Machine Learning for Humans

@ GDG RAJKOT DevFest Season'18

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This presentation is more fun with GIFs and animations, access it from here: https://goo.gl/Bu6qNr

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Do you use machine learning?

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MACHINE LEARNING
MACHINE LEARNING EVERYWHERE!
memegenerator.net

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Hello!

I AM Pratik Parmar

And I am here to bore you with Machine Learning.

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- Shocking IT NEWS last year?

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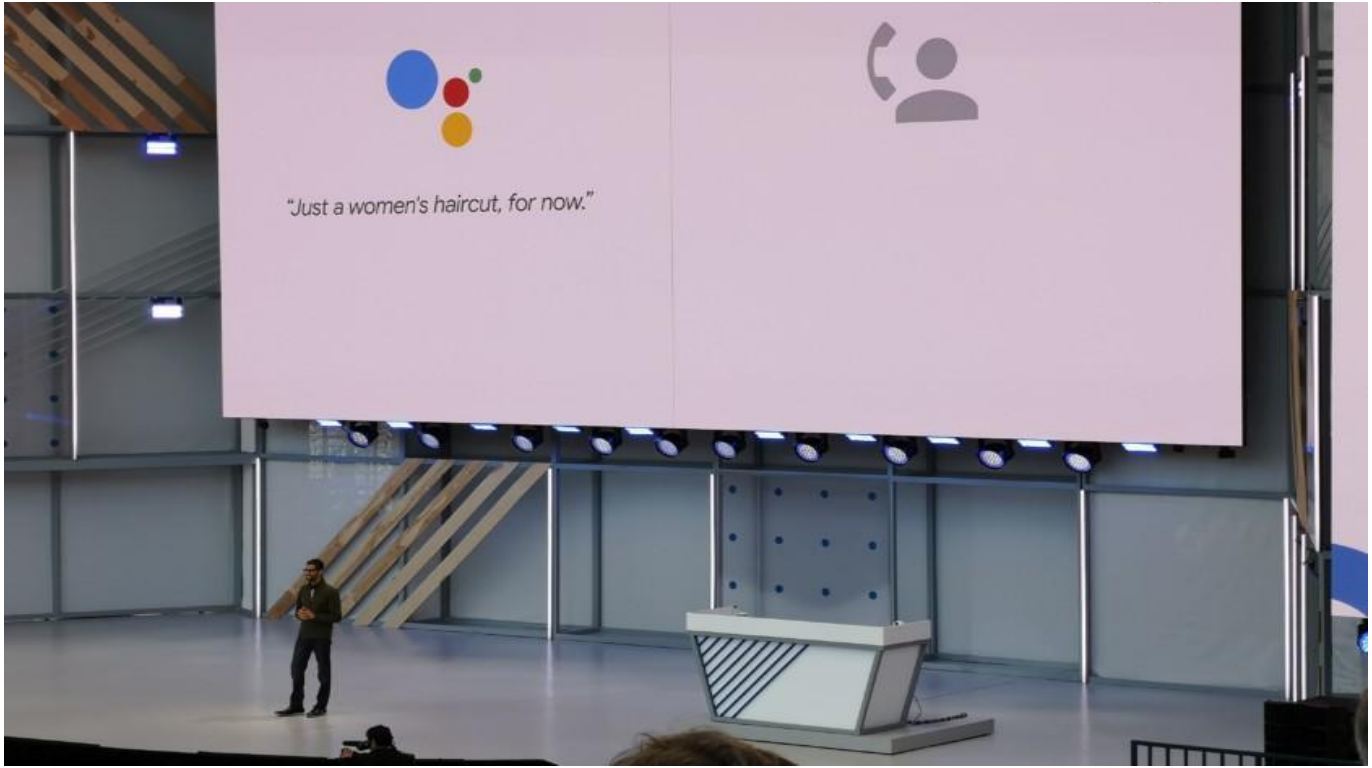

Google Duplex?

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OpenAI's 'Dota 2' bots taking on pro teams ?

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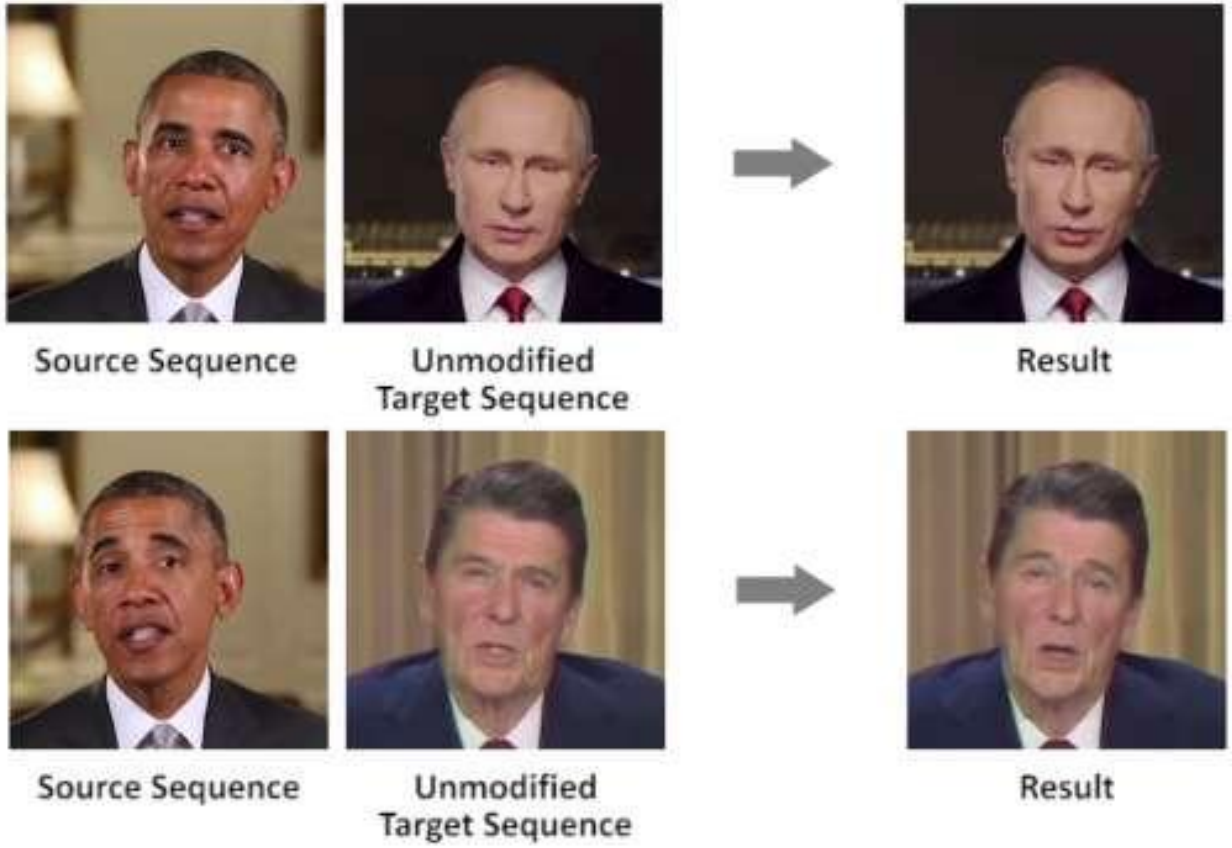

