7585-A High Performance Computing
Problem 1

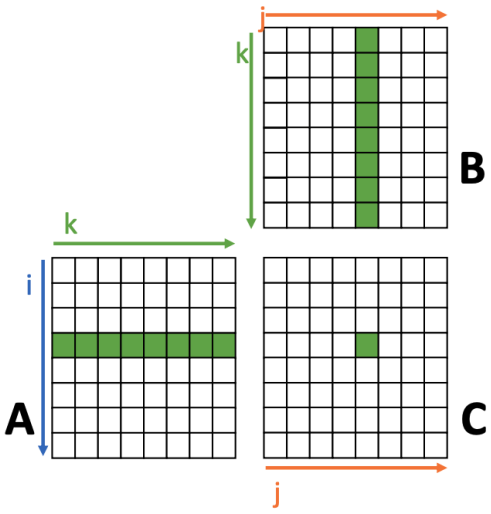
Full Name: Ramesh Adhikari
ID Number: 912147172

February 2023

Suppose each cache line has four floats Set associative, no conflict among arrays
Each set has 32 lines LRU

```
float A[1024][1024], B[1024][1024], C[1024][1024];
for (int i = 0; i < N; i++) do
  for (int j = 0; j < N; j++) do
    for (int k = 0; k < N; k++) do
      C[i][j]+ = A[i][k] * B[k][j];
    end for
  end for
end for
```

what are the hit rates for A, B and C?



Solution:

In a set associative cache with 32 lines per set and 4 floats per cache line, each set can hold a total of 4 floats * 32 lines = 128 floats.

Let's analyze the inner loop (i.e k loop), where A is a row-major here so it miss the first time, and hit for three-time so the miss rate is N/B. Similarly, B is column major so it miss all the time i.e. N time and C is missed one time.

Similarly, for the middle (i.e. j) loop, A miss the N times, B also miss the N times, and C miss the N/B times as it is row-major.

Finally, For the outer (i.e. i) loop, all of A, B, C are miss N times.

Calculation for hit rate:

Total number = N^3 and $B = 4$; $N = 1024$

Miss Ratio of $A = \frac{N}{B} * N * N$

So, Hit rate of $A = 1$ - $\frac{\frac{N}{B}*N*N}{N^3} = \frac{B-1}{B} = \frac{4-1}{4} = \frac{3}{4} = 75\%$

Miss Ratio of $B = N * N * N$

So, Hit rate of $B = 1$ - $\frac{N*N*N}{N^3} = 1 - 1 = 0 = 0\%$

Miss Ratio of $C = 1 * \frac{N}{B} * N$

So, Hit rate of $C = 1$ - $\frac{1*\frac{N}{B}*N}{N^3} = 1 - \frac{1}{N*B} = 1$- $\frac{1}{1024*4} = \frac{4095}{4096} \approx 100\%$