Introduction to Machine Learning and Tensorflow

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Creative Coding Lab

What is Machine Learning ?

A class of algorithms which learns to performs a specific task based on sample data and without any explicit instruction

Example: Classifying whether an email is a spam or not

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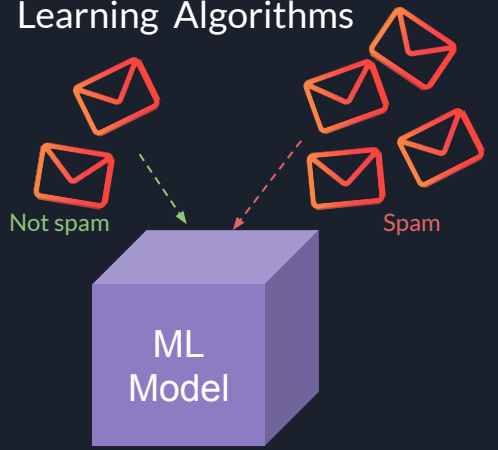
Learning Algorithms



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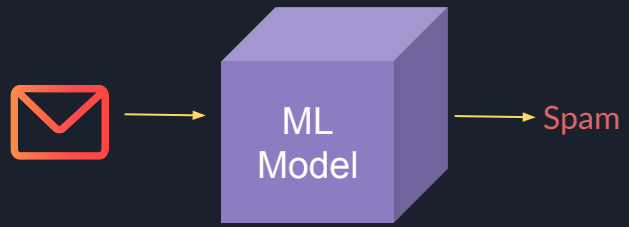
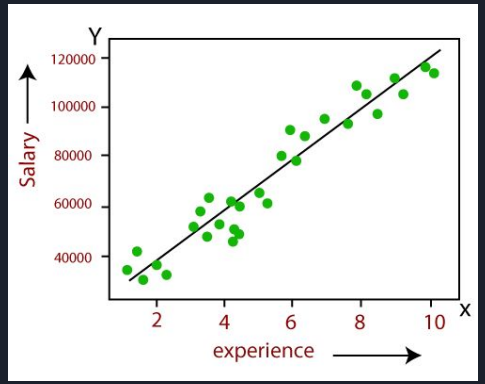
Learning Algorithms



Types of Machine Learning

Supervised learning - find patterns and insights from a labelled dataset

Regression



Linear regression

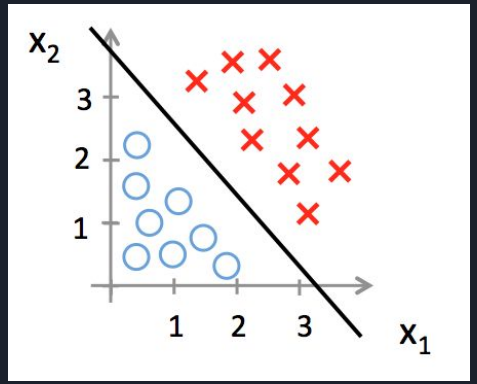
Support Vector

Decision tree

Random Forest

Neural Networks

Classification



K Nearest Neighbor

Naive Bayes

Support Vector Machine

Decision tree

Random Forest

Neural Networks

Types of Machine Learning

Unsupervised learning - find patterns and insights from an unlabelled dataset

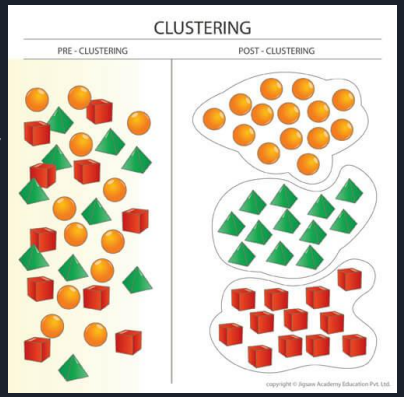
Clustering

K Mean

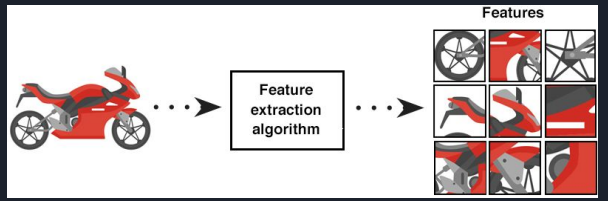
K Nearest Neighbor

SVD

Neural Networks



Feature Extraction



Principal Component Analysis

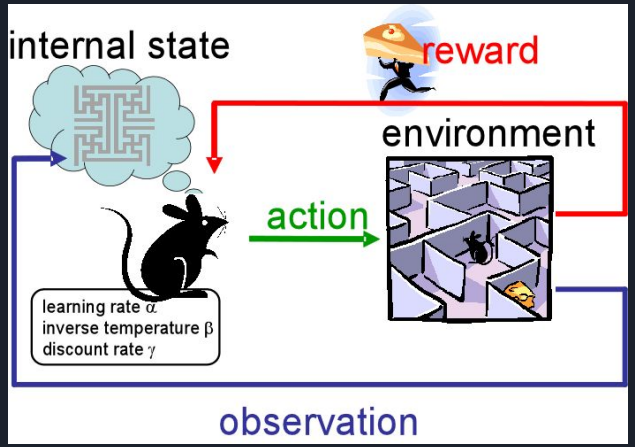
Gaussian Mixture Model

Hidden Markov Model

Neural Networks

Types of Machine Learning

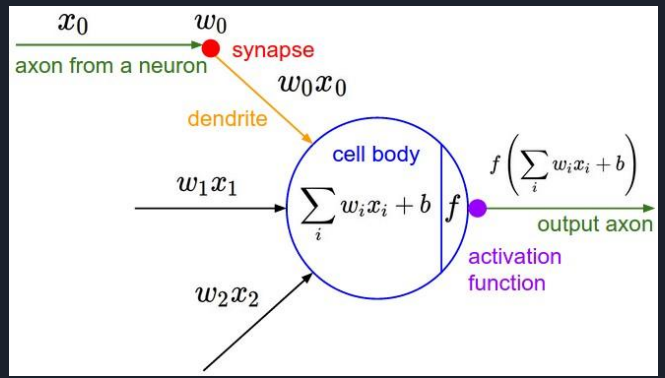
Reinforcement learning - agent does an action to increase the reward



Neural Networks

NNs are a collection of small processing units (neurons) arranged in a hierarchical fashion

Each processing units is a combination of a linear function followed by a nonlinear function



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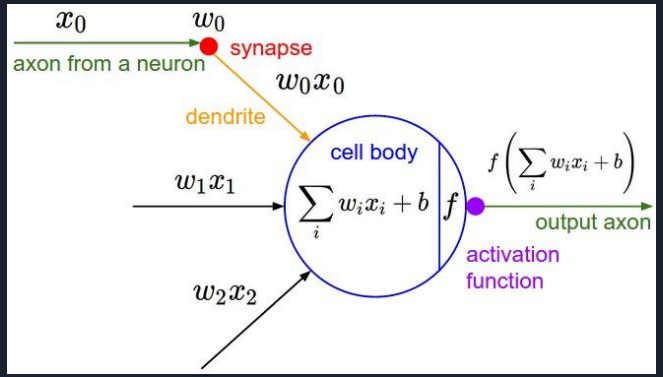

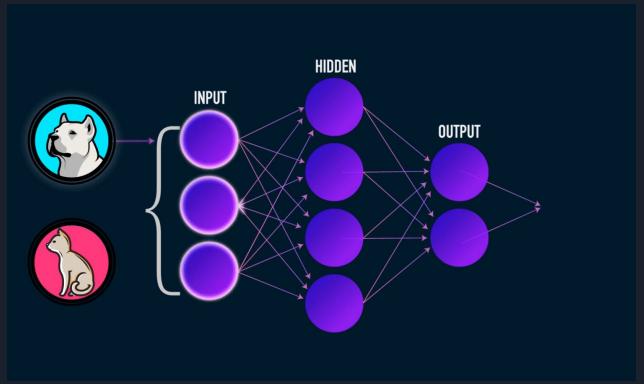

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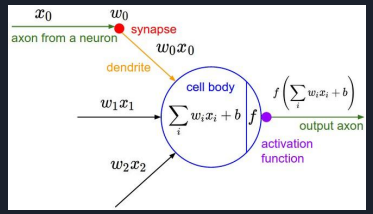

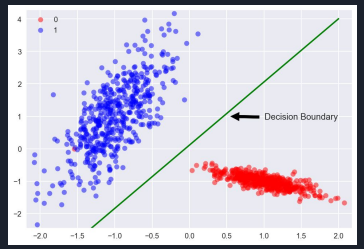

Linear Function: Wx + b

Wx + b is the equation for a straight line (y = Mx+c)
where M is the slope and c is the y-intercept

Wx+b is preferred because:

- Straight lines are useful to model decision boundaries
- It's easier to work with

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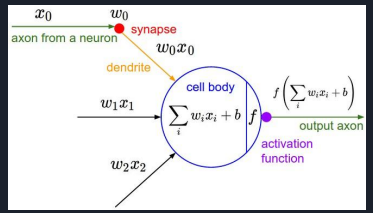
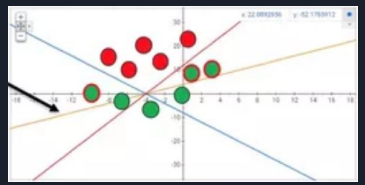
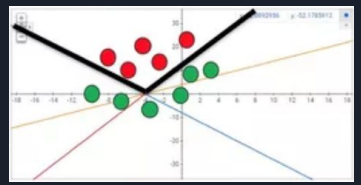


