

Denoting

---

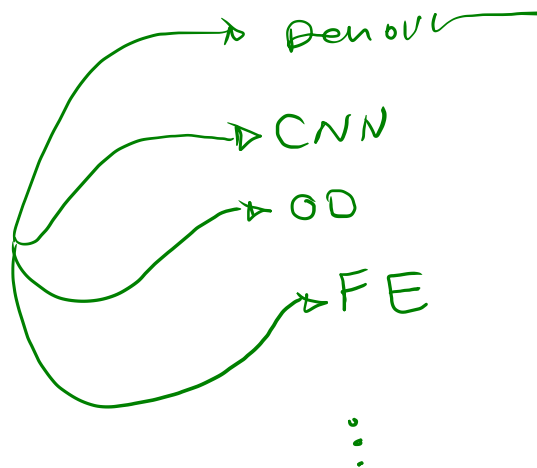
Common  
noises →

1. Salt & pepper  $\rightsquigarrow$   $\left\{ \begin{array}{l} - \text{Randomly} \\ - \text{almost} \\ - \text{white / black} \end{array} \right.$

2. Gaussian  $\rightsquigarrow$   $\left\{ \begin{array}{l} \propto \text{Gaussian!} \\ \propto 0-255 \rightarrow \text{Gray!} \end{array} \right.$

$$\textcircled{I} + n$$

# Convolution



Image

a	b	c	d	e
f	g	h	i	j
k	l	m	n	o
p	q	r	s	t
u	v	w	x	y

Convolve

Kernel

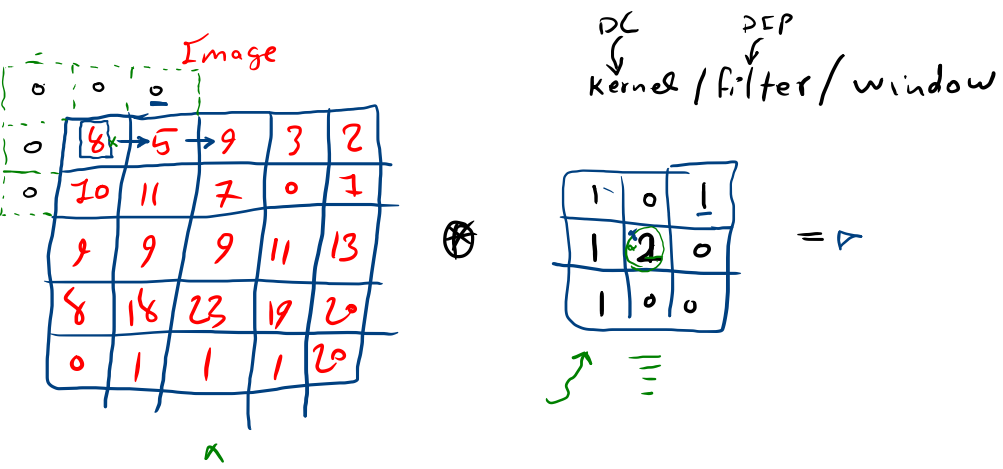
A	B	C
D	E	F
G	H	I

$\alpha$



aA	bB	cC
fD	gE	hF
kG	lH	mI

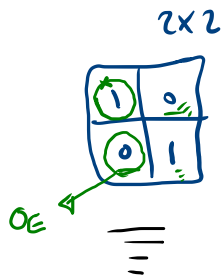
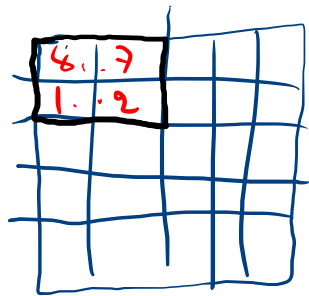
$$I_{\text{new}} = A \alpha a + bB + cC + fD + gE + hF + kG + lH + mI$$



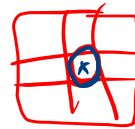
$$1 \times 0 + 0 \times 0 + 1 \times 0 + 1 \times 0 + \underline{2 \times 8} + 0 \times 5 + 1 \times 0 + 0 \times 10 + 0 \times 11 = 16$$

