

# Introduction to Computer Vision

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# Agenda

- Computer Vision Quiz
- Problems with ANNs for Images
- Convolutional Neural Networks (CNNs)
- Components of CNNs

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# Let's begin the discussion by answering a few questions on computer vision and convolutional neural networks (CNNs)

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# Computer Vision Quiz

ANNs are not invariant to which of the following transformations?

A

Translation

B

Rotation

C

Scaling

D

Translation followed by Rotation

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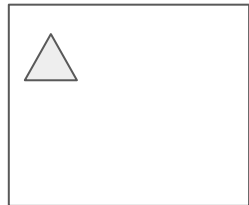
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# Problems with ANNs for Images

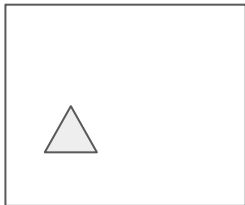
ANNs may struggle with recognizing objects that are translated, rotated, and/or scaled within an image

Each of the pairs below (T and T' for translation, R and R' for rotation, S and S' for scaling) are different sets of inputs to the ANN - the outputs will also be different

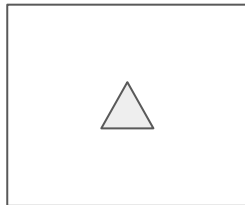
But if the task is to identify a triangle in an image, then each pair should give the same output.



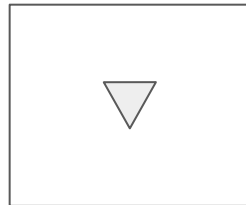
**T**



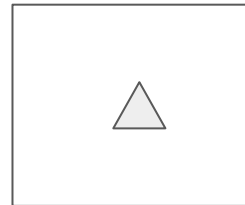
**T'**



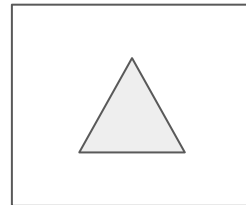
**R**



**R'**



**S**



**S'**

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# Computer Vision Quiz

How do CNNs address the problem of translation invariance?

A

By moving filters across the entire image to detect patterns at different locations.

B

By randomly selecting regions of the image for feature extraction.

C

By resizing the image.

D

By adding brightness to the image.

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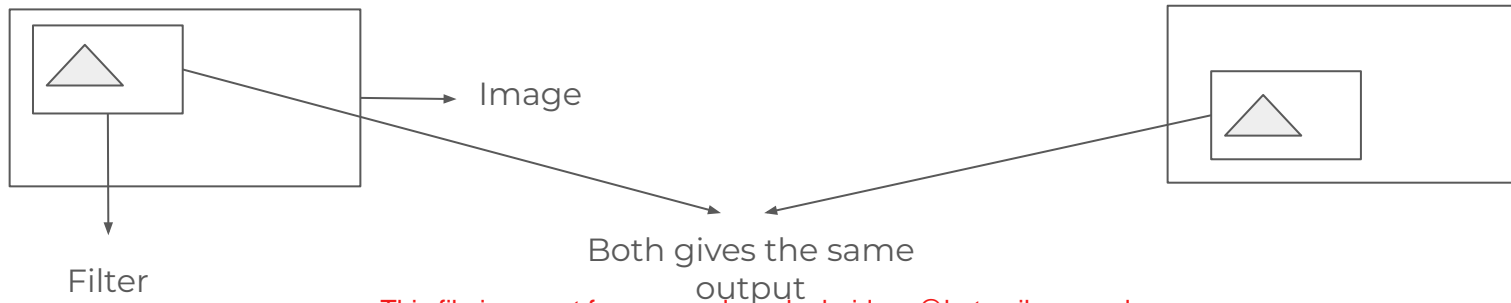
# CNN Filters

A CNN filter scans an image to find features like edges or textures

Adapts its parameters to recognize particular patterns during training

CNNs address the problem of translation invariance by moving filters across the entire image through a sliding mechanism

Allows the network to detect patterns or features at different spatial locations



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# Computer Vision Quiz

What is the output of convolving a  $2 \times 2$  filter of all ones with any  $2 \times 2$  input matrix of real values?

A

The product of all elements in the input matrix.

B

The mean of all elements in the input matrix

C

The sum of all elements in the input matrix.

D

The maximum value of all elements in the input matrix.

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# Convolution Operation

Refers to the process of applying a filter to the input data by computing the dot product between the filter and the local regions of the input

a	b
c	d

 \* 

1	1
1	1

$$= a * 1 + b * 1 + c * 1 + d * 1$$

$$= a + b + c + d$$

Thus, we get the sum of all elements of the input matrix

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# Computer Vision Quiz

Which operation applied to an image helps in preserving its dimensionality after convolution?

