

*Dr. Denton Bobeldyk*

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# CIS 365 Artificial Intelligence

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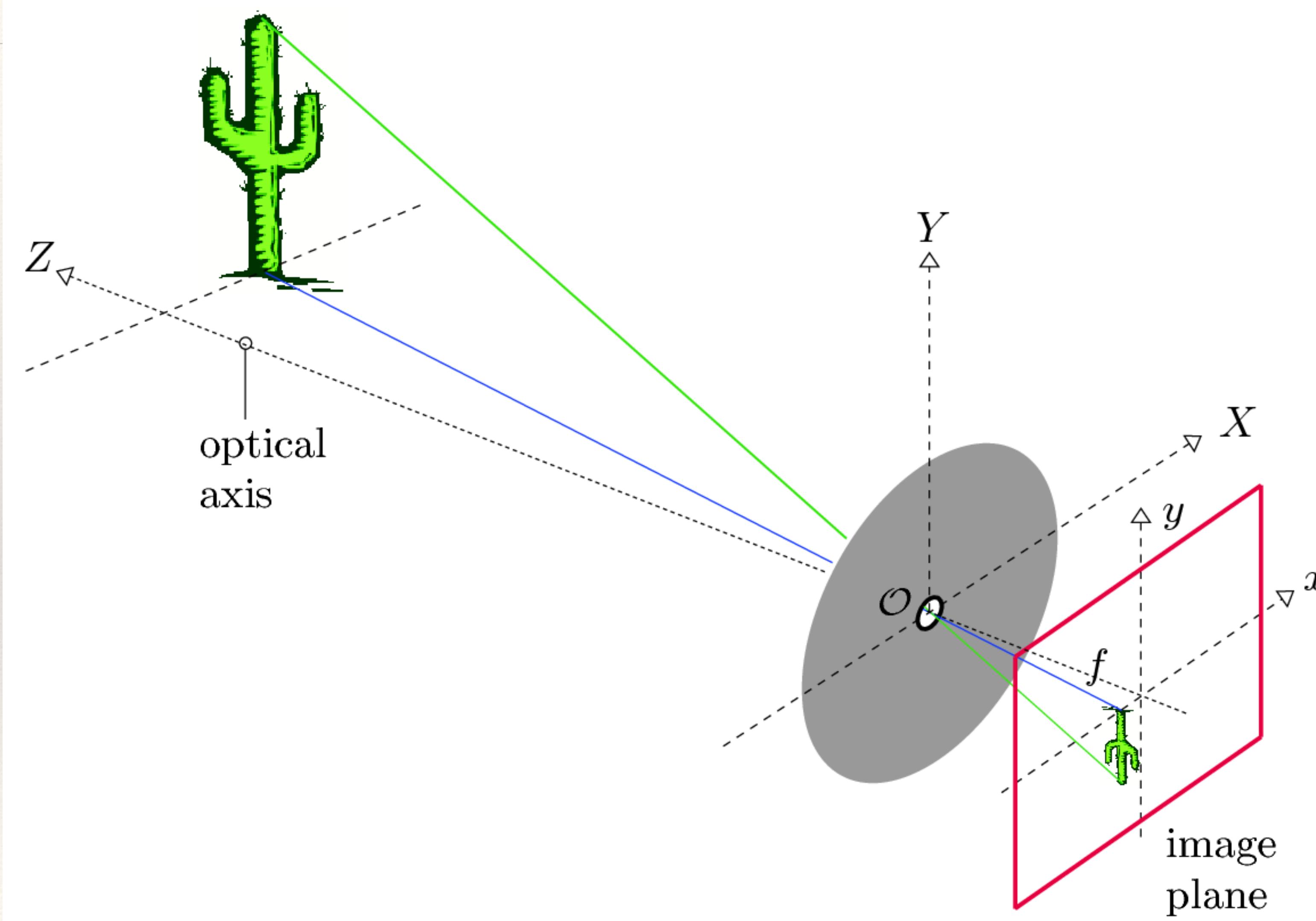
Computer Vision Introduction

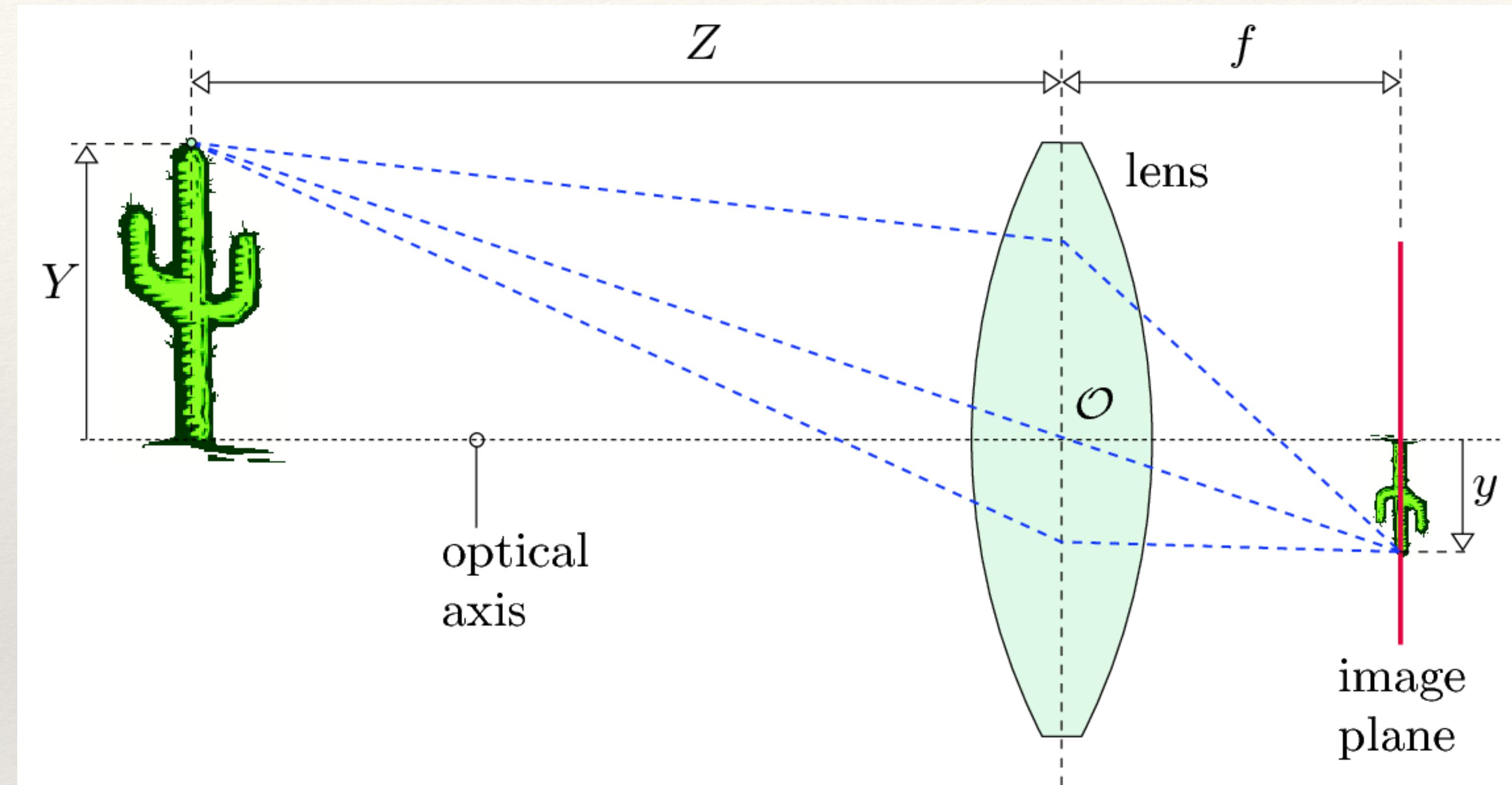
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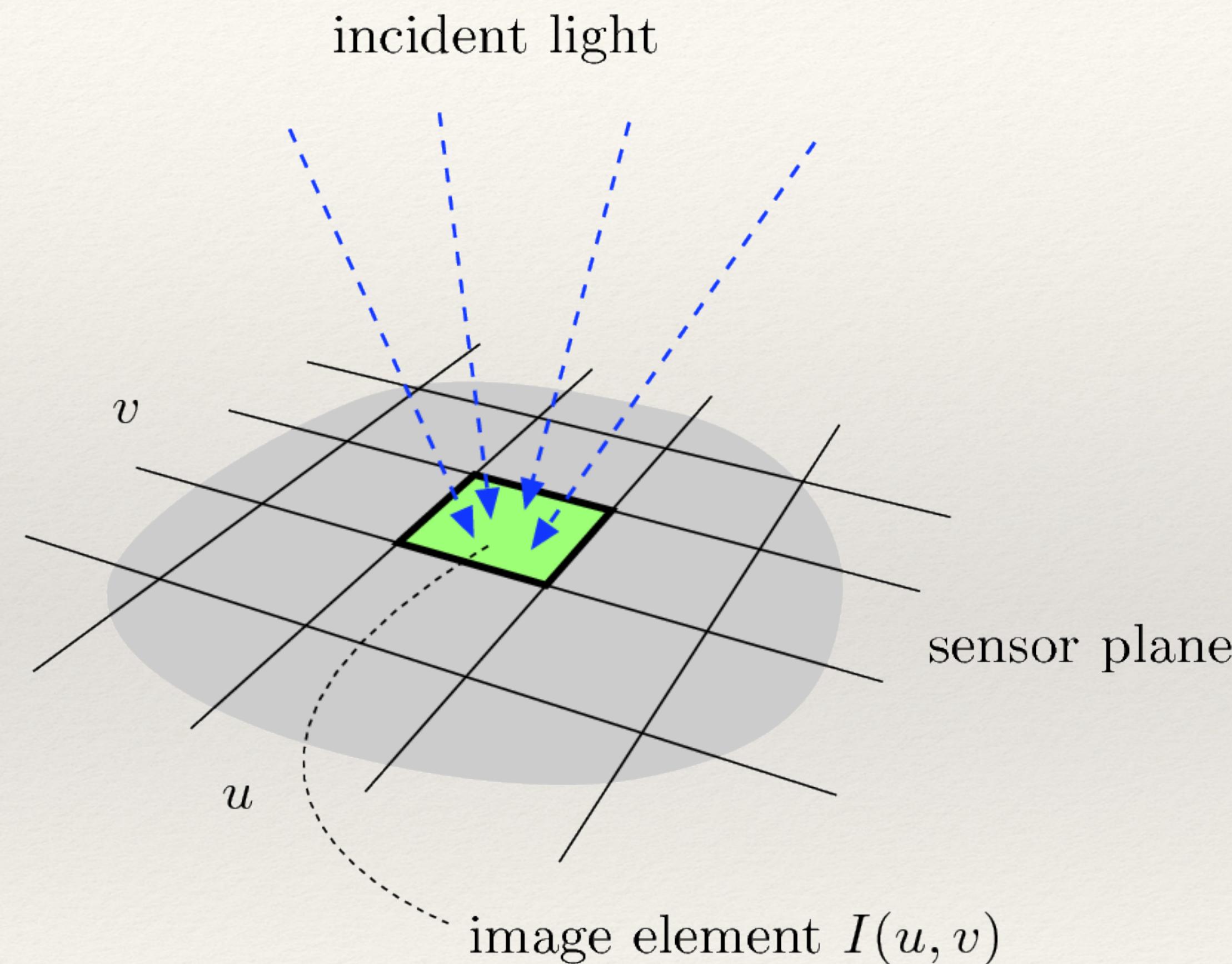
Images from these slides are taken from:

‘Digital Image Processing  
An Algorithmic Introduction Using Java’  
Burger/Burge





