

HOMEWORK 1 REPORT

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Exercise 1:

1. The exercise focuses on Cache hit vs Cache miss cycle counts.

Please find the plot below.

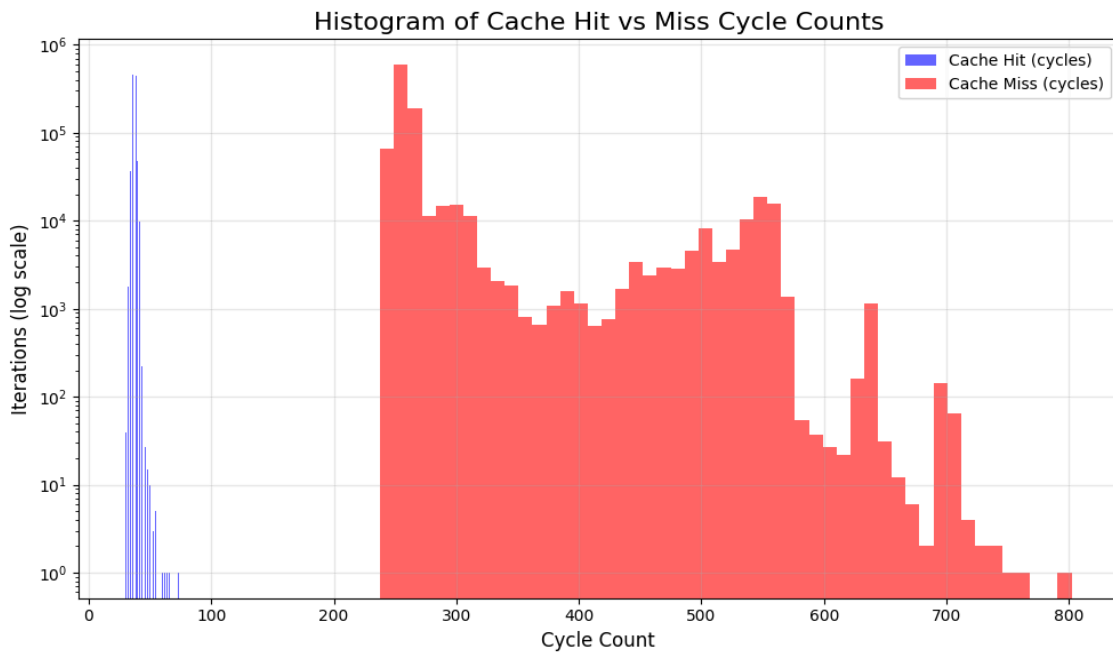


Figure 1: Histogram Plot of Cache hit vs Cache miss Cycle counts

The observations from the plot are as follows:

1. The hit times are primarily concentrated in the range of 32-48 cycles.
2. The miss times are mainly concentrated in the range of 250-400 cycles.
3. The average cycle counts for a Cache hit (Filtered data): 37.07 cycles
4. The average cycle counts for a Cache miss (Filtered data): 282.12 cycles
5. The average cycle counts for a Cache miss (Raw data): 282.58 cycles
6. The average cycle counts for a Cache hit (Raw data): 37.19 cycles

The exercise was performed using a warm-up for cache hit and cflush, followed by mfence for a Cache miss. The operation was repeated for 1 million iterations.

Exercise 2:

2. The exercise focuses on the timing of an AVX2 operation.

Please find the plot below:

