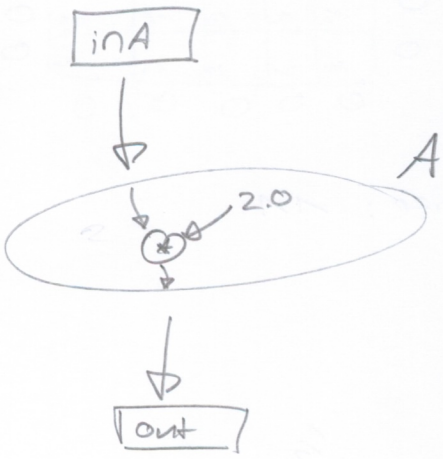
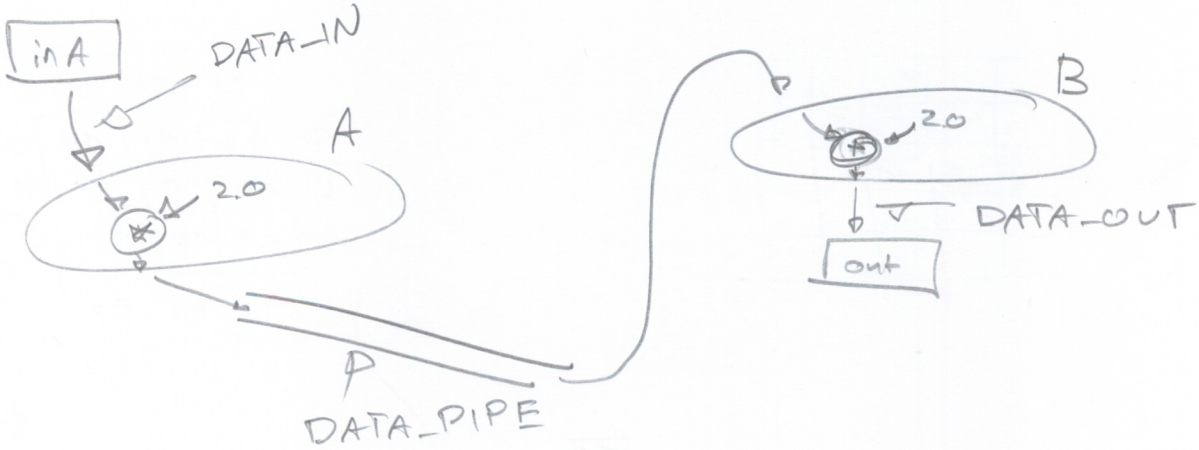
Intel FPGA OpenCL : Getting Started

N=128

example #1 : single stencil (simple)



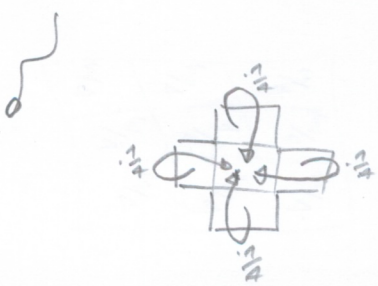
example #2 : simple channel



example #3 : complex stencil (with boundary condition: zero padding)

e.g jacobian 2D :

$$out[i,j] = \frac{1}{4} \cdot (in[i,j-1] + in[i,j+1] + in[i-1,j] + in[i+1,j])$$



example #3 : continued

input: 5 * 5 matrix

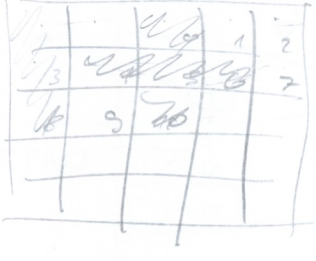
isPadding (index) {

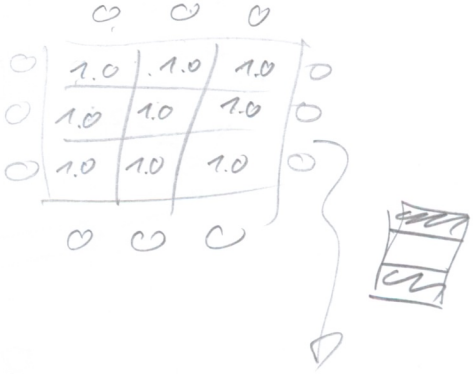
if

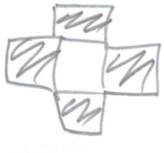
buffer size: 11

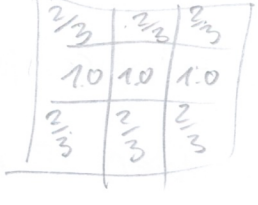
→ we start with stencil:

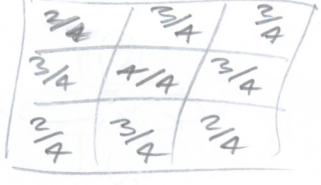
out[i,j] = (in[i-1,j] + in[i,j] + in[i+1,j]) * 1/3