8 → 16
--------

اگر مرکز در آن اعداد زوج باشد! ، یک ربع از کدام عناصر گزینش می شود؟



origin element



## 2. Box filter.

average filter

mean filter

$$\frac{1}{9} \begin{array}{|c|c|c|} \hline 1 & 1 & 1 \\ \hline 1 & 1 & 1 \\ \hline 1 & 1 & 1 \\ \hline \end{array} \quad 3 \times 3$$

$$\frac{1}{25} \begin{array}{|c|c|c|c|c|} \hline 1 & 1 & 1 & 1 & 1 \\ \hline 1 & 1 & 1 & 1 & 1 \\ \hline 1 & 1 & 1 & 1 & 1 \\ \hline 1 & 1 & 1 & 1 & 1 \\ \hline 1 & 1 & 1 & 1 & 1 \\ \hline \end{array} \quad 5 \times 5$$

$$\begin{array}{|c|c|c|} \hline 10 & 15 & 20 \\ \hline 10 & 5 & 0 \\ \hline 1 & 0 & 6 \\ \hline \end{array} \otimes \frac{1}{9} \begin{array}{|c|c|c|} \hline 1 & 1 & 1 \\ \hline 1 & 1 & 1 \\ \hline 1 & 1 & 1 \\ \hline \end{array} =$$

$$s_{\text{new}} = \frac{10 + 15 + 20 + 10 + 5 + 1}{9} = \text{ave} \quad \xrightarrow{\text{green arrow}} \quad \frac{1}{9} [1 \times 10 + 1 \times 15 + 1 \times 20 + 1 \times 10 + 1 \times 5 + 1 \times 0 + 1 \times 1 + 1 \times 0 + 1 \times 0]$$

$\alpha$  اخ فیلتر تصویر در در  $\text{smooth} / \text{blurring} / \text{blur}$  می کنند. یعنی خرابی های تصویر را

denoising محو می کند یا از بین می برد!

Input Image



Box Filter (5,5)





# 2. Gaussian Filter!

→

هر نوزدهم هستی!

5\*5

$(-1, -1)$

3x3

$\alpha$

→

$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{16}$
$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{8}$
$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{16}$

$\alpha$

$$\frac{1}{273}$$

1	4	7	4	1
4	16	26	16	4
7	26	41	26	7
4	16	26	16	4
1	4	7	4	1

$$G(x, y) = \frac{1}{2\pi\sigma^2} \exp\left(\frac{-(x^2 + y^2)}{2\sigma^2}\right)$$

↓

<u>(-1, -1)</u>	(-1, 0)	(-1, 1)
(0, -1)	(0, 0)	(0, 1)
(1, -1)	(1, 0)	(1, 1)

$$\frac{\sigma=1}{\sigma}$$

$$G(-1, -1) = \frac{1}{2\pi} \exp\left(\frac{-((-1)^2 + (-1)^2)}{2}\right)$$

$$= \frac{1}{2\pi} \exp\left(-\frac{2}{2}\right) = \frac{1}{2\pi} \exp(-1) \approx \frac{1}{16}$$

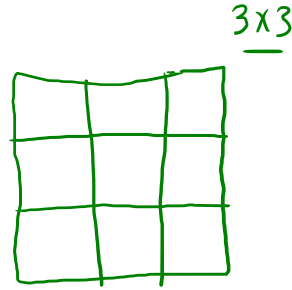
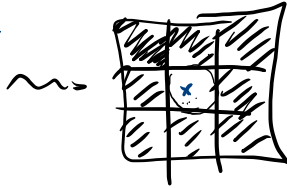
کاترولش نیست! → non linear

### 3. median filter

میان

Salt and pepper / درین تیزه

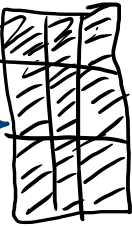
1	0	0
0	255	1
1	1	1



sort : [ 0 0 0 1 1 1 1 1 255 ]

255 → 1

1	0	0
0	1	1
1	1	1

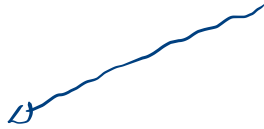


# 4. max filter

کاغذوں پر ہے!