Non-linear function or Activation function: σ(Wx + b)

σ activates neuron based on the output of the linear function

Creates non-linearity in the network





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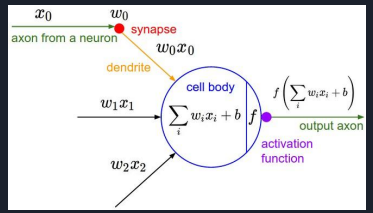
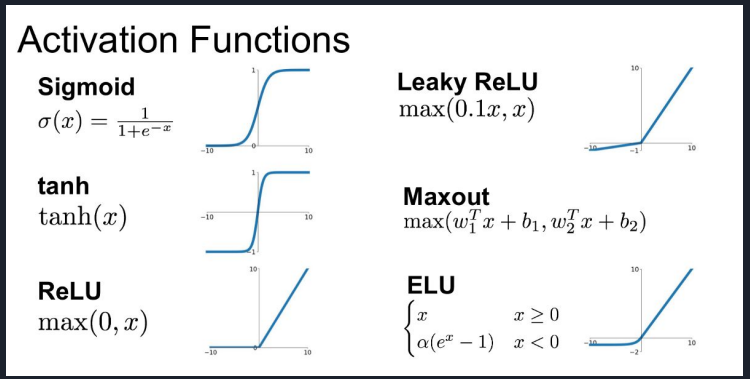
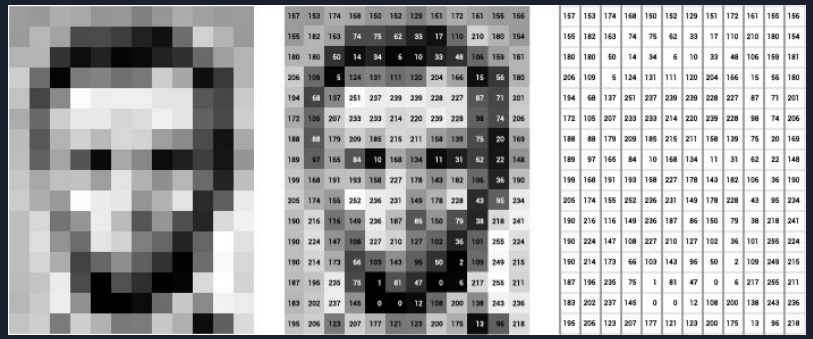


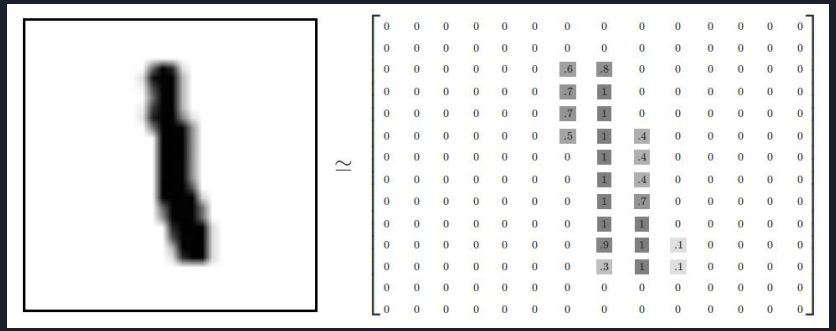


Let’s build an image classifier

Images are just numbers (usually between 0 and 255)

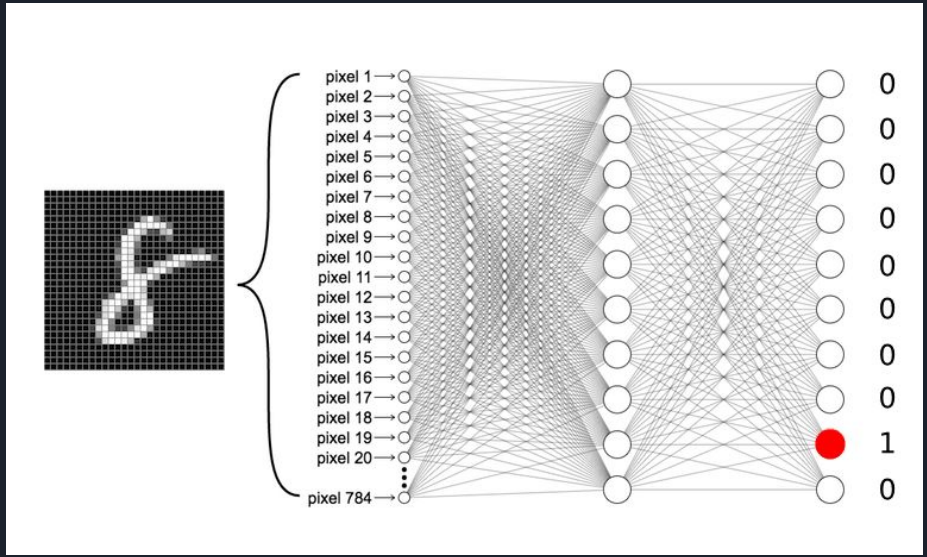
We scale the images in the range [0,1] as part of feature scaling





Let’s build an image classifier

Fully Connected Network(FCN) - Each neuron in one layer is connected to every neuron in the next layer



No spatial information

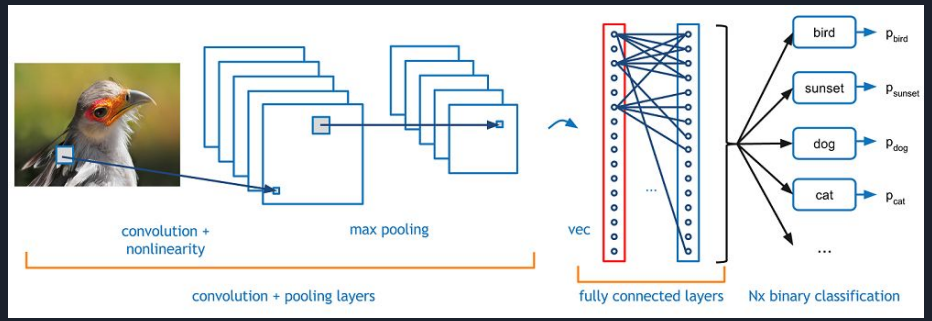
Need a large number of neuron (parameters)

Increases computations and memory footprint

Not commonly used anymore

Let’s build an image classifier

Convolutional Neural Network - Each neuron is connected to a local region neurons of previous layer



Looks at spatial information

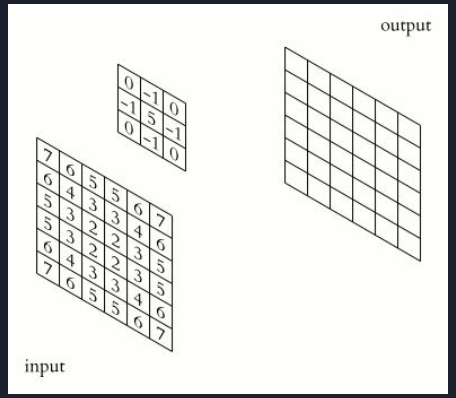
Reuse neurons (less # parameters)

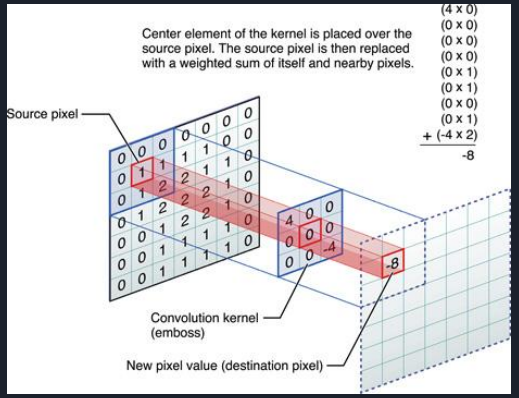
Lower computations and memory footprint

Let’s build an image classifier

Convolution in image processing

Kernel slides over the image and computes new pixel value as a sum/avg of element-wise multiplication

