

# Smoothing Filters

Blurring

# Median Blur

Smoothing Filter

# Median Blur

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- Step-1: Define  $k \times k$  sliding window on top of the image.
  - $k$  is always odd number
- Step-2: Slide the window from left to right and top to bottom
- Step-3: For each stride (usually stride =1), pixel at the center of the matrix is **Median** of pixels surrounding it.

# Median Blur

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- Median blurring is more effective at removing *salt and pepper style noise* from the image.



# Median Blur for Salt-Pepper Noise





# Median Blur (3 x 3)





# Median Blur (5 x 5)





# Median Blur (7 x 7)





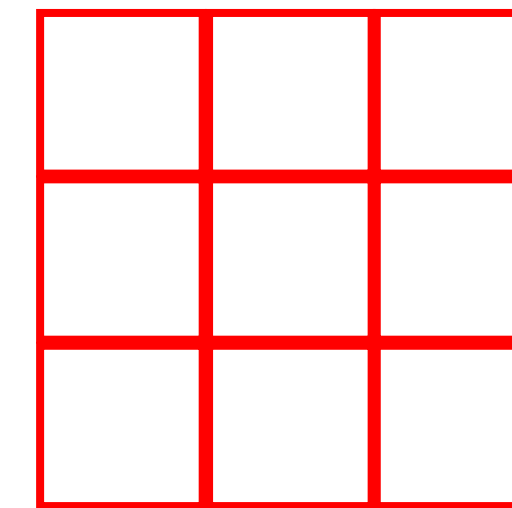
# Median Blur (11 x 11)



