CS18BTECH11041

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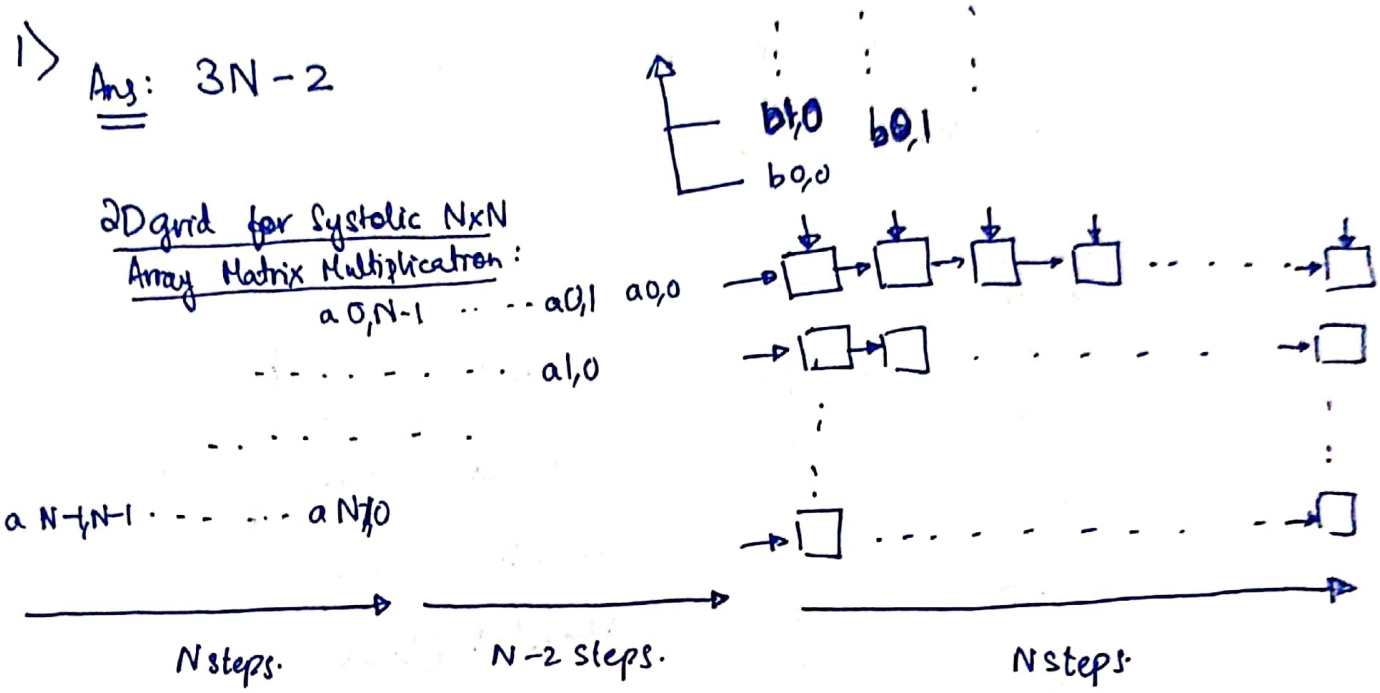
Computer Architecture.

Homework - 4.

1) Ans: $3N-2$



Total = $3N-2$ steps.

2).

```
for (row=0; row<R; row+=B)
for (col=0; col<C; col++)
for (to=0; to<M; to++)
for (ti=0; ti<N; ti++)
for (i=0; i<K; i++)
for (j=0; j<K; j++)
  for (rr=row; rr<min(row+B, R); rr++).

Output_fmaps[to][rr][col] += Weights[to][ti][i][j] *
Input_fmaps[ti][S*rr+i][S*col+j]
```

3)

i) ~~device void Func1~~

- device_ void addFunc1 (int *a, int *b, int *c)

ii) _global_ void addFunc2 (int *a, int *b, int *c)

iii) _host_ void random_ints (int *x, int size)

iv) _host_ int main (void)

4)

Variables	Location
x_dim	register (local)
y_dim	register (local)
iteration	register (local)
pqr	local
ABC	global
maxValue	global.

5)

a) Dimension = 16x16 //

Size of Cache = 128 Bytes //

b)

Unblocked Cache :

Total Hits: 192 hits, Total Misses : 320 Misses.