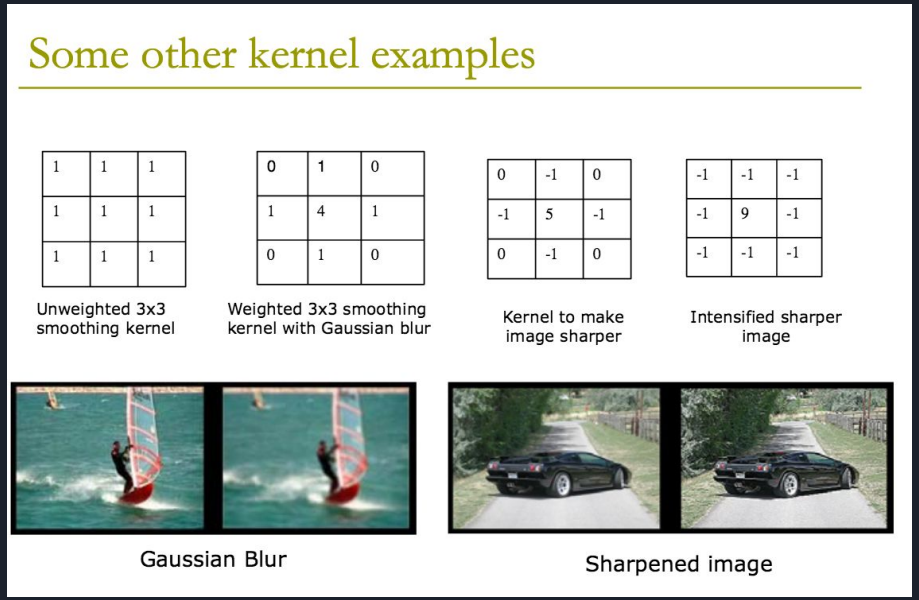




Let’s build an image classifier

Convolution in image processing

Examples: http://setosa.io/ev/image-kernels/



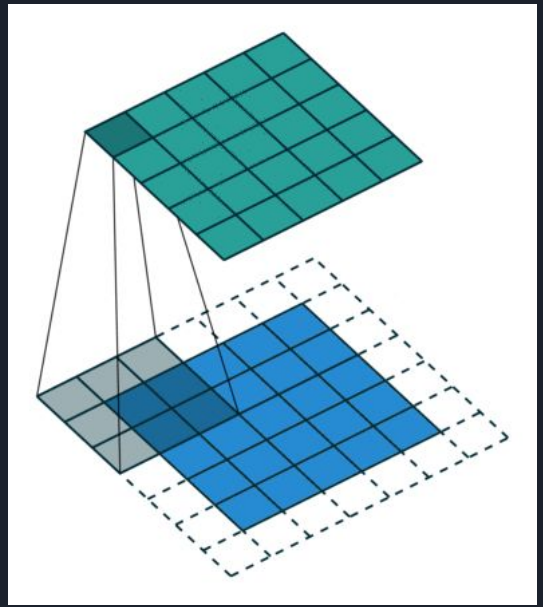
Let’s build an image classifier

Padding

3_0	3_1	2_2	1	0
0_2	0_2	1_0	3	1
3_0	1_1	2_2	2	3
2	0	0	2	2
2	0	0	0	1

12.0	12.0	17.0
10.0	17.0	19.0
9.0	6.0	14.0

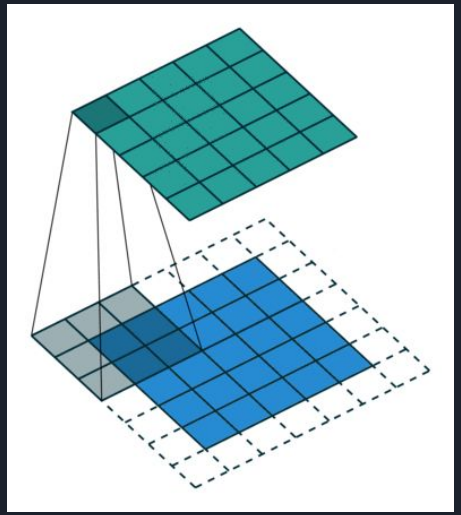
without padding, 5x5 -> 3x3



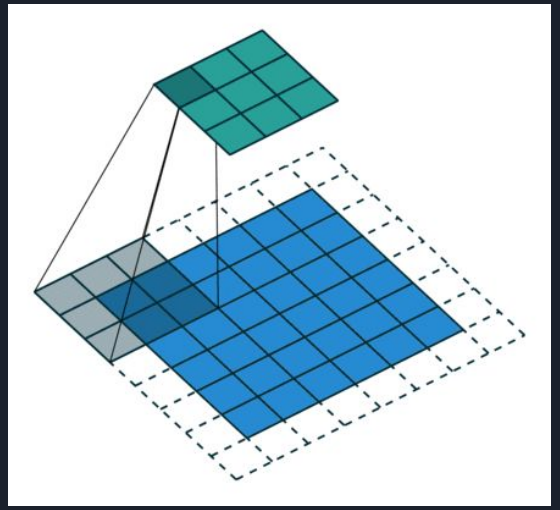
with padding, 5x5 -> 5x5

Let’s build an image classifier

Stride



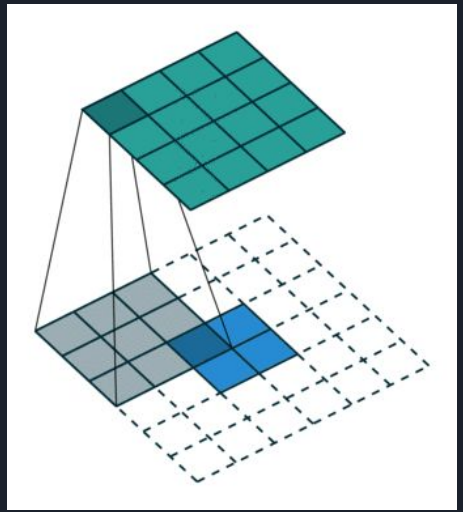
Stride - 1

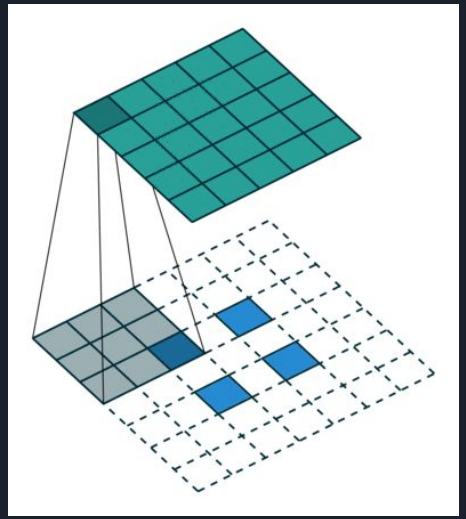


Stride - 2

Let’s build an image classifier

Deconvolution





Let’s build an image classifier

