403    system.l2cache.overallMissRate::total         0.463811
```

33) L2 Cache Size - 1024kB, L2 Associativity - 1

```
401    system.l2cache.overallMissRate::cpu.inst      0.877221
402    system.l2cache.overallMissRate::cpu.data      0.285424
403    system.l2cache.overallMissRate::total         0.289927
```

34) L2 Cache Size - 1024kB, L2 Associativity - 2

```
401    system.l2cache.overallMissRate::cpu.inst      0.876414
402    system.l2cache.overallMissRate::cpu.data      0.300825
403    system.l2cache.overallMissRate::total         0.305205
```

35) L2 Cache Size - 1024kB, L2 Associativity - 4

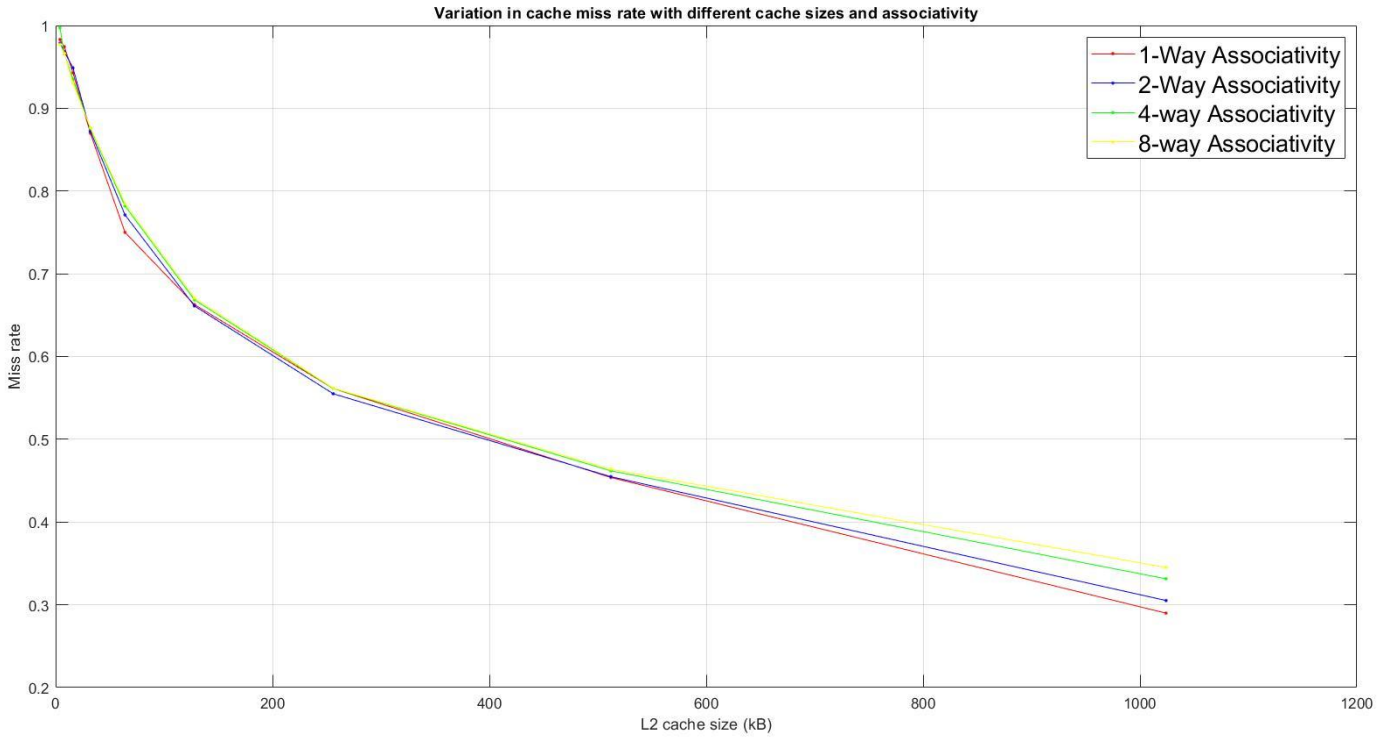
```
401    system.l2cache.overallMissRate::cpu.inst      0.876414
402    system.l2cache.overallMissRate::cpu.data      0.330284
403    system.l2cache.overallMissRate::total         0.334440
```

36) L2 Cache Size - 1024kB, L2 Associativity - 8

```
401    system.l2cache.overallMissRate::cpu.inst      0.876414
402    system.l2cache.overallMissRate::cpu.data      0.341116
403    system.l2cache.overallMissRate::total         0.345188
```

Cache Size	**ASSOCIATIVITY**			
	1-way	2-way	4-way	8-way
4kB	0.9830	0.9786	0.9972	0.9771
8kB	0.9744	0.9684	0.9658	0.9665
16kB	0.9429	0.9488	0.9351	0.9305

32kB	0.8700	0.8725	0.8756	0.8767
64kB	0.7750	0.7711	0.7819	0.7847
128kB	0.6628	0.6611	0.6685	0.6706
256kB	0.5614	0.5550	0.5614	0.5618
512kB	0.4538	0.4548	0.4619	0.4638
1024kB	0.2899	0.3052	0.3344	0.3451



We know that when the Cache Size is larger, this means that the cache has more number of blocks. Due to which the possibility of accessing a block which is already kept in the cache increases. We can observe this same result from our readings above where the miss rate decreases as we increase the Cache size because it is able to access the blocks more easily.

Consequently, Cache Set Associativity determines how data fetched from main memory is allocated a location in the cache. In the case of a 4-way set associative architecture, each memory data block can choose from four potential locations within the cache, typically based on the last two bits of its memory location. This allocation scheme can sometimes result in conflicts in how data from main memory is placed in the cache.

The outcome depends on several factors, including the cache size. Generally, a cache with higher associativity experiences fewer conflicts within the same set, leading to a lower miss rate. However, when set associativity becomes very high, the number of sets in the cache decreases, which may increase conflicts within a set, potentially causing a higher miss rate.

It's important to note that these relationships are not easily determined mathematically and often require experimental validation.

Observation: It's noticeable that higher associativity tends to correlate with a higher miss rate.