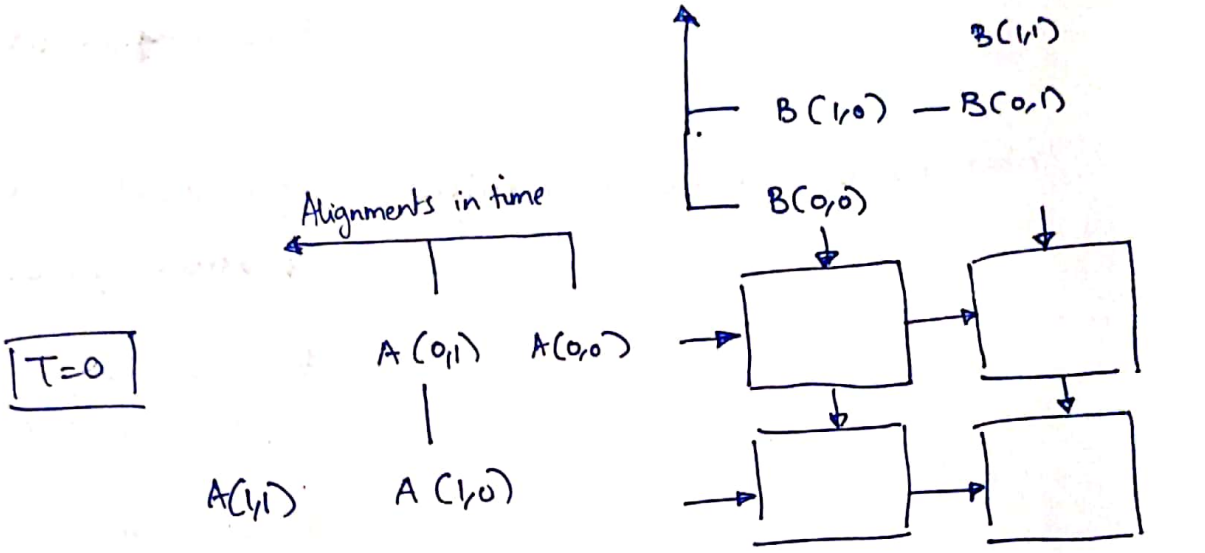
Input Matrix misses: 64, Output Matrix Misses : 256

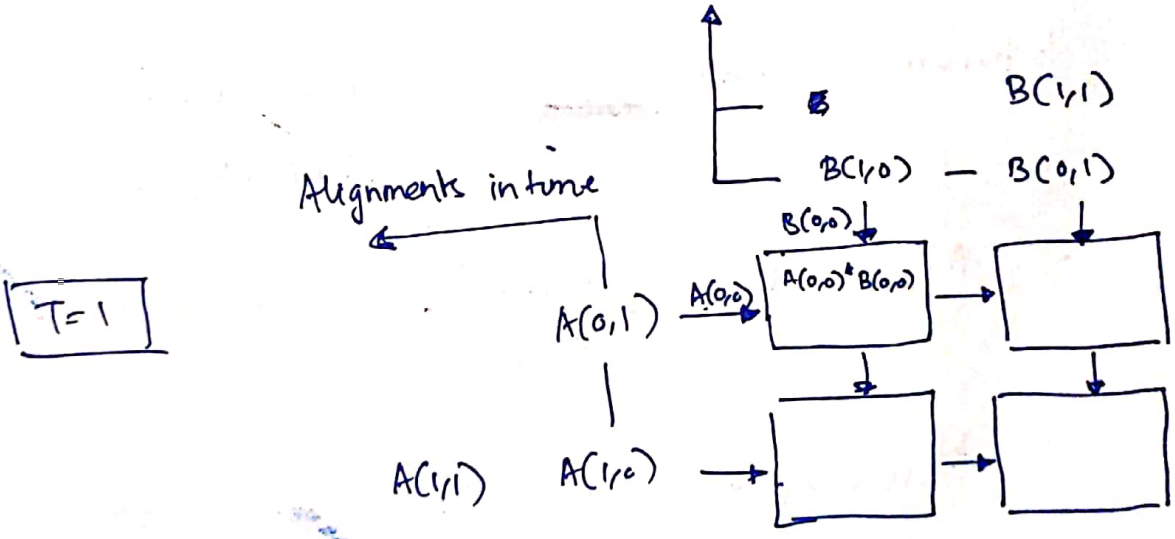
Blocked Cache :

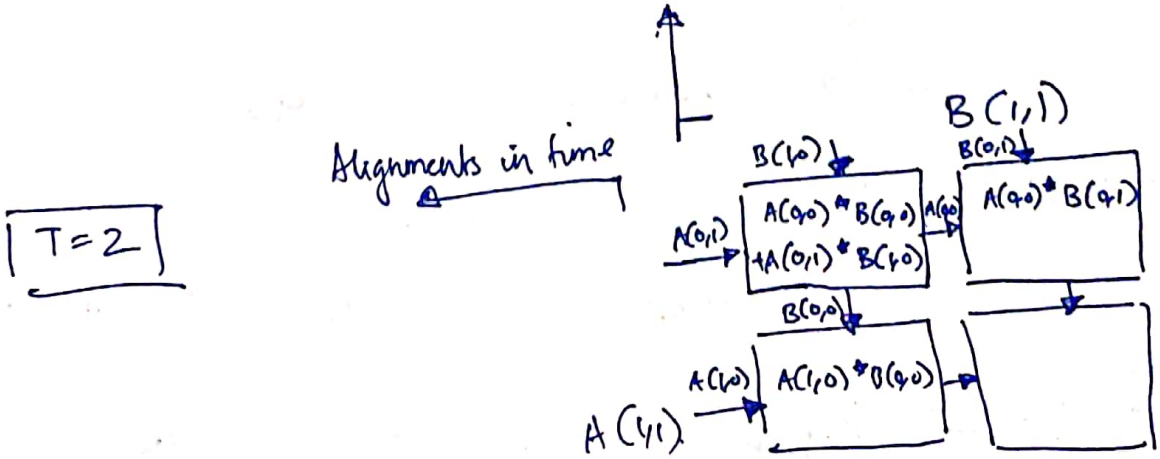
Total Hits: 384, Total Misses : 128

Input Matrix misses: 64, Output Matrix misses : 64

6).

