Image filtering

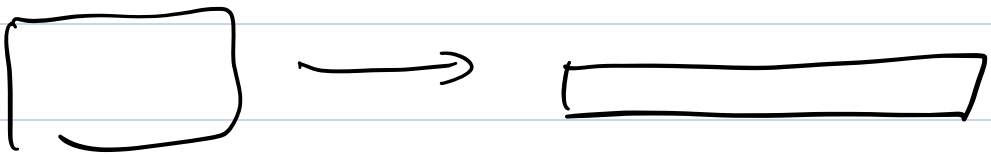
- There are two main types of image processing

  1) Image filtering

  2) Image warping

- Image filtering - changes the range (pixel values) of an image.
  - Colors are altered without changing location

- Image warping - changes the domain (pixel location)
  - points are mapped to other points



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

Such as

- De-noising
- edge detection
- corner dectection
- blobs?

Noise example

90	91	90	91
92	90	93	92
91	0	90	91
90	91	255	93

Black white → Salt and peper noise

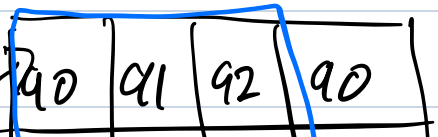
- How do we handle this?
  - Check each pixel's Neighbor to see how close it in Value.
  - A 3x3 Window
- In mathematic we can express this window as a 2D convolution.

- Convolution in 2D uses two images
  - The orginal image
  - and a kernel, serving as a filter.

- The kernel expresses the amount overlap of one function as if is shifted over another function.

input image 4x4

3x3 kernel



q1	q0	0	q3
q0	q1	q0	q1
q2	q1	q2	q0

→

0	0	0
0	1	0
0	0	0

= ?

Step 1

0	0	0	
0	1	0	
0	0	0	

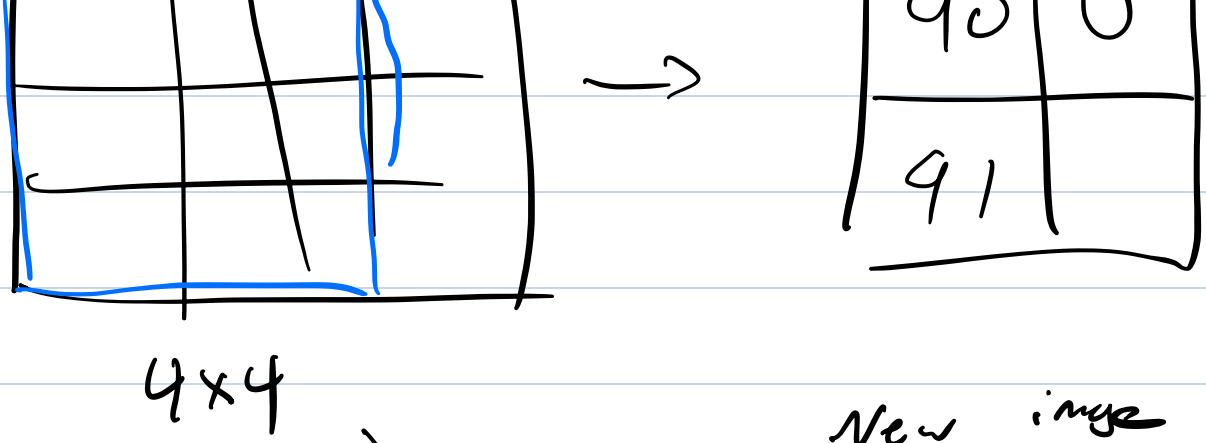
$[q_0 \cdot 0 + q_1 \cdot 0 + q_2 \cdot 0$
$q_1 \cdot 0 + q_0 \cdot 1 + 0 \cdot 0$
$q_0 \cdot 0 + q_1 \cdot 0 + q_0 \cdot 0]$

q0	0

Step 2 Slide window over

	0	0	0
	0	1	0
	0	0	0

Step 3 Shift window to next row



4x4

Step

New image

90	0
91	92

2x2

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 constent value around the image

- Clamp → extend the outside pixels of the original image

5	20	100
10	40	110
20	50	120

→

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 across the image edge.