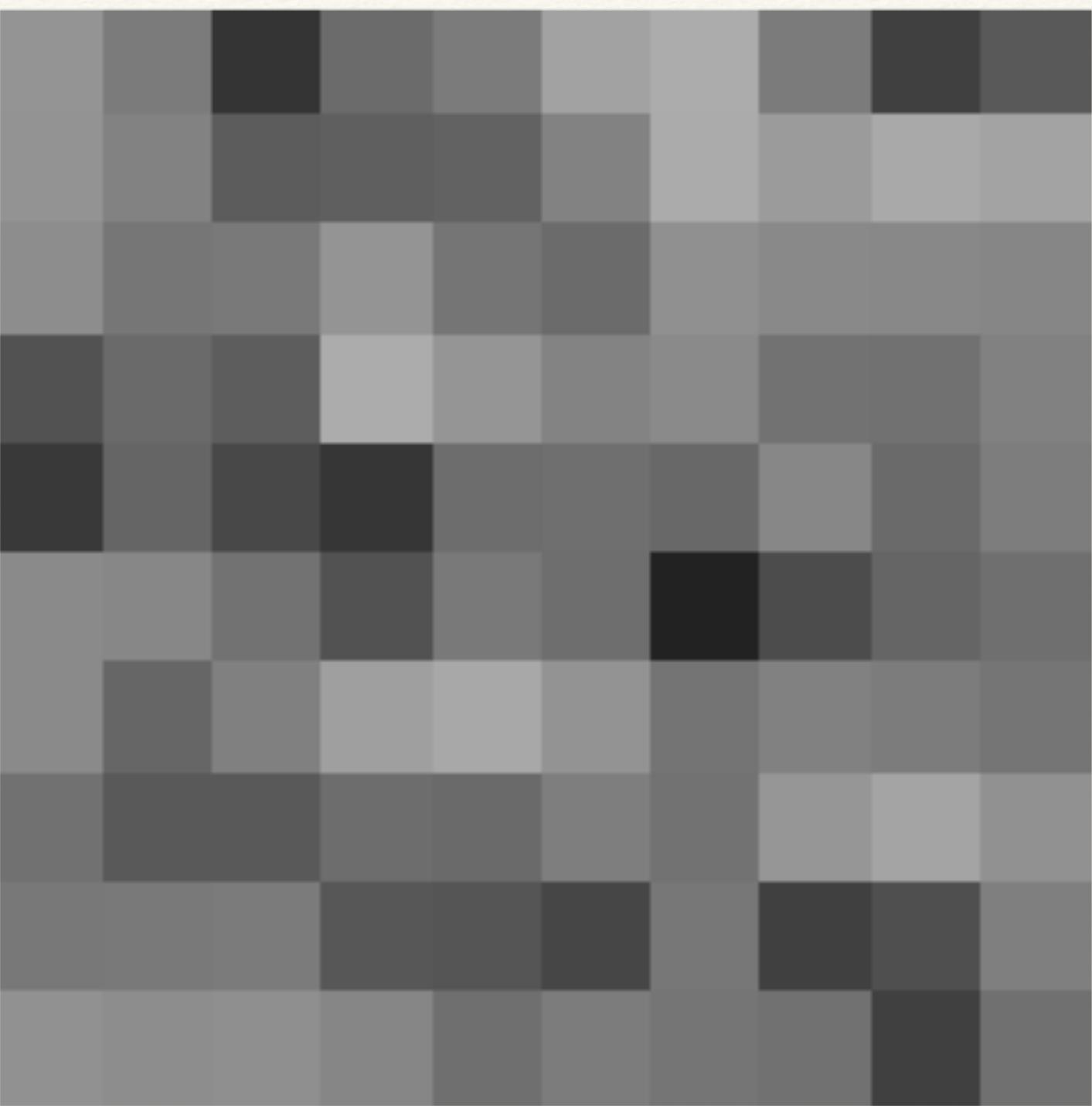
# Computer Vision Introduction

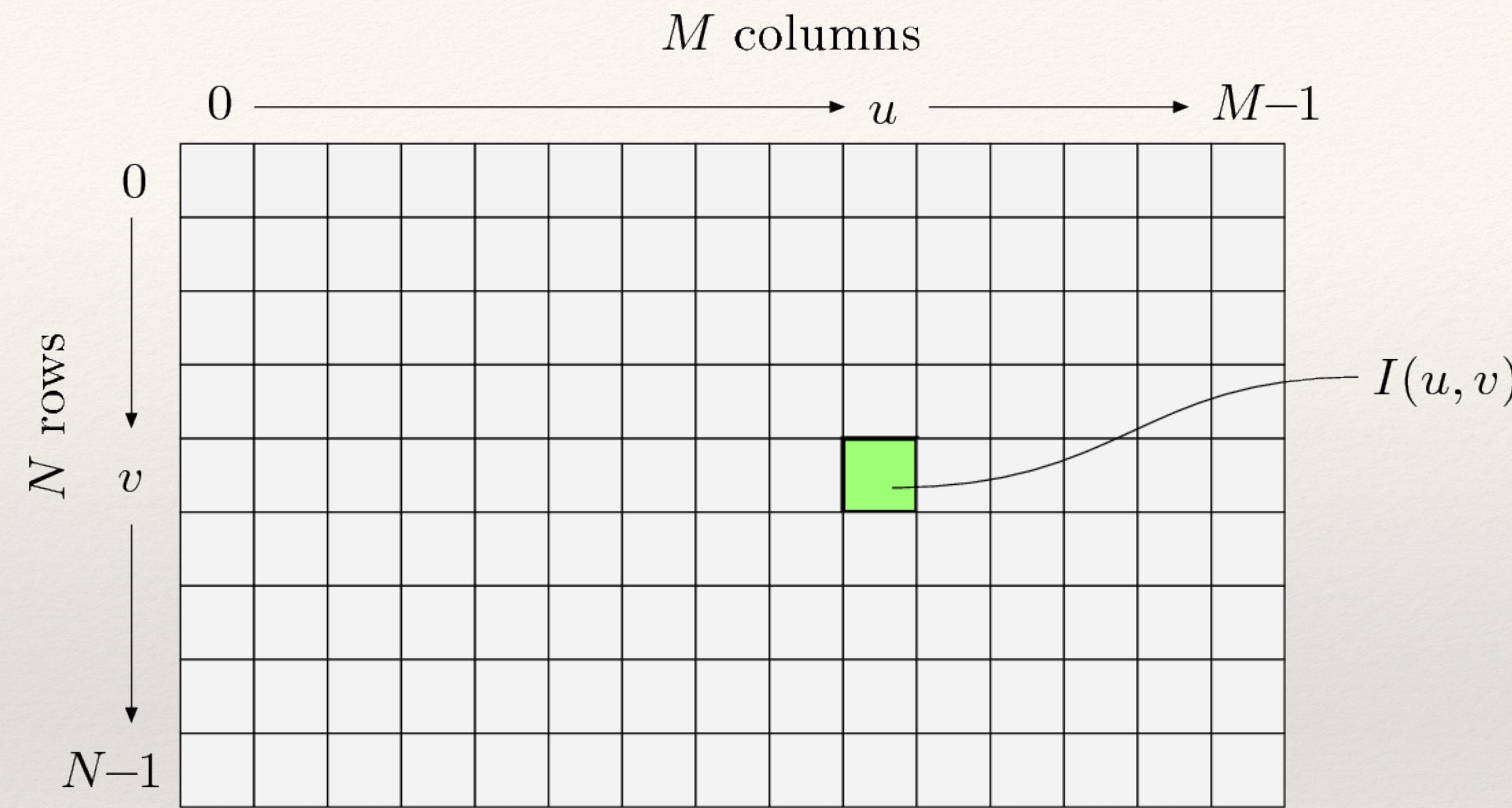


 $F(x, y)$ 

148	123	52	107	123	162	172	123	64	89	...
147	130	92	95	98	130	171	155	169	163	...
141	118	121	148	117	107	144	137	136	134	...
82	106	93	172	149	131	138	114	113	129	...
57	101	72	54	109	111	104	135	106	125	...
138	135	114	82	121	110	34	76	101	111	...
138	102	128	159	168	147	116	129	124	117	...
113	89	89	109	106	126	114	150	164	145	...
120	121	123	87	85	70	119	64	79	127	...
145	141	143	134	111	124	117	113	64	112	...
:	:	:	:	:	:	:	:	:	:	...
:	:	:	:	:	:	:	:	:	:	...

 $I(u, v)$





## Grayscale (Intensity Images):

<i>Chan.</i>	<i>Bits/Pix.</i>	<i>Range</i>	<i>Use</i>
1	1	0...1	Binary image: document, illustration, fax
1	8	0...255	Universal: photo, scan, print
1	12	0...4095	High quality: photo, scan, print
1	14	0...16383	Professional: photo, scan, print
1	16	0...65535	Highest quality: medicine, astronomy

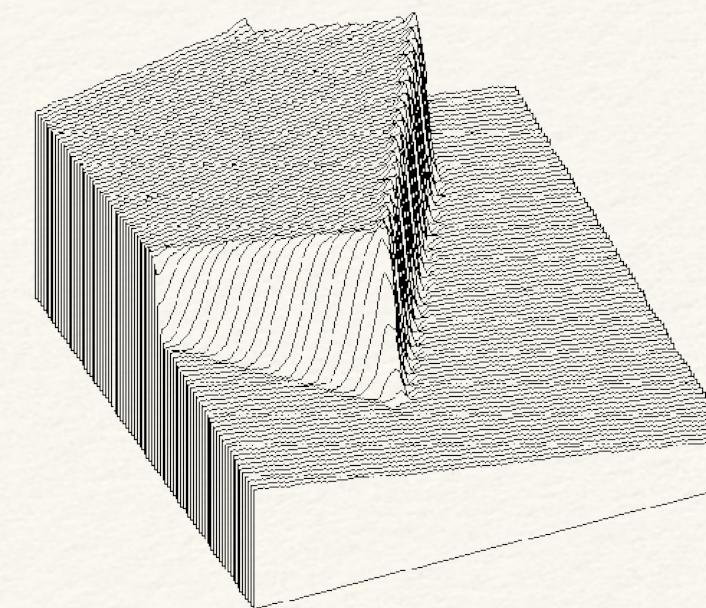
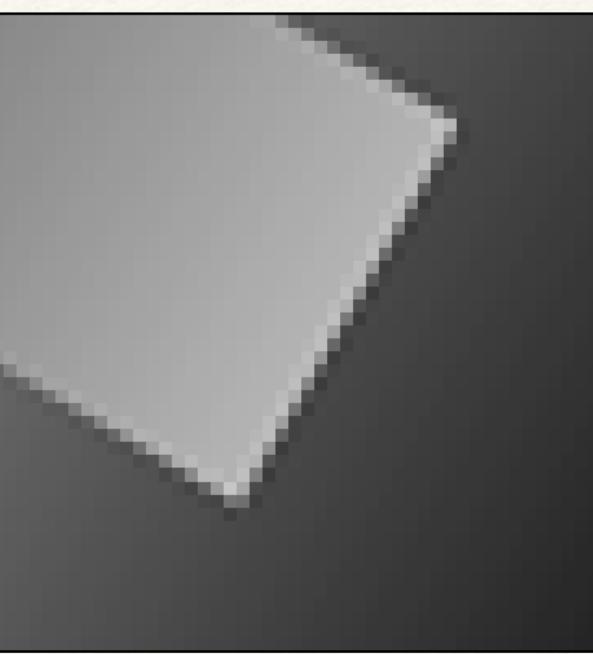
## Color Images:

<i>Chan.</i>	<i>Bits/Pix.</i>	<i>Range</i>	<i>Use</i>
3	24	$[0\dots255]^3$	RGB, universal: photo, scan, print
3	36	$[0\dots4095]^3$	RGB, high quality: photo, scan, print
3	42	$[0\dots16383]^3$	RGB, professional: photo, scan, print
4	32	$[0\dots255]^4$	CMYK, digital prepress

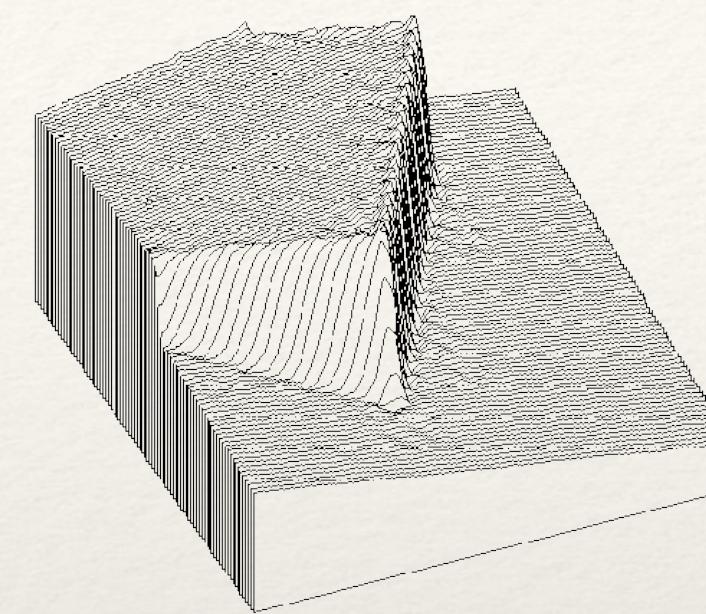
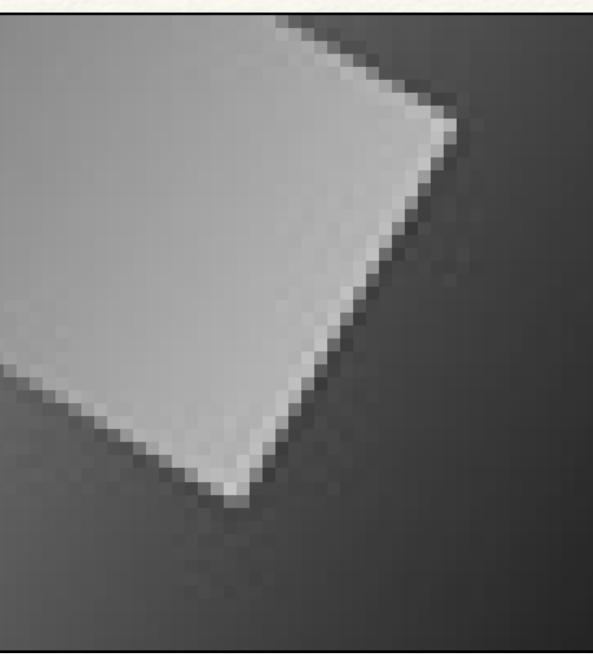
## Special Images:

<i>Chan.</i>	<i>Bits/Pix.</i>	<i>Range</i>	<i>Use</i>
1	16	$-32768\dots32767$	Whole numbers pos./neg., increased range
1	32	$\pm3.4 \cdot 10^{38}$	Floating point: medicine, astronomy
1	64	$\pm1.8 \cdot 10^{308}$	Floating point: internal processing

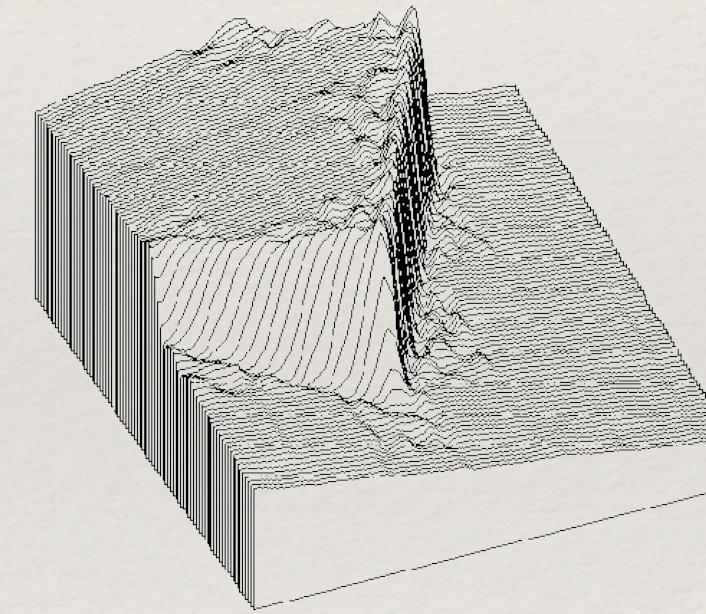
(a) Original  
(75.08 kB)



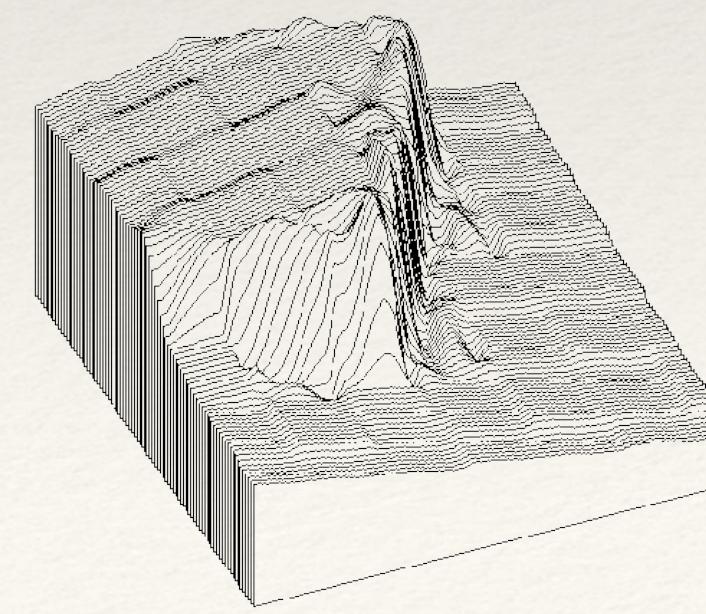
(b)  $Q_{\text{JPEG}} = 10$   
(11.40 kB)

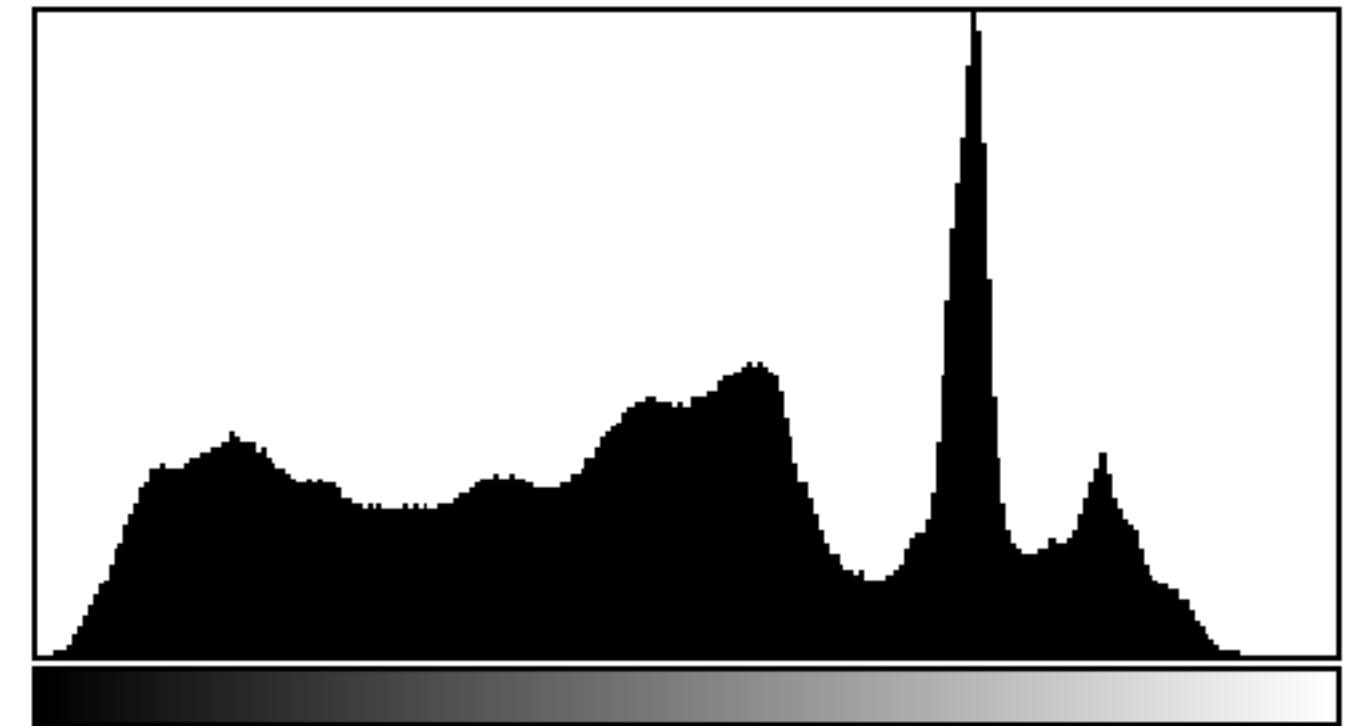


(c)  $Q_{\text{JPEG}} = 5$   
(7.24 kB)