Deep Fake ?

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PART 1
DEEP FAKES
Good or Bad??

What to expect?

- Why Machine Learning?
- Basic Machine Learning
- Neural Networks
- Image Classification
- Resources to learn ML

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Intuition

+

Coding

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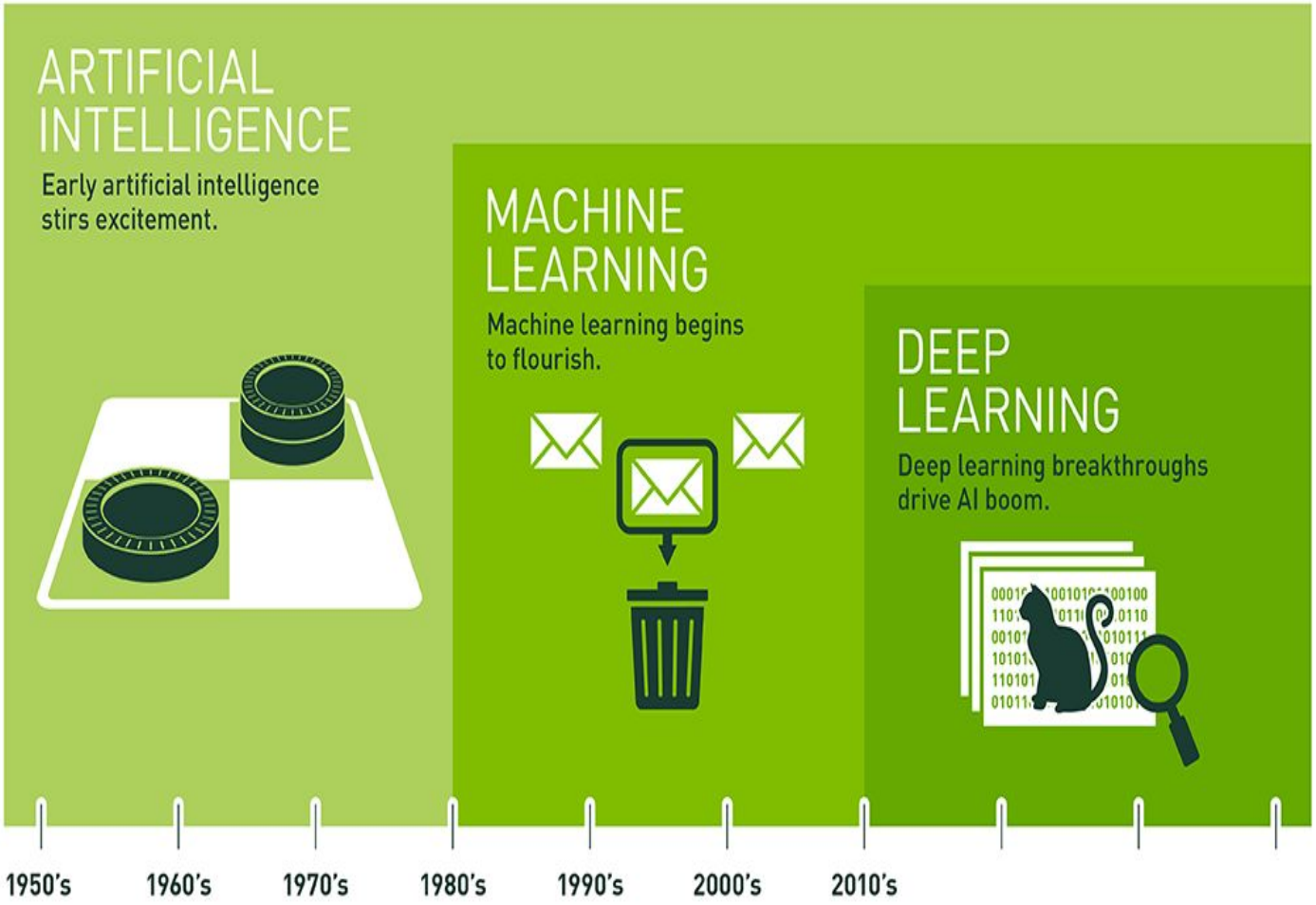
ARTIFICIAL INTELLIGENCE
Early artificial intelligence stirs excitement.
MACHINE LEARNING
Machine learning begins to flourish.
DEEP LEARNING
Deep learning breakthroughs drive AI boom.
1950's
1960's
1970's
1980's
1990's
2000's
2010's