5×5 filter → 2 width for padding

⋮	⋮
60	70
80	90
⋮	⋮

→

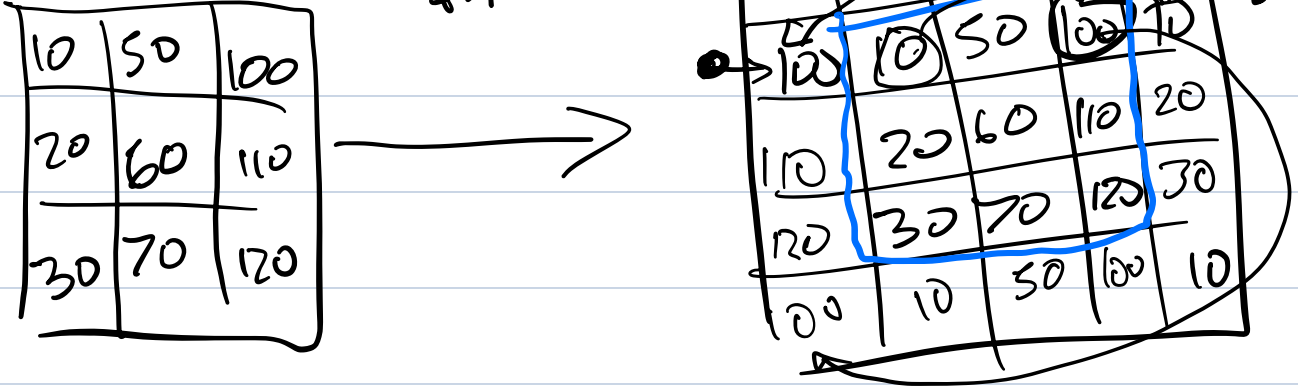
⋮	⋮	⋮	⋮
70	60	60	70
90	80	80	90
⋮	⋮	⋮	⋮

original

- Wrap: loop "around" the image and use the pixel value on the other side

3×3 filter

120	30	70	120	30

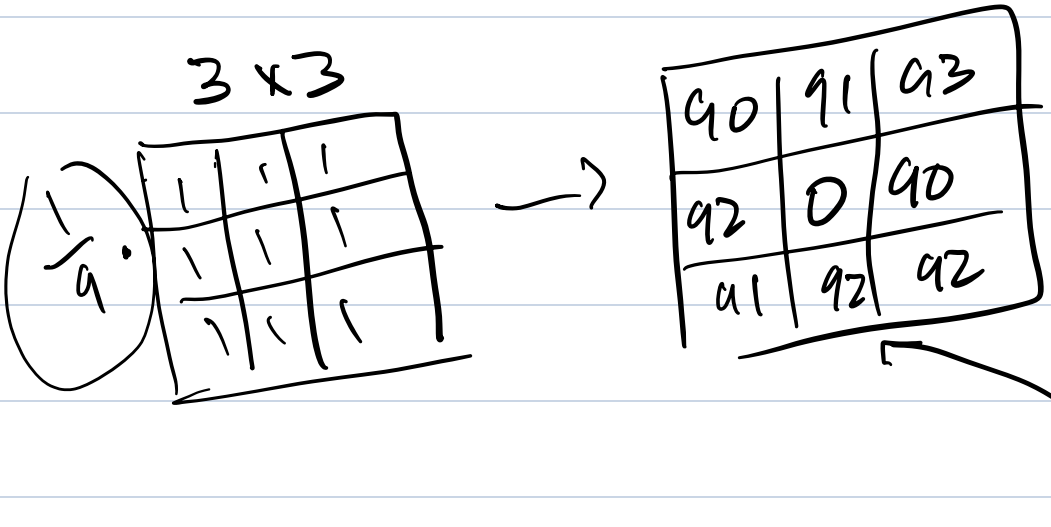


- There are no real benifit between the last 3 Methods

  - Zero / Constant - add a more noticable artifact around the edge after convolution.

- De-noising / blurring

  - use a neighborhood kernel / local kernel.



$= (90 \cdot 1) + (91 \cdot 1) + (93 \cdot 1)$
$+ (92 \cdot 1) + (0 \cdot 1) + (90 \cdot 1)$
$+ (91 \cdot 1) + (92 \cdot 1) + (92 \cdot 1)$

$= \frac{731}{9} = 81$