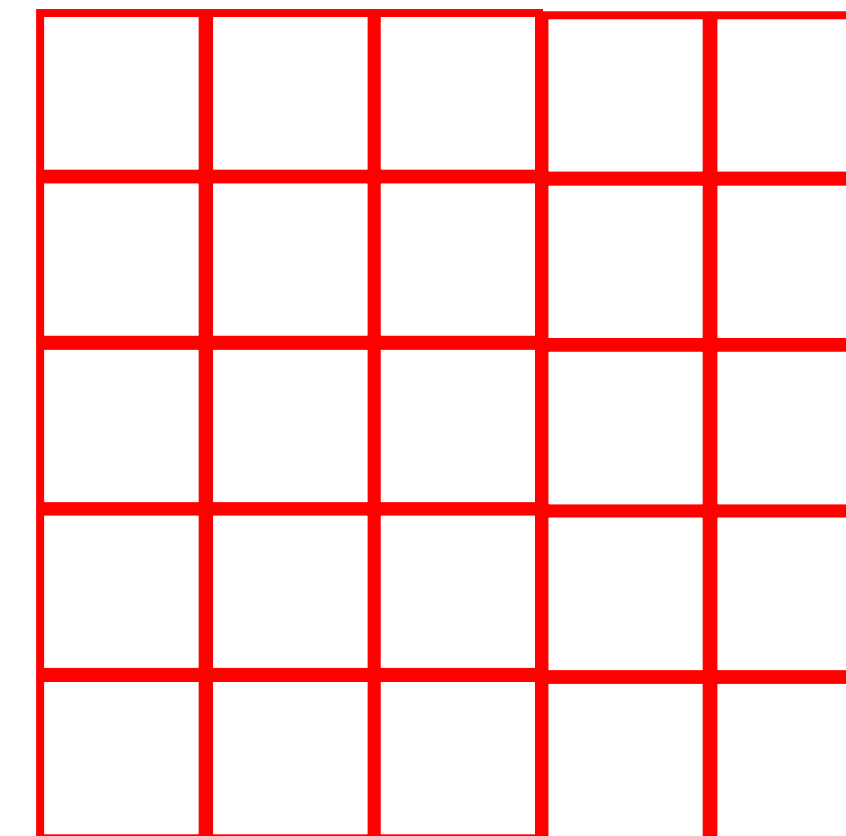


# Convolve Process

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31



$$3 \times 3$$



$$5 \times 5$$



# Convolve Process

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31



# Convolve Process

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

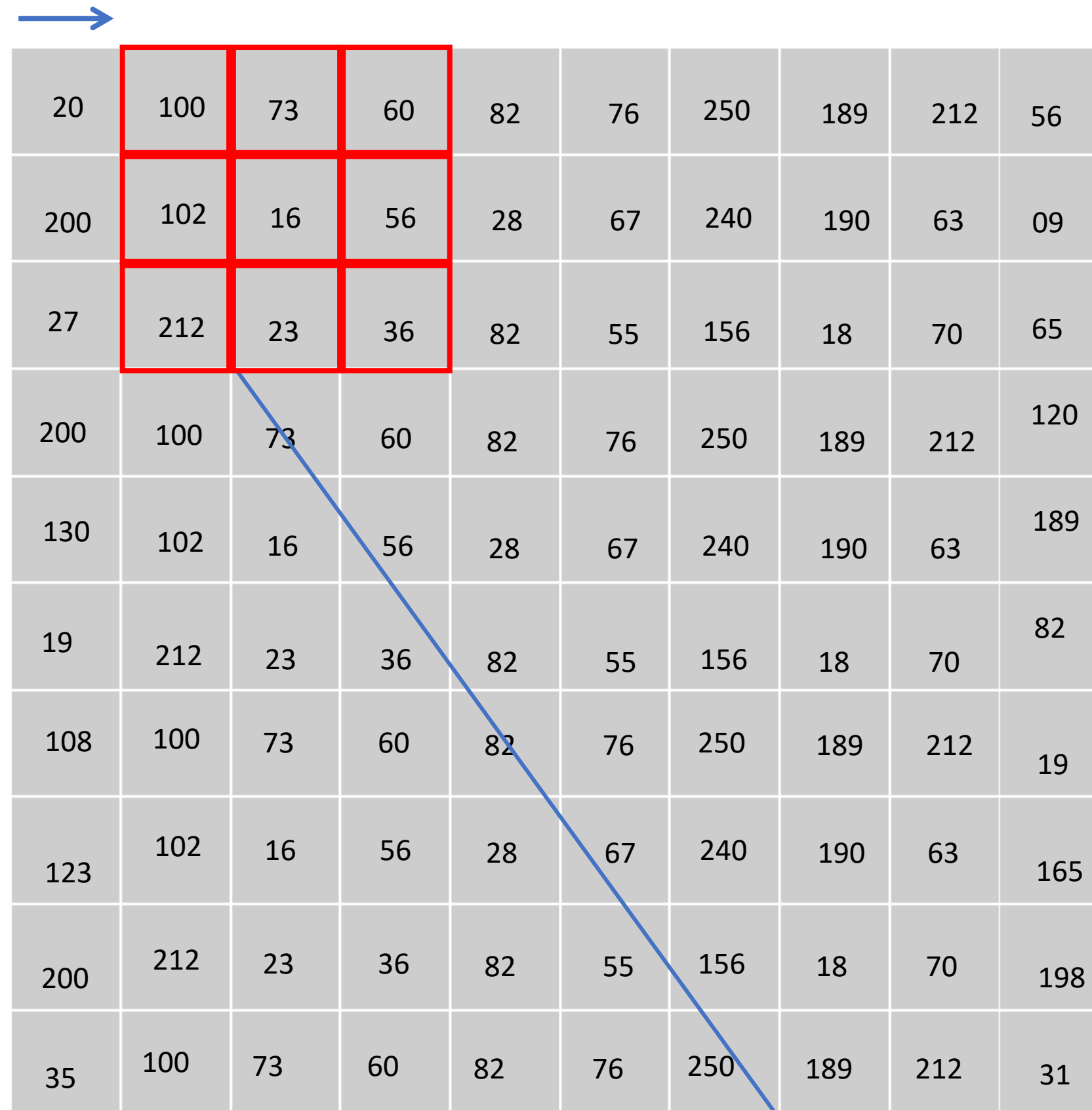
Median

(16,20,23,27,73,100,102,200,212)= 73



# Convolve Process

Stride = 1



