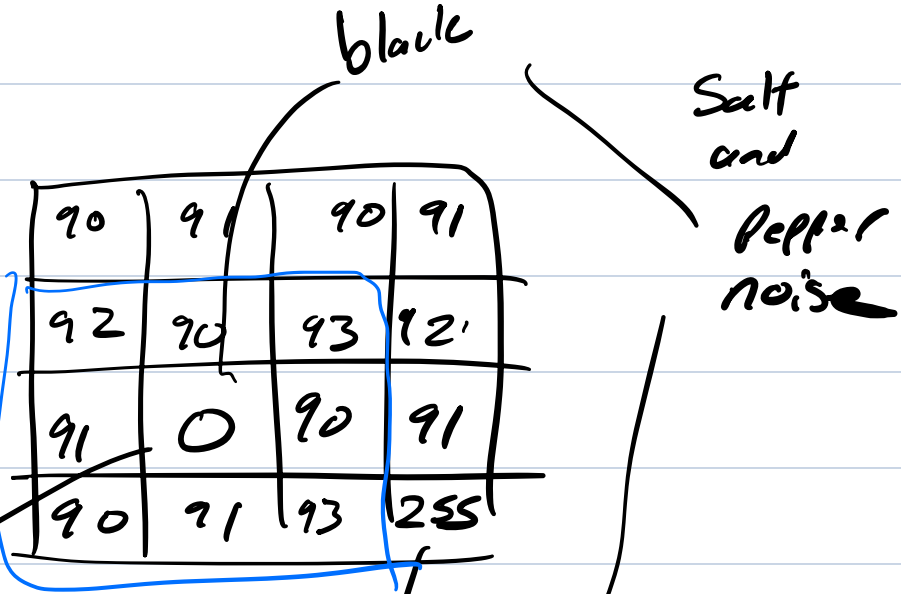
Image filtering

Image filtering - changes the range (pixel values) of an image.

- The goal of image filtering is modify or enhance image properties and/or extract valuable information from a picture.

- De-noising
- edge detection
- Corner detection

Noise example



white

estimate ~ 91

How do we handle this?

- check each pixel's neighbors

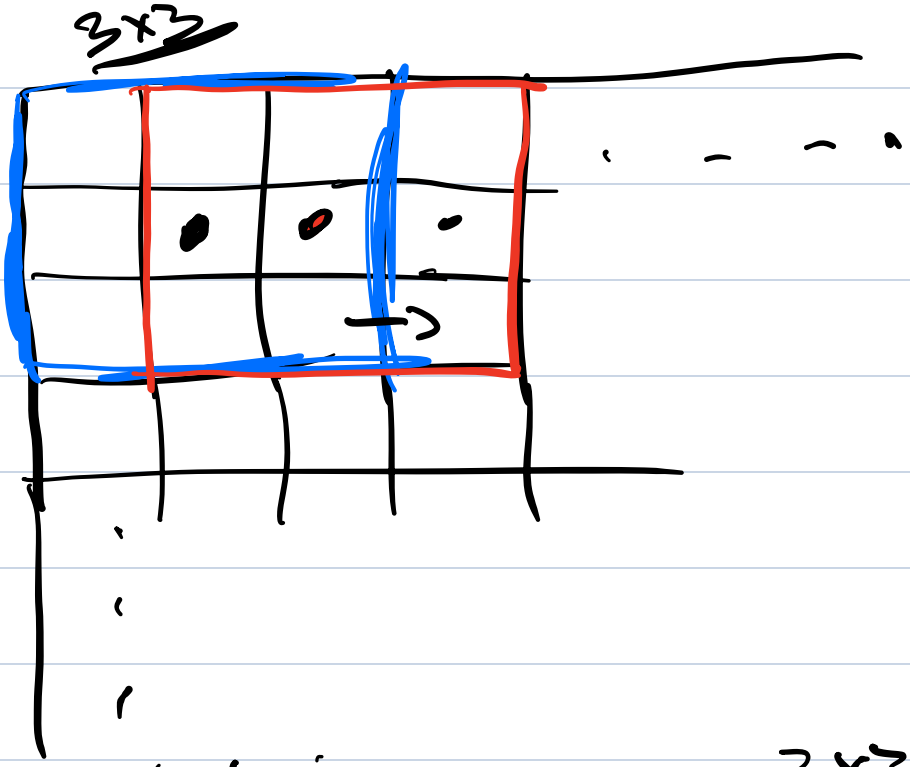
- 3 x 3 window

- In mathematics we can express this window as a 2D convolution.