Classifying a number using hand-made image kernels

*

1	1	1
0	0	0
0	0	0

→ True

Let’s build an image classifier

Classifying a number using hand-made image kernels

*

0	0	1
0	1	0
1	0	0

→ True

Let’s build an image classifier

Classifying a number using hand-made image kernels

*

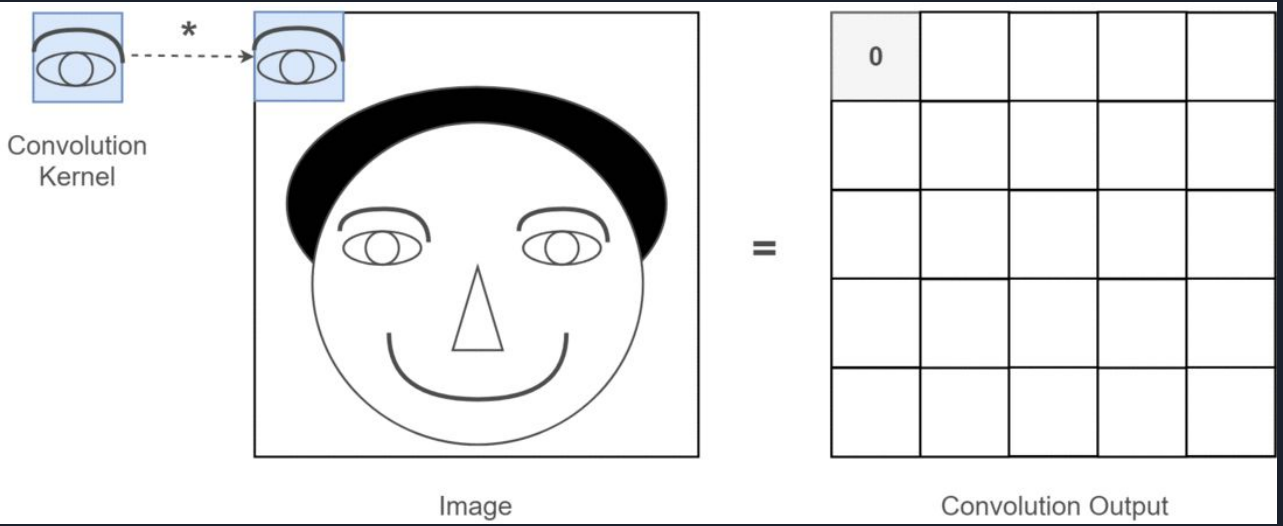
0	1	0
1	0	0
0	1	0

→ False

Let’s build an image classifier

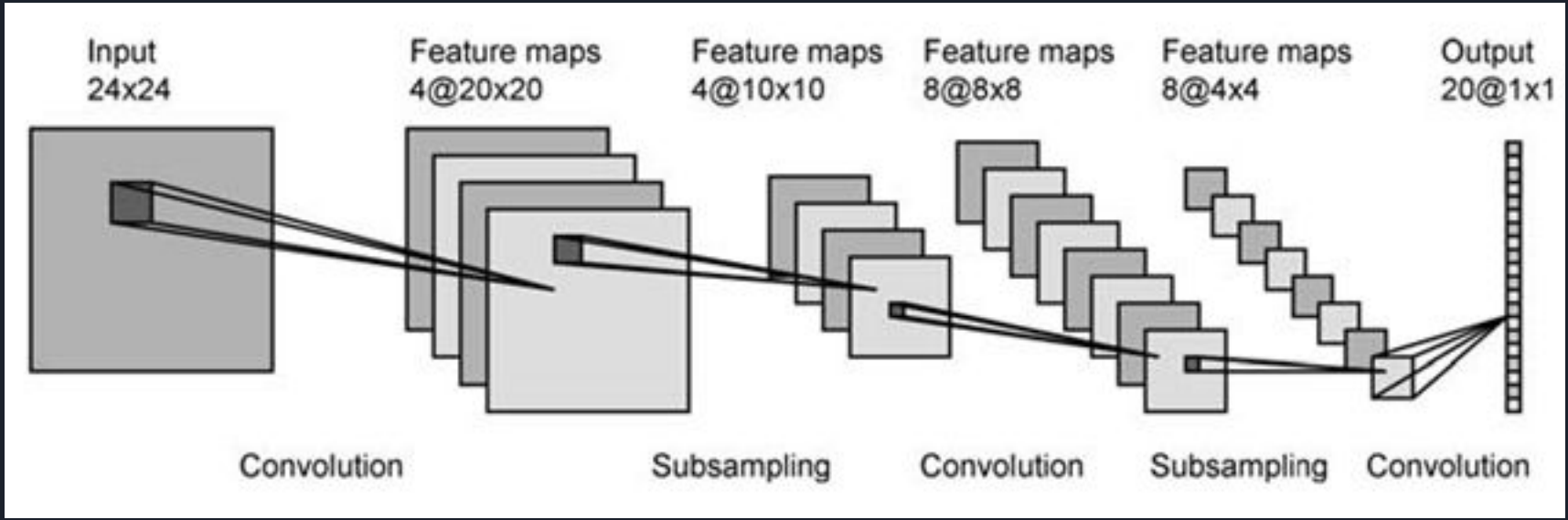
Classifying a face using hand-made image kernels

Hard to build complex kernels



Let’s build an image classifier

Kernels/Filters are learnable parameters in a CNN



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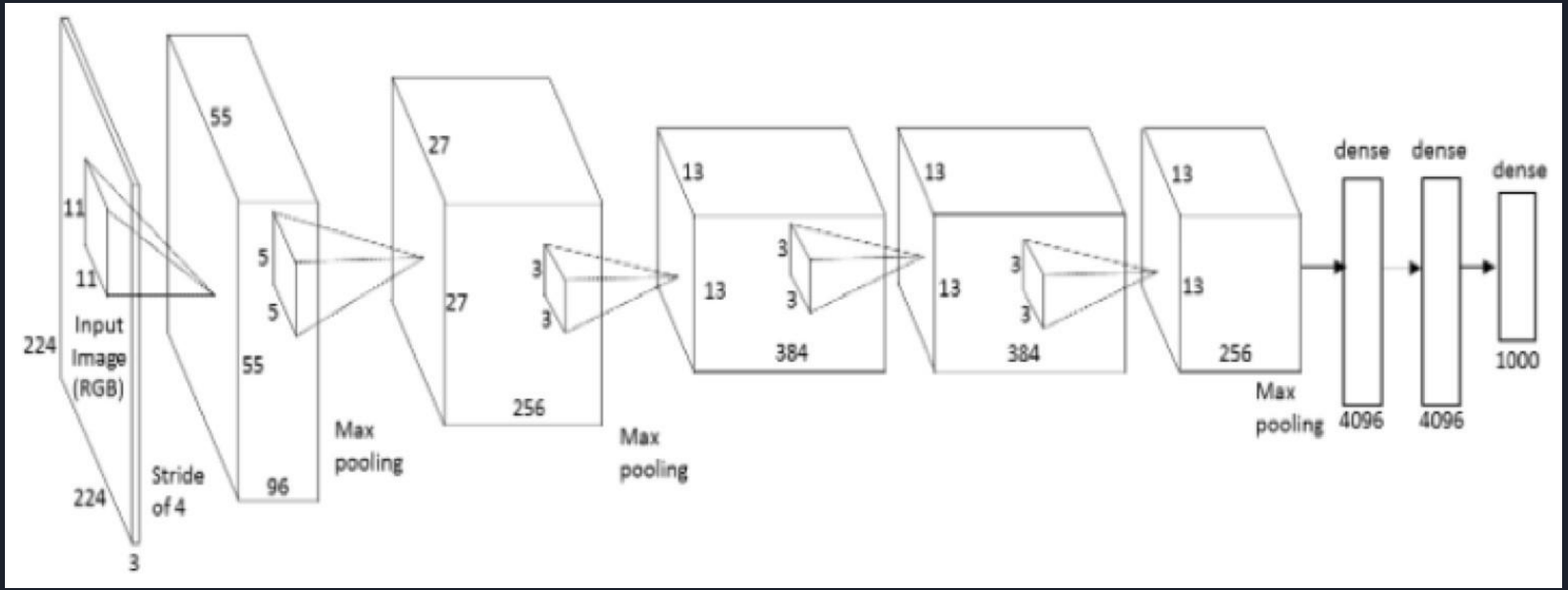
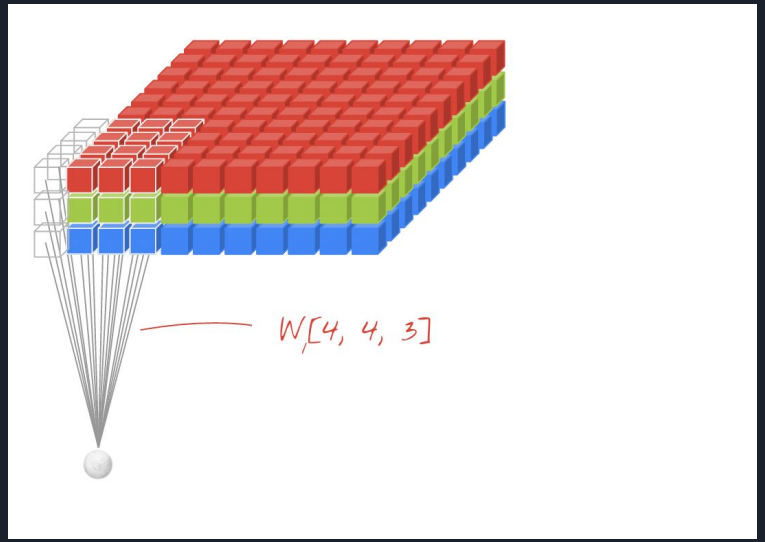
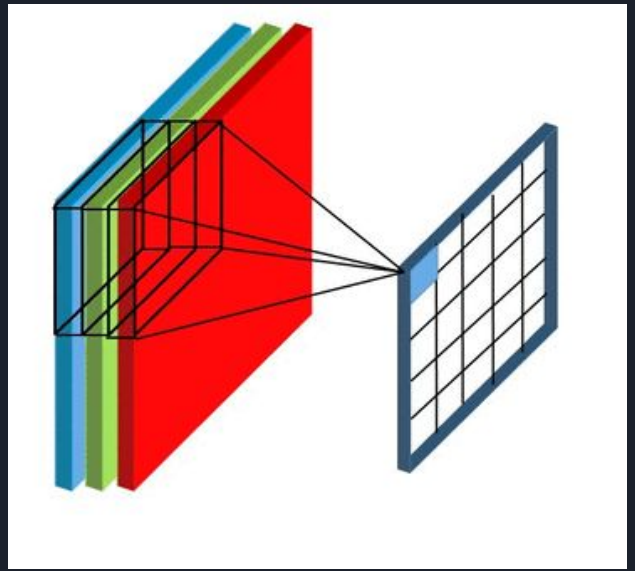