20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

Median

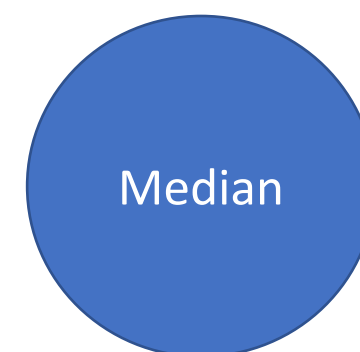
(16,23,36,56,60,73,100,102,212)= 60



# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

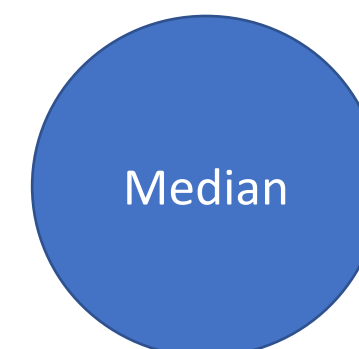




# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

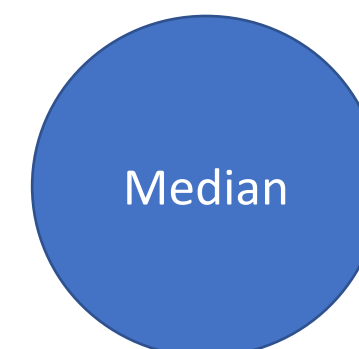




# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

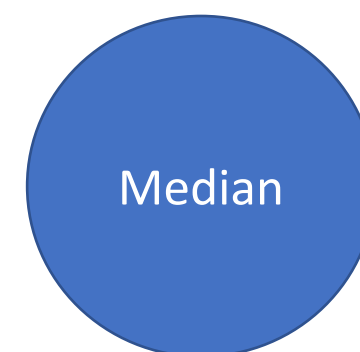
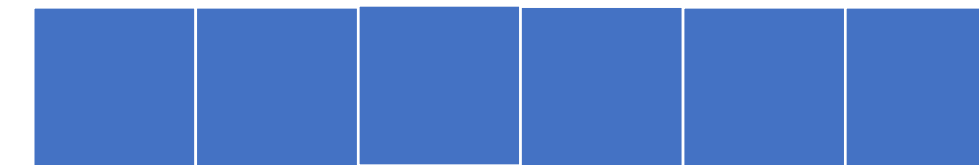




# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

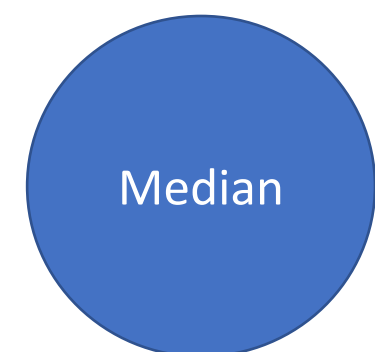




# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

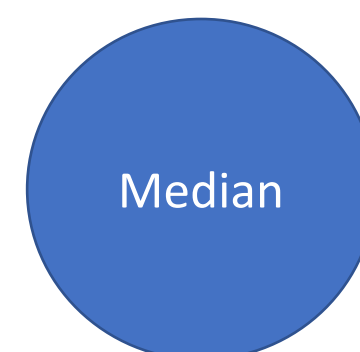




# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

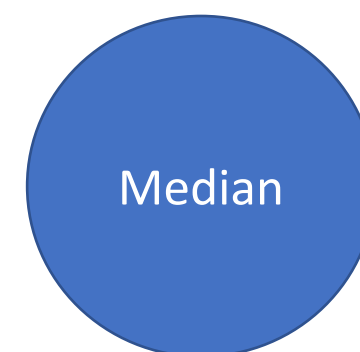
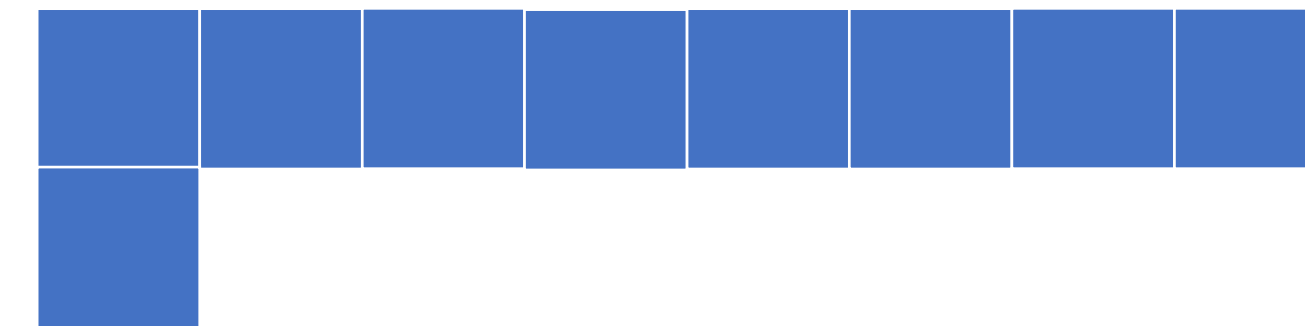