- Convolution in 2D uses two images (matrix)

  - 1) the orginal image
  - 2) and a kernel, serving as a filter

• The kernel expresses the amount of overlap of one function as it is shifted over another function.



original image

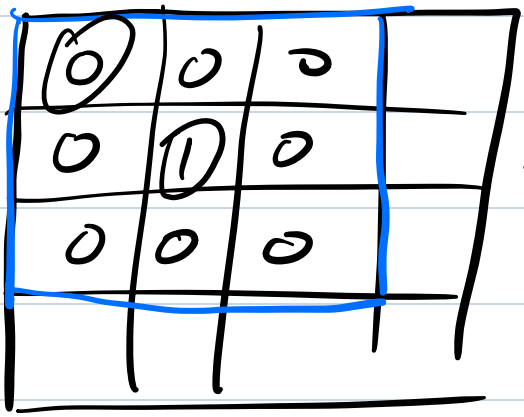
90	91	92	90
91	90	0	93
90	91	90	91
92	91	92	90

→

3x3

0	0	0
0	1	0
0	0	0

Step 1



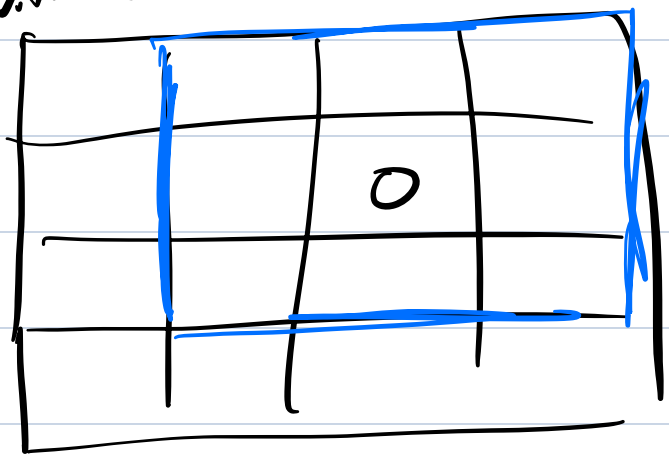
→

90·0	91·0	92·0
91·0	90·1	0·0
90·0	91·0	90·0

= 90

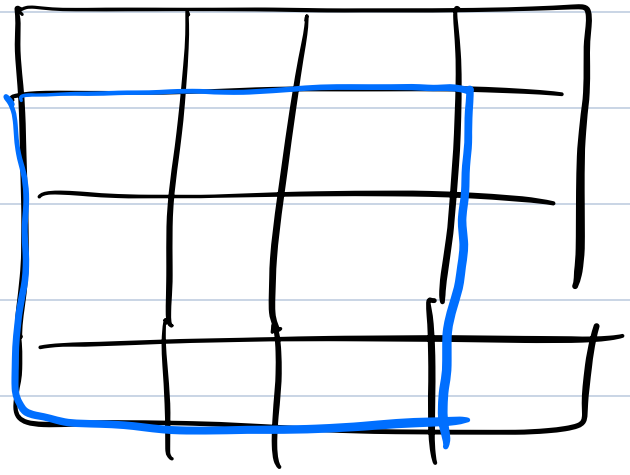
Shift the window

Step 2



= 0

Step 3



= 91

Step 4

= 90

4x4

3x3

2x2

90	91	92	91
91	90	0	93
90	91	90	91
92	91	92	90

→

0	0	0
0	1	0
0	0	0

=

90	0
91	90

Issue - the image is not the orginal size.

Solution - add a Padding / mask / buffer to the orginal image.

- 5 Different Padding methods.
  - Zero → add all 0's around the image
  - Constant → add a constant value
  - Clamp → extend the outside pixels of the original image.