Let’s build an image classifier

CNNs for RGB images





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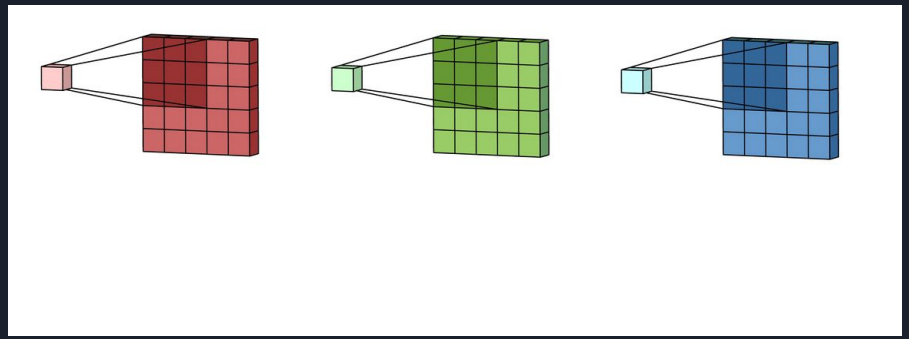
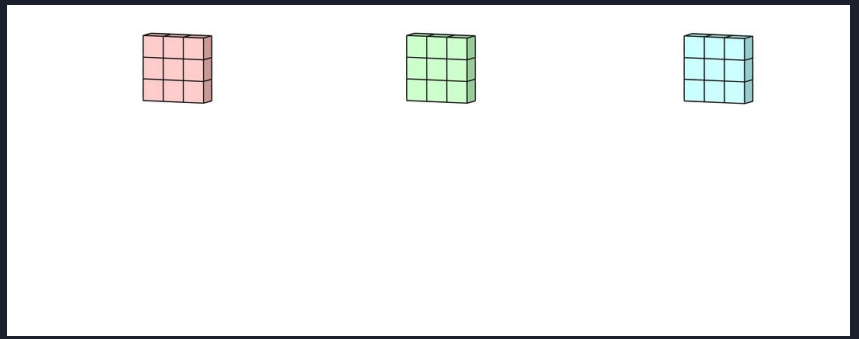
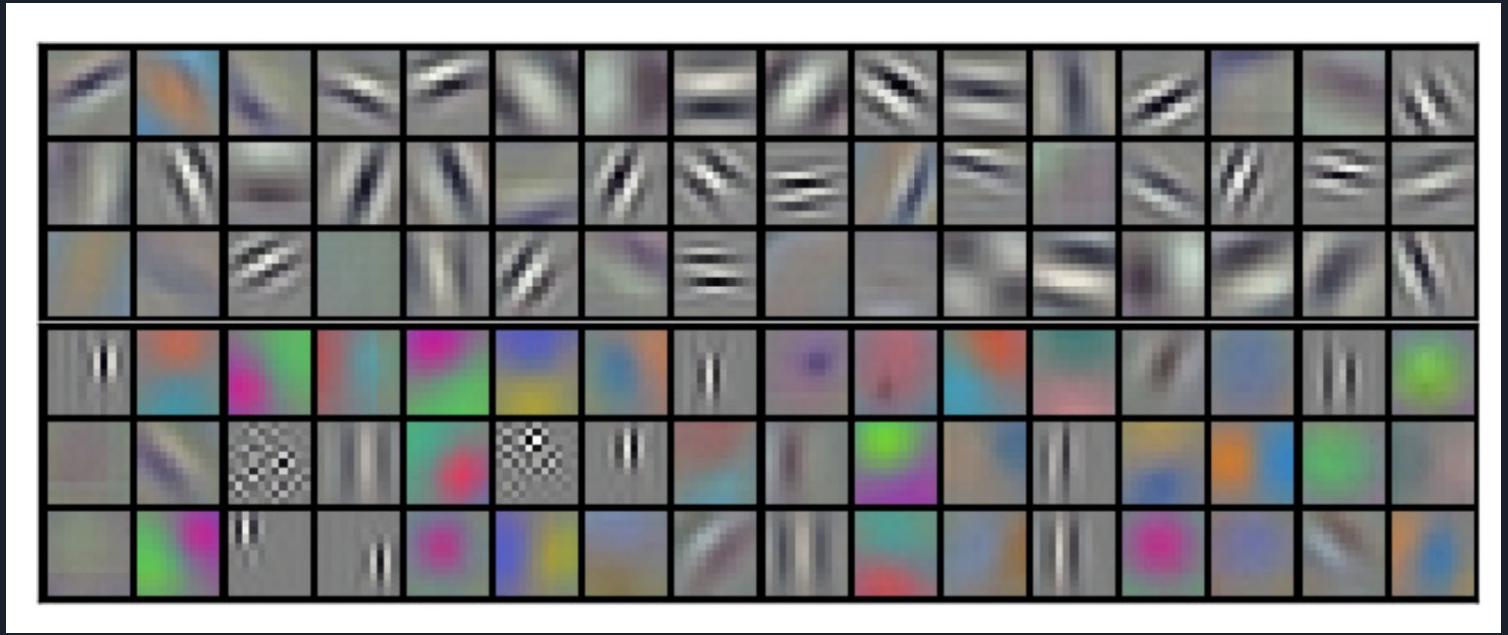




Let’s build an image classifier

Learned kernels/filters

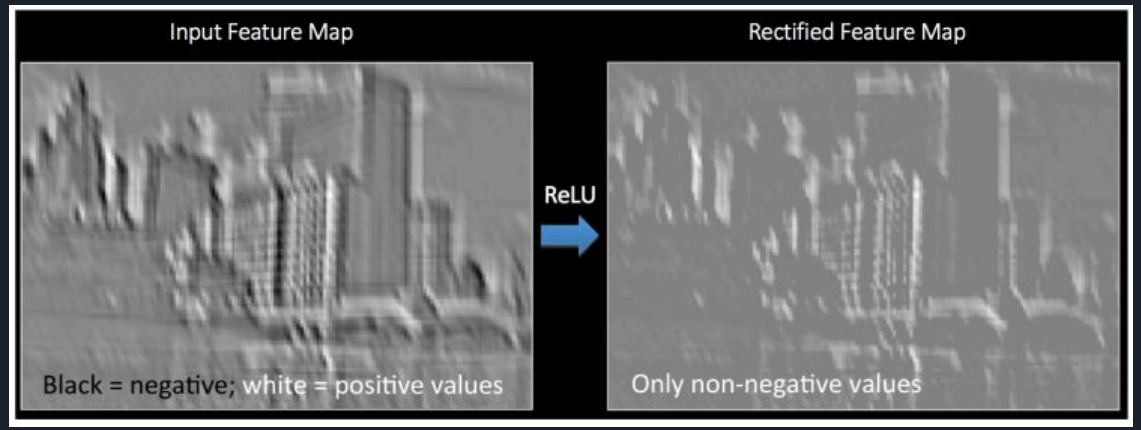


Let’s build an image classifier

Feature maps - output of each convolution (linear function)

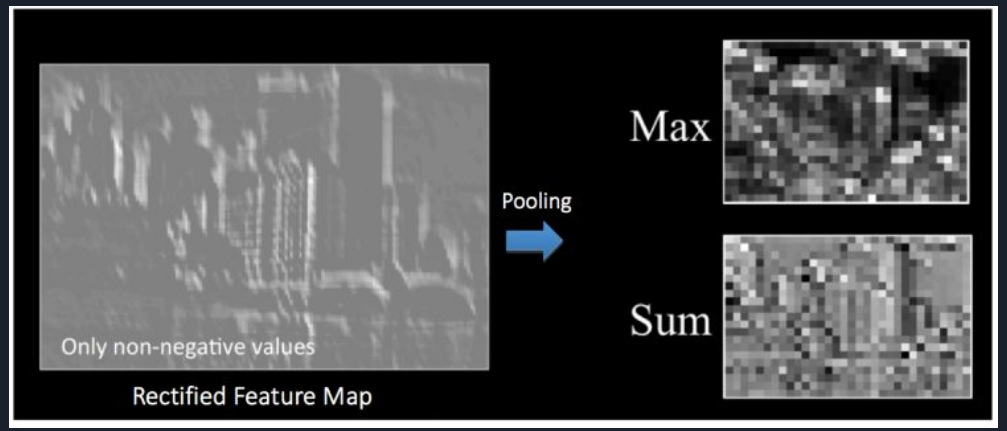
Let’s build an image classifier

Activation function(nonlinear function)



Let’s build an image classifier

Pooling/Downsampling



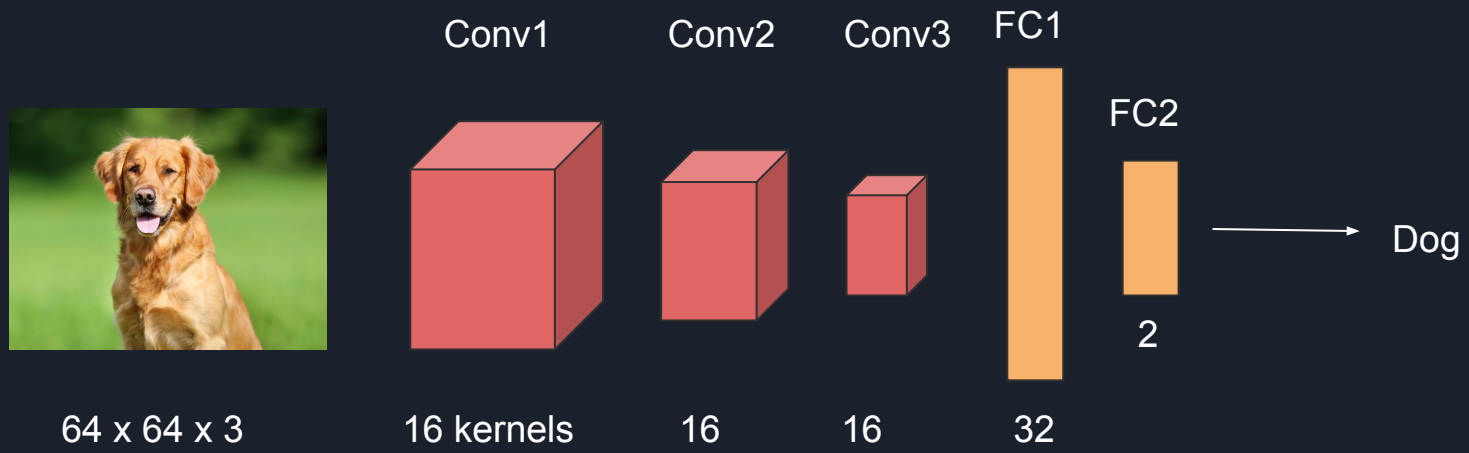
Pooling is good for extracting the most important features

