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Homework 3

1. Given :

   N = 256, C= 64K, |Element| = 8, B = 128, S=1, LRU eviction
   Number of cache lines = $2^{16}/2^7 = 2^9 = 512$
   Number of elements in each cache line = $2^7/2^3 = 2^4 = 16$
   Inner loop analysis => analysis for the loop k

Array	Miss Rate	Access Stride
A	1/16	1
B	1	N (=256)
C	0	0 (temporal locality)
	= 1.0625	

2. Given :
   N = 256, C= 64K, |Element| = 8, B = 64, E = 4, LRU eviction
   Number of sets = $2^{16}/2^6.2^2 = 2^8 = 256$
   Number of elements in each cache line = $2^6/2^3 = 2^3 = 8$
   Inner loop analysis => analysis for the loop k

Array	Miss Rate	Access Stride
A	1/8	1
B	1	N (=256)
C	0	0 (temporal locality)
	= 1.125	

3. Given :
   N = 256, C= 64K, |Element| = 8, B = 32, E = 2, LRU eviction
   Number of sets = $2^{16}/2^5.2^1 = 2^{10} = 1024$
   Number of elements in each cache line = $2^5/2^3 = 2^2 = 4$
   Inner loop analysis => analysis for the loop k

Array	Miss Rate	Access Stride
A	1/4	1
B	1	N (=256)
C	0	0 (temporal locality)
	= 1.25	

4.

	A	B	C
I	N	N	N
K	N/B	N	N
J	1	N/B	N/B
	N^2/B	**N^3/B**	**N^3/B**

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5.

	A	B	C
K	N	N	N
I	N	N	N
J	1	N/B	N/B
	N^2	**N^3/B**	**N^3/B**

6.

	A	B	C
J	N	N	N
K	N	N	N
I	N	1	N
	N^3	**N^2**	**N^3**

7.

	A	B	C
K	N	N	N
J	N	N/B	N
I	N	1	N
	N^3	**N^2/B**	**N^3**

8. Given :
@a[1024] = AAAA0000
@b[1024] = AAAA8000
@c[1024] = AAAB0000

```
for i = 0 to 1023
    for j = 0 to 1023
        for k = 0 to 1023
            sum_prod += a[ i ] * b[ j ] + c[ k ]
```

$C = 2^{11}$, $E = 2$, $B = 2^4$
⇨ $S = 2^{11}/2.2^4 = 2^6 = 64$

a. Access Stride for each loop

	A	B	C
I	1	1	1
J	0	1	1
K	0	0	1

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b. The overall hit rate will be ¾ or 75%. The block size is 16 whereas the element size is 4. Thus , each block will hold 4 elements. First will be a cold miss and subsequent 3 will be hits. The same holds for all the tree arrays. So hit rate is :
A : 75%
B:75%
C:75%

c. Initially A[0 .. 3] and B[0 .. 3] will be in S0. C will start filling from set1.
After 251 iterations, C[0 .. 251] will be from set 0 to set 63.
There will be thrashing in set 0 for the next 4 iterations.
And C[256 .. 507] will occupy set 1 to set 63.
And so on.
In the last iteration A[1023], B[1023] and elements from C will be in cache.
Final cache contents:

Set #	Cache line 1	Cache line 2
S0	C[1020 .. 1023]	C[764 .. 767]
S1	C[512 .. 515]	C[768 .. 771]
S2	C[516 .. 519]	C[772 .. 775]
:		
:		
:		
S62	C[756 .. 759]	C[1012 .. 1015]
S63	A[1020 .. 1023]	B[1020 .. 1023]

9. Where N = 512, B = 4

a. This is one of the optimal ordering.

	A	B	C
I	N	N	N
J	N	N	N/B
K	N/B	N	1
	N^3/B	N^3	N^2/B

b. Showing miss analysis to justify above answer.

	A	B	C
I	N	N	N
K	N	N	N
J	N	1	N/B
	N^3	N^2	N^3/B

	A	B	C
K	N	N	N
J	N	N	N
I	1	N/B	N
	N^2	N^3/B	N^3

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	A	B	C
K	N	N	N
I	N	N/B	N
J	N	1	N/B
	N^3	N^2/B	N^3/B

	A	B	C
J	N	N	N
I	N	N	N
K	N/B	N	1
	N^3/B	N^3	N^2

	A	B	C
J	N	N	N
K	N/B	N	N
I	1	N/B	N
	N^2/B	N^3/B	N^3