3x3

5	20	100
10	40	110
20	50	120

→

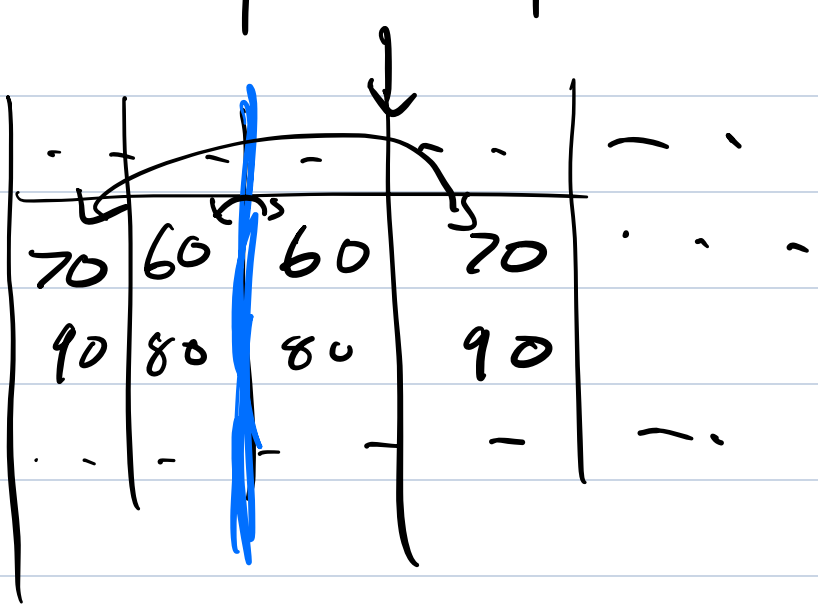
5x5

5	5	20	100	100
5	5	20	100	100
10	10	40	110	110
20	20	50	120	120
20	20	50	120	120

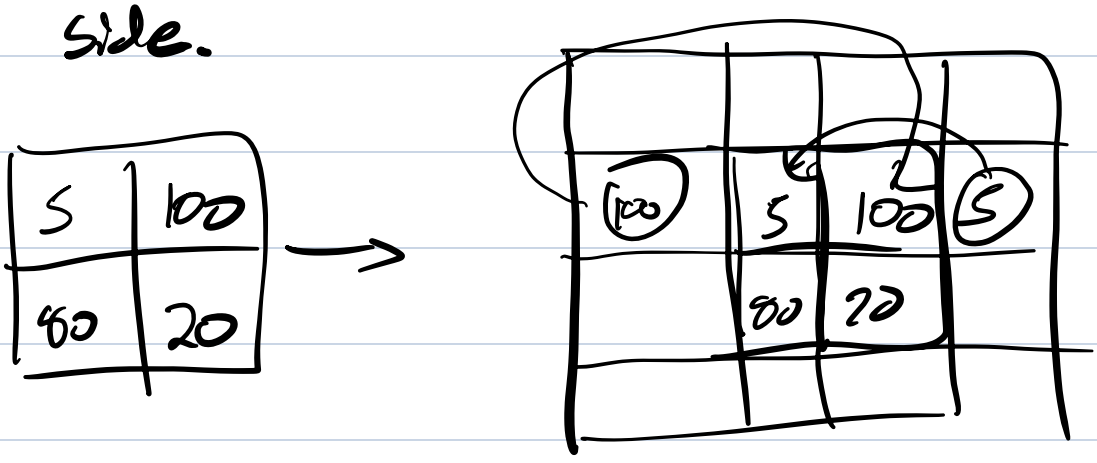
  - mirror → reflect the pixels

.	.	.
60	70	
80	90	
-	-	-

i.e. 5x5 filter
add 2 pixels around the edge



- Wrap : loops "around" the image and uses the pixel from the other side.



- There are no real benifits between the last 3 methods

  - Zero / constant - adds a more noticable artifact around the edge.

- De-noisy / blurring

- use a neighborhood kernel / local kernel / Averag kernel.

average over a pixels

3x3

1	1	1
1	1	1
1	1	1

$\frac{1}{9}$

or

3 x 3

1	1	1
1	0	1
1	1	1

$\frac{1}{8}$

average over 8 pixels used to normalize between [0-255]