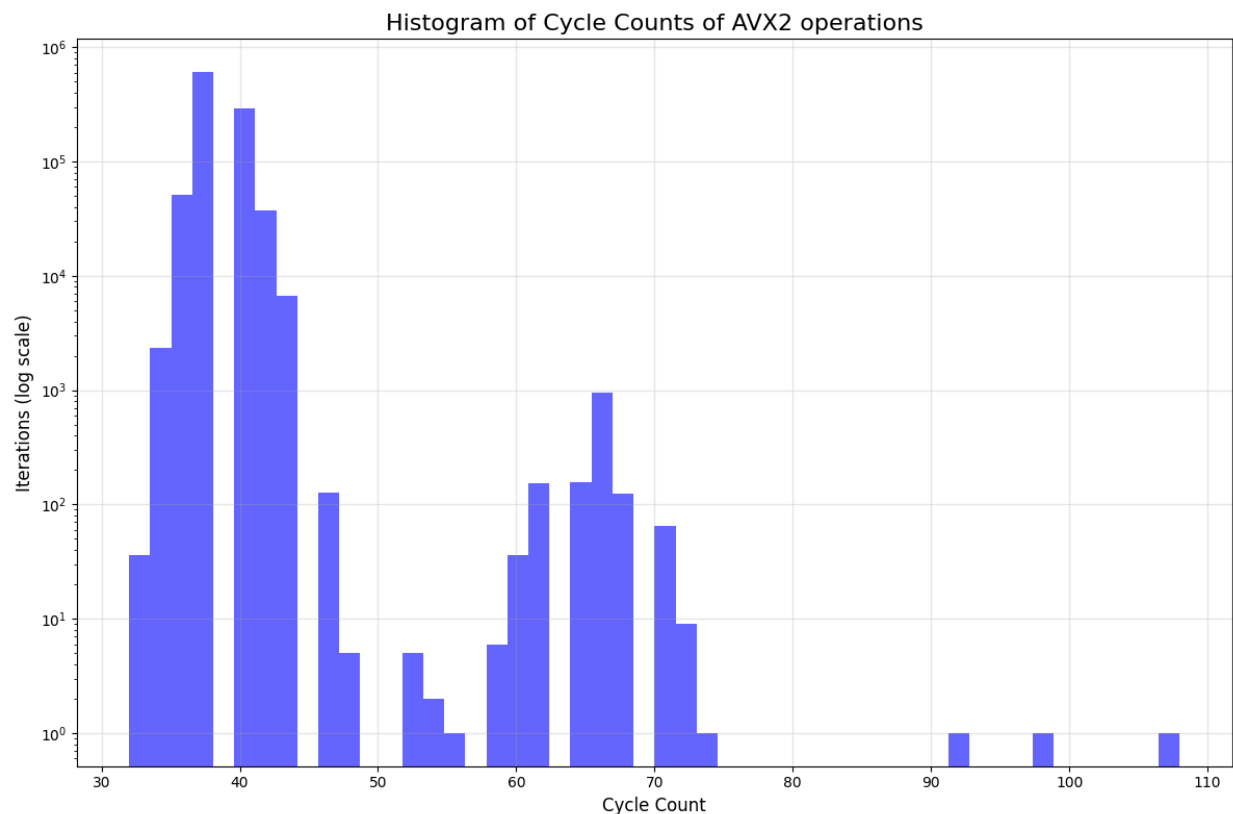


Figure 2: Plot of timing of an AVX2 operation

The observations from the plot are:

1. The cycle counts are concentrated in 32-48 cycle counts for most of the iterations
2. The average cycle count for an AVX2 operation (Raw data): 38.84
3. The average cycle count for an AVX2 operation (Filtered data): 38.70

The exercise times an AVX2 multiplication operation, which uses the built-in function `_mm256_mul_ps`. `Rdtscp` is used to time the multiplication.

Raw data and filtered data are both written to separate .txt files. The data is filtered to exclude noise, which typically produces higher cycle counts than usual.