A

Translation

B

Rotation

C

Increasing the brightness

D

Padding

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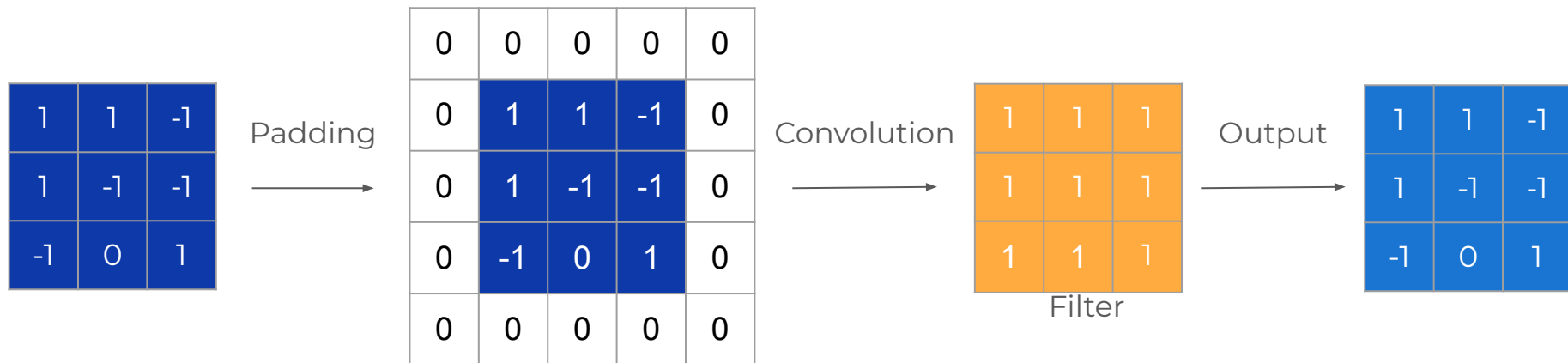
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# Padding

Refers to adding extra border pixels around the input data before applying the convolution operation

Helps preserve spatial dimensions and information at the edges of the input, ensuring that the output feature map has the desired size



# Computer Vision Quiz

**In convolutional neural networks (CNNs), what effect does increasing the stride value have on the output feature map size?**

A

It increases the size of the output feature map.

B

It has no effect on the size of the output feature map.

C

It reduces the number of channels in the output feature map.

D

It decreases the size of the output feature map.

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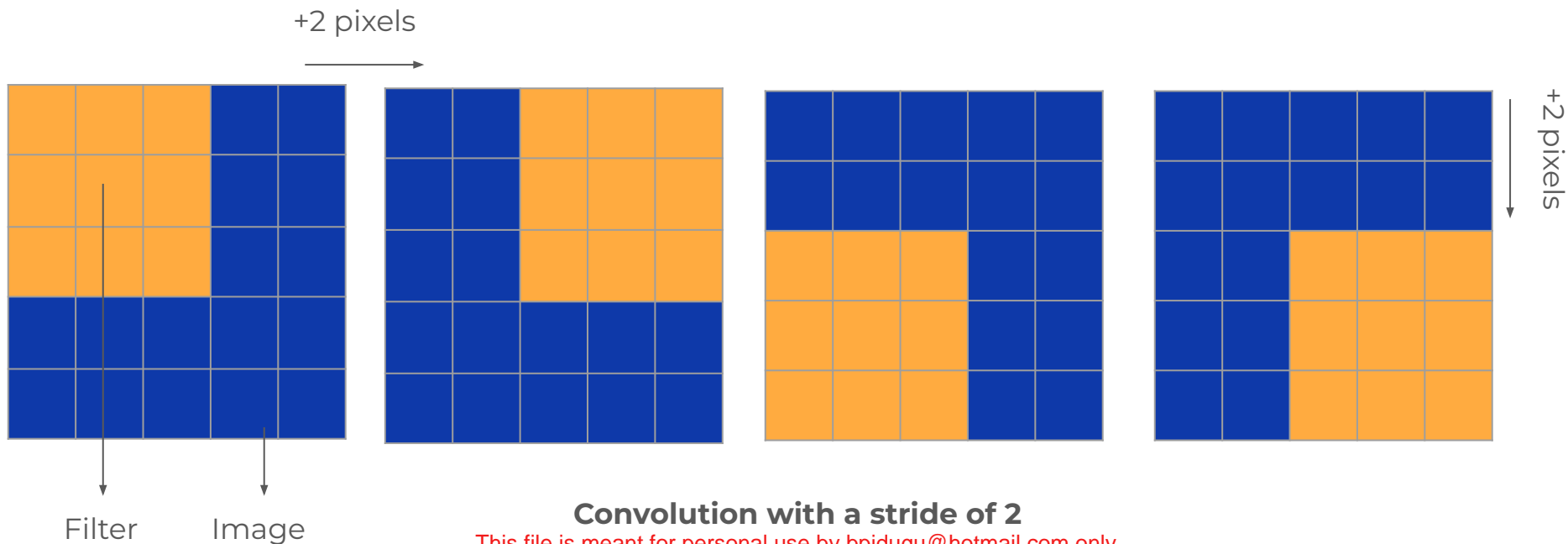
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Refers to the number of pixels by which the filter is moved across the input data during the convolution operation



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# Computer Vision Quiz

Why do we need a pooling layer in Convolutional Neural Networks (CNNs)?

