Computation

1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

Input: 4x5

1	1	0
0	3	1
2	1	1

Kernel: 3x3

Computation

1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

input

1	1	0
0	3	1
2	1	1

kernel

Computation

output

41		

1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

input

1	1	0
0	3	1
2	1	1

kernel

1*1 + 2*1 + 3*0 + 6*0 + 7*3 + 8*1 + 3*2 + 2*1 + 1*1 = 41

Computation

output

41		

1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

input

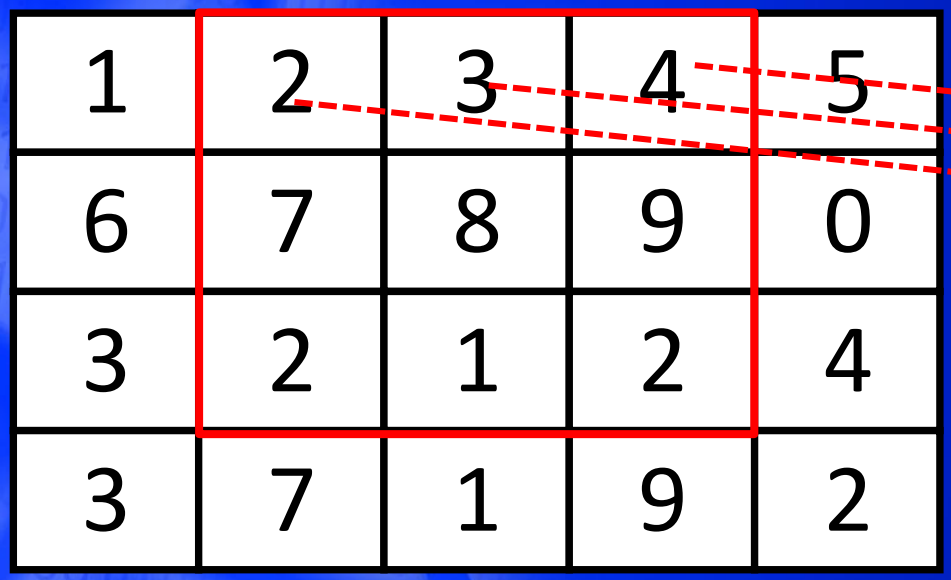
1	1	0
0	3	1
2	1	1

kernel

Computation

output

41	45	



1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

input

1	1	0
0	3	1
2	1	1

kernel

2*1 + 3*1 + 4*0 + 7*0 + 8*3 + 9*1 + 2*2 + 1*1 + 2*1 = 45

Computation

output

41	45	

1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

input

1	1	0
0	3	1
2	1	1

kernel

Computation

output

41	45	42

1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

input

1	1	0
0	3	1
2	1	1

kernel

3*1 + 4*1 + 5*0 + 8*0 + 9*3 + 0*1 + 1*2 + 2*1 + 4*1 = 42

Computation

output

41	45	42

1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

input

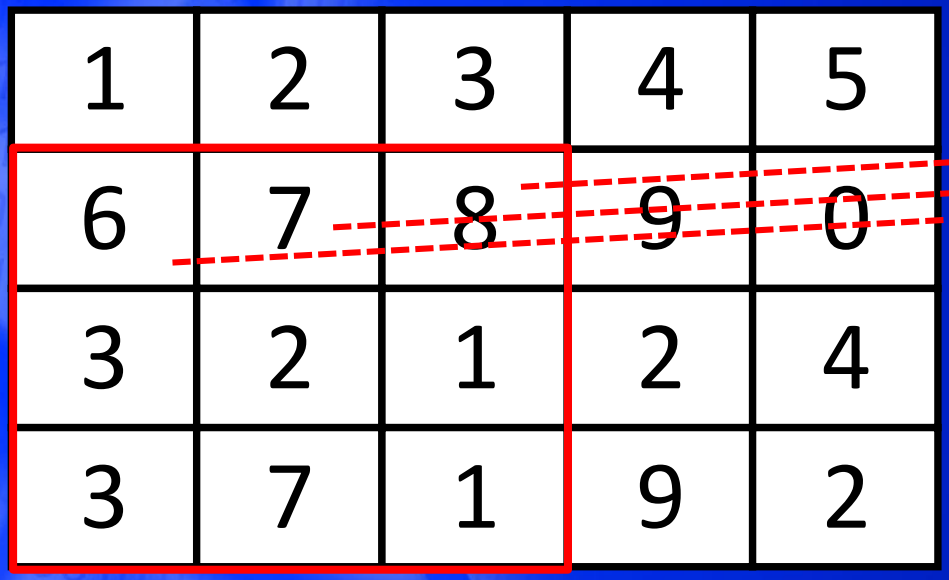
1	1	0
0	3	1
2	1	1

kernel

Computation

output

41	45	42
34		



1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

input

1	1	0
0	3	1
2	1	1

kernel

6*1 + 7*1 + 8*0 + 3*0 + 2*3 + 1*1 + 3*2 + 7*1 + 1*1 = 34

Computation (Final)