Exercise 3:

3. The exercise focuses on the timing of an AVX512 operation.

Please find the plot below:

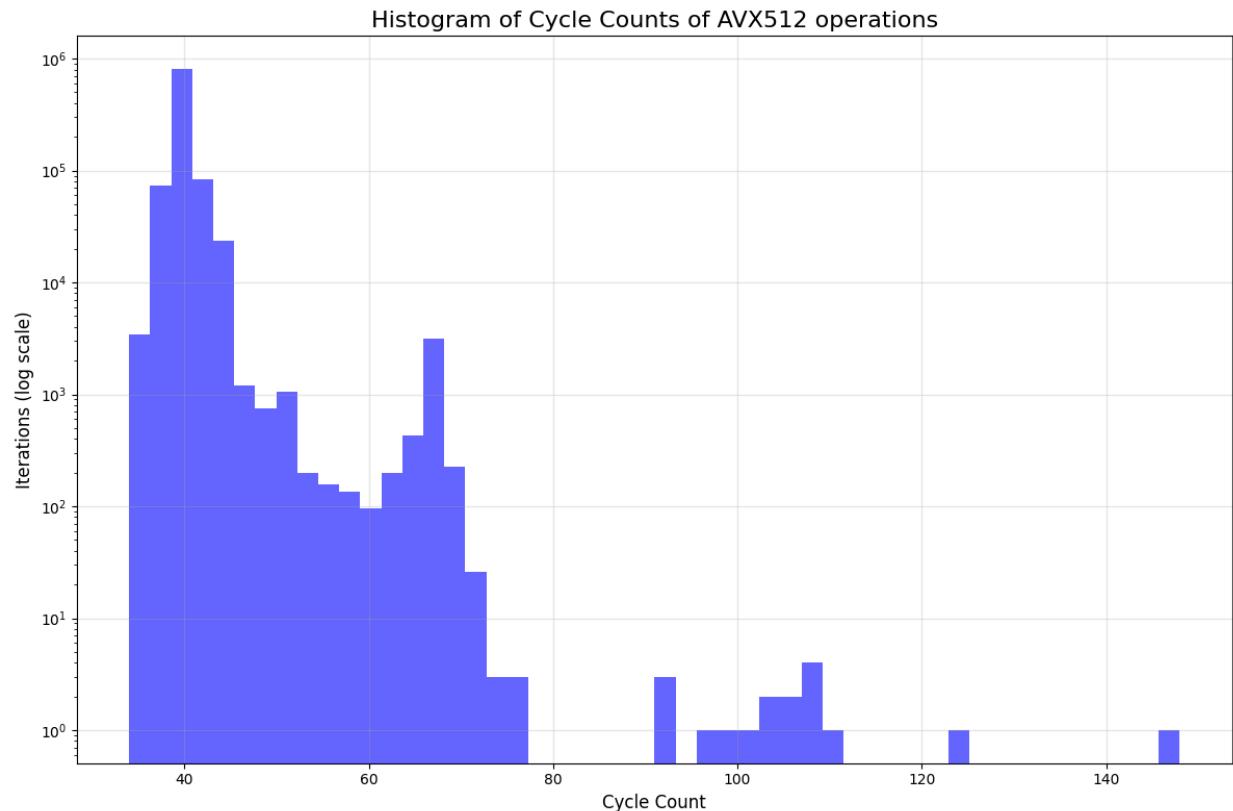


Figure 3: Plot of timing of AVX512 operations

The observations from the plot are:

1. The cycle counts are concentrated in 32-48 cycle counts for most of the iterations
2. The average cycle count for an AVX512 operation (Raw data): 40.01
3. The average cycle count for an AVX512 operation (Filtered data): 40.24

The exercise times an AVX512 multiplication operation, which uses the built-in function `_mm512_mul_ps`. `Rdtscp` is used to time the multiplication.

Raw data and filtered data are both written to separate .txt files. The primary difference between AVX, AVX2, and AVX512 lies in the size of the registers they operate on.