→

<u>250</u>	<u>253</u>	14
19	250	16
19	0	1



3x3


200 → 253

250	253	14
19	253	16
19	0	1

max filter

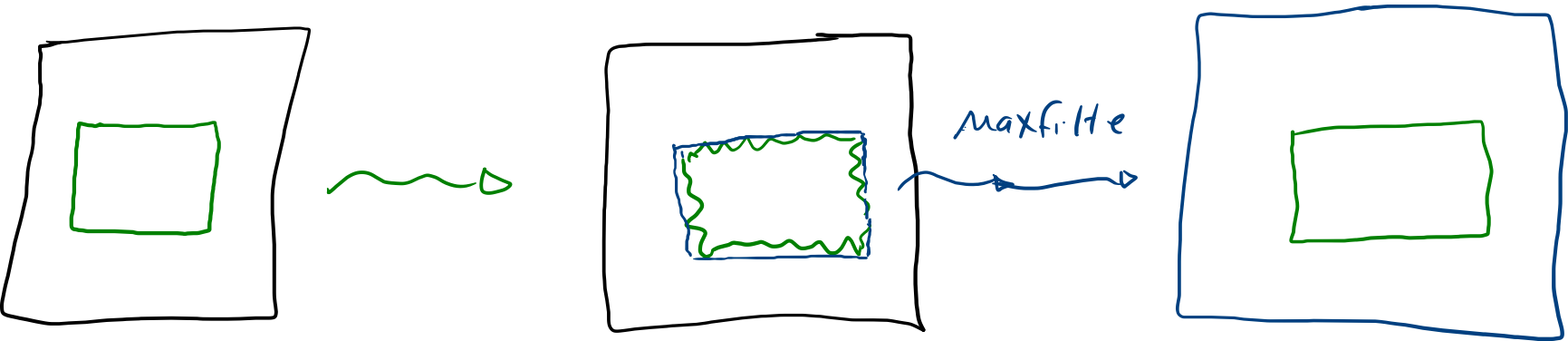


window

ماکزعم عناصر اردوں پنجرے

را کاغذ پر بنی عناصر سب سے بڑی کی گئی

max filter  $\longrightarrow$  Dilation  $\longrightarrow$   $\{C\}$



5. Min filter

3x3

erosion!

انقاص min elements

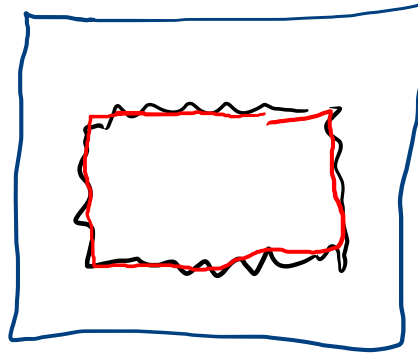
window يا صغير!

كانت لو كانت بزرگ!

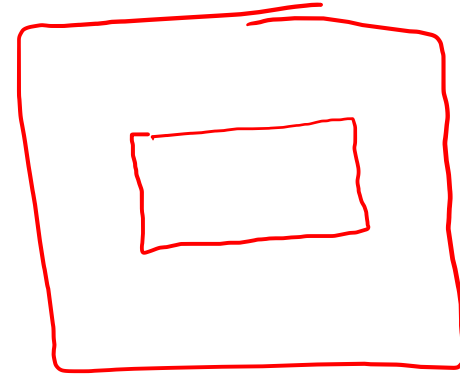
0	1	0
80	90	13
32	27	19

min Filter

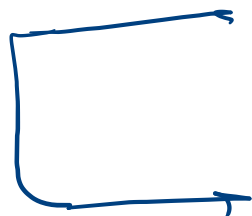
0	1	0
80	0	13
32	27	19



min Filter  
erosion!

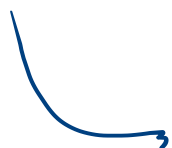


morphological  
operators.