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Training	Prediction
many	*answer*
examples	*questions*

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Basic Terminologies

- Features
- Labels
- Examples
  - Labeled examples
  - Unlabeled examples
- Models
  - Classification
  - Regression

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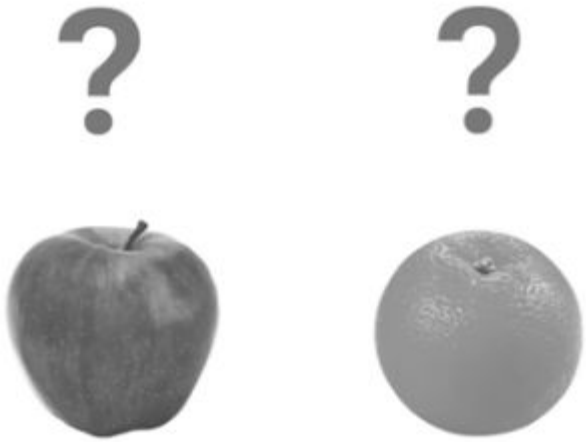
“apple”



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```
def detect_colors(image):
    # lots of code

def detect_edges(image):
    # lots of code

def analyze_shapes(image):
    # lots of code

def guess_texture(image):
    # lots of code

def define_fruit():
    # lots of code

def handle_probability():
    # lots of code
```

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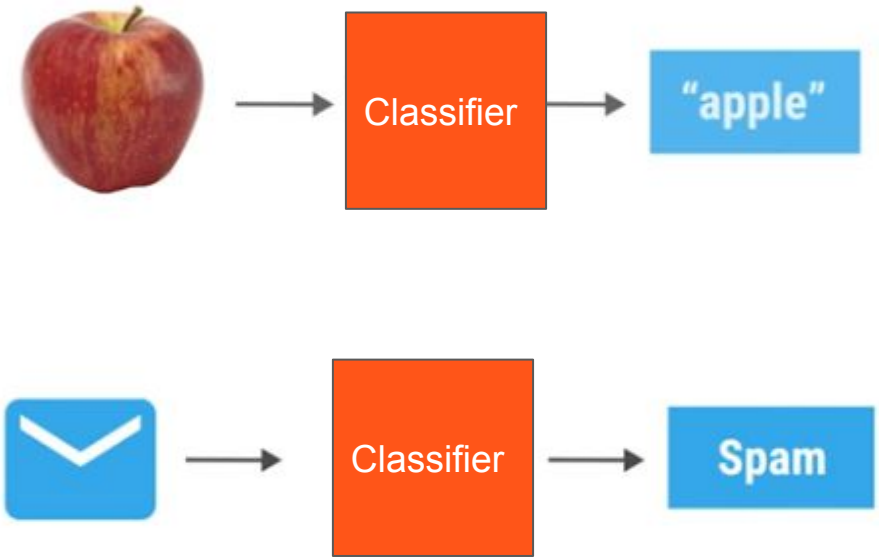
?



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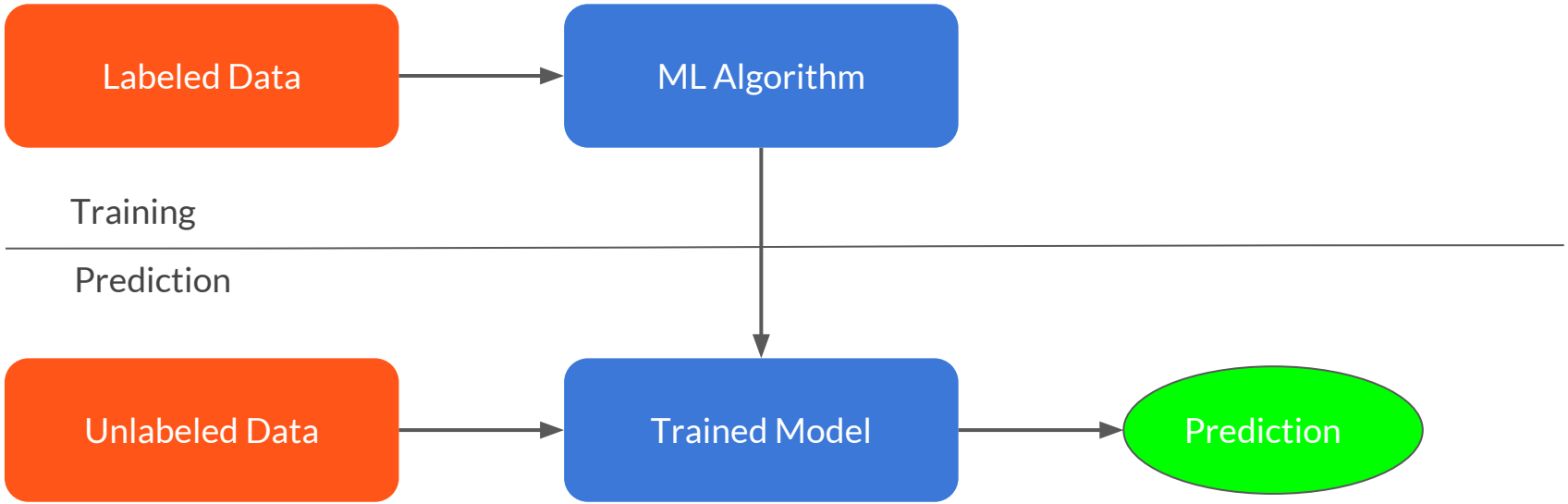
Workflow (supervised)



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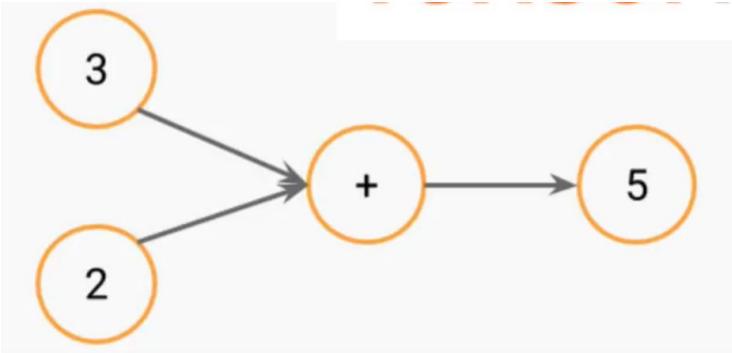
Scalar	Vector	Matrix	Tensor
1	$\begin{bmatrix} 1 \\ 2 \end{bmatrix}$	$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$	$\begin{bmatrix} \begin{bmatrix} 1 & 2 \\ 1 & 7 \end{bmatrix} & \begin{bmatrix} 3 & 2 \\ 5 & 4 \end{bmatrix} \end{bmatrix}$

TensorFlow