Exercise 4:

4. The exercise focuses on performing two AVX512 operations with a sleep or wait operation that separates them.

Please find the plot below:

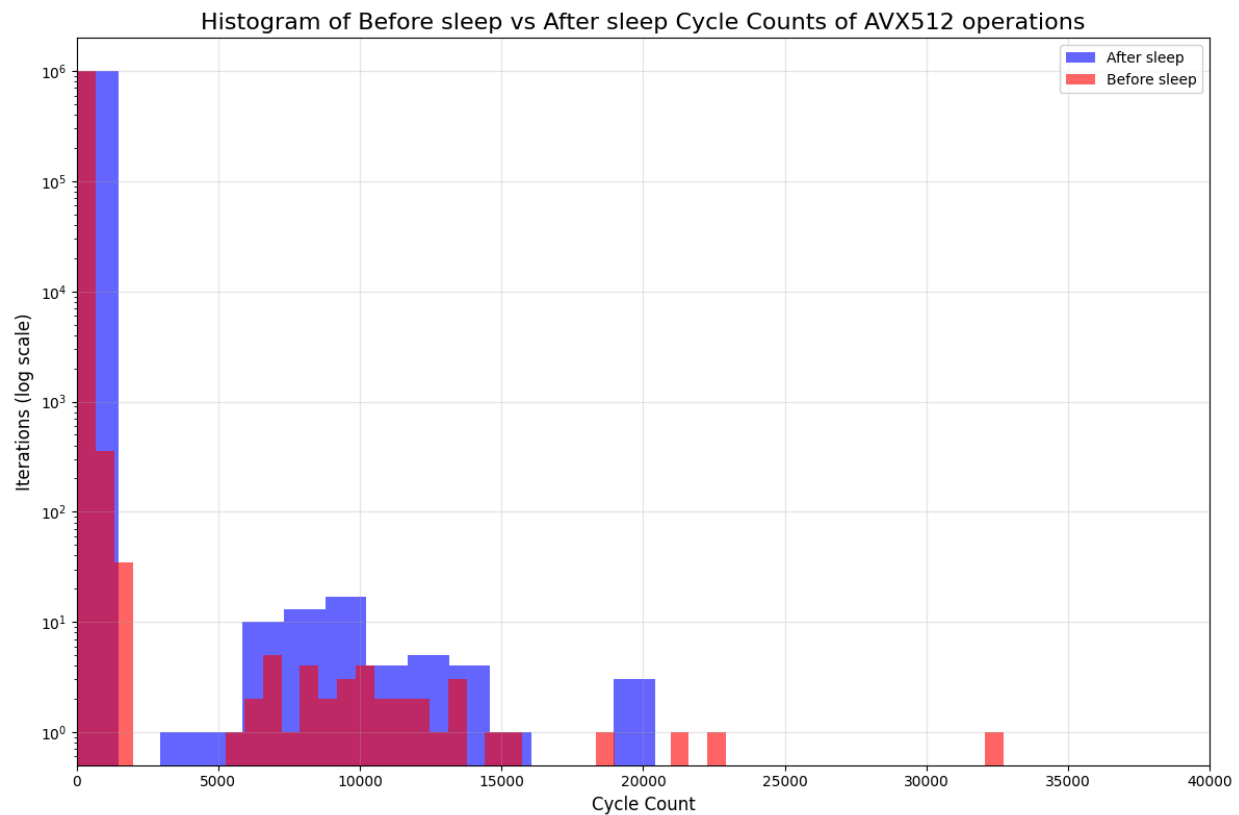


Figure 4: Plot of timing of AVX512 operation before sleep vs after sleep

Please find the observations below:

1. The before-sleep timings are predominantly in the range of 80-100 cycles.
2. The after-sleep timings are predominantly in the range of 70-90 cycles.
3. The average before-sleep timings of an AVX512 operation: 92.53 cycles
4. The average after-sleep timings of an AVX512 operation: 83.37 cycles

The timing of an AVX512 multiplication is calculated in the same manner as previous exercises. But in this exercise, we wait for 100ms (using `usleep`) and then perform another multiplication.

The before-sleep takes more cycles than the after-sleep operations.