Reduces the no. of parameters(weights) in the next layer

Another alternative is stride = 2 or 3

Let’s build an image classifier

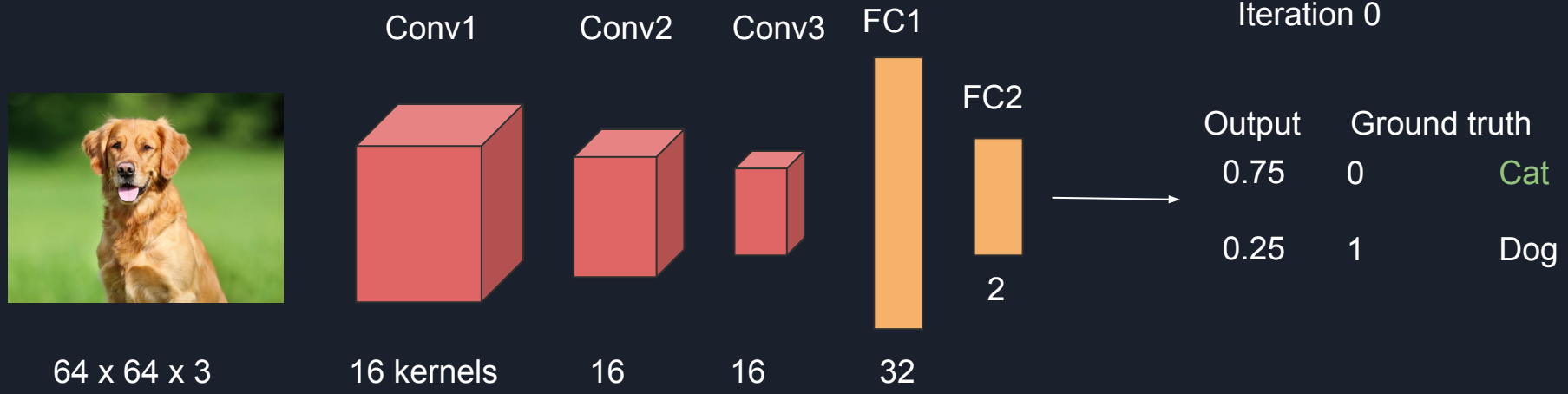
Our simple network



5 Layers are not deep enough (but CPU friendly)

Let’s build an image classifier

Our simple network - Training



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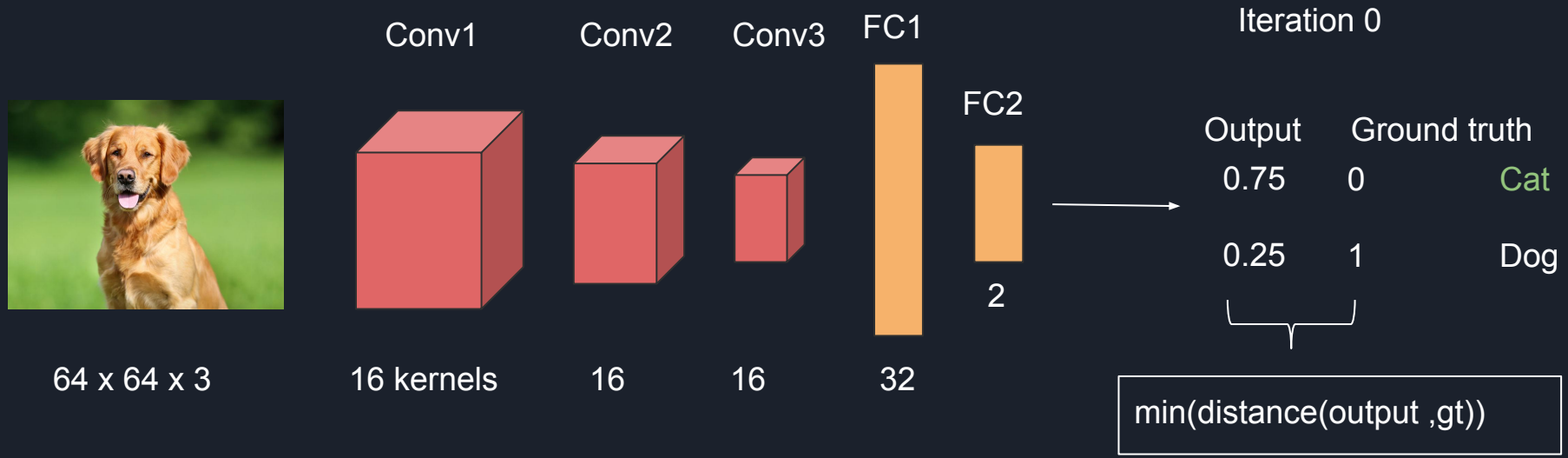

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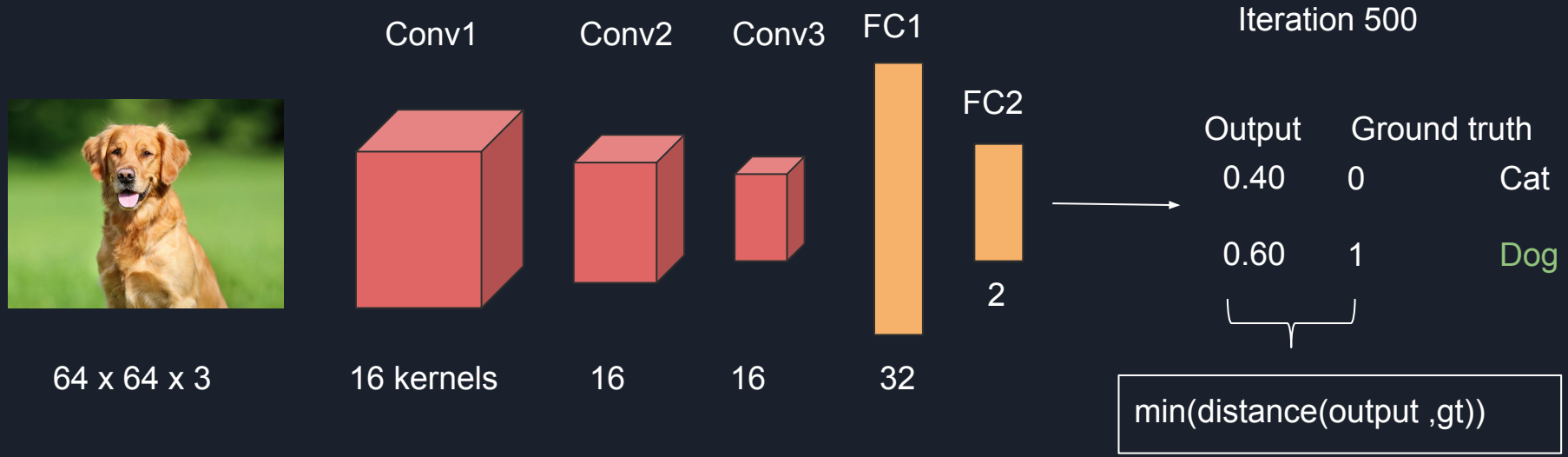
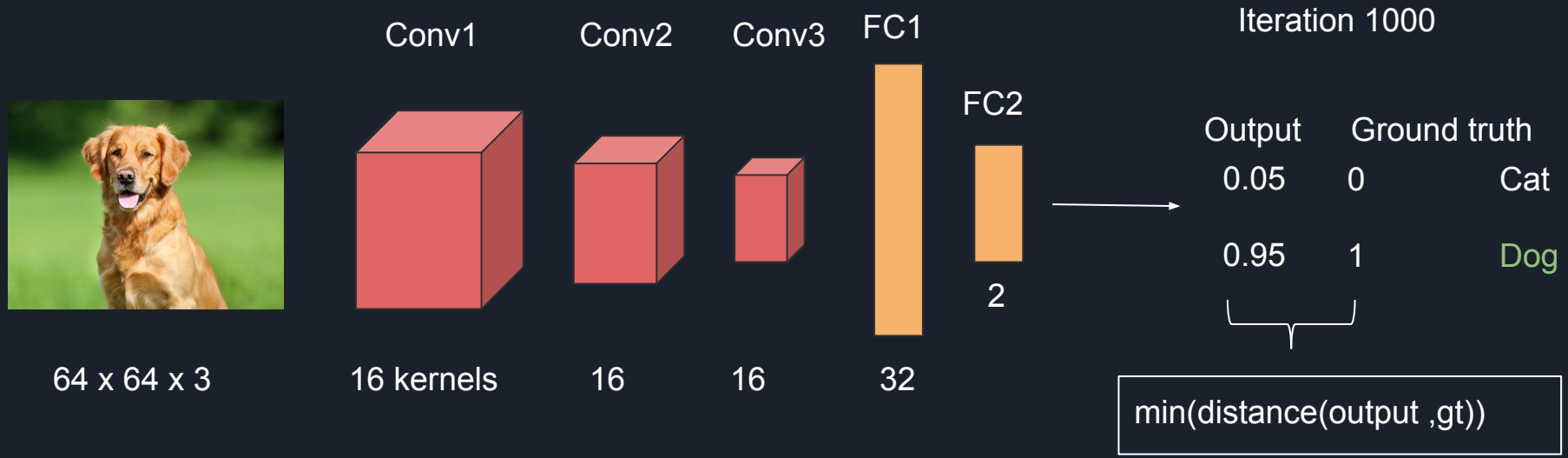