# Convolve Process

Stride = 1 ↓

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31



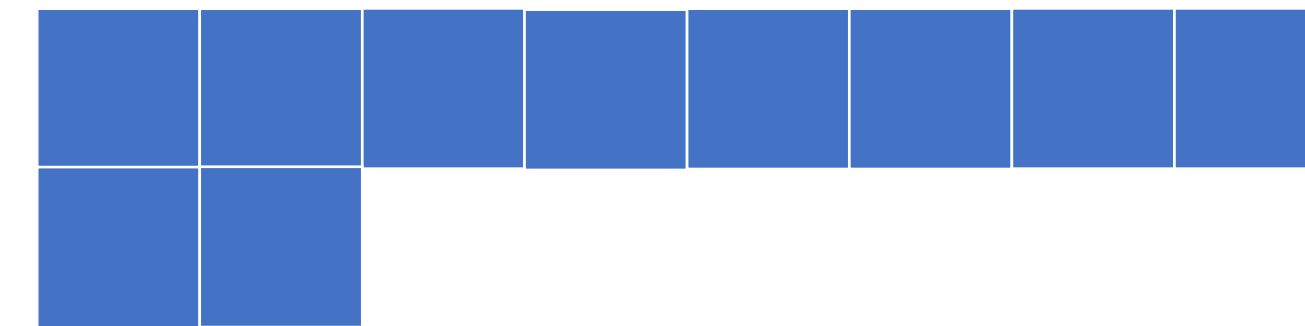


# Convolve Process

Stride = 1



20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31



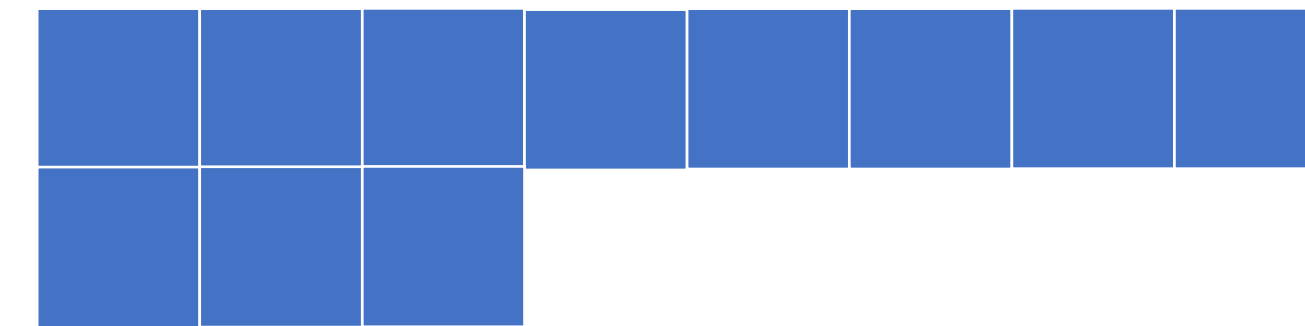
Median



# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

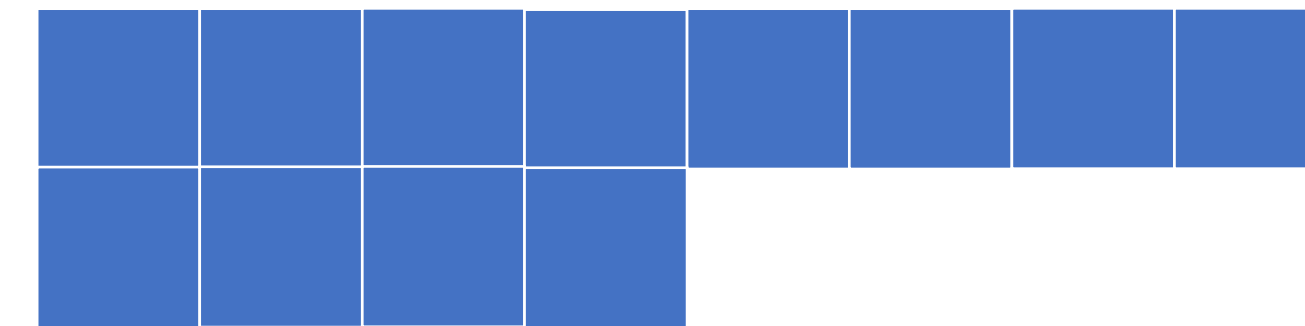




# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31



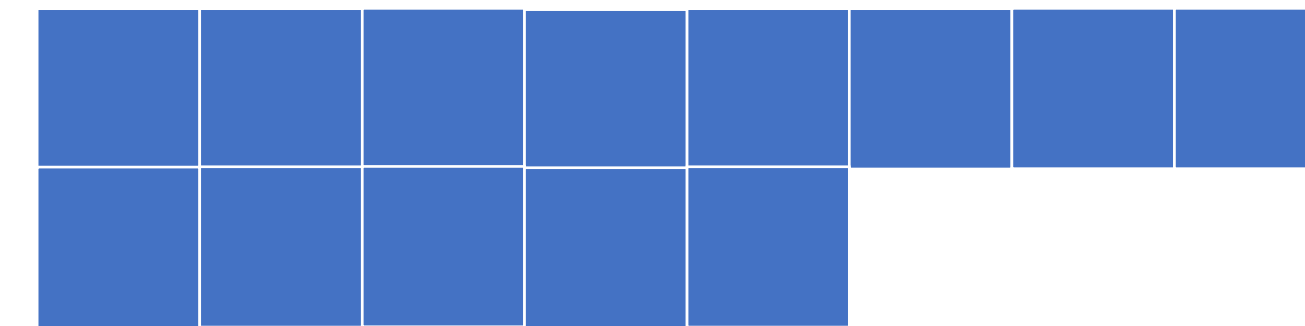
Median



# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31



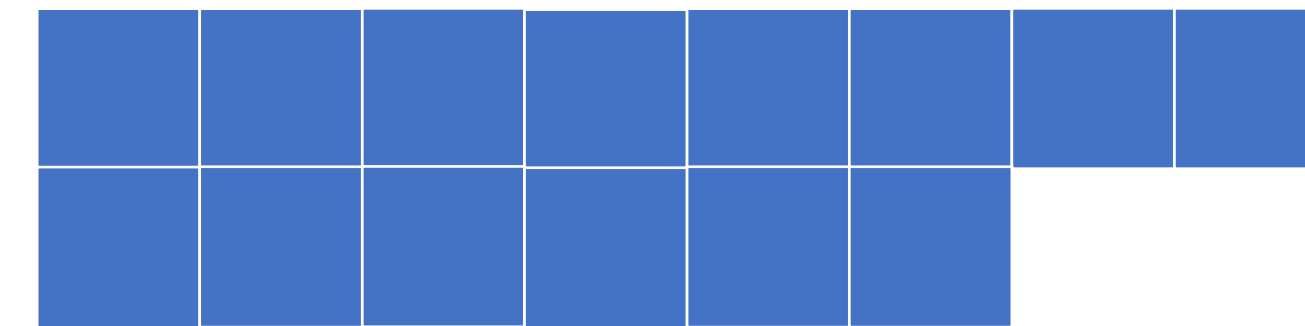
Median



# Convolve Process

Stride = 1  
→

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31



Median

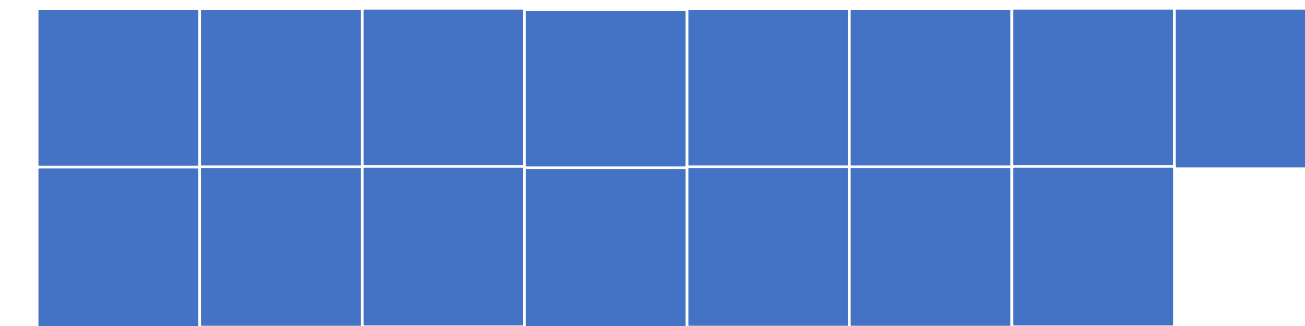


# Convolve Process

Stride = 1



20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31



Median



# Convolve Process

Stride = 1  
→

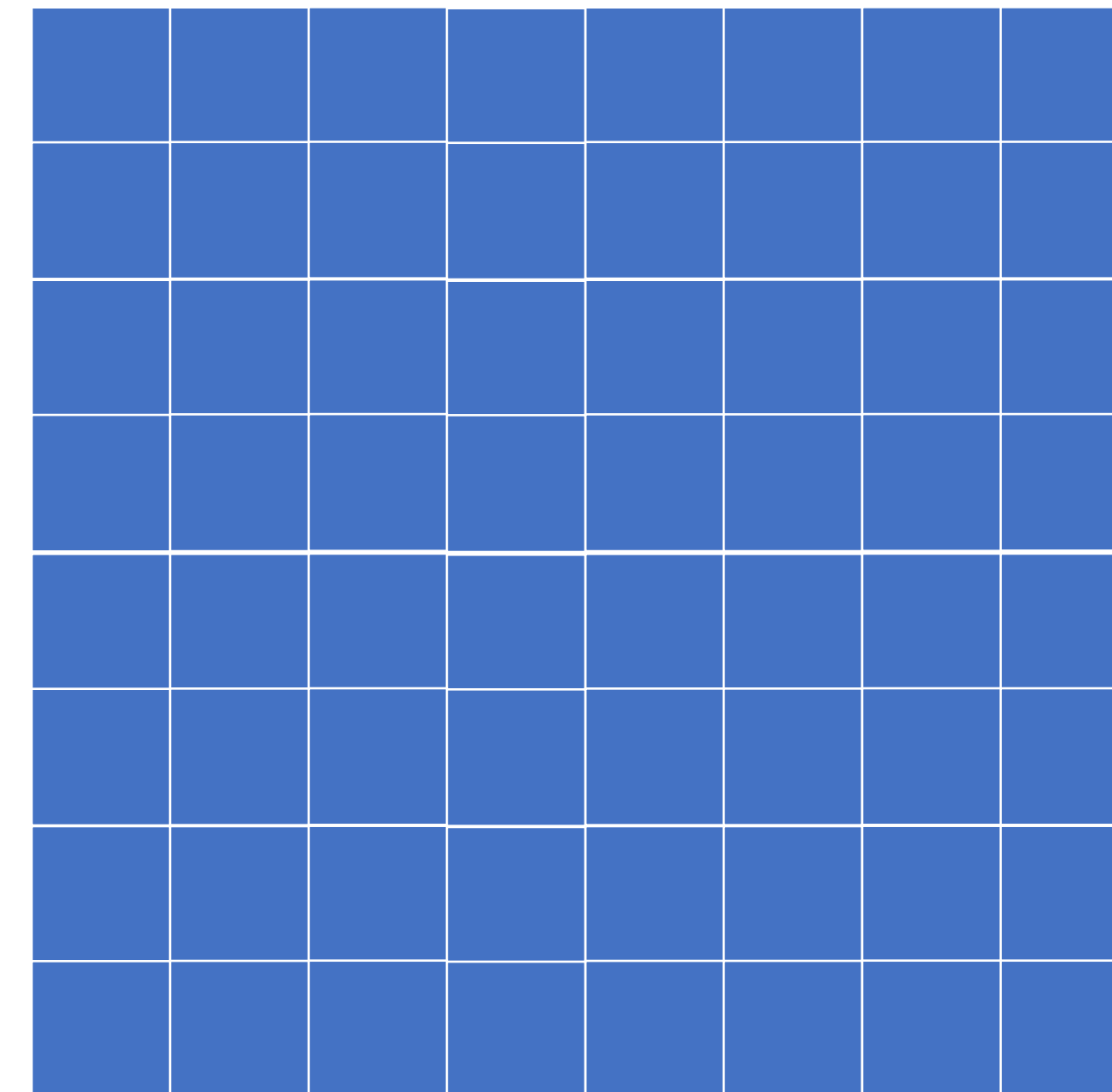
20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31