Wanna be a cool guy like me?

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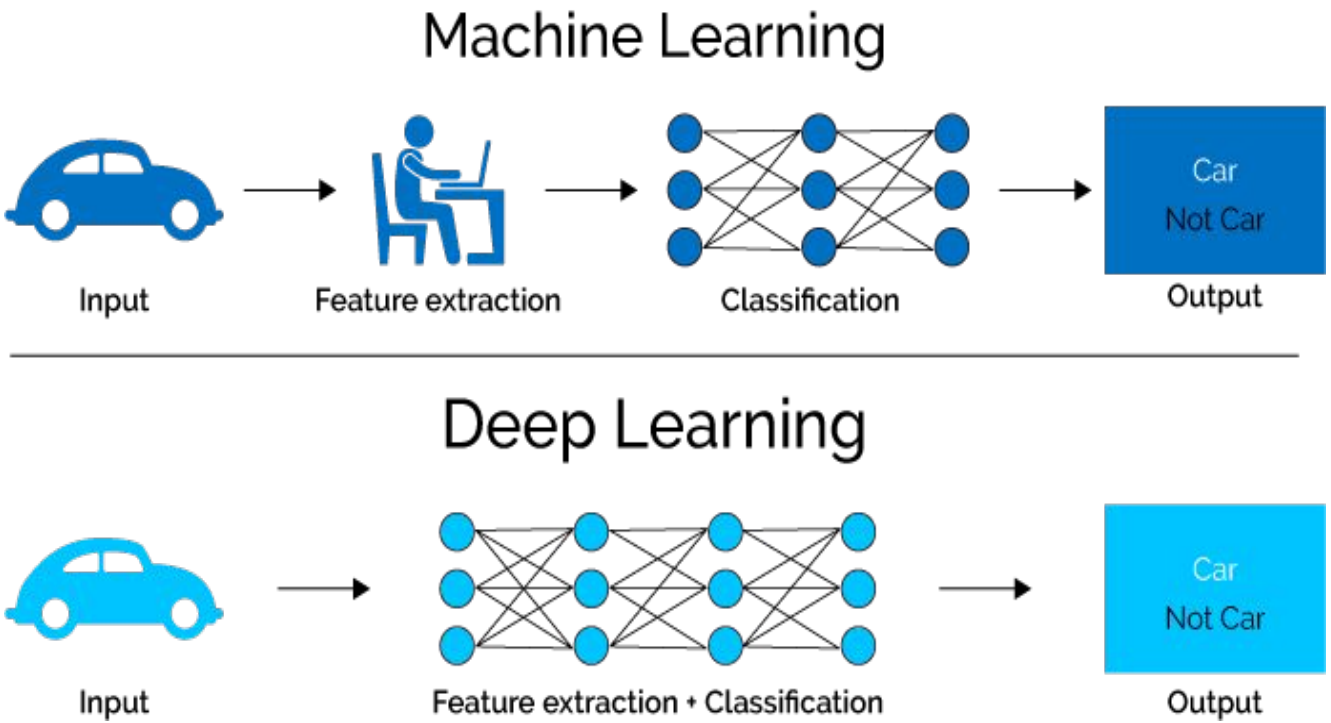
Machine Learning vs Deep Learning



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Neuron

A simple estimation function that takes in a set of inputs and multiplies them by weights to get an output.

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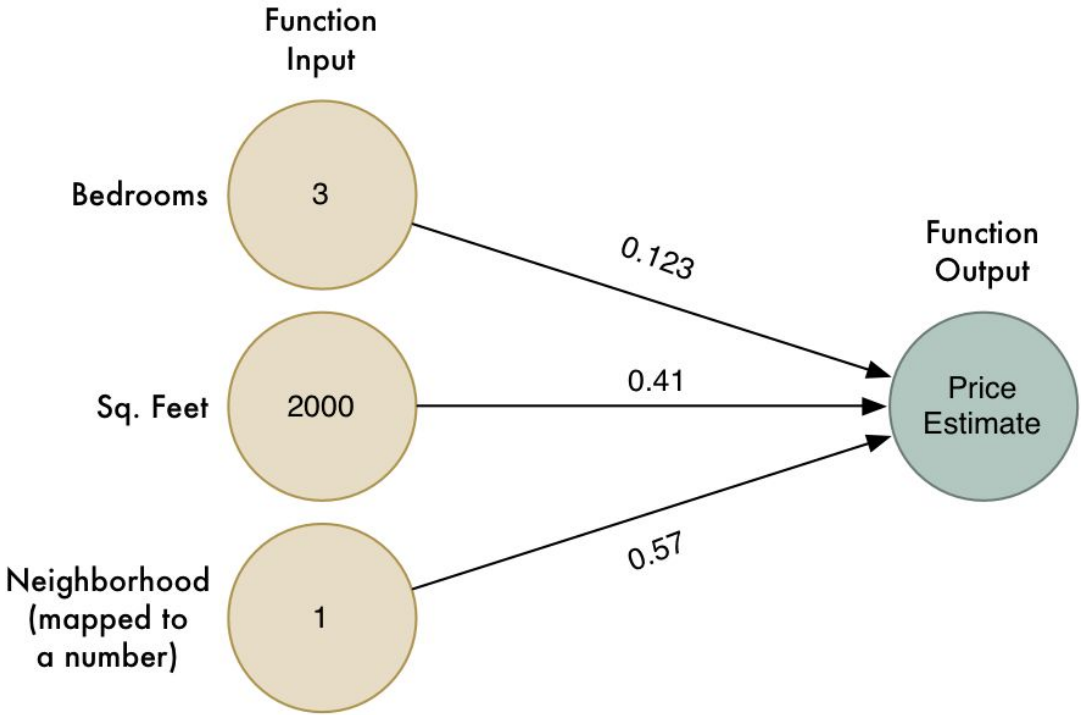
House price



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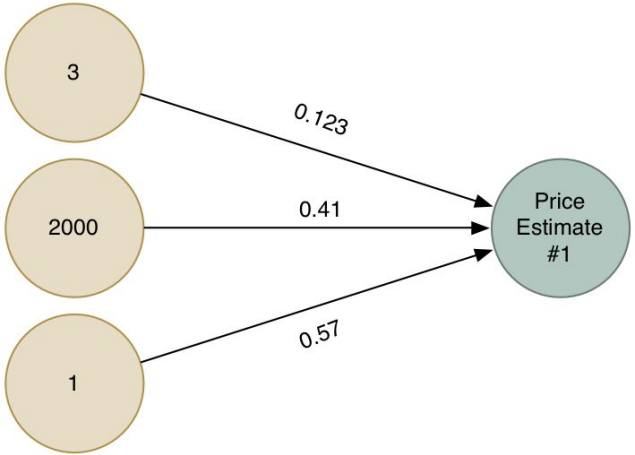
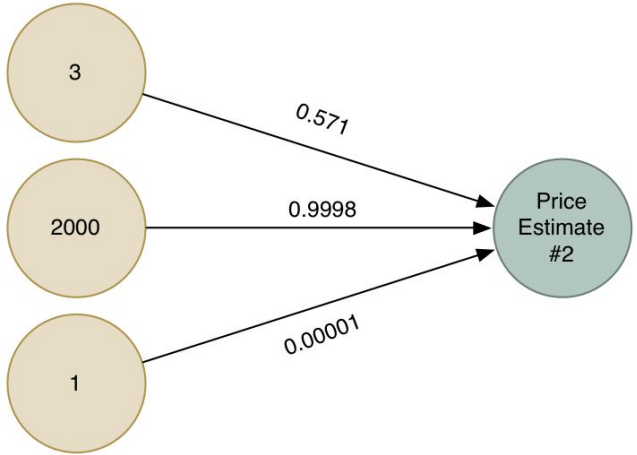
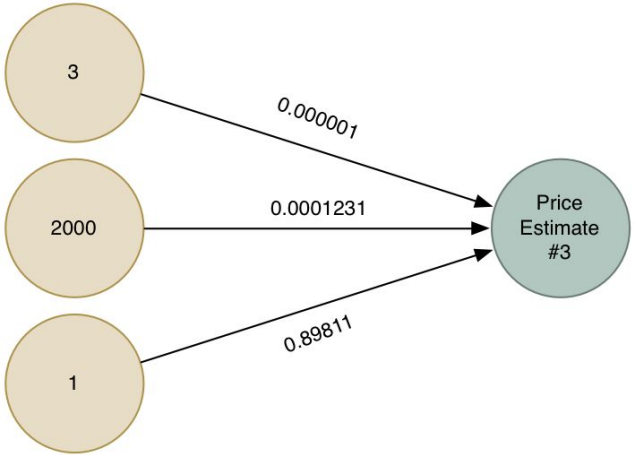
First set of weights



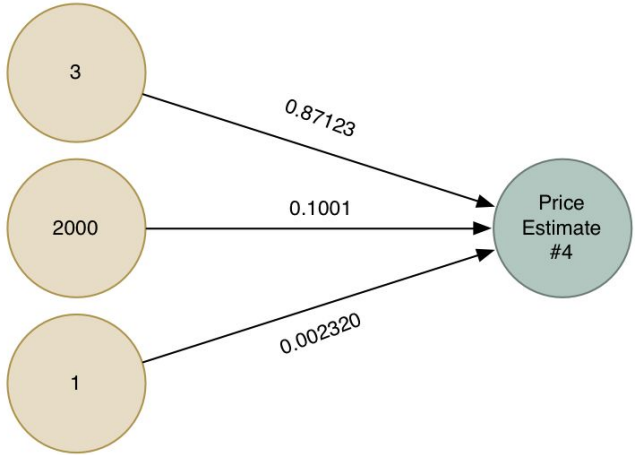