A

To increase the number of parameters.

B

To reduce the spatial dimensions of the feature maps, reducing computational complexity.

C

To increase the spatial dimensions of the feature maps, reducing computational complexity.

D

To scale the input.

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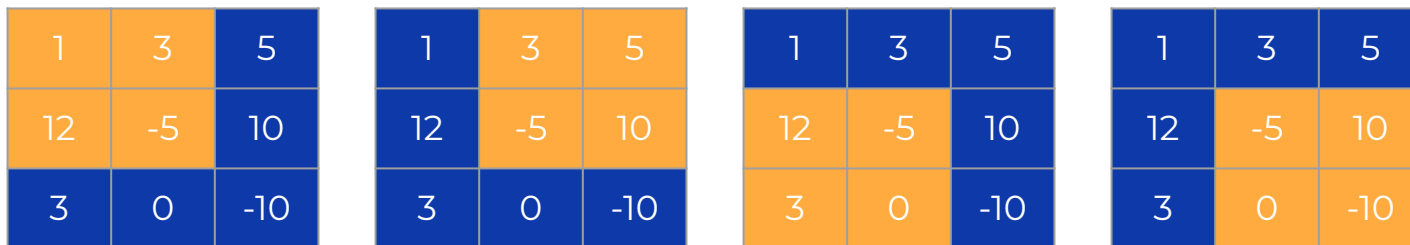
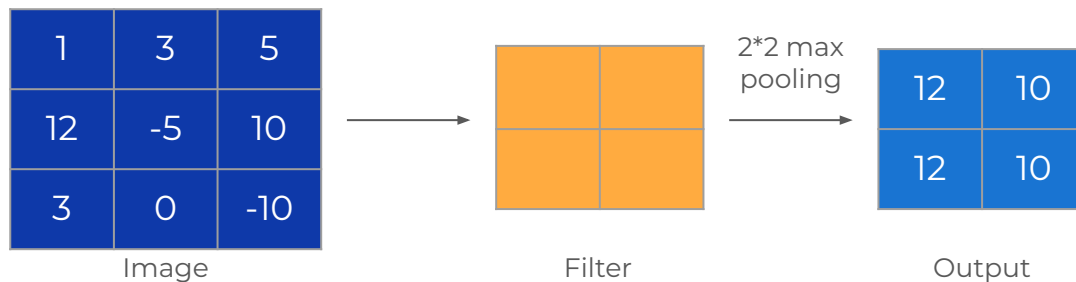
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# Pooling

Decreases the spatial dimensions of feature maps

Reduction in size aids in managing computational complexity, facilitating faster training



# Computer Vision Quiz

What is the total number of learnable parameters in a Max Pooling layer ?

A

Depends on the kernel size.

B

1

C

Depends on the size of the input feature map

D

0

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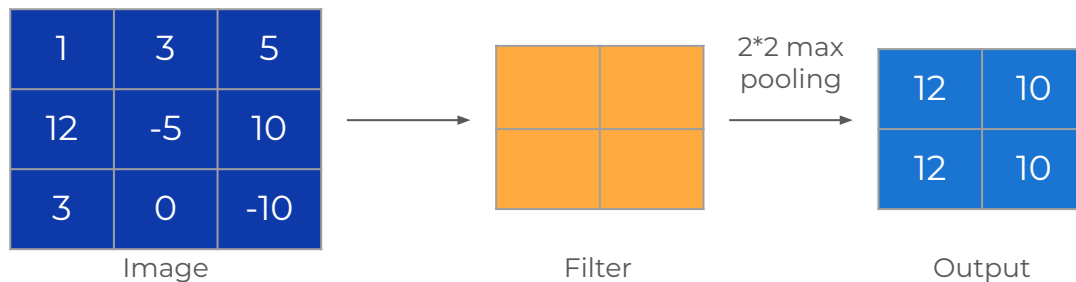
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# Max Pooling

Operates by selecting the maximum value within each pooling region, without any trainable weights or biases.

As we are performing an operation to find the maximum value, there are **no learnable parameters**



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# Computer Vision Quiz

Consider the following code snippet for defining a CNN:

```
model = Sequential()  
model.add(Conv2D(filters=1, kernel_size=(2, 2), input_shape=(3, 3, 1)))  
model.add(Flatten())  
model.add(Dense(units=1))
```

Given this model architecture with a 3x3 input image, how many learnable parameters are there in the entire model?

A

10

B

8

C

9

D

5

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# CNN Parameters

w11	w12
w21	w22

**b\_w**

d1
d2
d3
d4

**b\_d**

Parameter	Parameter Description	Count
<b>wij</b>	Weights of the CNN layer	4
<b>b_w</b>	Bias of the CNN layer	1
<b>d_i</b>	Weights of the Dense layer	4
<b>b_d</b>	Bias of the Dense layer	1

Thus, we have 10 learnable parameters in this neural network

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