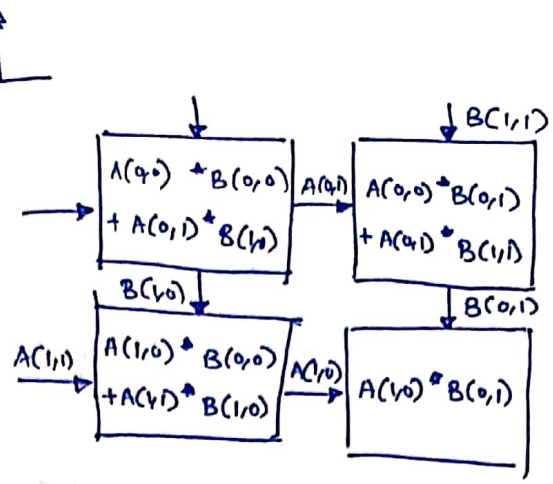




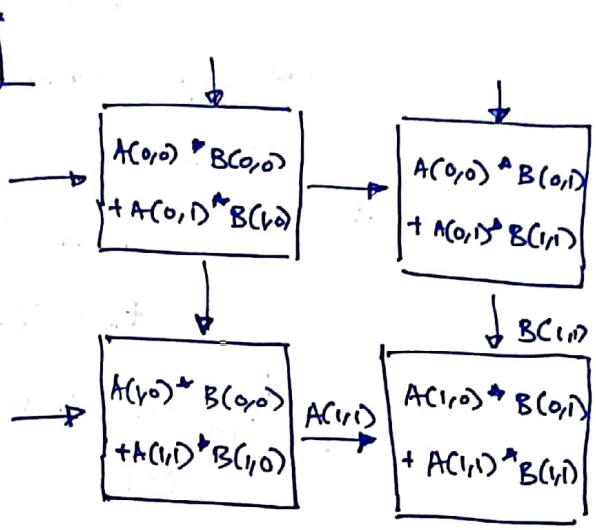


Alignments in time

T = 3



Alignments in time



7)

A) 4

B) 5.5

C) 5.6875

D) 5.6953125

8)

Instruction	Semantics
v.ld vr1, 20[r_2]	vr1 ← ([r_2+20], [r_2+24])

9)

a) Case 1:

$$AI = \text{Flops} / \text{DRAM Bytes}.$$

Note: We are considering that dense implies no non-zero elements and also one memory access is 4 bytes//

$$\Rightarrow AI = \frac{1 \times N^2}{(4 \times 3) \times N^2} = 1/12 = 0.0833 //$$

(Per iteration we need to access X[i][j], Y[i][j] and Z[i][j])

Case 2:

$$AI = \frac{(1 \times N^2/4) + (0 \times 3N^2/4)}{(4 \times 3) \times N^2} = 1/48 //$$

(only $N^2/4$ of the iterations involve non-zero elements i.e $3N^2/4$ iterations have 0 floating point operations)

b)

$$AI = \frac{(1 \times N^2/4) + (0 \times 3N^2/4)}{(4 \times 3) \times N^2/4 + (0 \times 3N^2/4)} = 1/12 //$$

(Now, 'zero' entries don't have any sort of memory access. Thus they contribute 0 bytes per iteration).

10)

a) Performance of this design = $0.75 \times 66 \times 1000$ GOPS

$= 49500$ GOPS.

=> Total operations done in 1 second = (49500 GOPS) x (1 sec)

= 49500 ~~Giga~~ operations

=> Total number of images classified = $\frac{\text{Total operations done}}{\text{Operations for one image}}$

$= \frac{49500 \text{ GOPs}}{1.5 \text{ GOPs/image}}$

$= 33000$ images

b)

Arithmetic Intensity ~~=~~ = $\frac{\text{Total flops.}}{\text{DRAM Bytes.}}$

=> $AI_{\text{Binarized}} = \frac{1.5 \times 10^9}{50 \times 10^6} = 30$ flops/Byte.

=> $AI_{\text{8b fixed point}} = \frac{1.5 \times 10^9}{7.4 \times 10^6} = 202.7$ flops/byte.

11)

AI x Bandwidth = Flops

MCDRAM: AI x 372 = 2199

$AI_{\text{MCDRAM}} = 2199/372 = 5.911$ flops/Byte

DRAM: ~~1114~~ $AI_{\text{DRAM}} = 2199/77 = 28.55$ flops/Byte