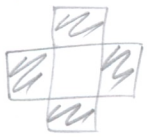








kernel:

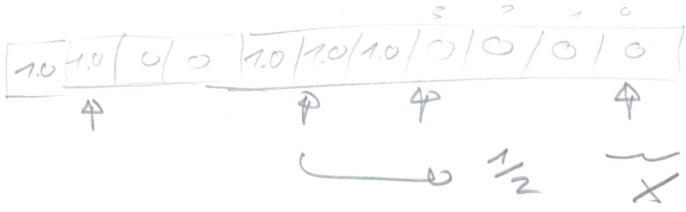


$$out[i,j] = \frac{1}{4} \cdot \left(in[i-1,j] + in[i,j-1] + in[i,j+1] + in[i+1,j] \right)$$

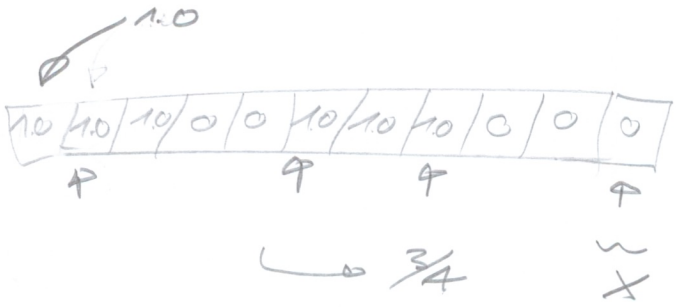
boundary padding

shift register size: 11

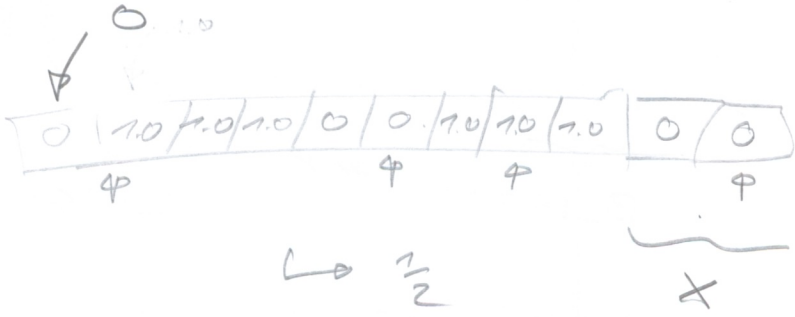
I



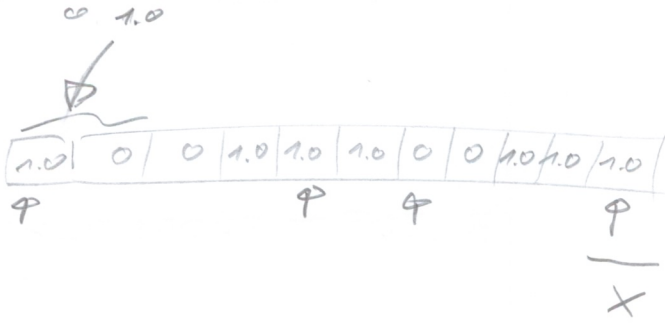
II



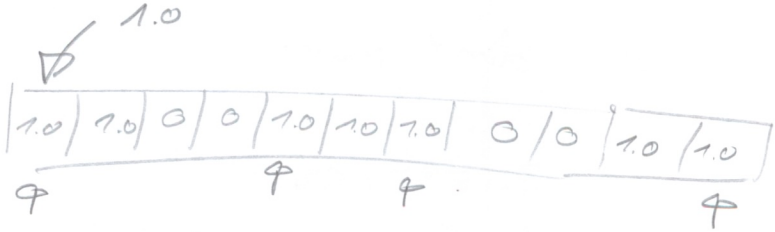
III

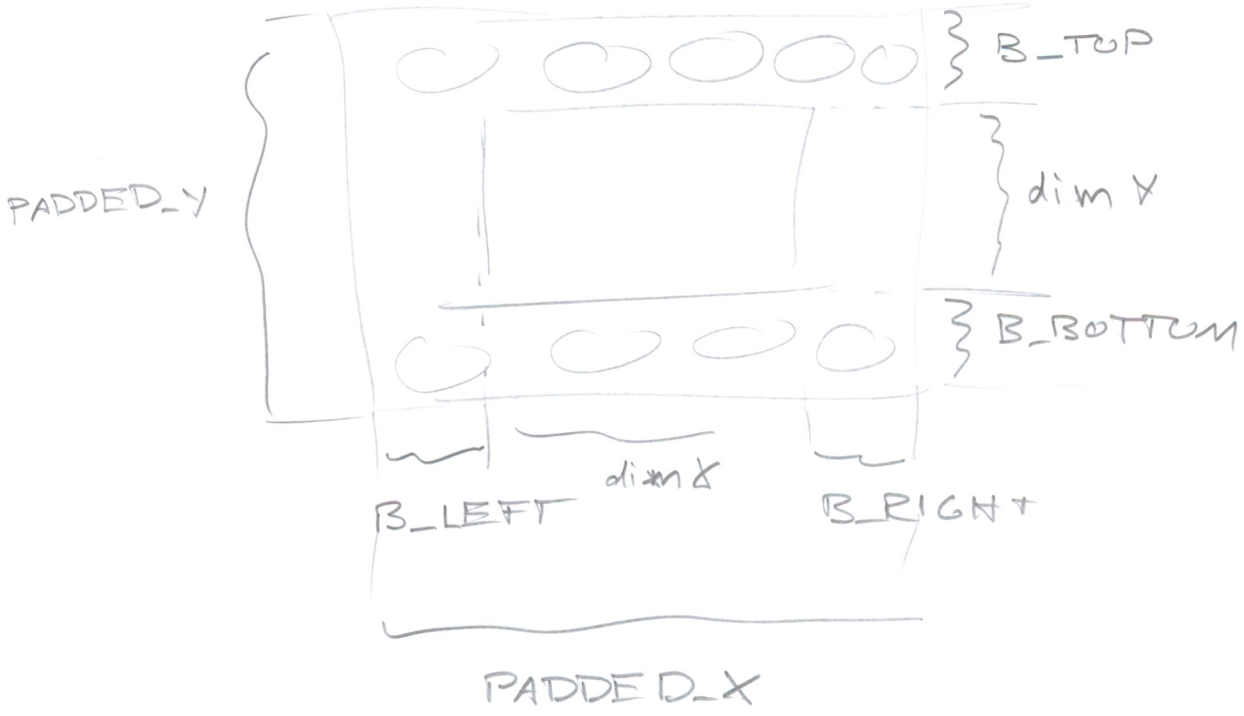


IV



V





(I)

Fill : B_TOP * PADDED_X with zeros

(II) for dimY rows:

B_LEFT: 0
dim X : read channel
B_RIGHT: 0

(III)

Fill B_BOTTOM * PADDED_X with zeros

$out[i,j] = \frac{1}{2} \cdot \left(in[i-1,j] + in[i+1,j] \right)$

shift register buffer size: 7

I

1.0	2.0	3.0
4.0	5.0	6.0
7.0	8.0	9.0

7.0	6.0	5.0	4.0	3.0	2.0	1.0

index: (-1,0) (1,0)

$\frac{1}{2}(0 + 4.0) = 2.0$

✗

II

1.0	2.0	3.0
4.0	5.0	6.0
7.0	8.0	9.0

7.0	6.0	5.0	4.0	3.0	2.0	1.0

index: (-1,1) (1,1)

$\frac{1}{2} \cdot (0 + 5.0) = 2.5$

✗

III

1.0	2.0	3.0
4.0	5.0	6.0
7.0	8.0	9.0

7.0	6.0	5.0	4.0	3.0	2.0	1.0