Cross entropy is a distance function(kind of) for probability distributions

Let’s build an image classifier

Our simple network - Training



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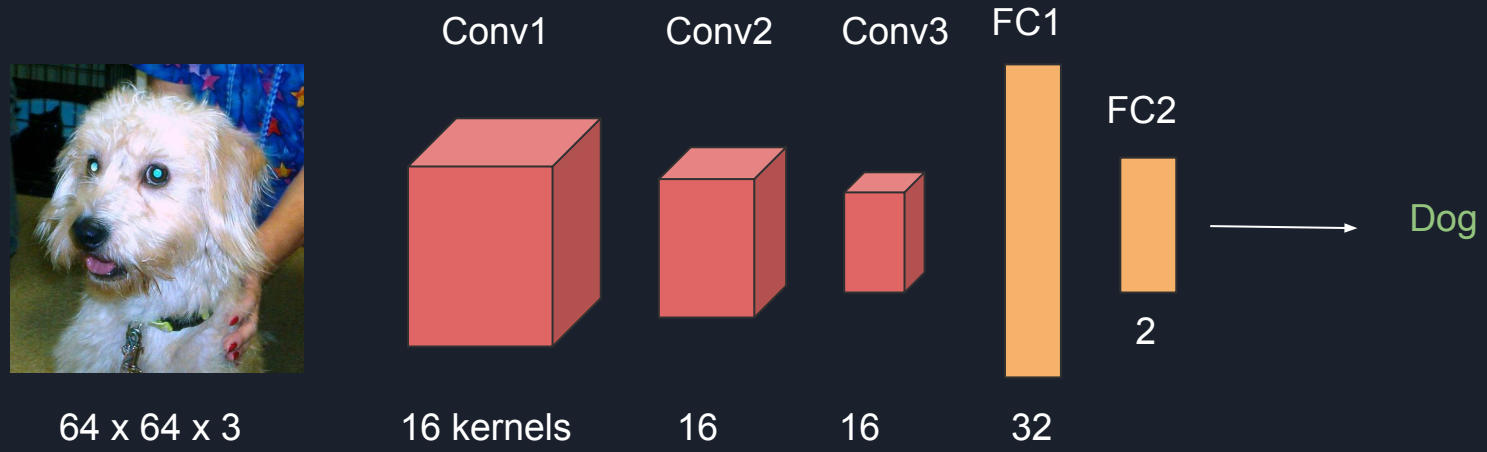
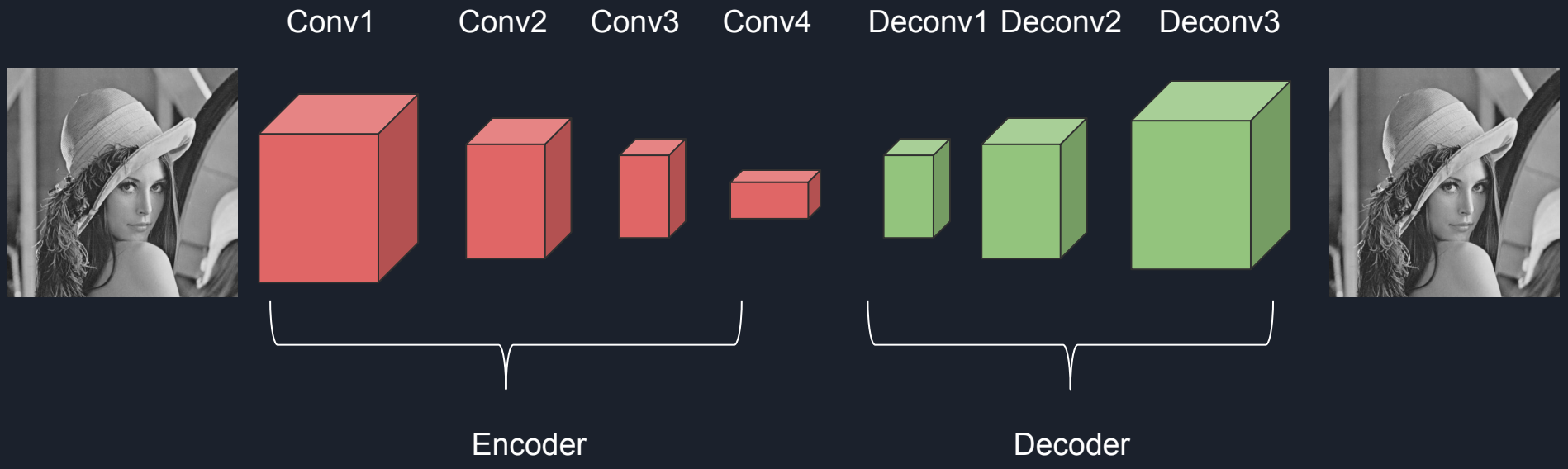
Let’s build an image classifier

Our simple network - inference

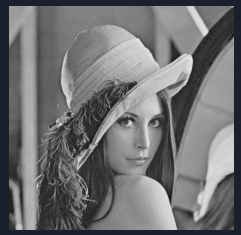


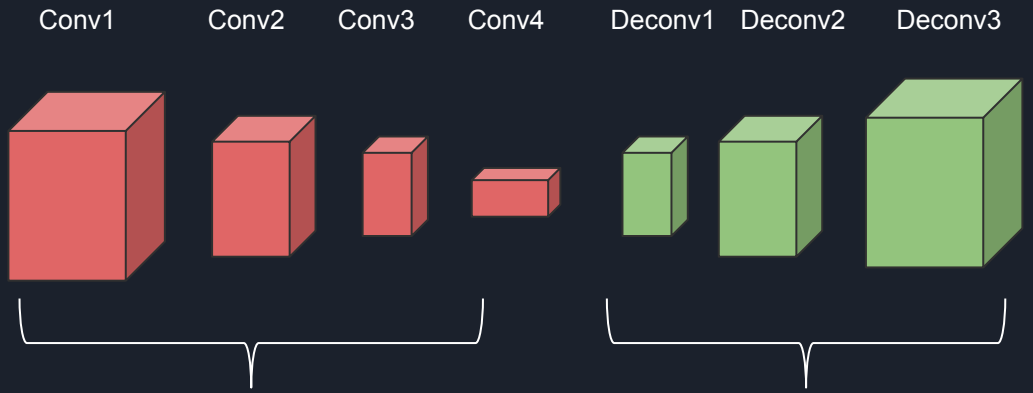
Generative CNN - Autoencoder



Convolution + Bottleneck extracts the most significant features from the input to reconstruct the output

Generative CNN - Autoencoder



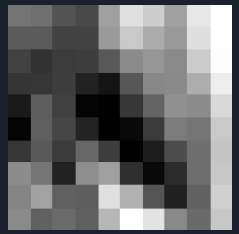


Encoder

Decoder

Iteration 0

Output

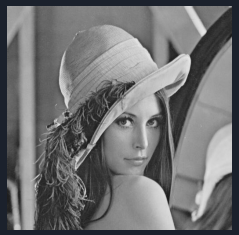


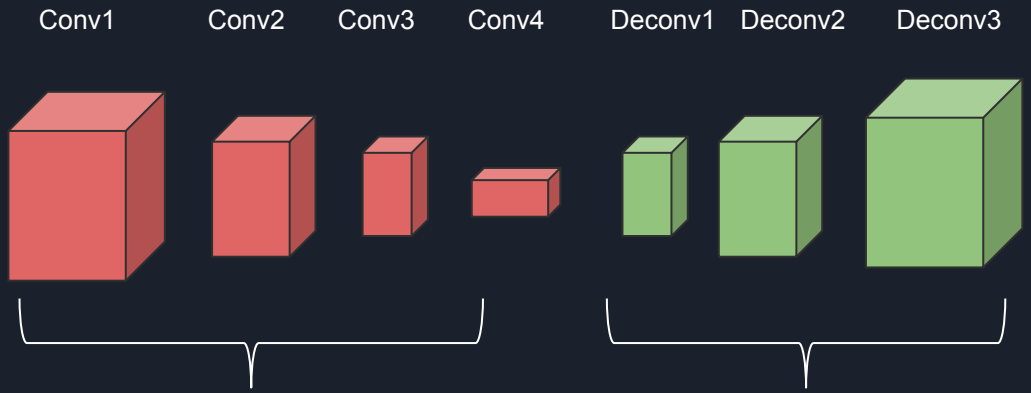
Ground truth

min(distance(output ,gt))

L1 and L2 norms are used for computing pixel distance

Generative CNN - Autoencoder





Encoder

Decoder

Iteration 10000

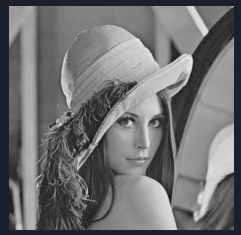
Output

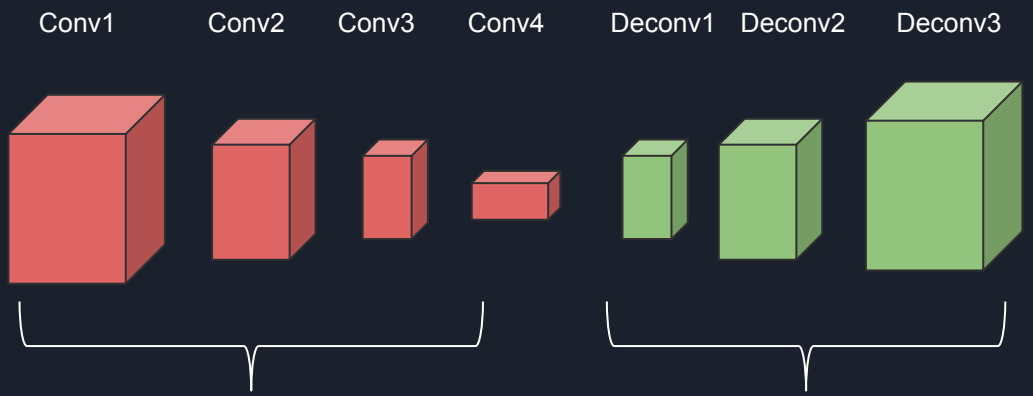
Ground truth

min(distance(output ,gt))

