



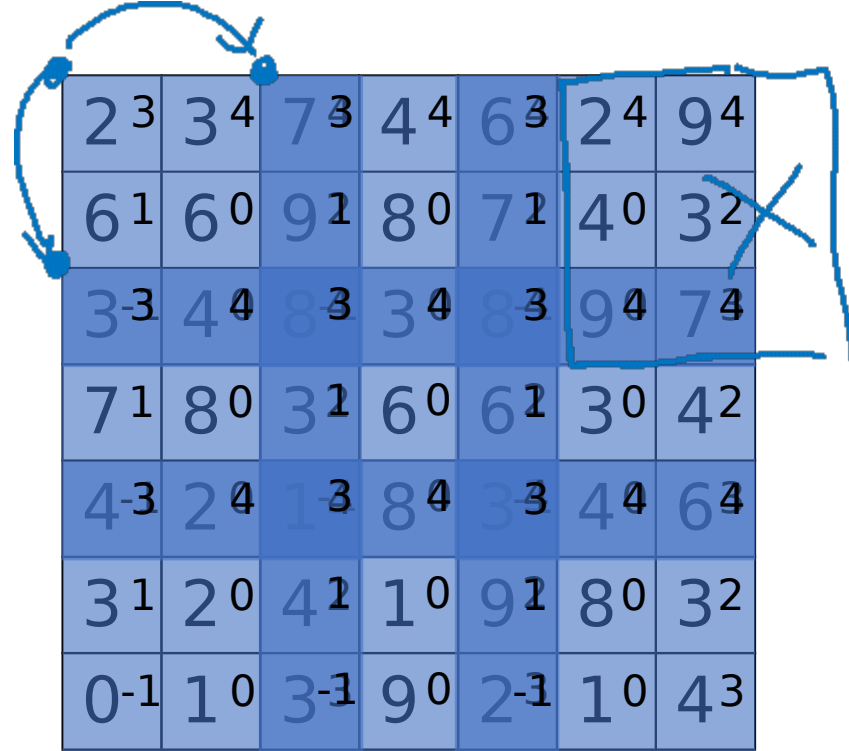
**deeplearning.ai**

# Convolutional Neural Networks

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Strided  
convolutions

# Strided convolution



|                 |                |                 |                |                 |                |                |
|-----------------|----------------|-----------------|----------------|-----------------|----------------|----------------|
| 2 <sup>3</sup>  | 3 <sup>4</sup> | 7 <sup>3</sup>  | 4 <sup>4</sup> | 6 <sup>3</sup>  | 2 <sup>4</sup> | 9 <sup>4</sup> |
| 6 <sup>1</sup>  | 6 <sup>0</sup> | 9 <sup>1</sup>  | 8 <sup>0</sup> | 7 <sup>1</sup>  | 4 <sup>0</sup> | 3 <sup>2</sup> |
| 3 <sup>-3</sup> | 4 <sup>4</sup> | 8 <sup>-3</sup> | 3 <sup>4</sup> | 8 <sup>-3</sup> | 9 <sup>4</sup> | 7 <sup>4</sup> |
| 7 <sup>1</sup>  | 8 <sup>0</sup> | 3 <sup>1</sup>  | 6 <sup>0</sup> | 6 <sup>1</sup>  | 3 <sup>0</sup> | 4 <sup>2</sup> |
| 4 <sup>-3</sup> | 2 <sup>4</sup> | 1 <sup>-3</sup> | 8 <sup>4</sup> | 3 <sup>-3</sup> | 4 <sup>4</sup> | 6 <sup>4</sup> |
| 3 <sup>1</sup>  | 2 <sup>0</sup> | 4 <sup>1</sup>  | 1 <sup>0</sup> | 9 <sup>1</sup>  | 8 <sup>0</sup> | 3 <sup>2</sup> |
| 0 <sup>-1</sup> | 1 <sup>0</sup> | 3 <sup>-1</sup> | 9 <sup>0</sup> | 2 <sup>-1</sup> | 1 <sup>0</sup> | 4 <sup>3</sup> |

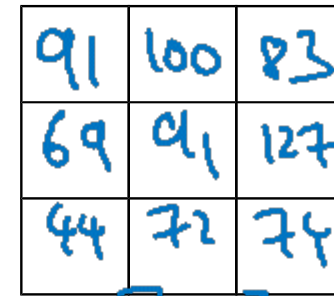
7x7

\*

|    |   |   |
|----|---|---|
| 3  | 4 | 4 |
| 1  | 0 | 2 |
| -1 | 0 | 3 |

3x3

=



|    |     |     |
|----|-----|-----|
| 91 | 100 | 83  |
| 69 | 91  | 127 |
| 44 | 72  | 74  |

3x3

stride = 2

$\lfloor \frac{7}{2} \rfloor = \text{floor}(\frac{7}{2})$

$n \times n$  \*  $f \times f$   
 padding  $p$  stride  $s$   
 $s = 2$

$$\left\lfloor \frac{n + 2p - f}{s} + 1 \right\rfloor \times \left\lfloor \frac{n + 2p - f}{s} + 1 \right\rfloor$$

$$\frac{7 + 0 - 3}{2} + 1 = \frac{4}{2} + 1 = 3$$

# Summary of convolutions

$n \times n$  image

$f \times f$  filter

padding  $p$

stride  $s$

Output Size:

$$\left\lfloor \frac{n+2p-f}{s} + 1 \right\rfloor \times \left\lfloor \frac{n+2p-f}{s} + 1 \right\rfloor$$

# Technical note on cross-correlation vs. convolution

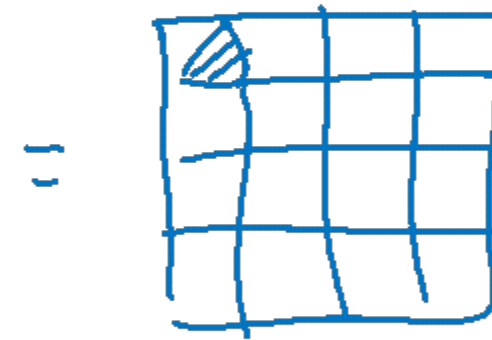
Convolution in math textbook:

|                |                |                |   |   |   |
|----------------|----------------|----------------|---|---|---|
| 2 <sup>7</sup> | 3 <sup>2</sup> | 7 <sup>5</sup> | 4 | 6 | 2 |
| 6 <sup>9</sup> | 6 <sup>0</sup> | 9 <sup>4</sup> | 8 | 7 | 4 |
| 3 <sup>7</sup> | 4 <sup>1</sup> | 8 <sup>3</sup> | 3 | 8 | 9 |
| 7              | 8              | 3              | 6 | 6 | 3 |
| 4              | 2              | 1              | 8 | 3 | 4 |
| 3              | 2              | 4              | 1 | 9 | 8 |

\*

|    |   |   |
|----|---|---|
| 3  | 4 | 5 |
| 1  | 0 | 2 |
| -1 | 9 | 7 |

|    |   |   |
|----|---|---|
| 7  | 2 | 5 |
| 9  | 0 | 4 |
| -1 | 1 | 3 |



$$(A * B) * C = A * (B * C)$$