index: (-1,2) (1,2)

$\frac{1}{2} \cdot (0 + 6.0) = 3.0$

✗

IV

4.0	2.0	3.0
4.0	5.0	6.0
8.0	8.0	9.0

7.0	6.0	5.0	4.0	3.0	2.0	1.0

index: (0,0) (2,0)

$\frac{1}{2} \cdot (1.0 + 7.0) = 4.0$

✓

V

1.0	2.0	3.0
4.0	5.0	6.0
7.0	8.0	9.0

8.0	7.0	6.0	5.0	4.0	3.0	2.0

✓

$$(1 + 2 + 125) \cdot \frac{1}{5}$$

$$\frac{1}{4} \cdot (1 + 2 + 25)$$

$$\frac{1}{5} \cdot (2 + 6 - 4) =$$

VI

9.0	8.0	7.0	6.0	5.0	4.0	3.0

index : (0,2) (2,2)

$\frac{1}{2} \cdot (3.0 + 9.0) = 6.0$

V

VII

	9.0	8.0	7.0	6.0	5.0	4.0

index: (1,0) (3,0)

$\frac{1}{2} (4.0 + 0) = 2.0$

II

VIII

		9.0	8.0	7.0	6.0	5.0

index: (1,1) (3,1)

$\frac{1}{2} \cdot (5.0 + 0) = 2.5$

X

IX

			9.0	8.0	7.0	6.0


offset
1.0 2.0 3.0
4.0 5.0 6.0
7.0 8.0 9.0
1/5 · (in[i-1,j] + in[i,j-1]
+ in[i,j] + in[i,j+1]
+ in[i+1,j])
0 0 0 0 0 0 9.0 8.0 7.0 0 0 6.0 5.0 4.0 0 0 3.0 2.0 1.0 0 0 0 0 0 0
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)

0.6 0.8 0.6

0	0	0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0	0	0	0

(1)

(2)

(3)

(4)

(5)

(6)

(7)

(8)

(9)