dilation

erosion



shape, size

شکل، اندازه

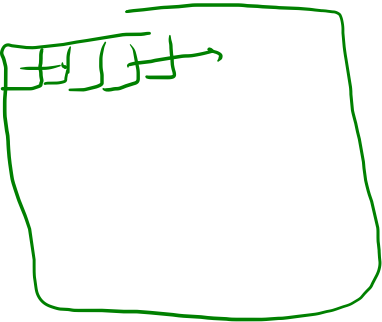
118	109	150
120	119	130
108	110	179

Max Filter



	179	

120 x 120

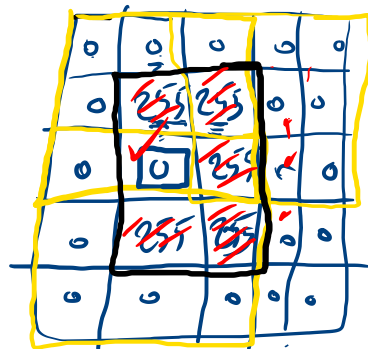




# Dilation

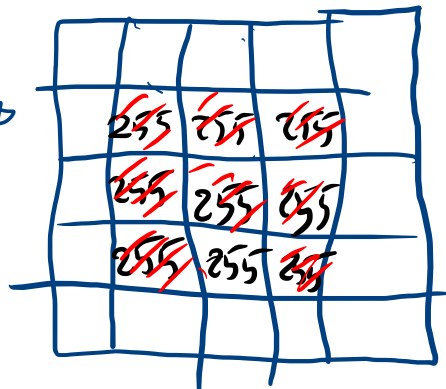
structuring filter

Image

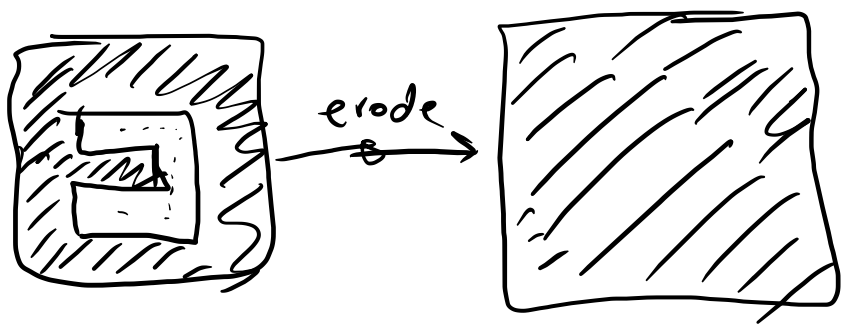
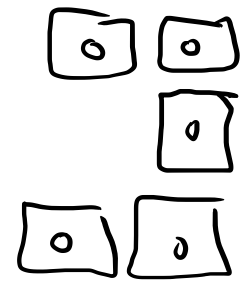
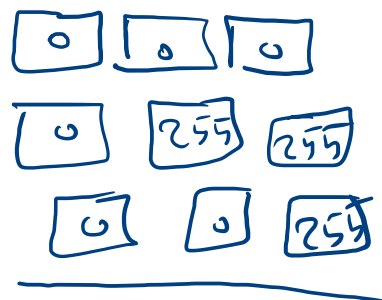
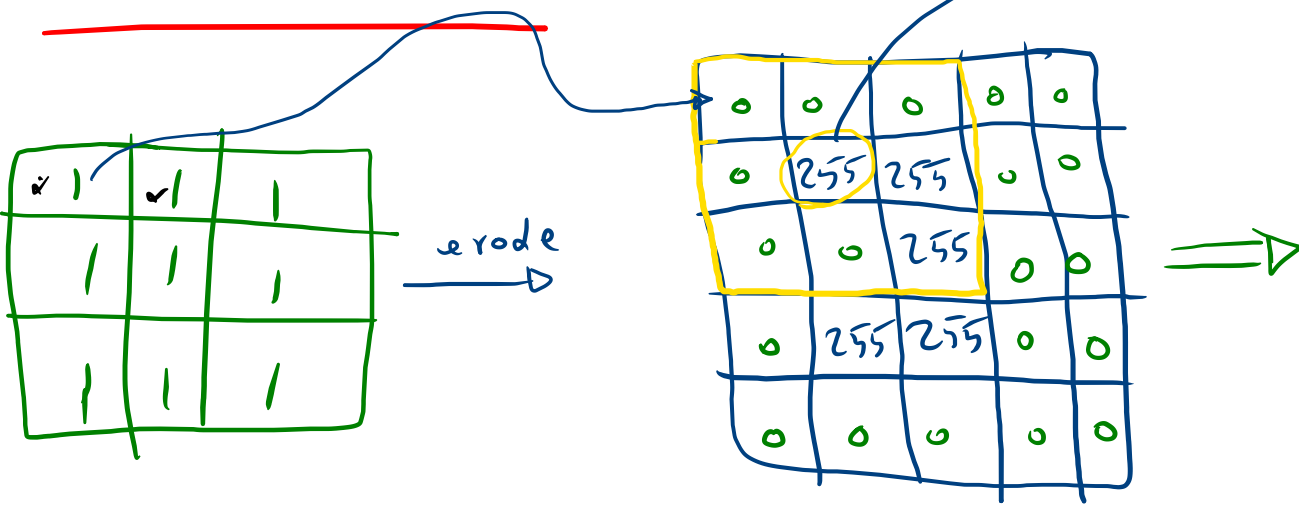


Sf

1	1	1
1	1	1
1	1	1



erosion  $\rightsquigarrow$  min filter



The End