Second set of weights



Third set of weights



Fourth set of weights 4




Price Estimate #1
Price Estimate #2
Price Estimate #3
Price Estimate #4
0.20
0.15
0.05
0.60
Final Price Estimate

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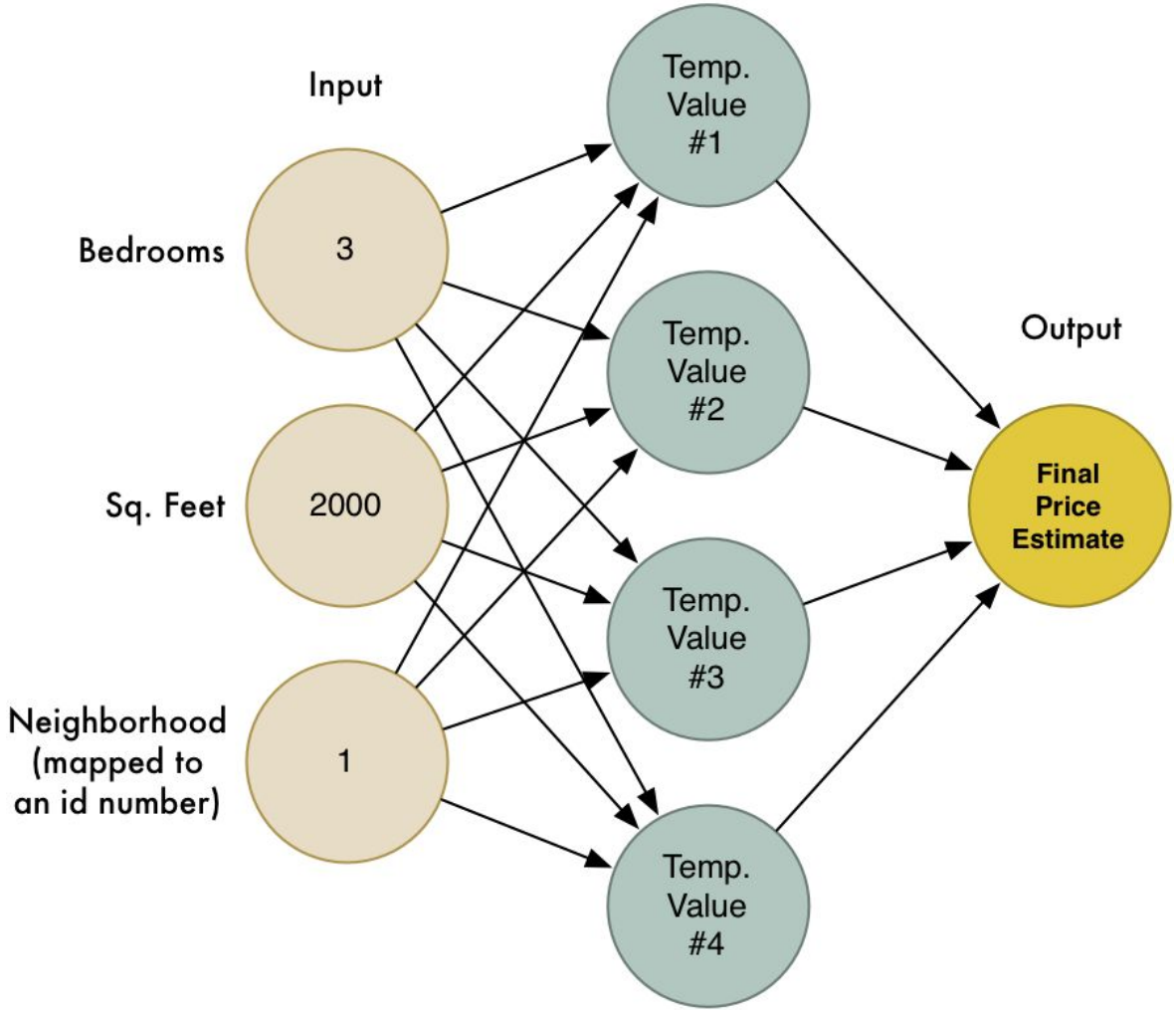
Input
Bedrooms
3
Sq. Feet
2000
Neighborhood
(mapped to
an id number)
1
Temp.
Value
#1
Temp.
Value
#2
Temp.
Value
#3
Temp.
Value
#4
Output
Final
Price
Estimate

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YESSS that is a neural network

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Neural Network

A mathematical function that maps a given input to a desired output.