Median



# Convolve Process

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31

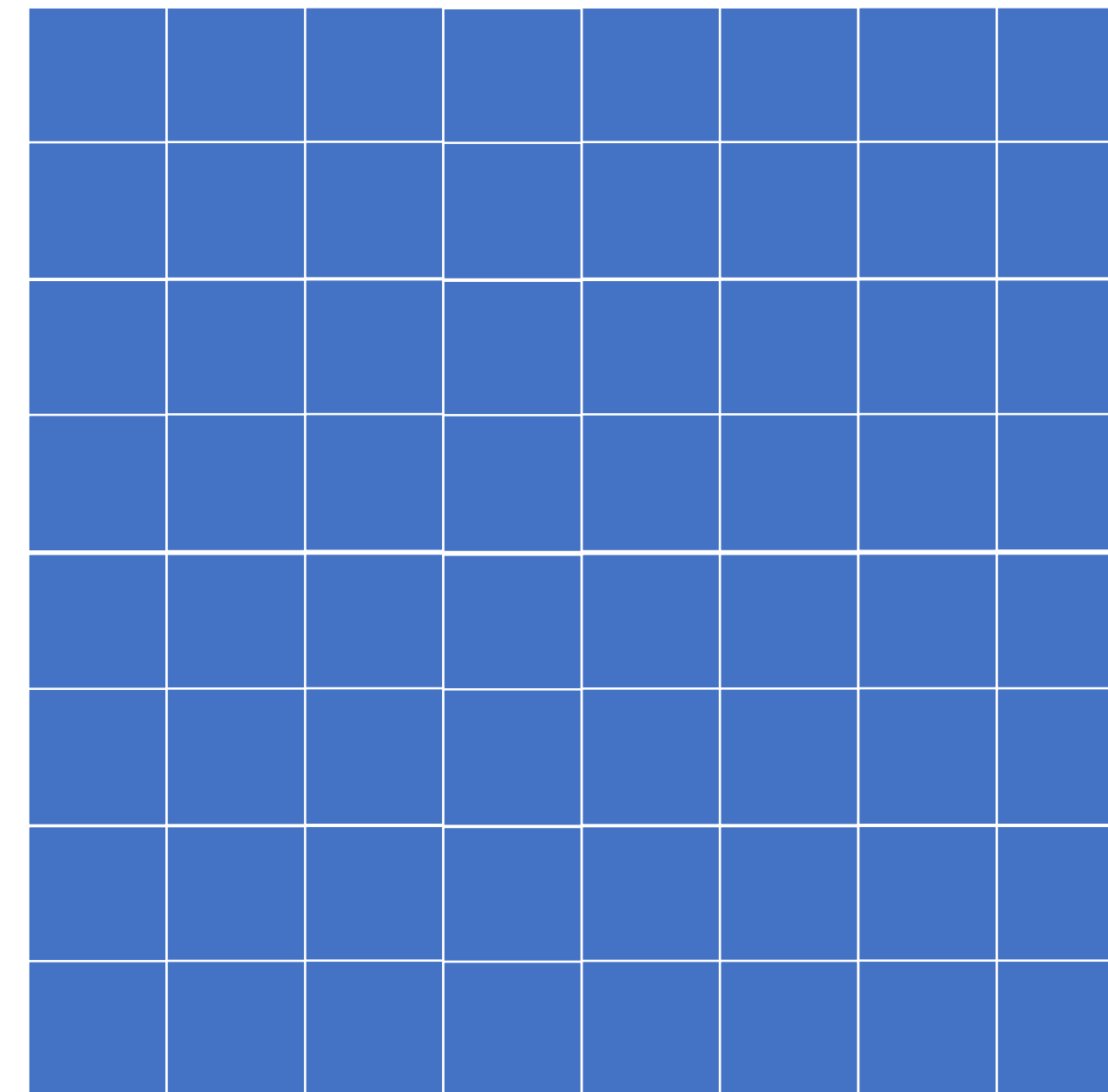


Median

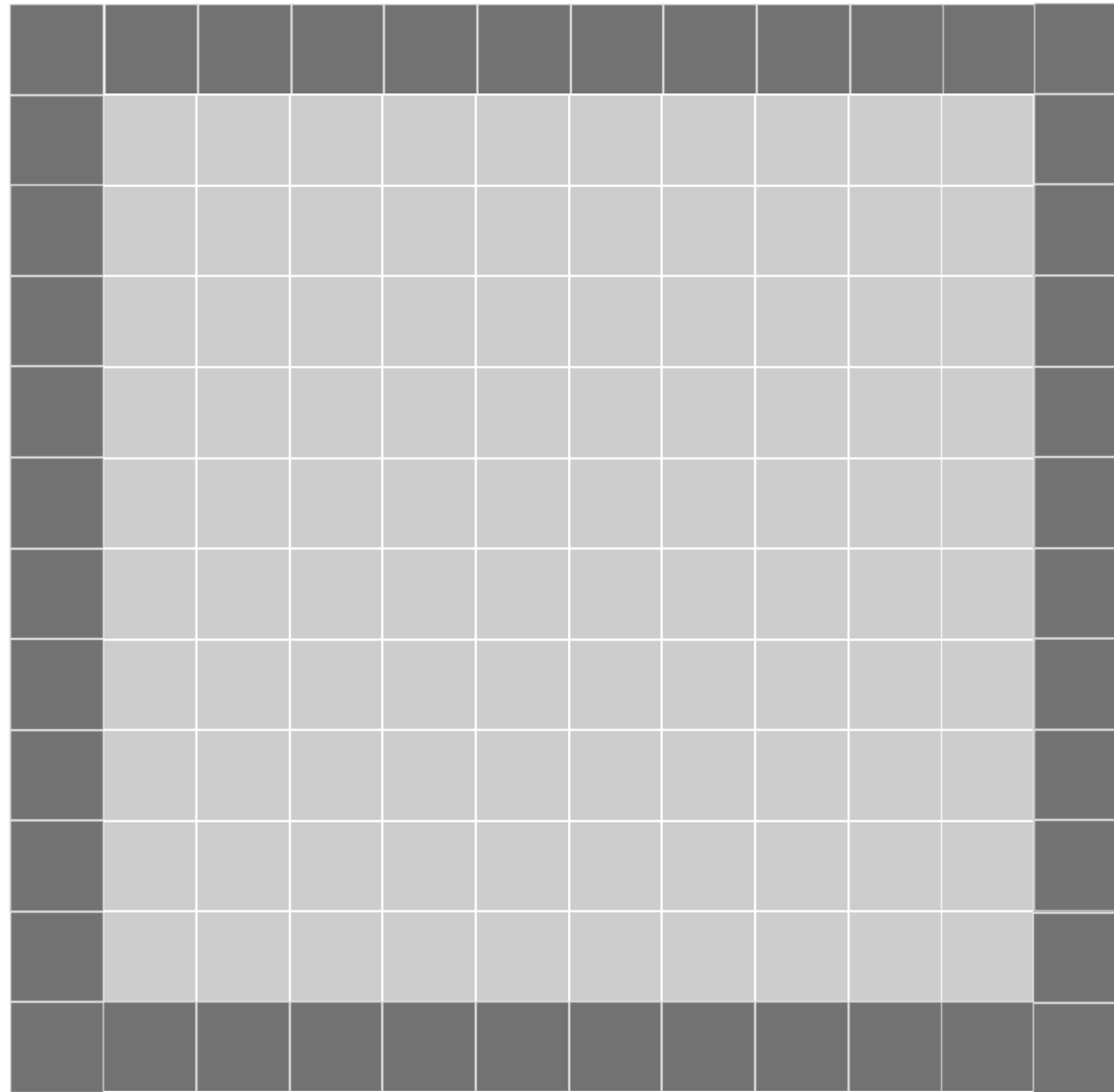


# Convolve Process

20	100	73	60	82	76	250	189	212	56
200	102	16	56	28	67	240	190	63	09
27	212	23	36	82	55	156	18	70	65
200	100	73	60	82	76	250	189	212	120
130	102	16	56	28	67	240	190	63	189
19	212	23	36	82	55	156	18	70	82
108	100	73	60	82	76	250	189	212	19
123	102	16	56	28	67	240	190	63	165
200	212	23	36	82	55	156	18	70	198
35	100	73	60	82	76	250	189	212	31