L1 and L2 norms are used for computing pixel distance

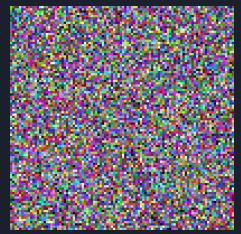
Generative CNN - Autoencoder





Iteration 0

Output

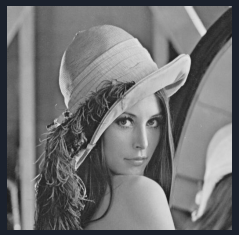


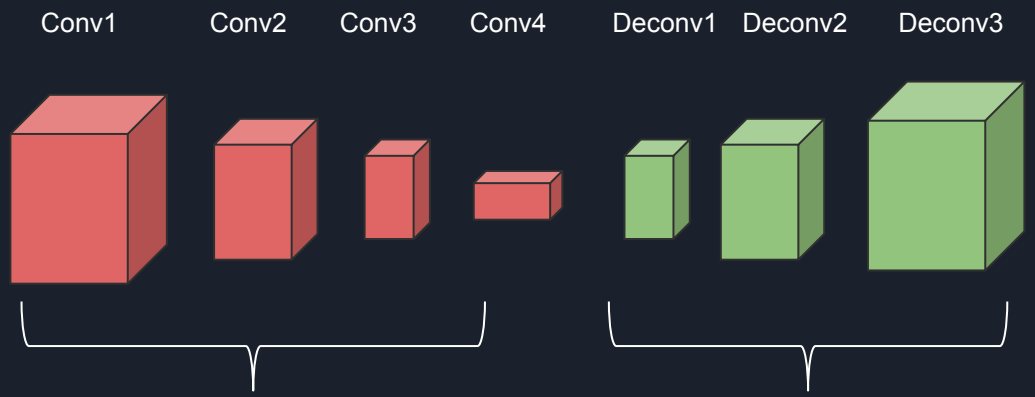
Ground truth

min(distance(output ,gt))

L1 and L2 norms are used for computing pixel distance

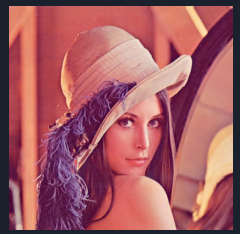
Generative CNN - Autoencoder



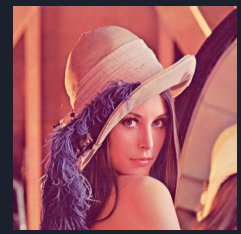


Iteration 10000

Output



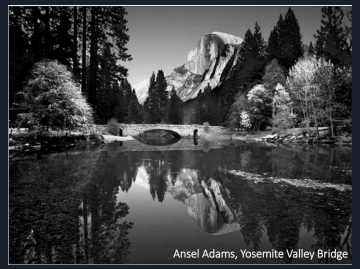
Ground truth

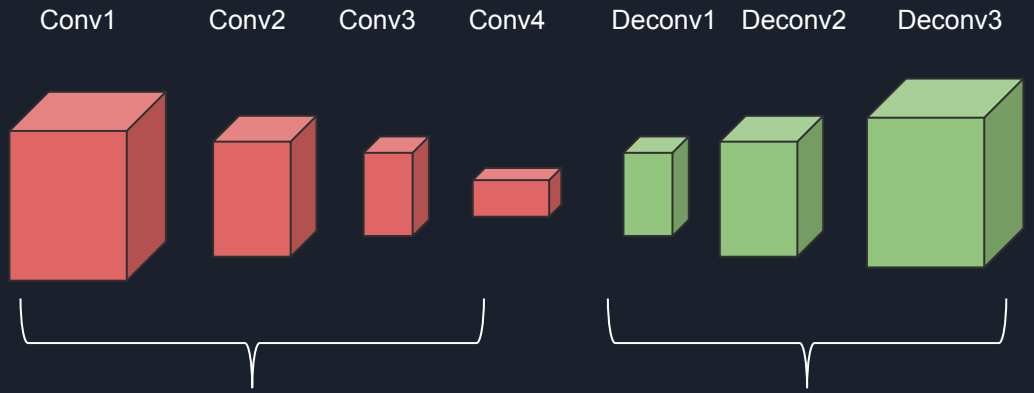


min(distance(output ,gt))

L1 and L2 norms are used for computing pixel distance

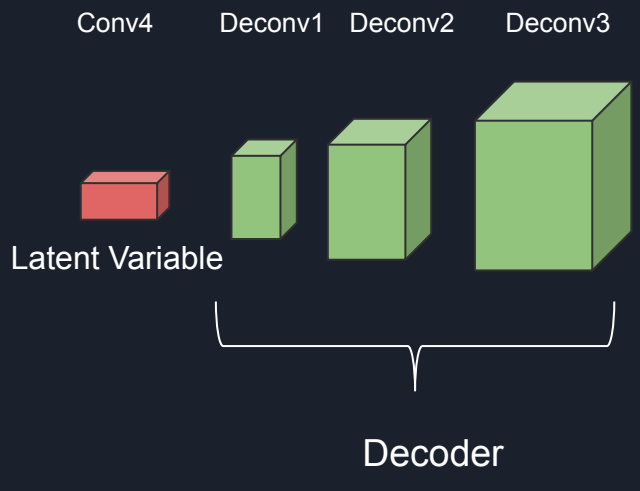
Generative CNN - Autoencoder

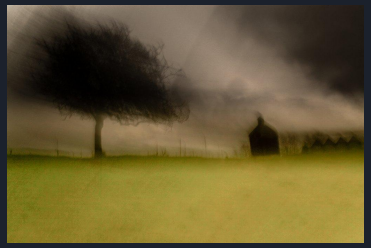


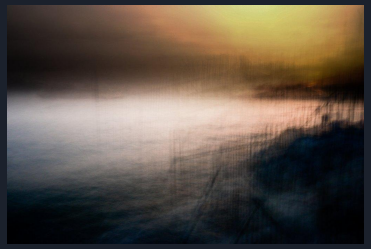


Dataset not used in training

Generative CNN - Autoencoder

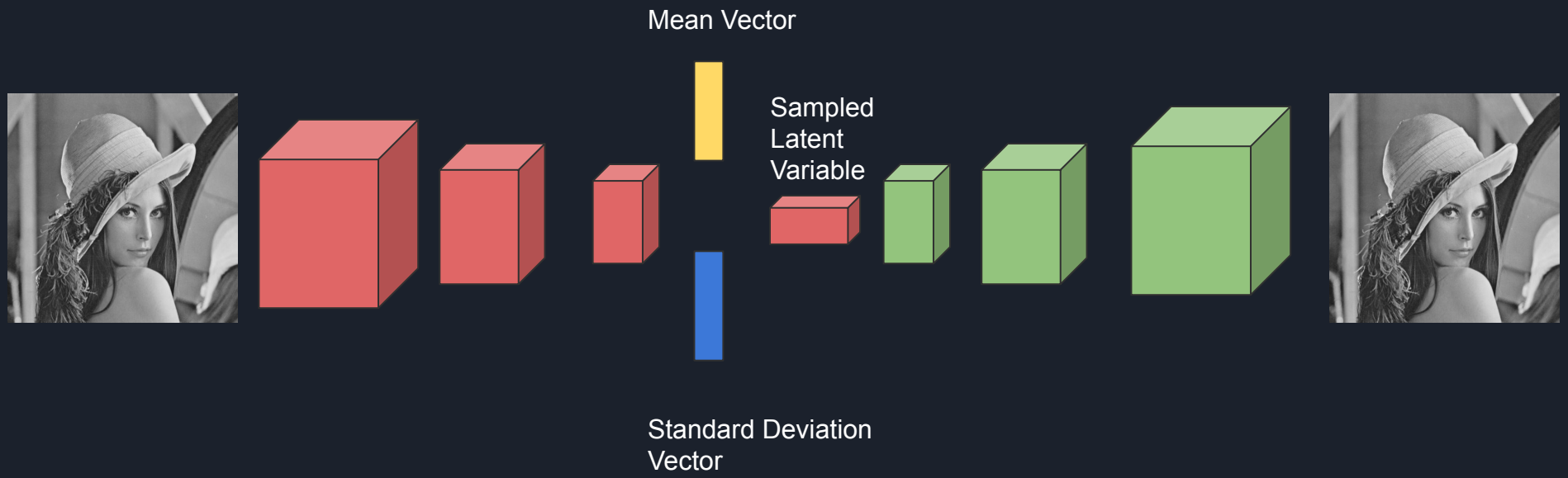






Changing the latent variable randomly will generate new images

Generative CNN - Variational Autoencoder



Next time

Setup tensorflow environment

Building a simple image classifier in tensorflow

Maybe Gans?