(d)  $Q_{\text{JPEG}} = 1$   
(5.52 kB)





Count: 1920000

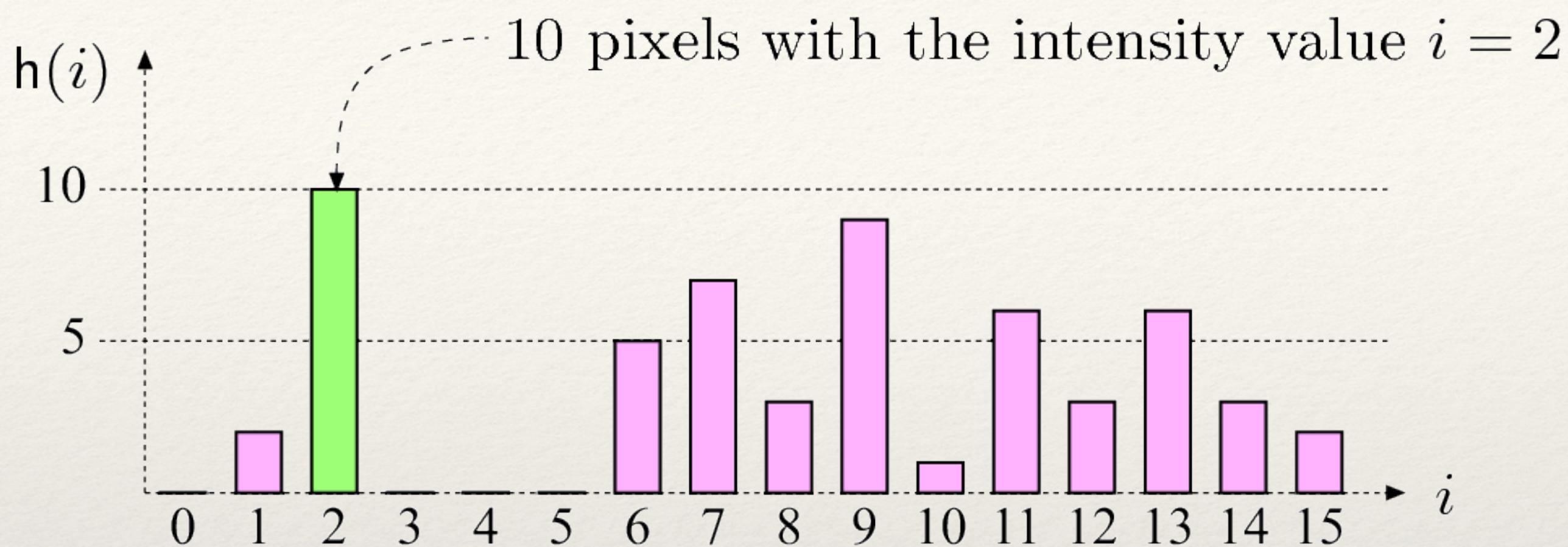
Mean: 118.848

StdDev: 59.179

Min: 0

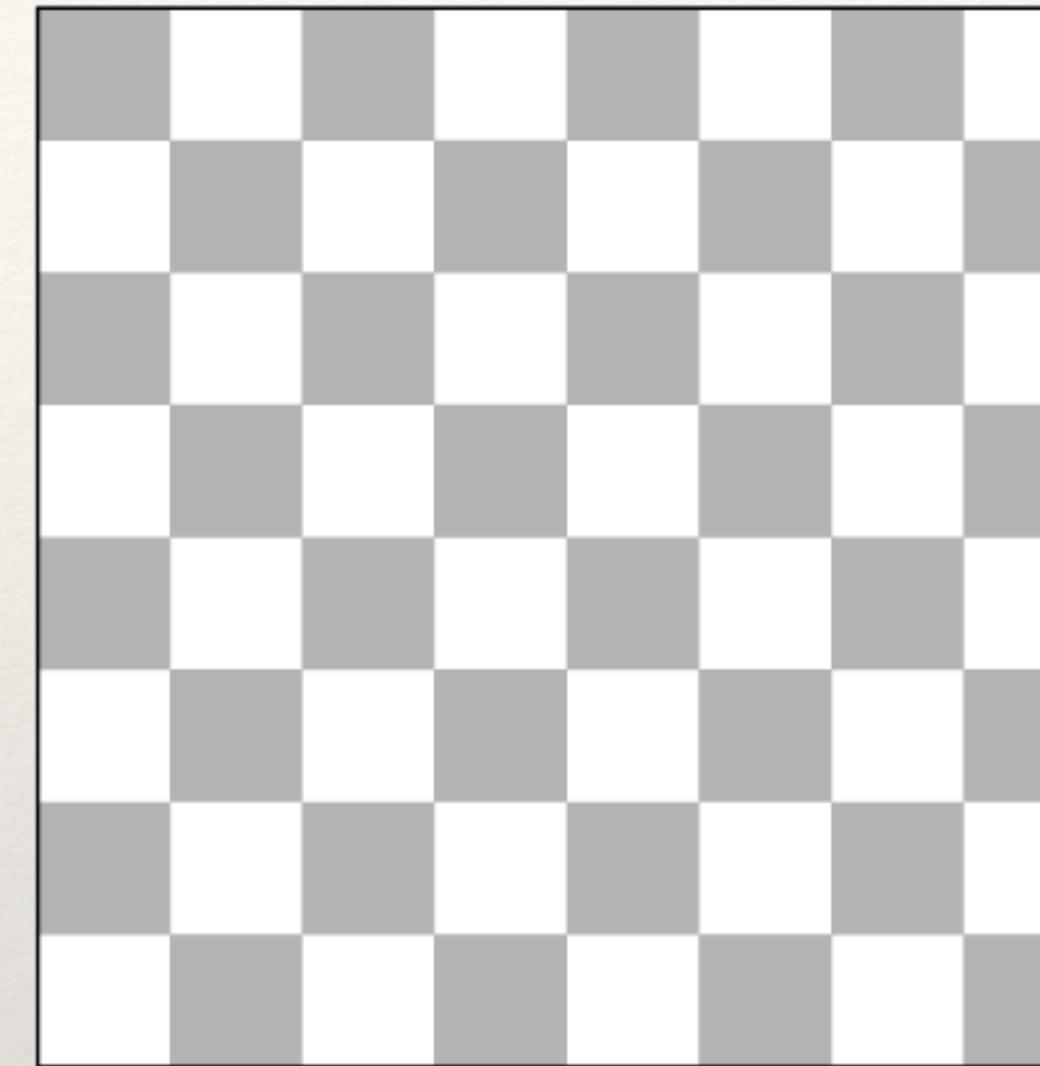
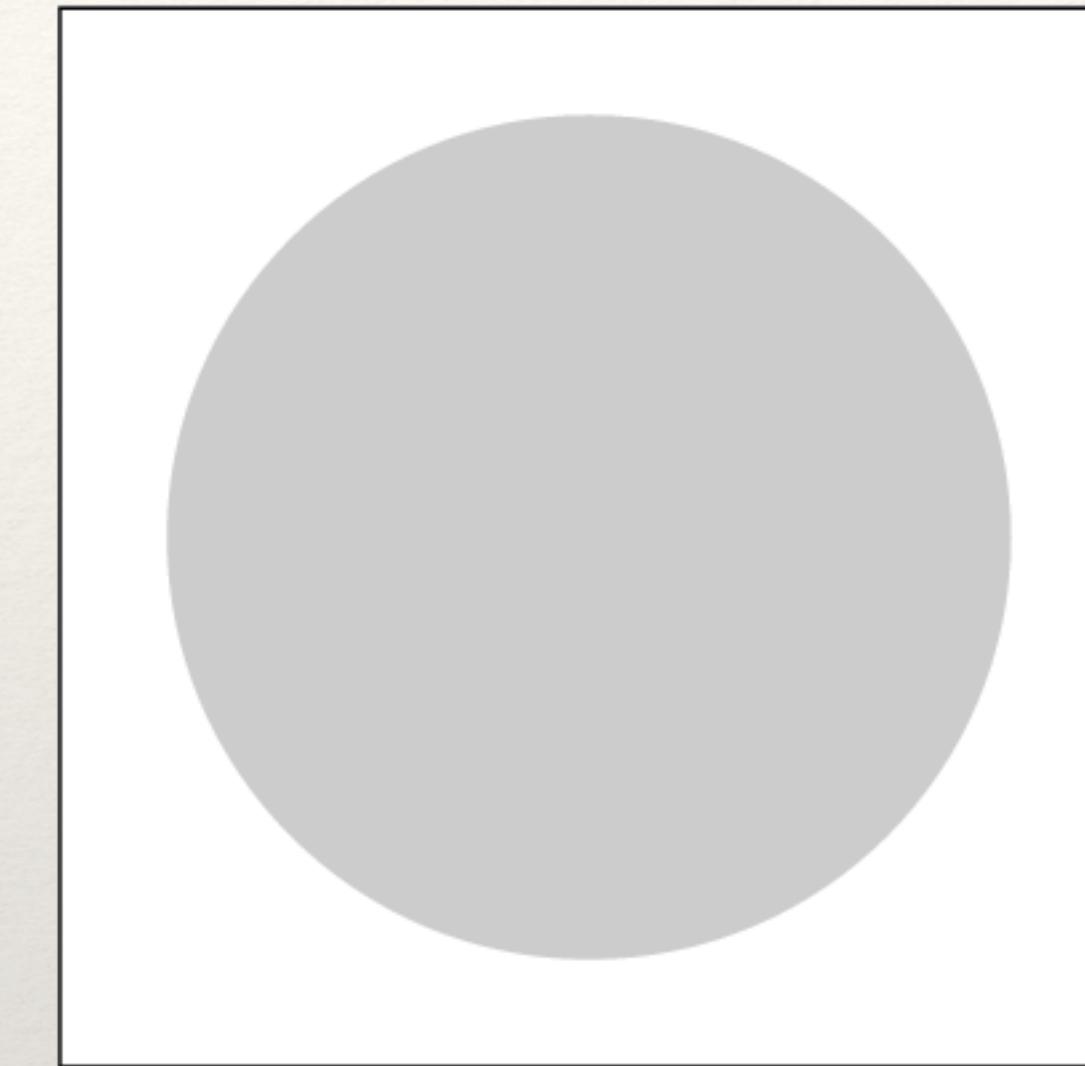
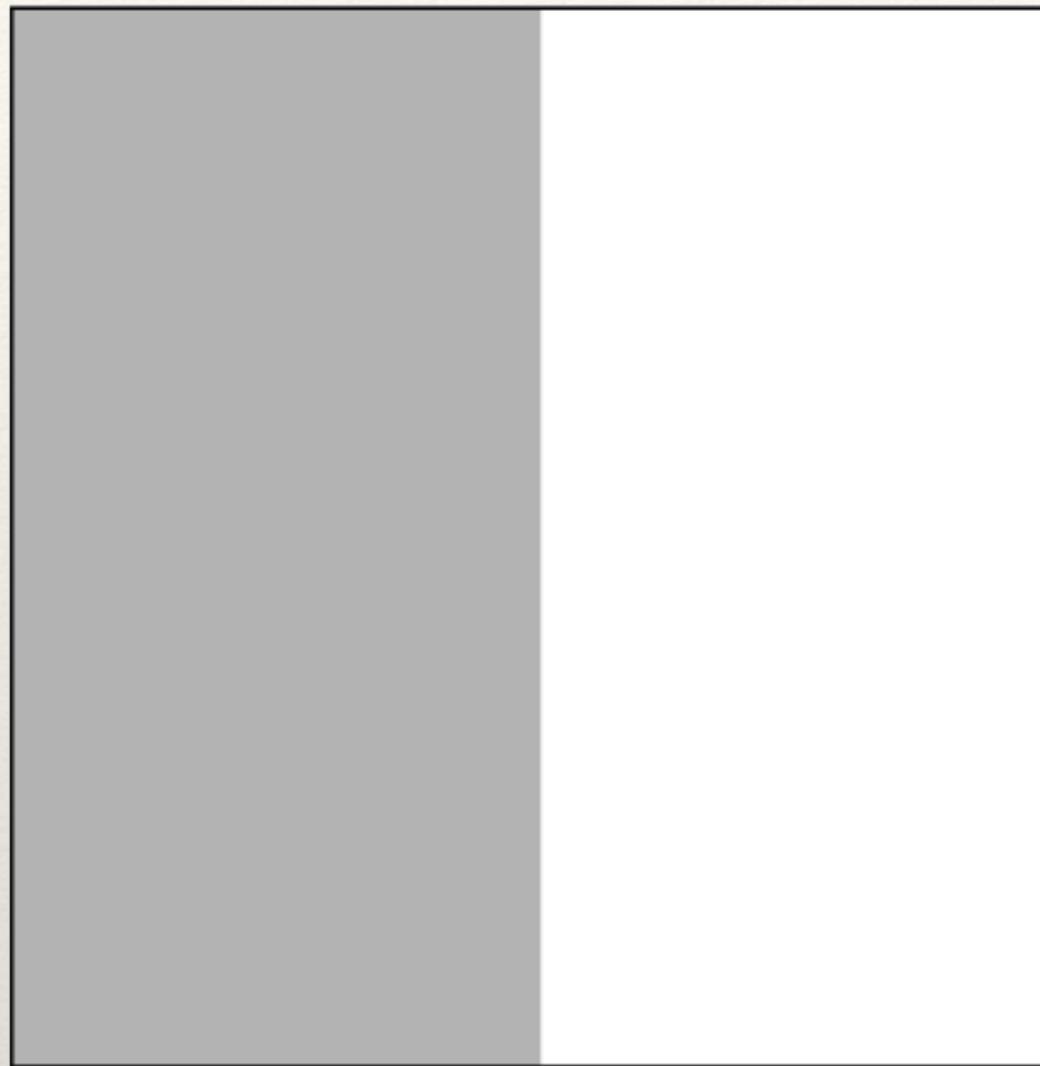
Max: 251