# Padding to Retain the W & H





# Same Padding

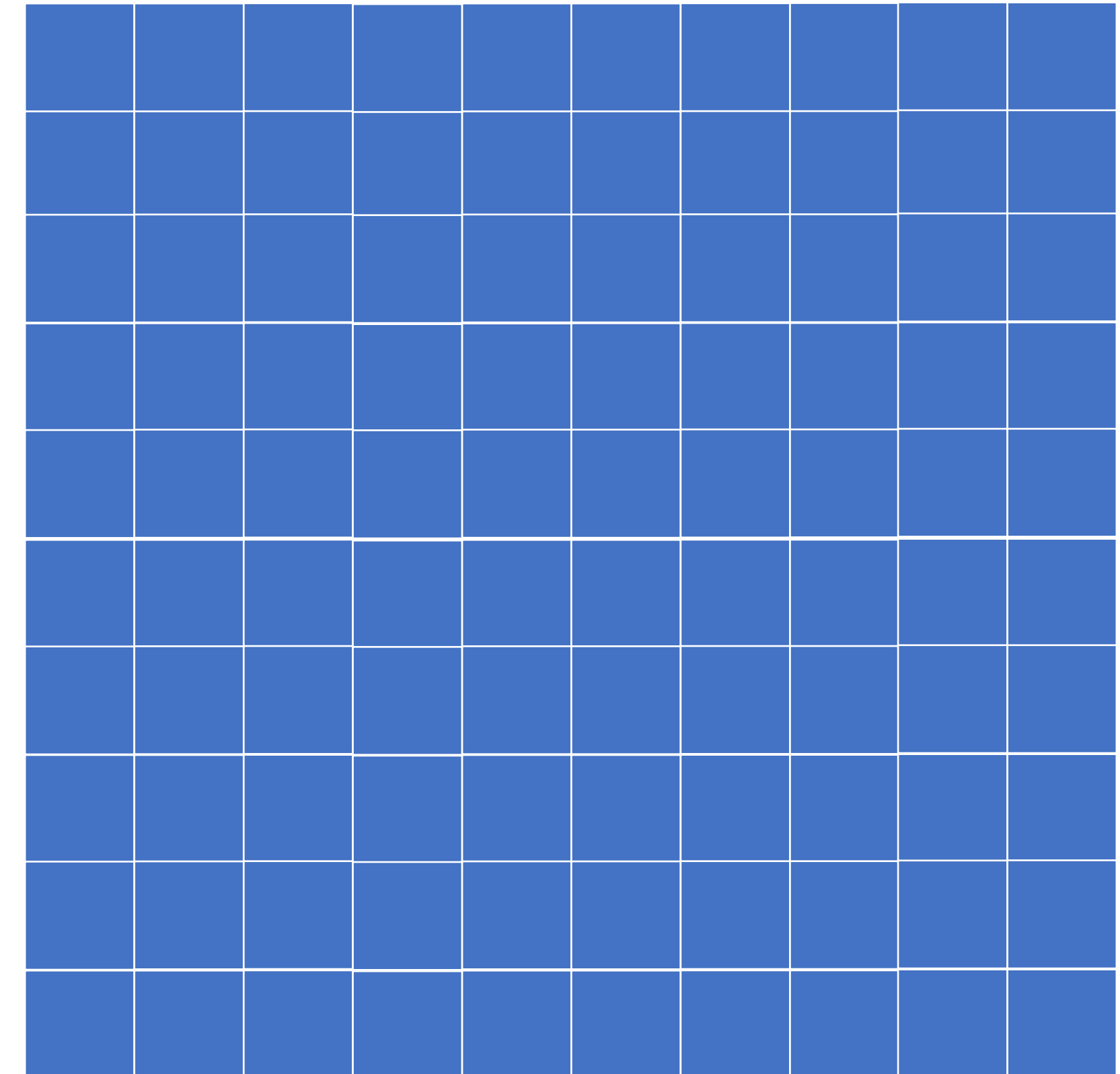
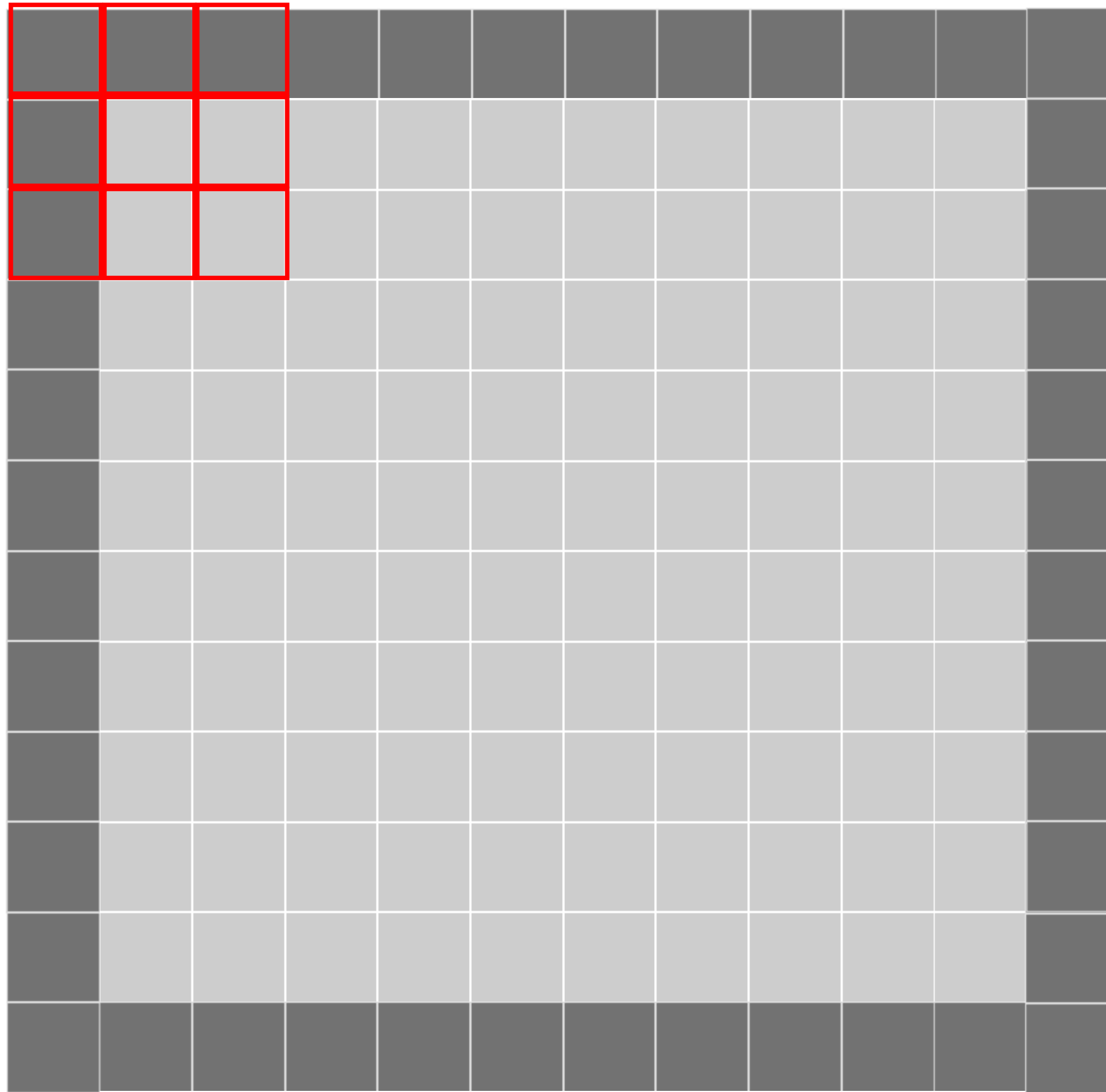
	20	100	73	60	82	76	250	189	212	56	
	200									09	
	27									65	
	200									120	
	130									189	
	19									82	
	108									19	
	123									165	
	200									198	
	35	100	73	60	82	76	250	189	212	31	

# Same Padding or Zero Padding

0	0	0	0	0	0	0	0	0	0	0	0
0	20	100	73	60	82	76	250	189	212	56	0
0	200									09	0
0	27									65	0
0	200									120	0
0	130									189	0
0	19									82	0
0	108									19	0
0	123									165	0
0	200									198	0
0	35	100	73	60	82	76	250	189	212	31	0
0	0	0	0	0	0	0	0	0	0	0	0



# Apply Convolve



Median

# Median Blur in OpenCV

---

```
cv2.medianblur(src,ksize)
```



# Next

Median Blur in OpenCV Python