Exercise 5:

5. The exercise focuses on performing two AVX operations, separated by a sleep or wait operation.

Please find the plot below:

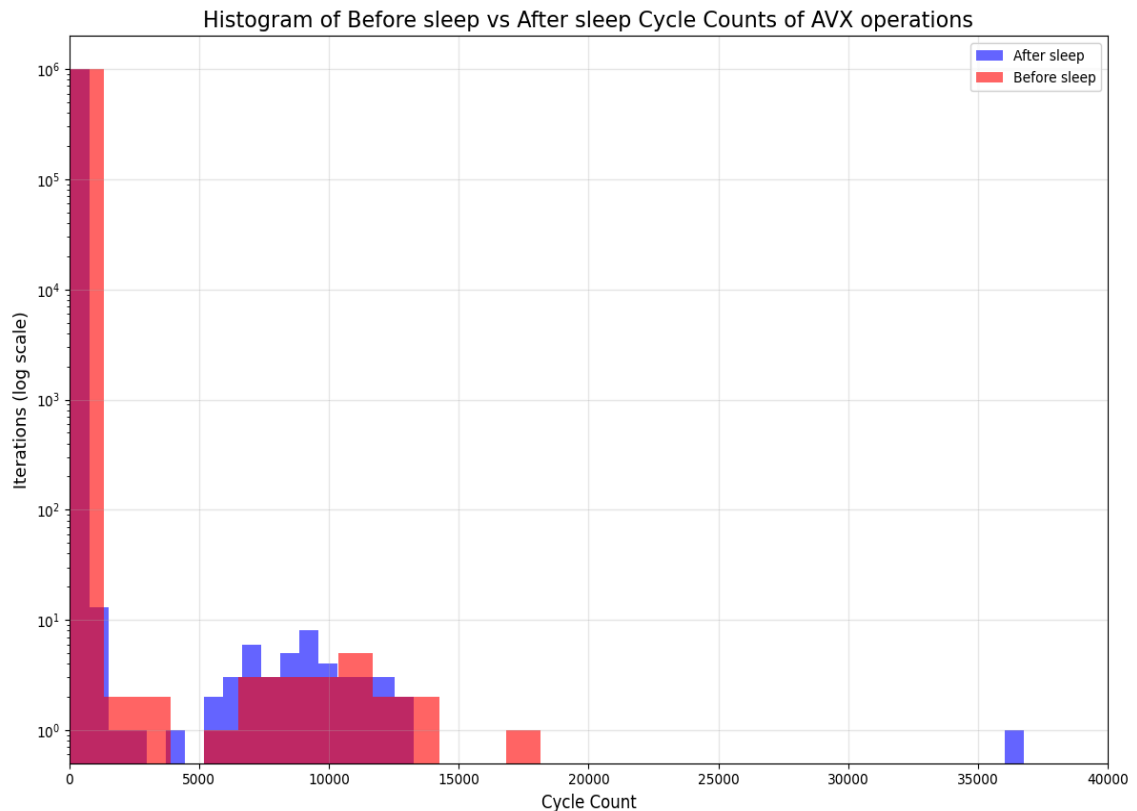


Figure 5: Plot of timing of AVX operations before sleep vs after sleep

Please find the observations below:

1. The before-sleep timings are predominantly in the range of 36-48 cycles.
2. The after-sleep timings are predominantly in the range of 48-62 cycles.
3. The average before-sleep timings of an AVX operation: 43.43 cycles
4. The average after-sleep timings of an AVX operation: 61.59 cycles

The timing of an AVX multiplication is calculated in the same manner as the previous exercise.

The before-sleep takes fewer cycles than the after-sleep operations.

Final Observations:

1. In the first exercise, the average cache hit times are less than the cache miss times, and this is the expected behavior.
2. In the fourth exercise, the average time before sleep is greater than the average time after sleep. This behavior is observed due to some iterations of abnormally high values recorded during both cases.
3. In the fifth exercise, the average time before sleep is less than the average time after sleep. In this exercise, abnormally high values are observed for some iterations in both cases.

Please find the link to GitHub for this Homework below:

[Harish1266/HW1](https://github.com/Harish1266/HW1)

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