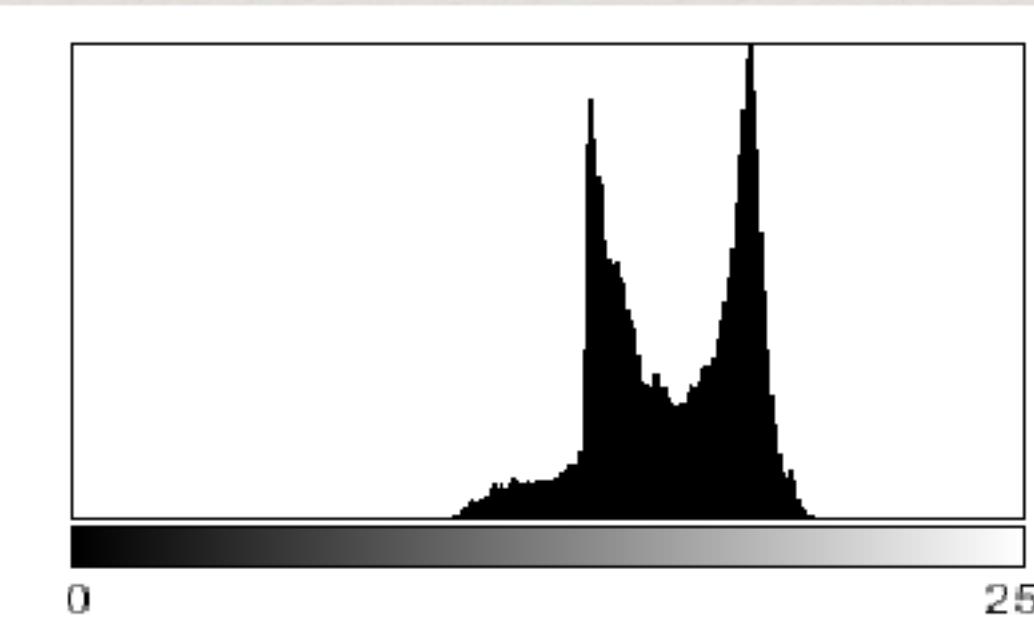
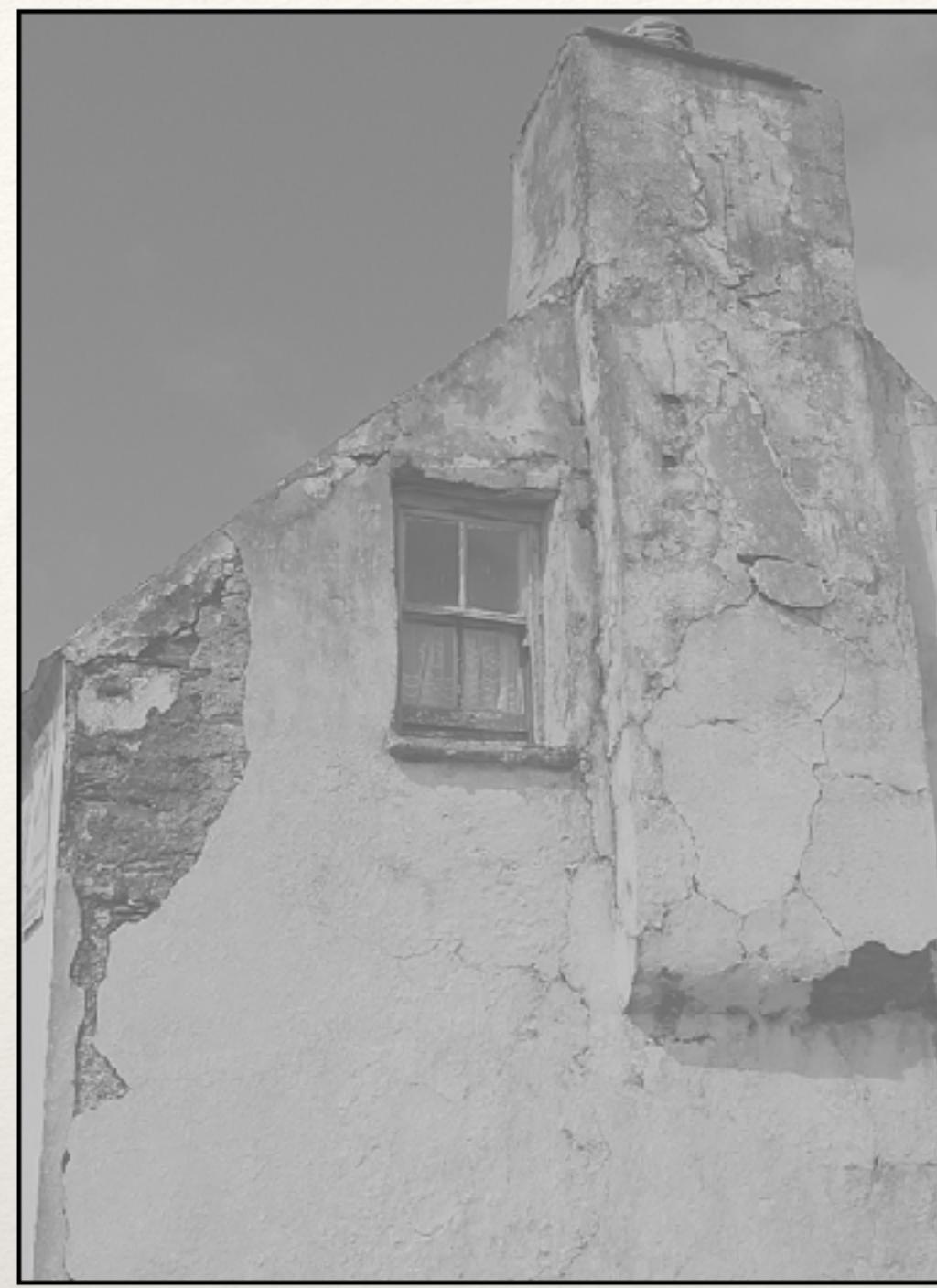
Mode: 184 (30513)



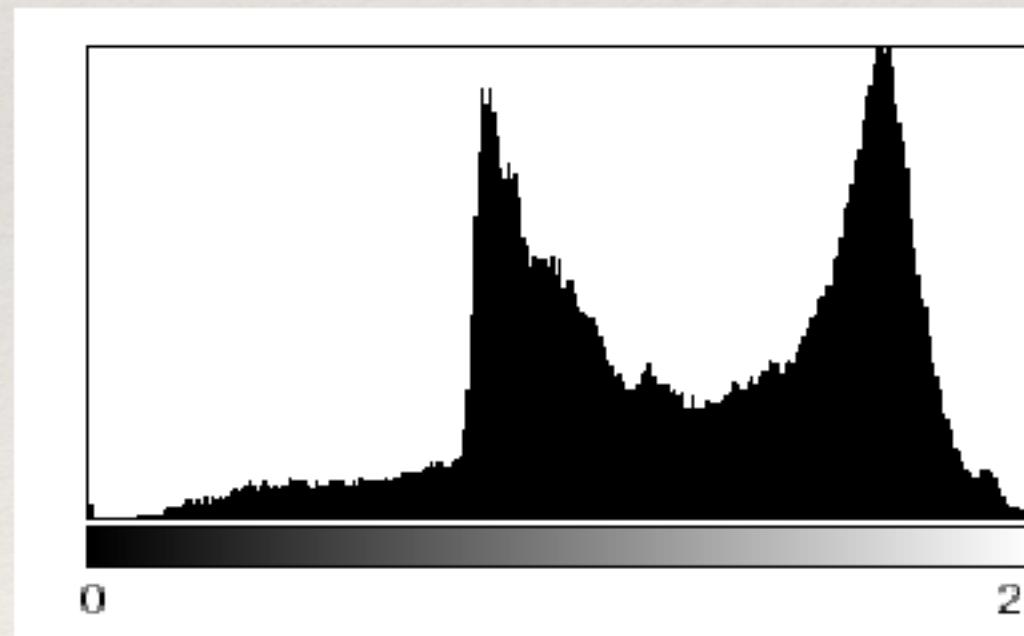
$h(i)$	0	2	10	0	0	0	5	7	3	9	1	6	3	6	3	2
$i$	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

All of these images have the same histogram

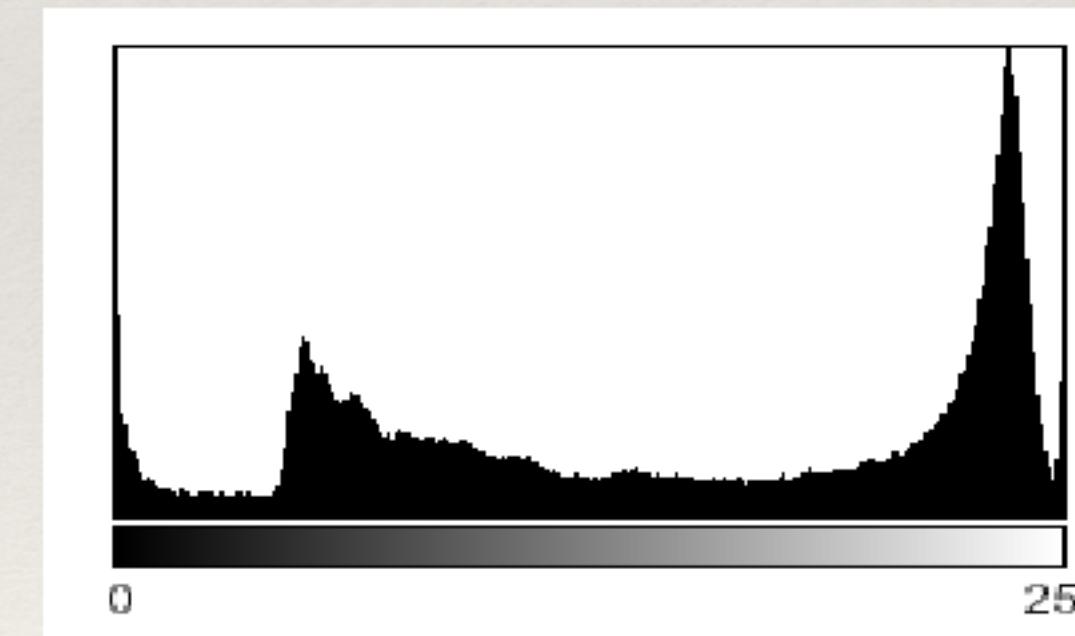




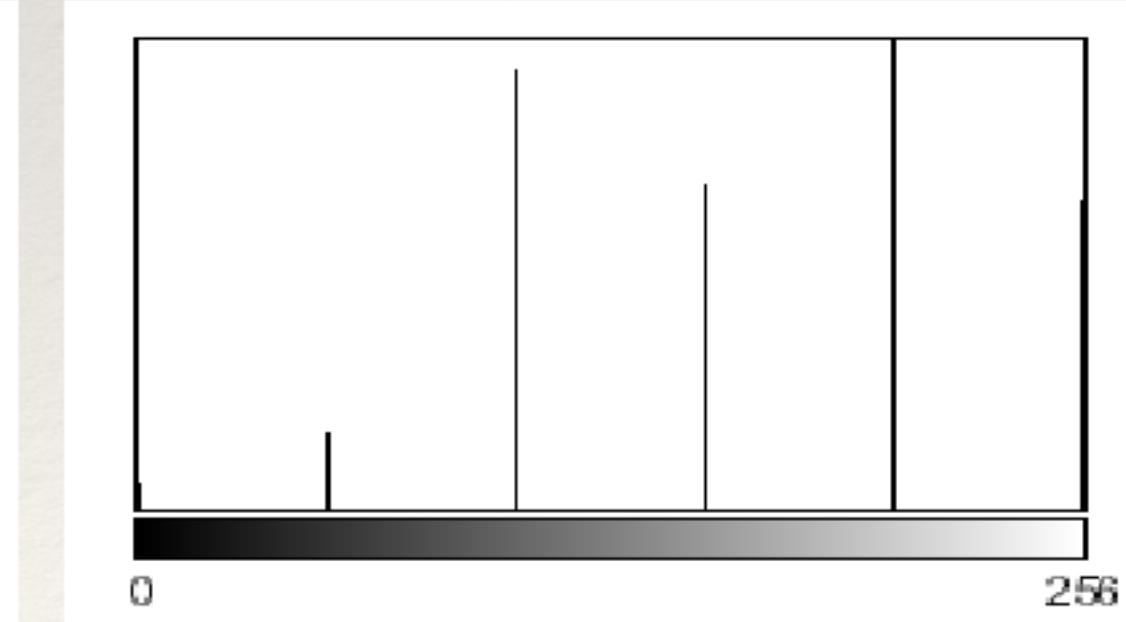
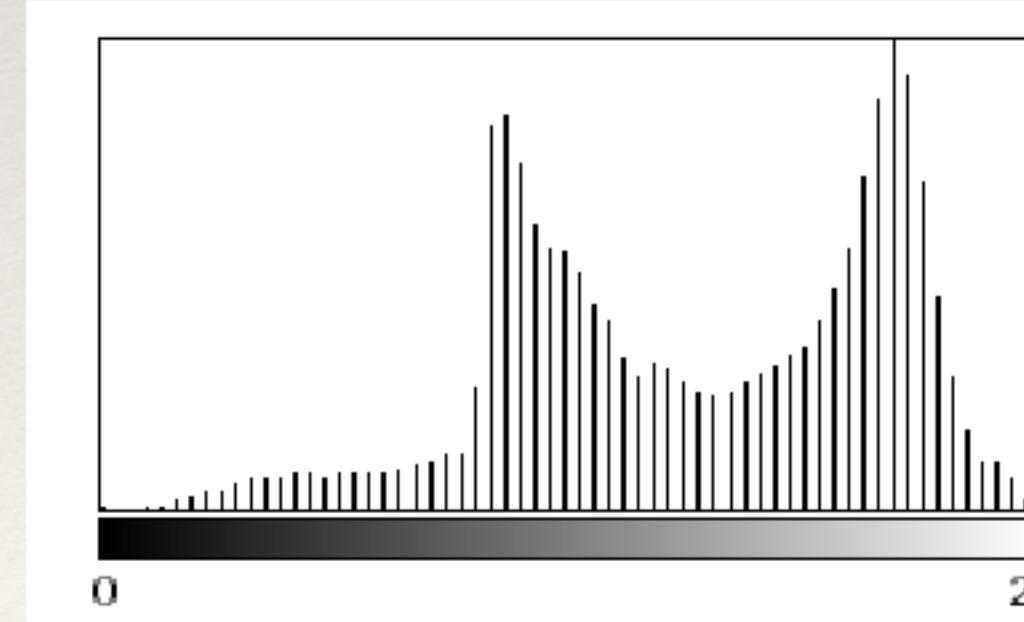
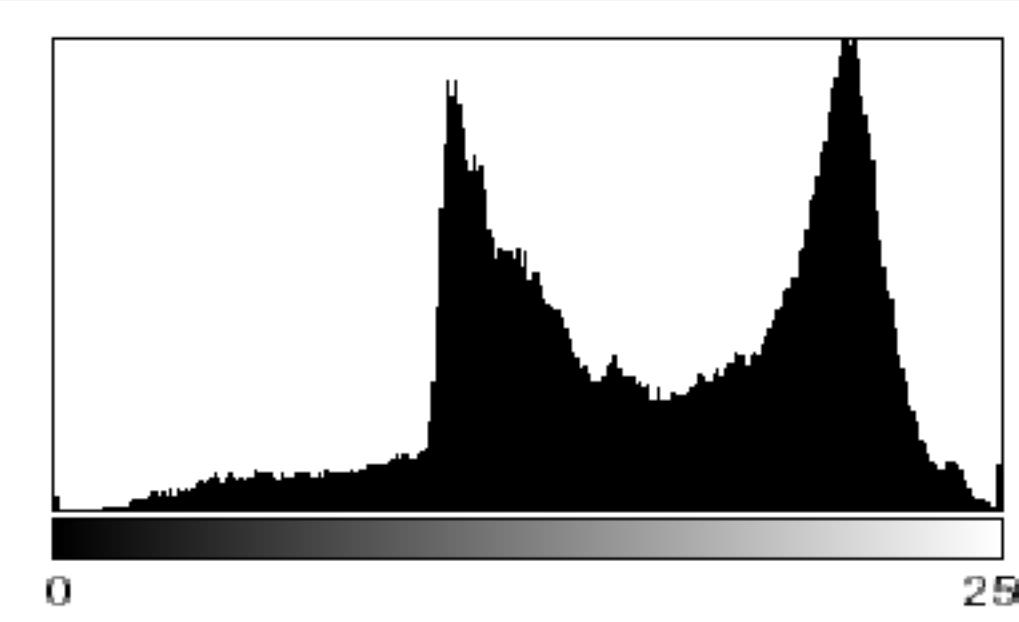
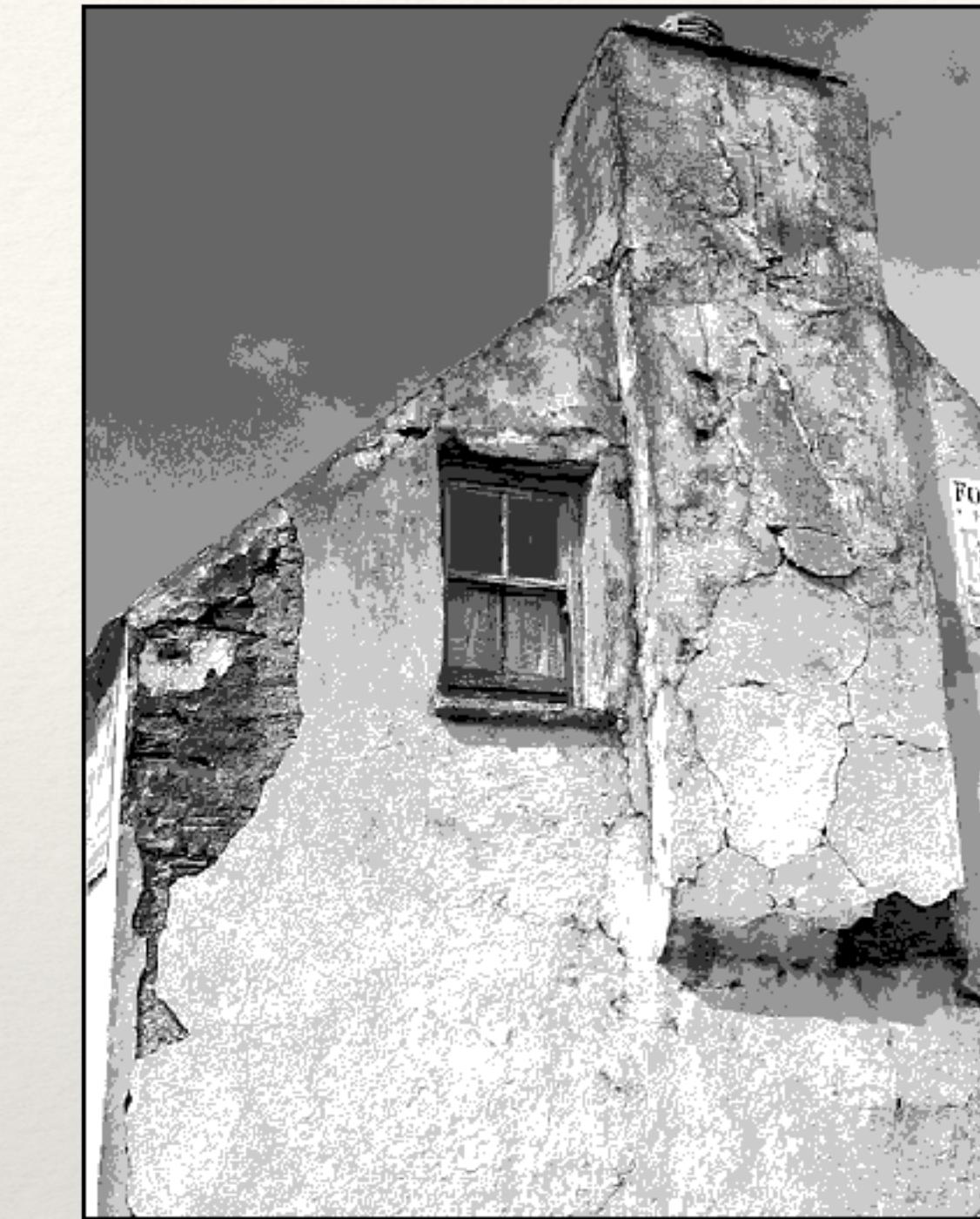
(a)