output

41	45	42
34	44	40

1	2	3	4	5
6	7	8	9	0
3	2	1	2	4
3	7	1	9	2

input

1	1	0
0	3	1
2	1	1

kernel

Pseudo Code

input: a[4][5], kernel: b[3][3], output: c[2][3]

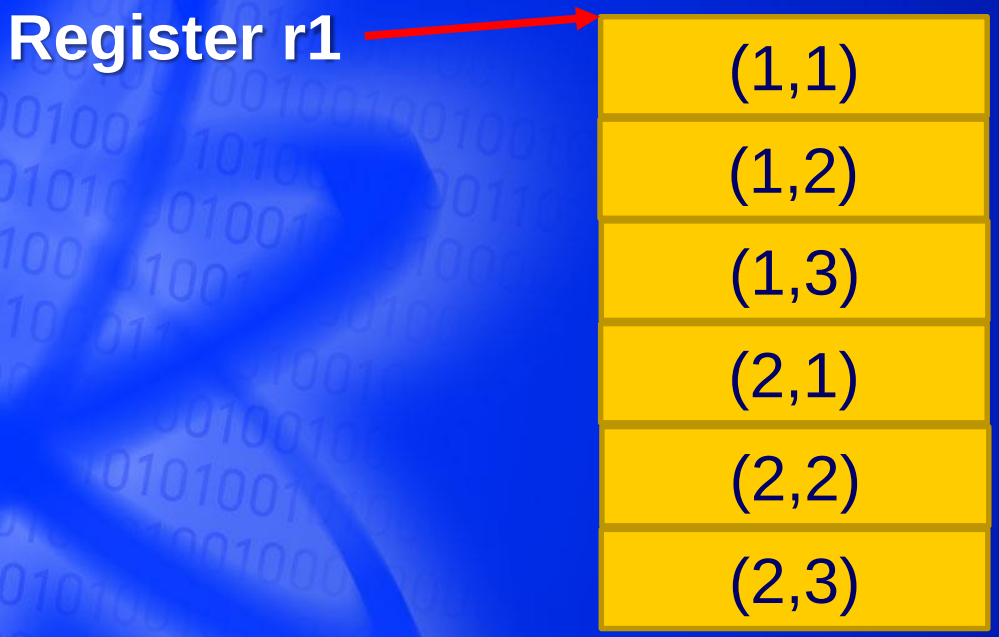
```
for (n=0; n<(4-3+1); n++) {
   for (m=0; m<(5-3+1); m++) {

      //------------------------
      for (i=n; i<(n+3); i++) {
        for (j=m; j<(m+3); j++) {
           tmp = tmp + a[i][j]*b[i-n][j-m];
        }
      }
      //------------------------

      c[n][m] = tmp;
   }
}
```

Homework #4 (1)

Write an ARM assembly program to do the computation.

- input is a 4x5 matrix and kernel is a 3x3 matrix
- output is a 2x3 matrix
- Figure 1 shows the layout of the output matrix
- Each element in input, kernel, and output is a word-sized integer
- The integer values of input and kernel are assigned by yourself

Layout of output matrix



Homework #4 (2)

- The overflow/underflow problems are not considered during the computation
- After computation, register r1 will point to the address of output's first element
- 請勿繳交【利用編譯器所自動產生的組合語言程式】
- 請勿抄襲

Homework #4 (3)

- You need to turn in the following files to ECOURSE2 system (http://ecourse2.ccu.edu.tw/):
- "README.txt" file describes the features in your program and how to compile and run your program.
- Your ARM assembly program, named hw4.s, with proper comments.
- Executable code: hw4.exe
- Makefile
- Any other files are required in your implementation.
- 請將欲繳交的檔案壓縮成 <hw4_學號.tar.bz2>，上傳壓縮檔
- Deadline: ~~November 27 (Wednesday)~~, 24:00, 2019.

  November 30 (Saturday)