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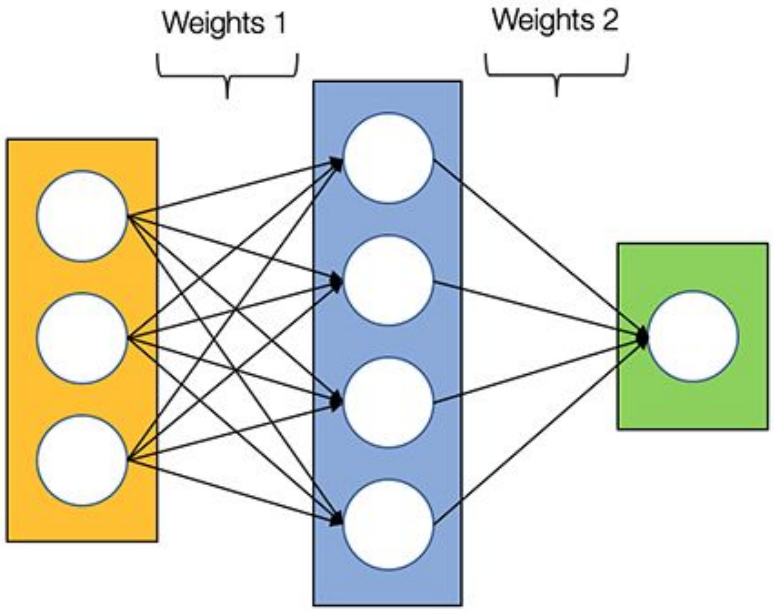
Neural Network



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Components

- Input Layer - x
- Hidden layer
- Output layer - $\hat{y}$
- Weights and biases - W and b
- Activation function - σ

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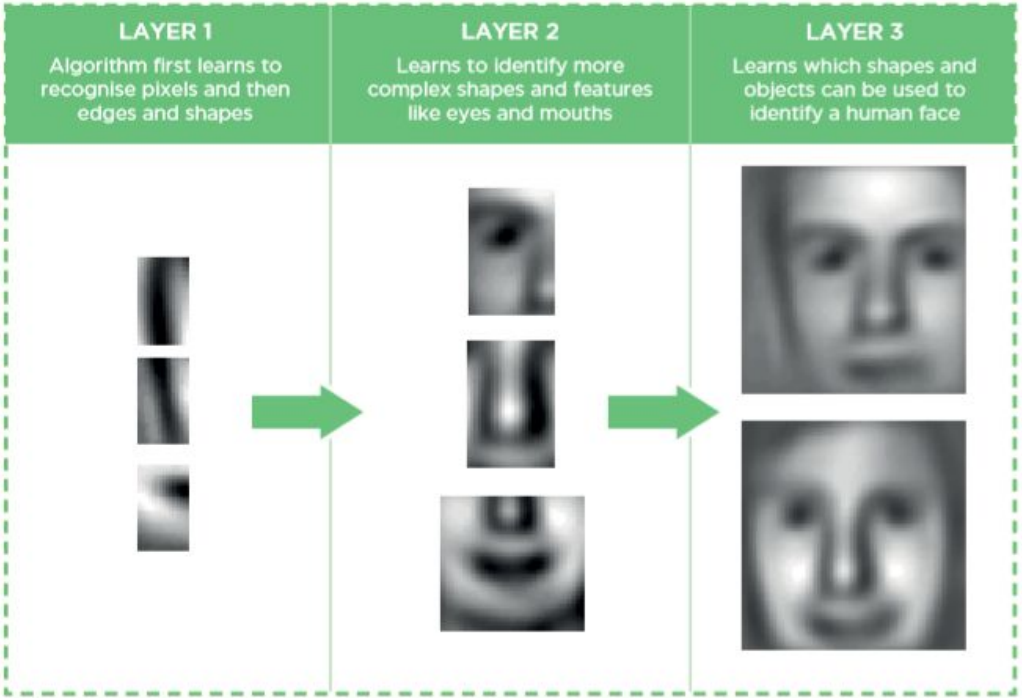
Working



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Tensorflow Playground

https://playground.tensorflow.org

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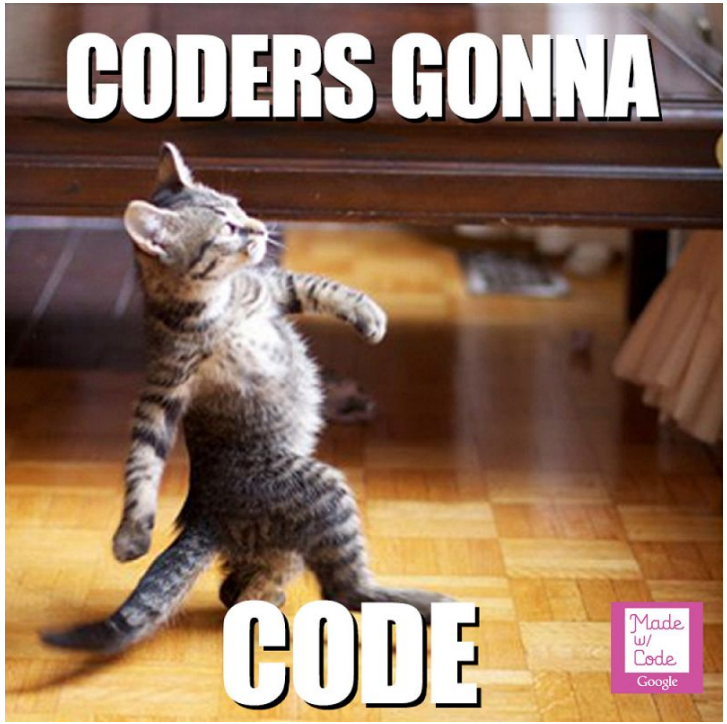
Give some space because...