(b)



(c)



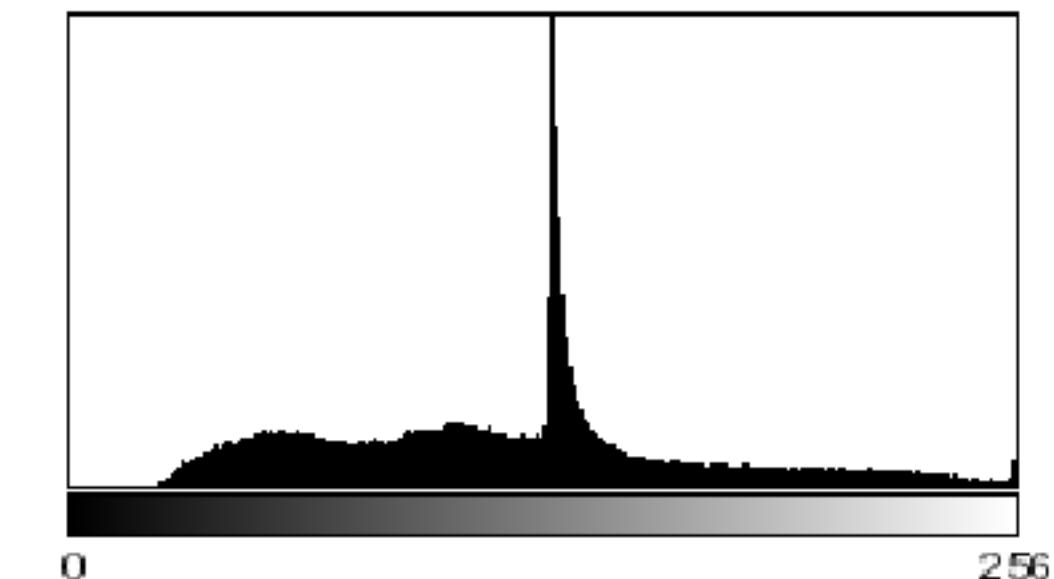
(a)

(b)

(c)



(a)

(b)  $h_{\text{Lum}}$ 

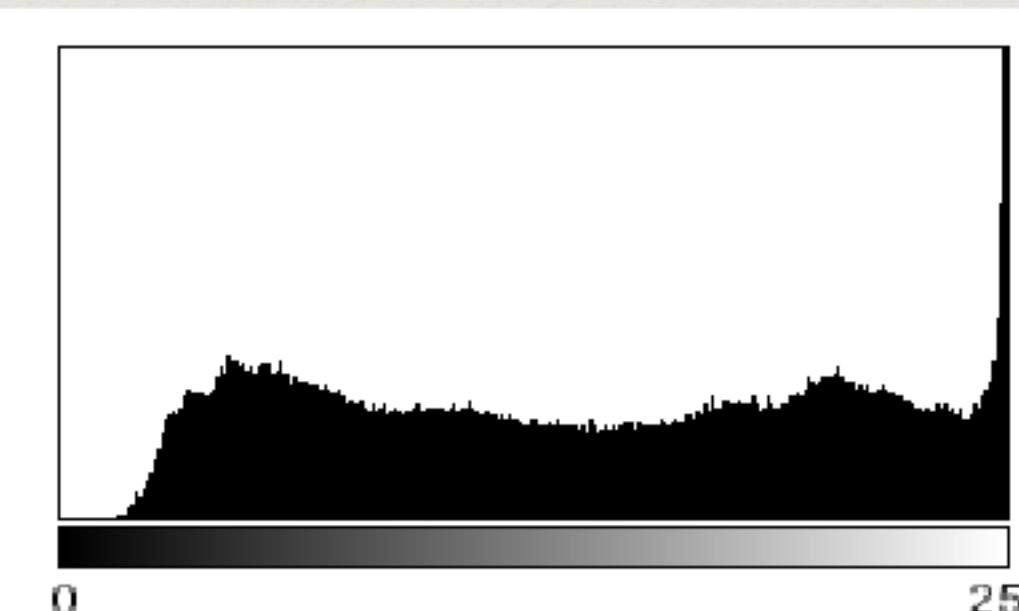
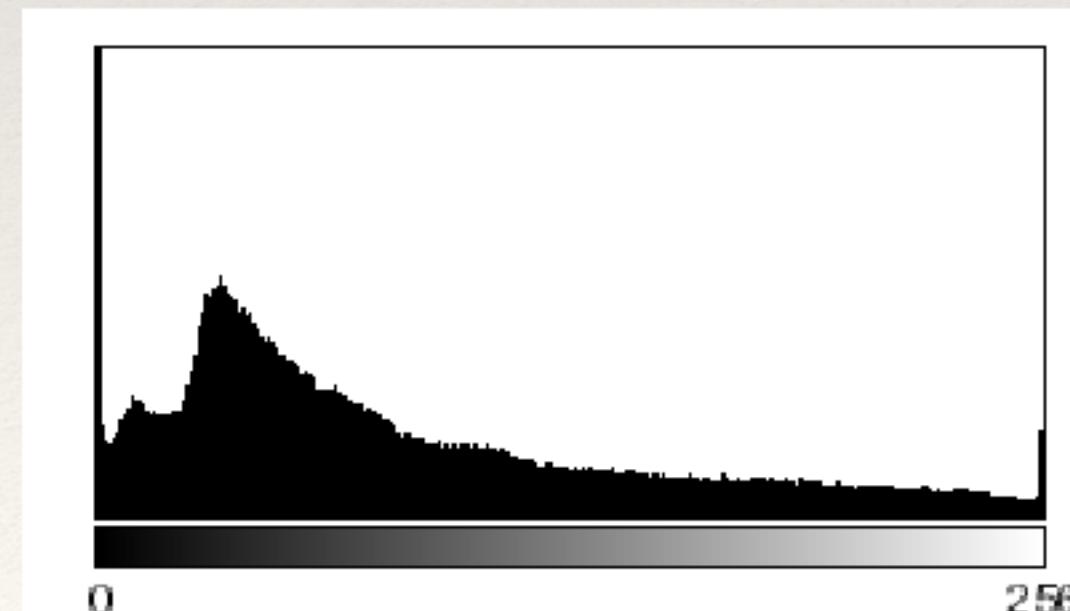
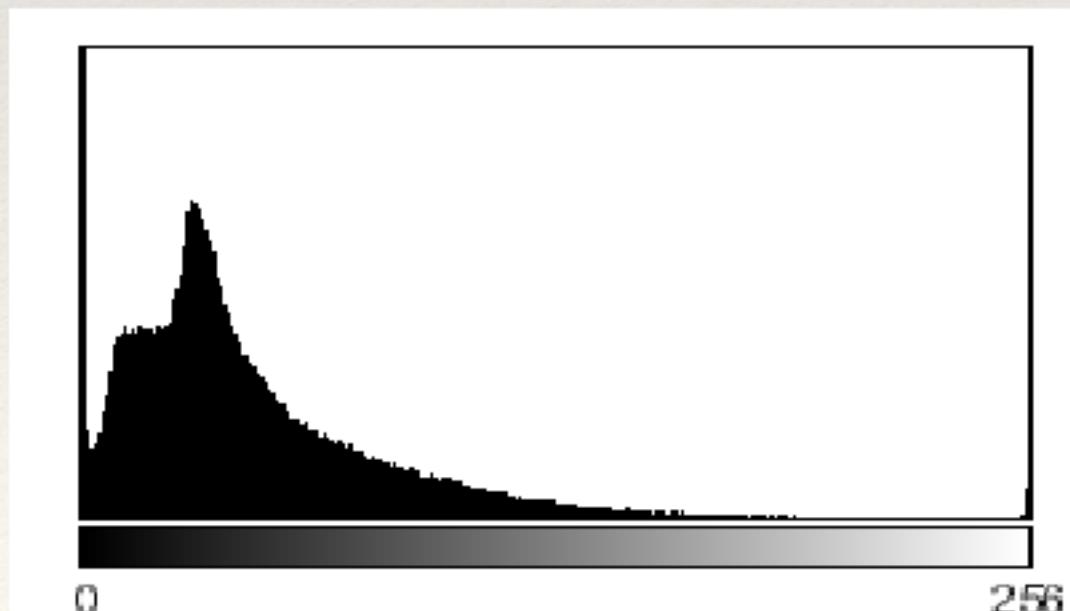
(c) R