90	91	93
90	0	90
91	92	92

$=$

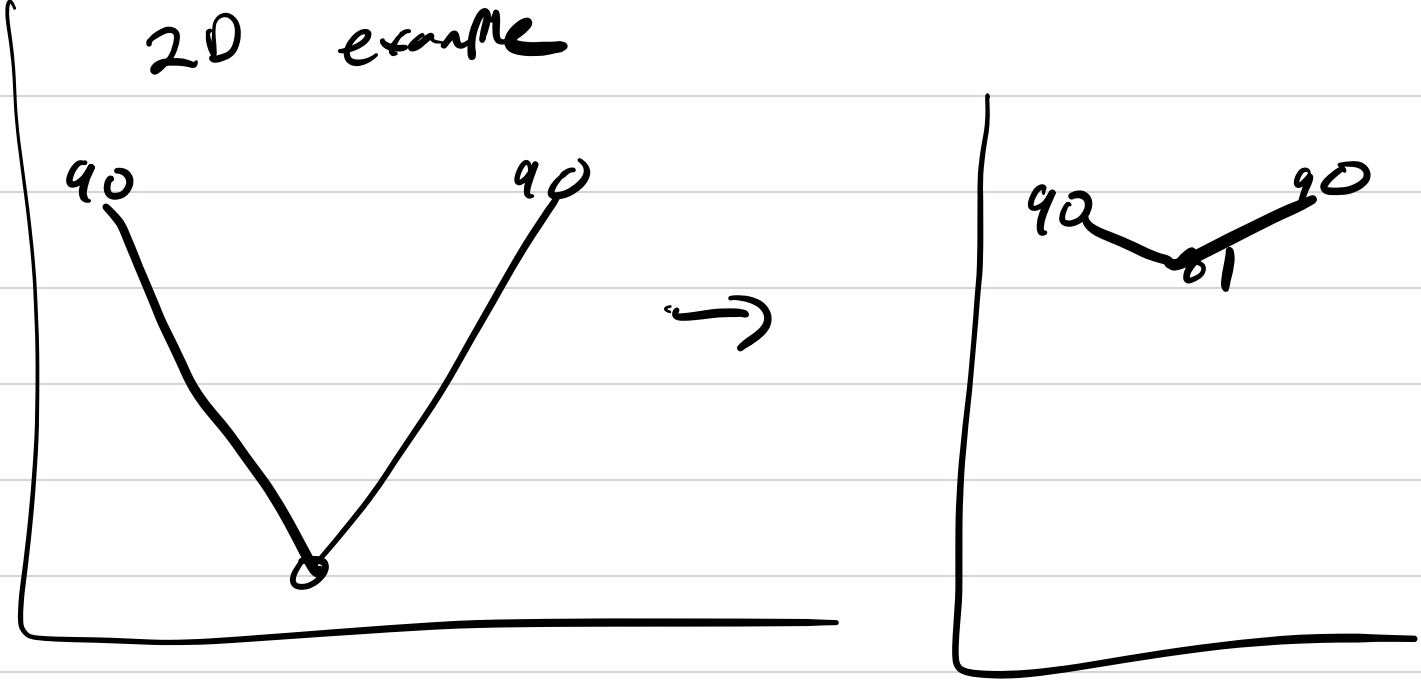
$$(90\cdot1)+(91\cdot1)+(93\cdot1)$$
$$+(90\cdot1)+(0\cdot1)+(90\cdot1)$$
$$(91\cdot1)+(92\cdot1)+(92\cdot1)$$

$= 729$ outside the bounds

devide by 9

$= \frac{729}{9} = 81$

2D example



3x3 filter

1	1	1
1	2	1
1	1	1

-1	0	1
-1	0	1
-1	0	1

Sum of an array

1	2	3	4	5

3 + 3

6 + 4

10 + 5

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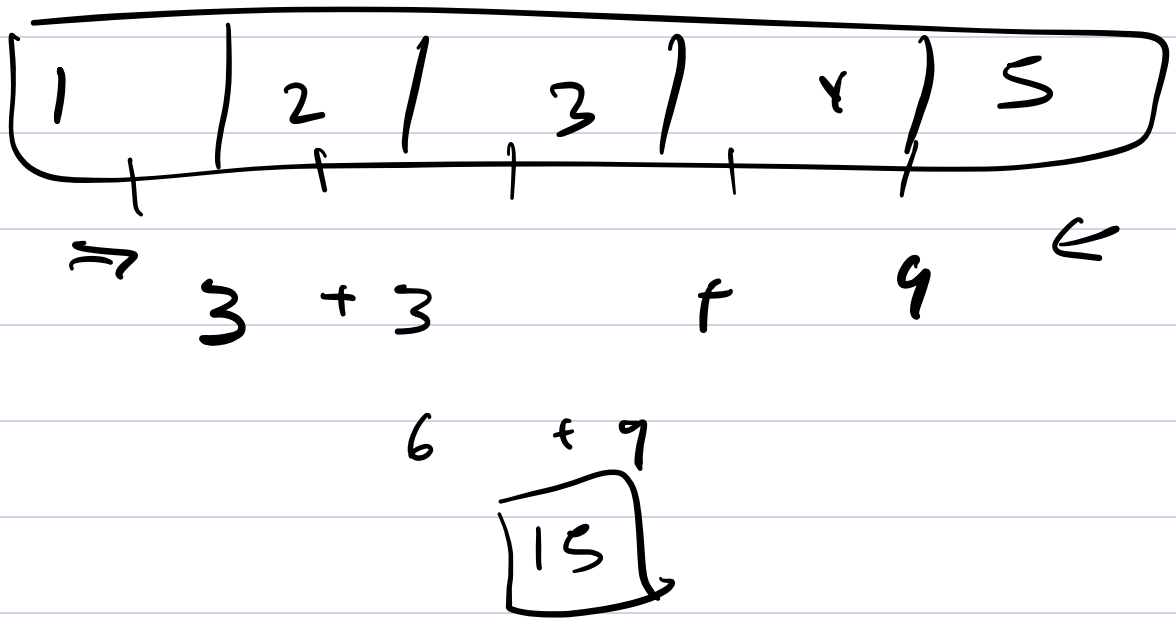

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