(d) G



(e) B

(f)  $h_R$ (g)  $h_G$ (h)  $h_B$

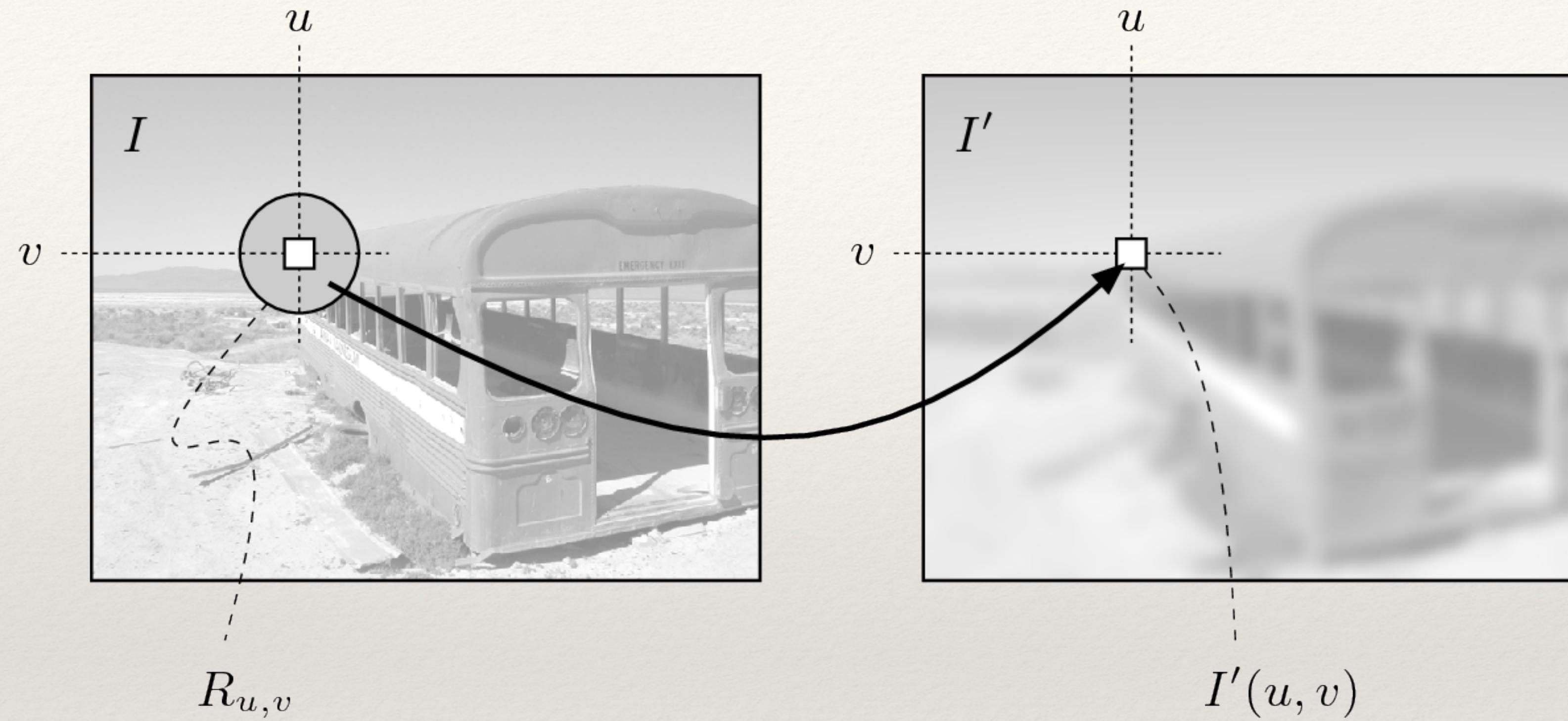
**Filters**



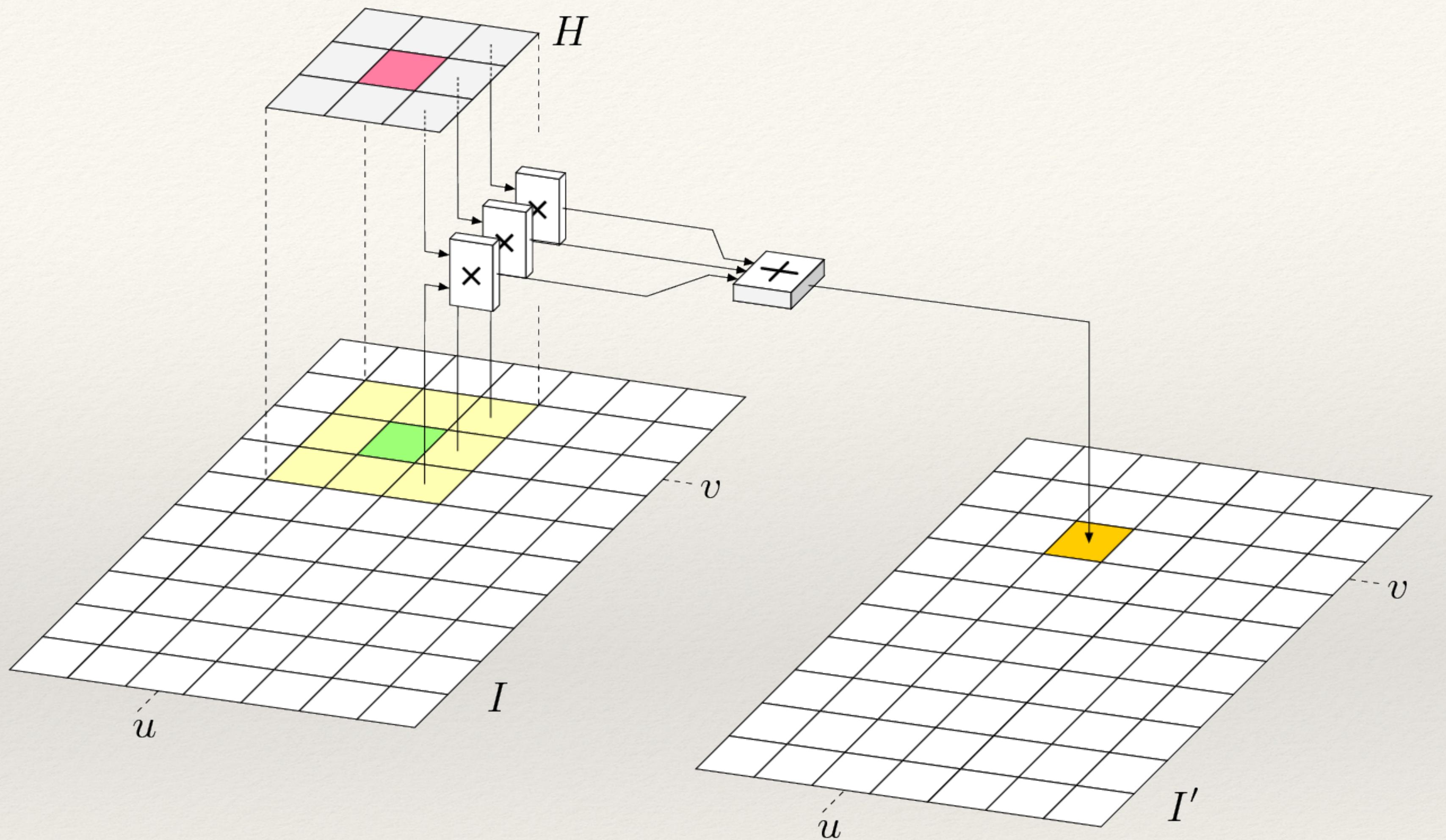
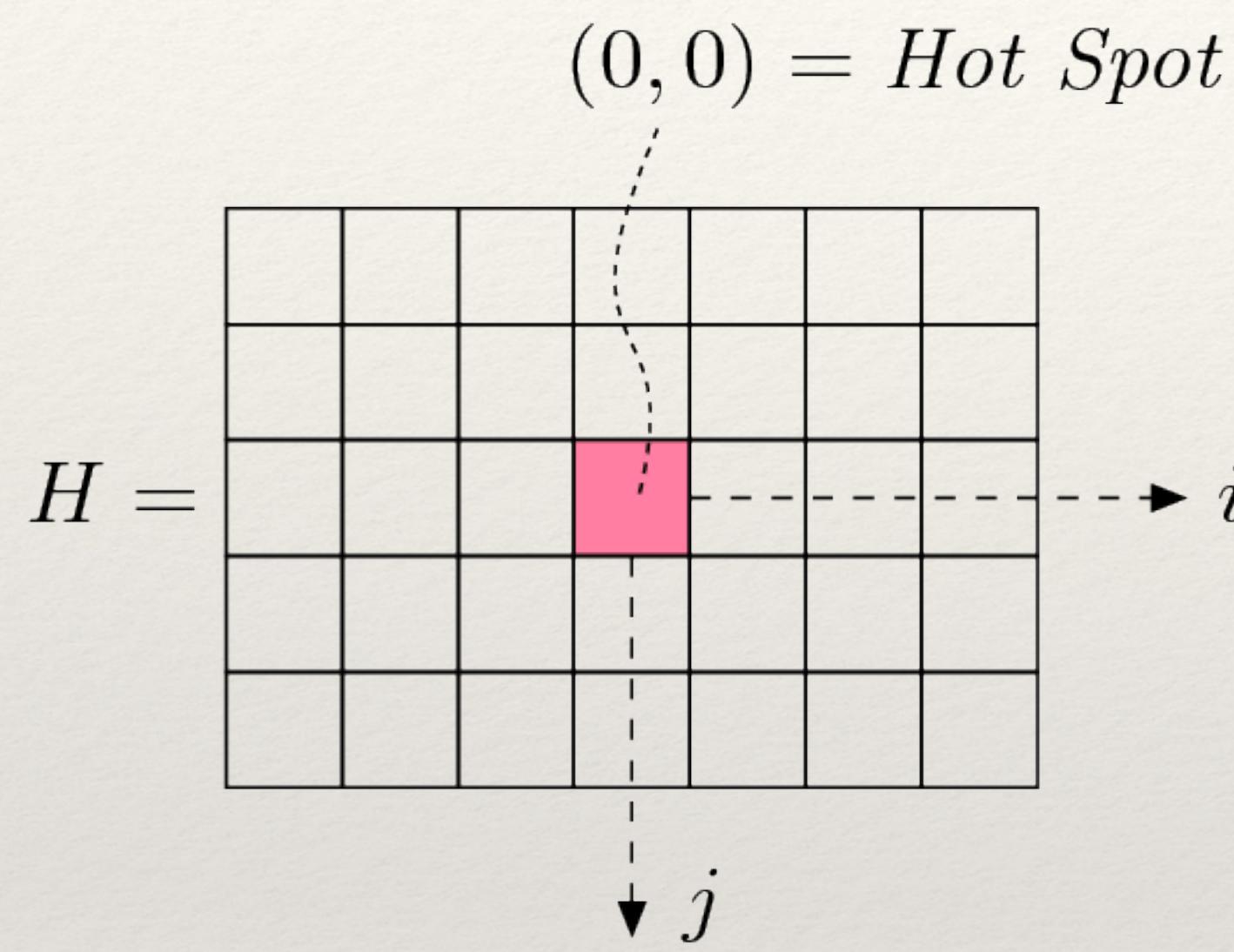
## Smoothing Filter

$$I'(u, v) \leftarrow \frac{p_0 + p_1 + p_2 + p_3 + p_4 + p_5 + p_6 + p_7 + p_8}{9}$$

$$\begin{aligned} I'(u, v) \leftarrow \frac{1}{9} \cdot [ & I(u-1, v-1) + I(u, v-1) + I(u+1, v-1) + \\ & I(u-1, v) + I(u, v) + I(u+1, v) + \\ & I(u-1, v+1) + I(u, v+1) + I(u+1, v+1) ] \end{aligned}$$

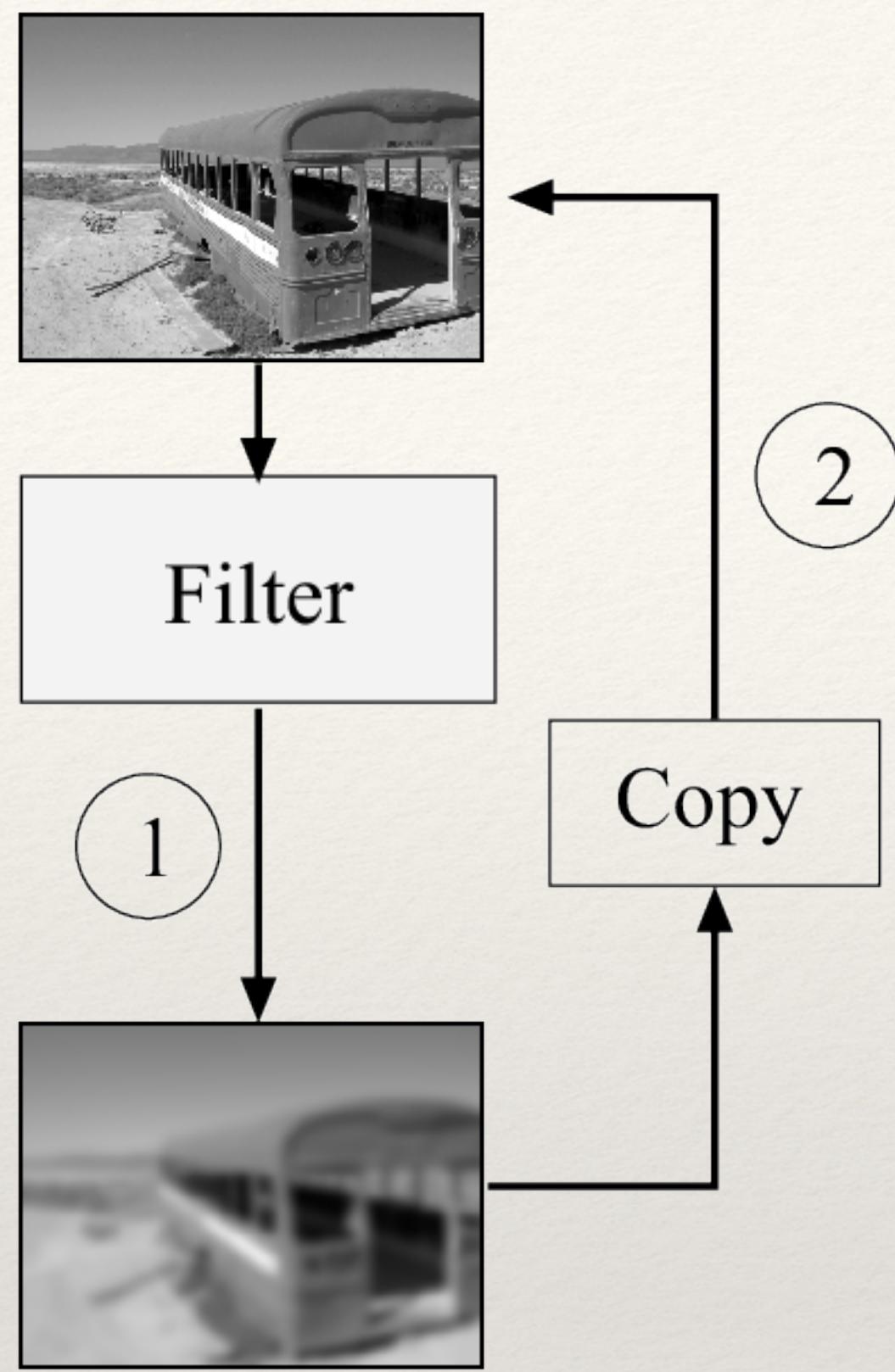


$$I'(u, v) \leftarrow \frac{1}{9} \cdot \sum_{j=-1}^1 \sum_{i=-1}^1 I(u+i, v+j)$$



$$I'(u, v) \leftarrow \sum_{(i,j) \in R_H} I(u + i, v + j) \cdot H(i, j)$$

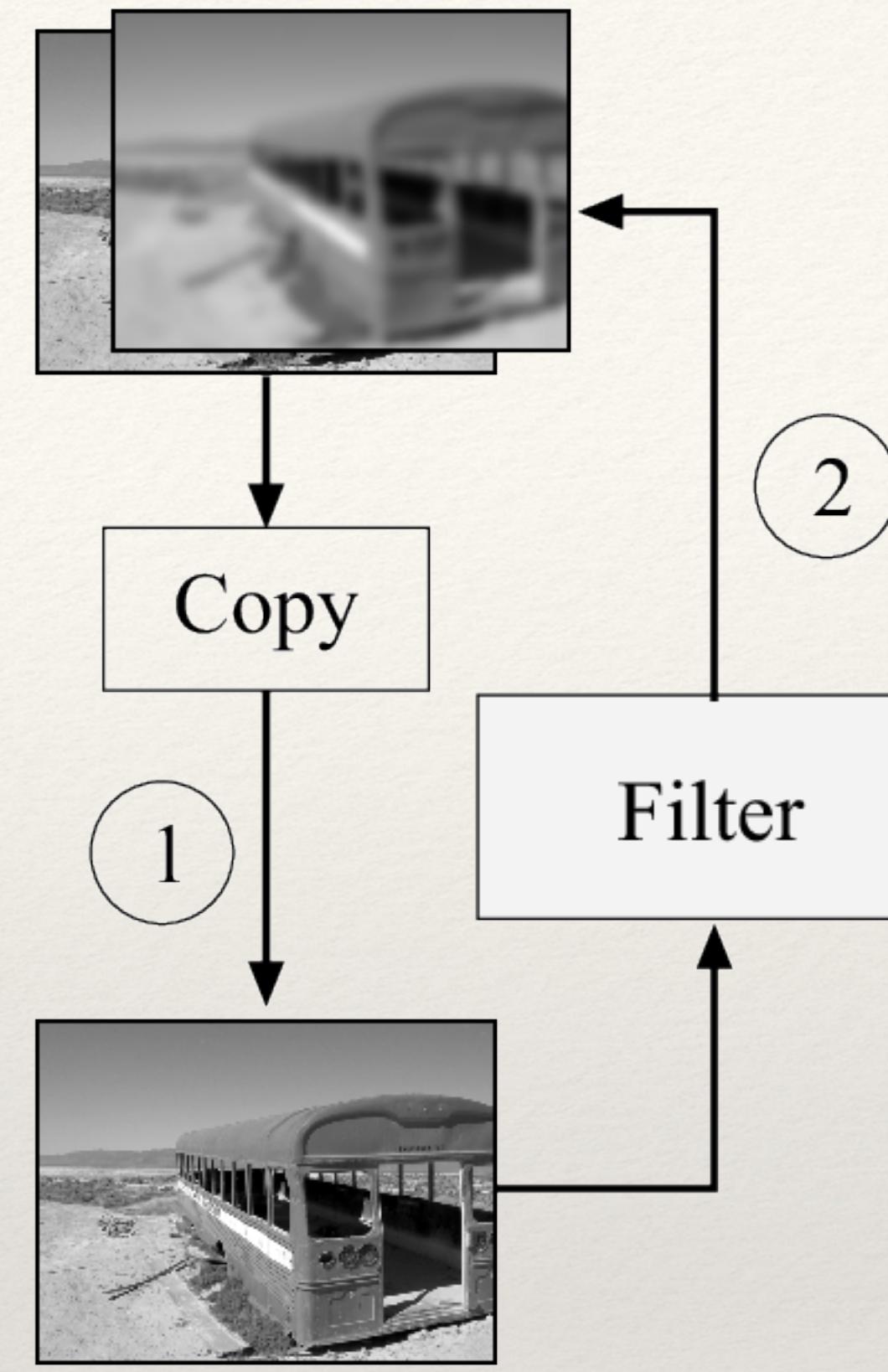
Original  
Image



Inter-  
mediate  
Image

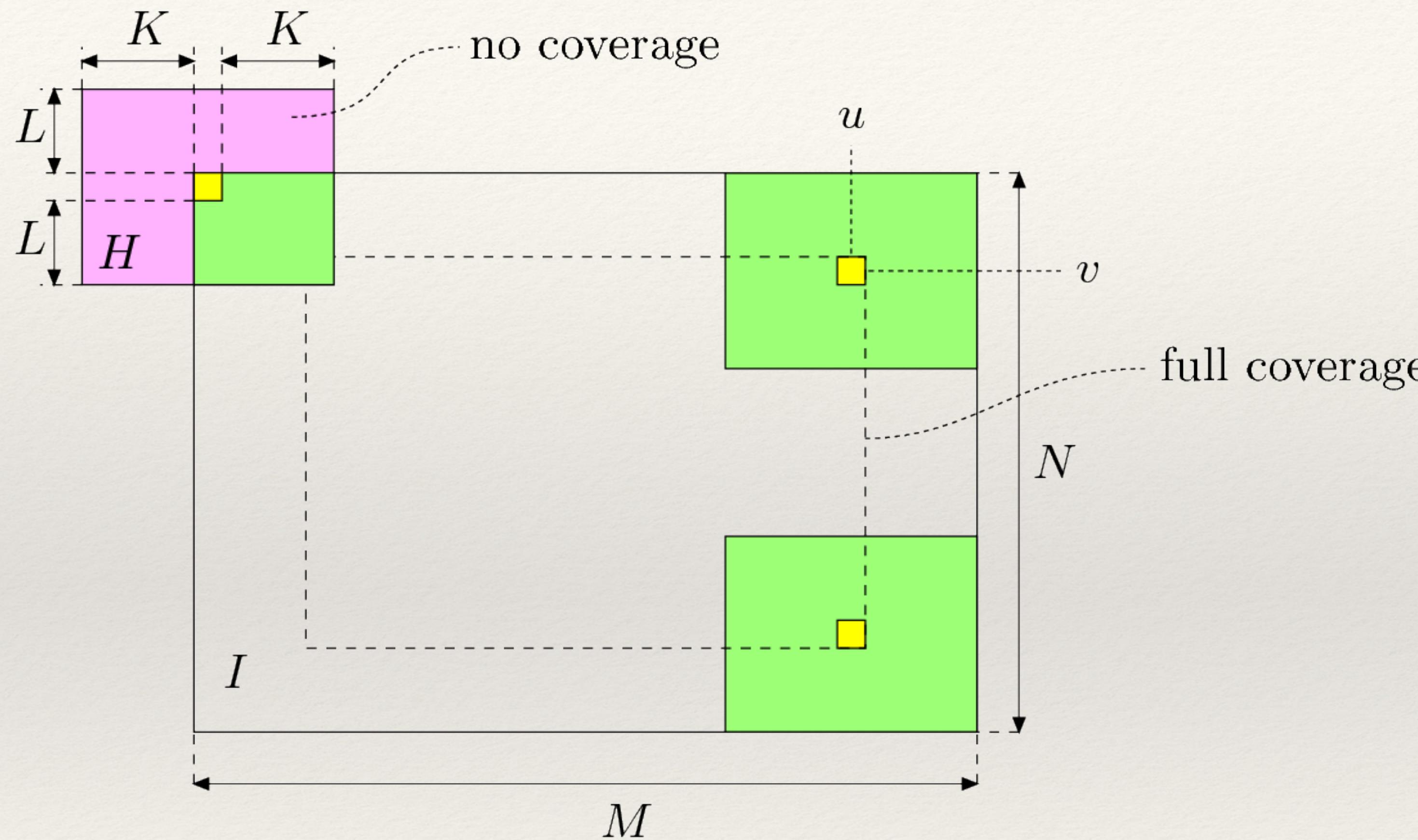
Version A

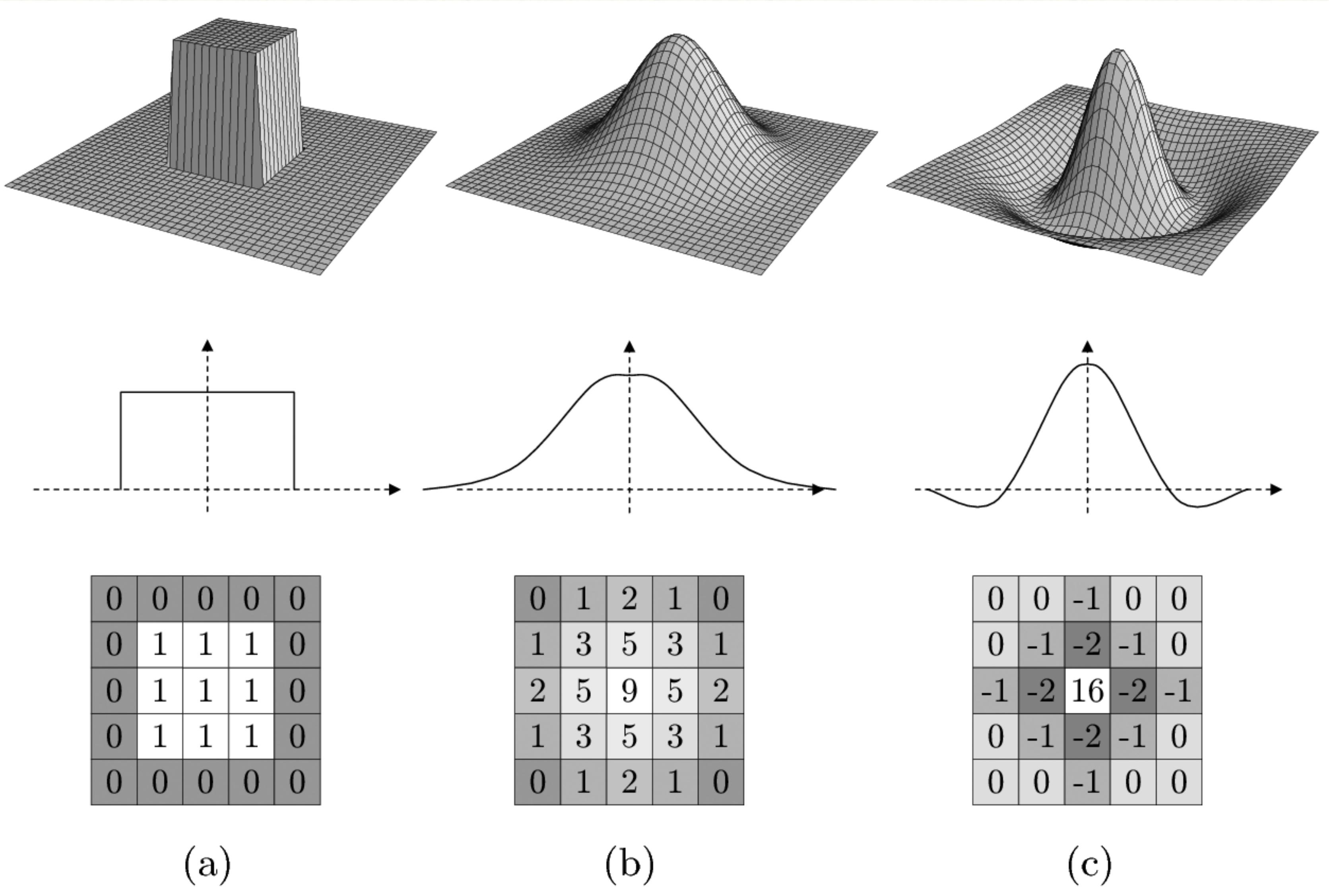
Original  
Image

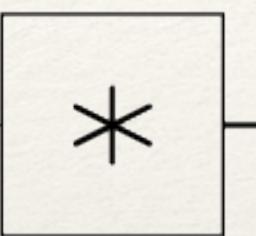
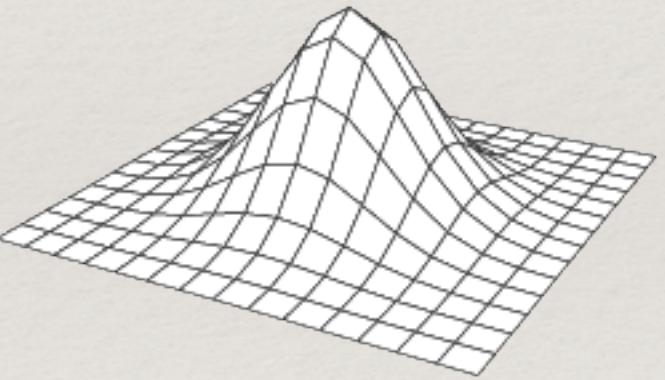


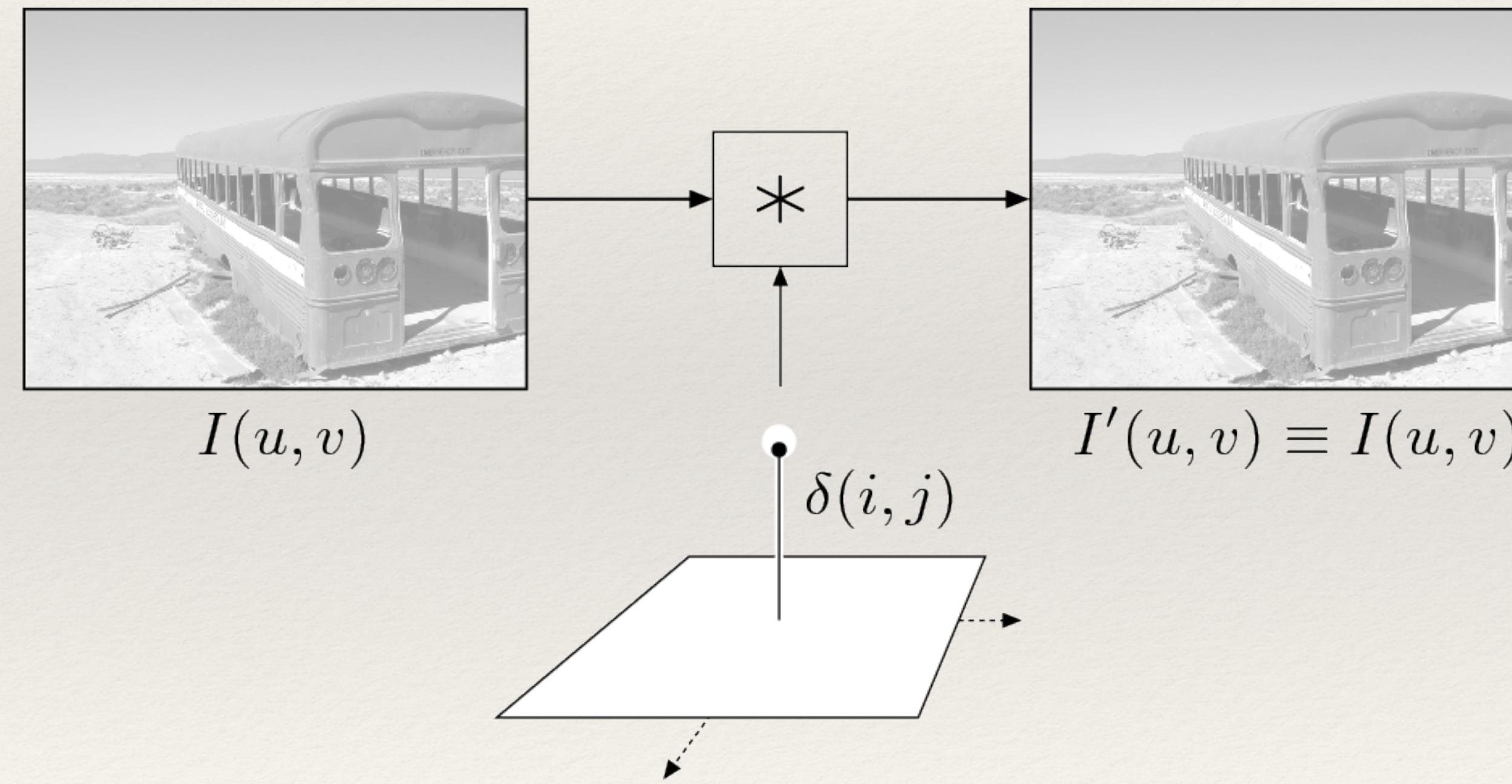
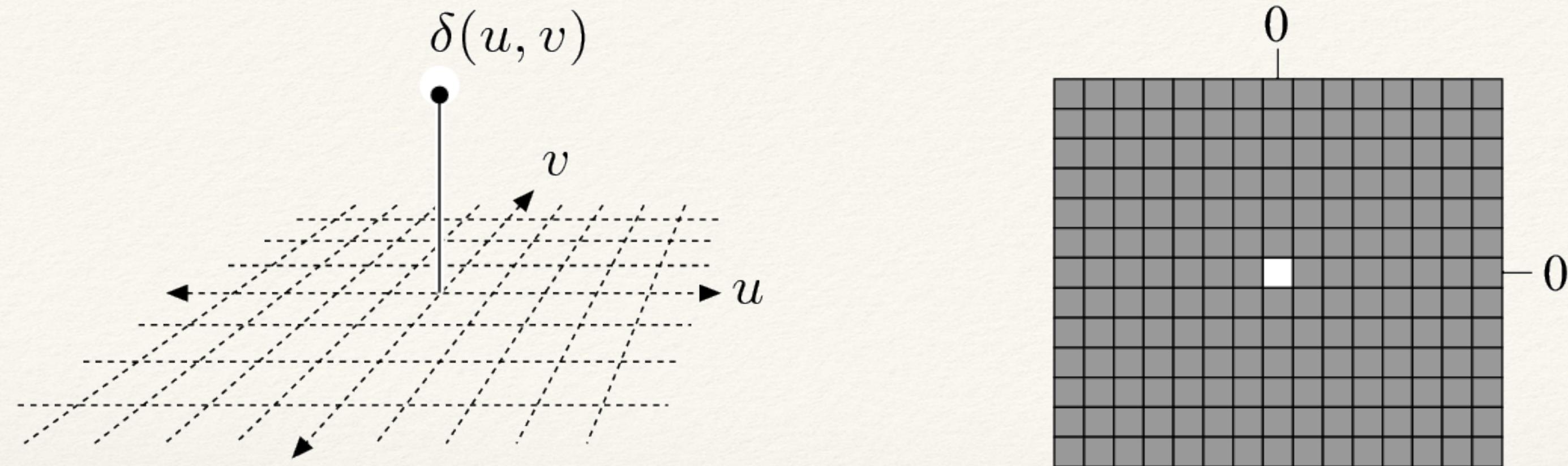
Inter-  
mediate  
Image

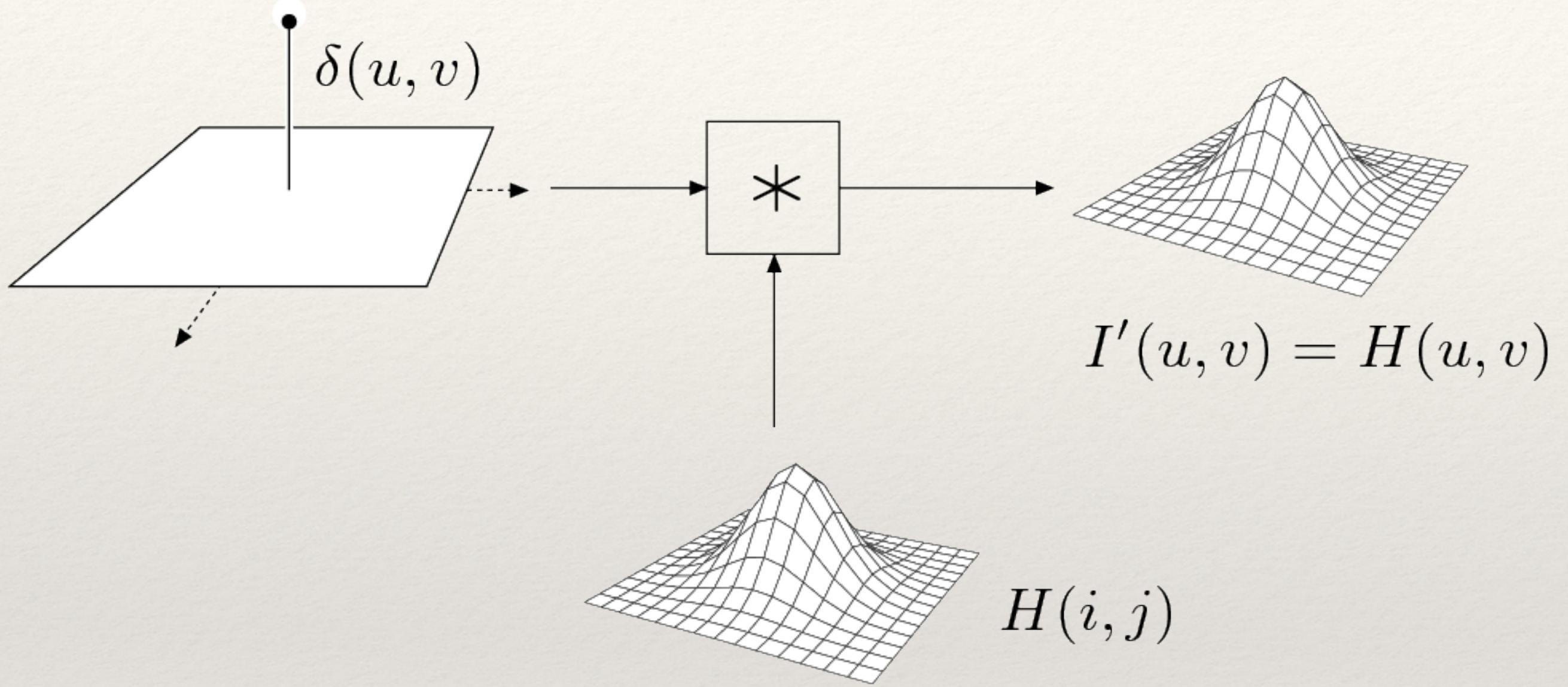
Version B

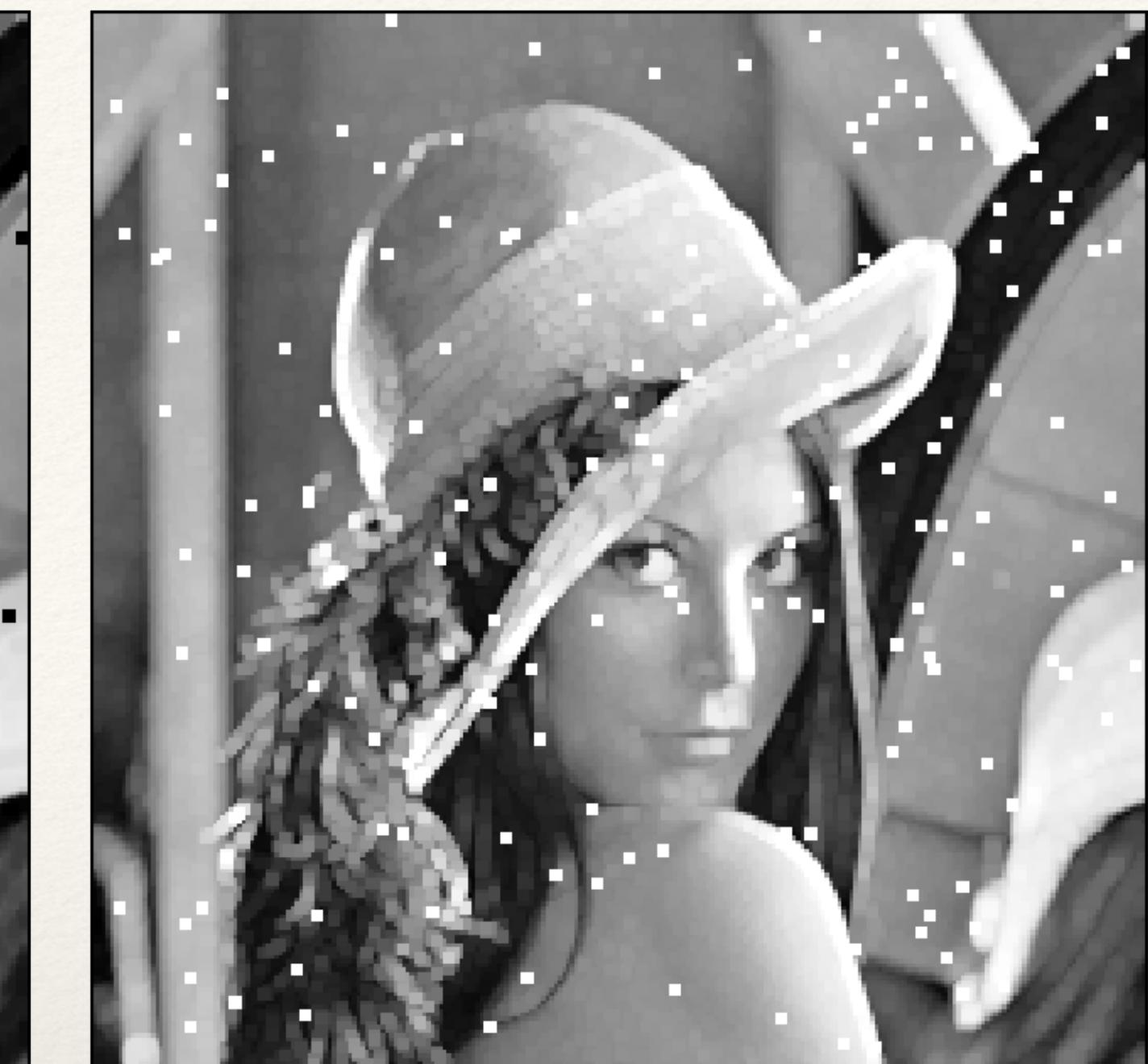




$I(u, v)$  $I'(u, v)$  $H(i, j)$ 



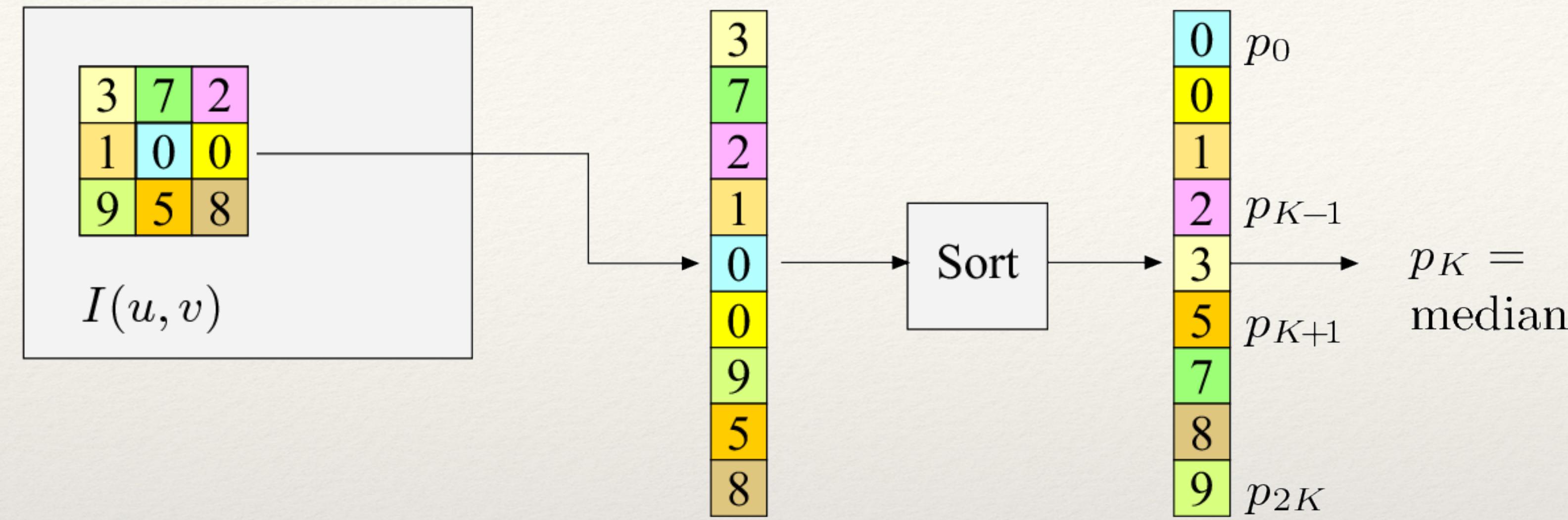




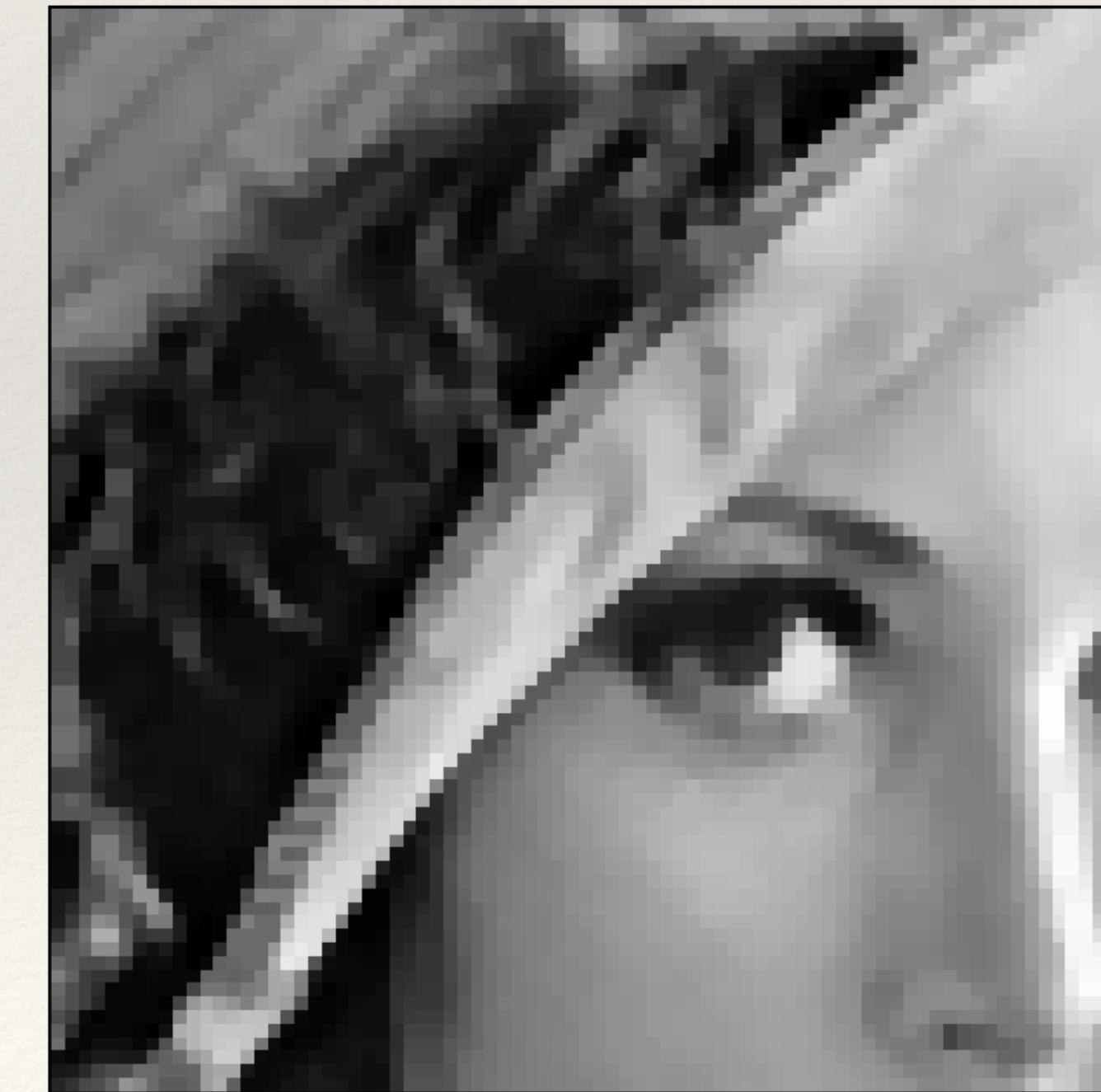
(a)

(b)

(c)



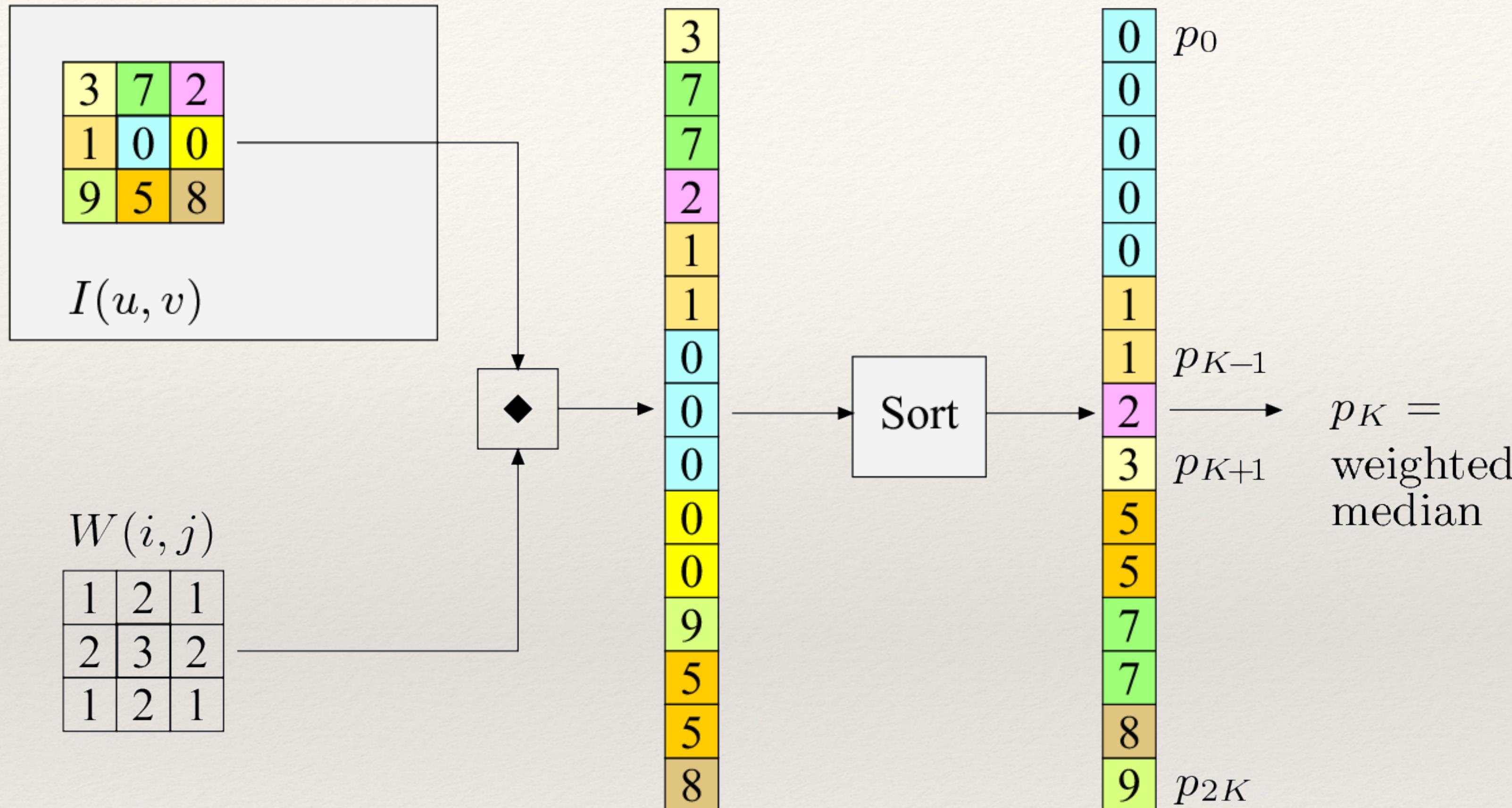
$$\text{median}(p_0, p_1, \dots, p_K, \dots, p_{2K}) \triangleq p_K$$



(a)

(b)

(c)



End of Slides