Google Colab

http://colab.research.google.com/

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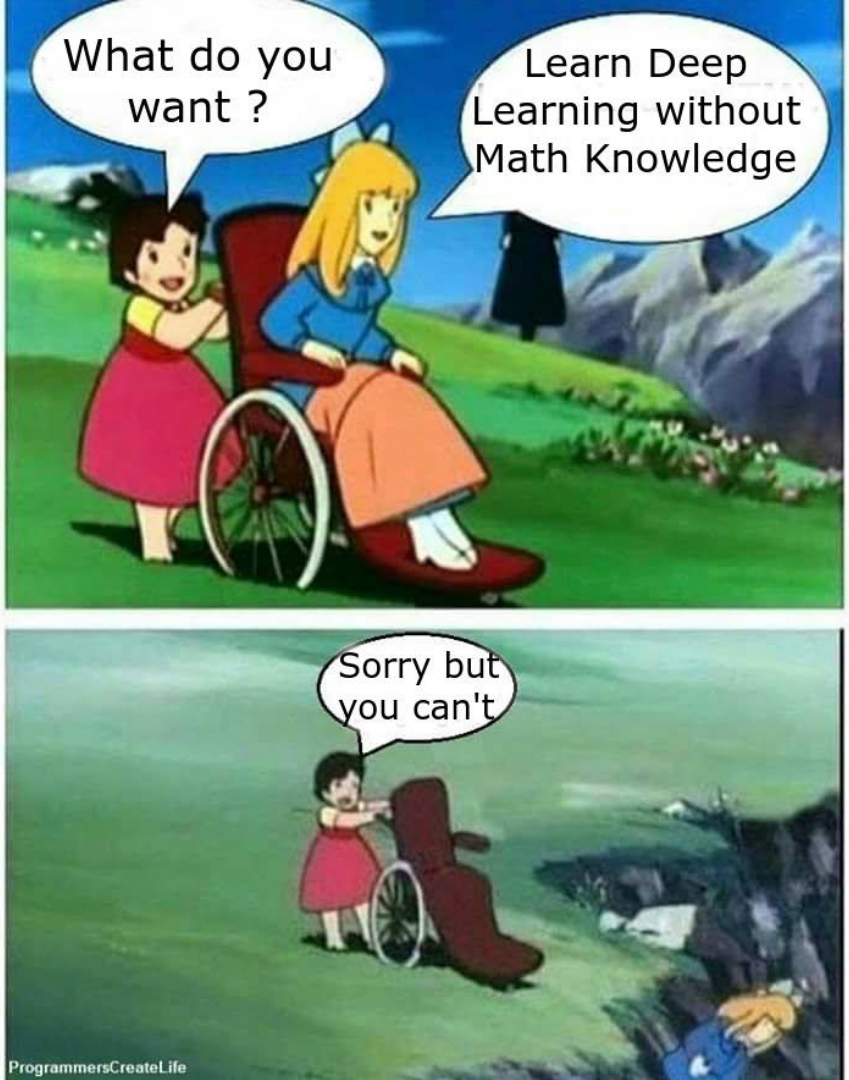
Free things

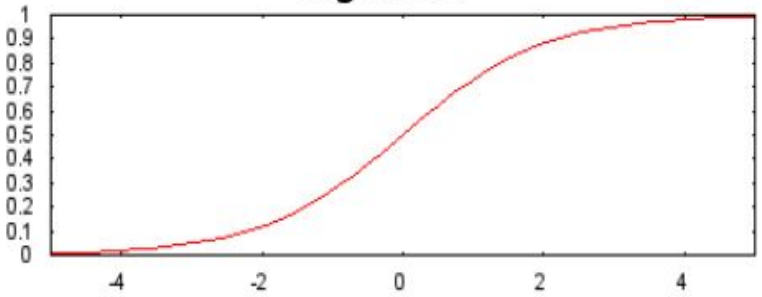
While learning Deep Learning



Activation Function

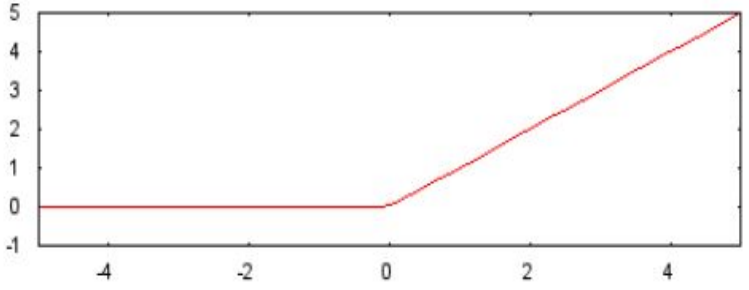
It's just a thing (**node**) that you add to the output end of any neural network. It is also known as **Transfer Function**.

Sigmoid



$$f(t) = \frac{1}{1+e^{-t}}$$

ReLU



$$f(t) = max(0, t)$$

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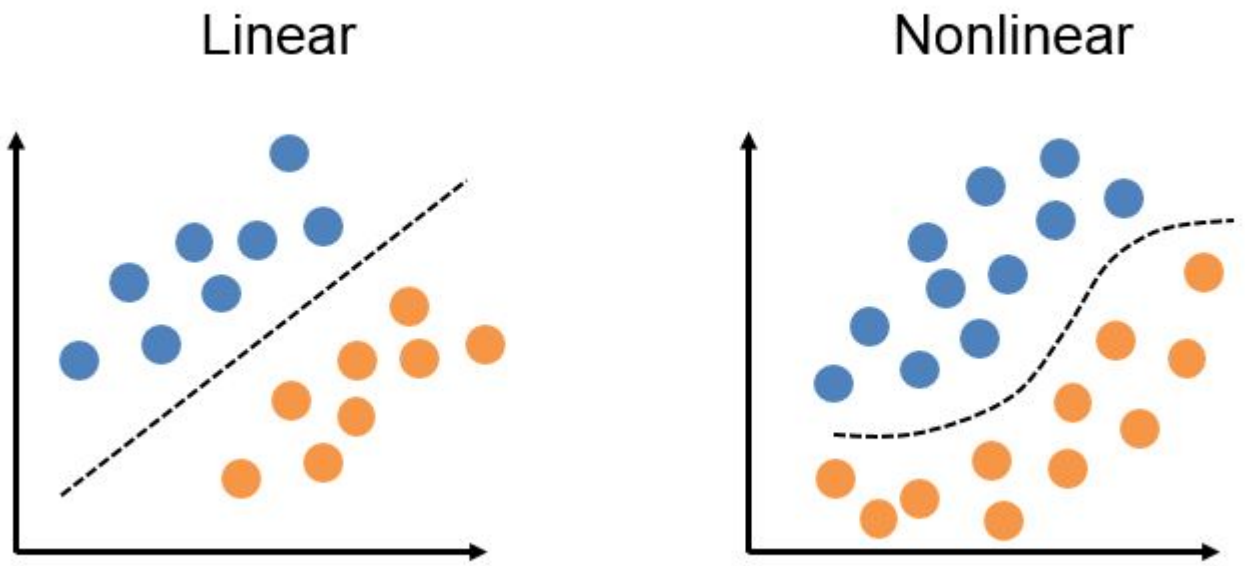
Why activation function?



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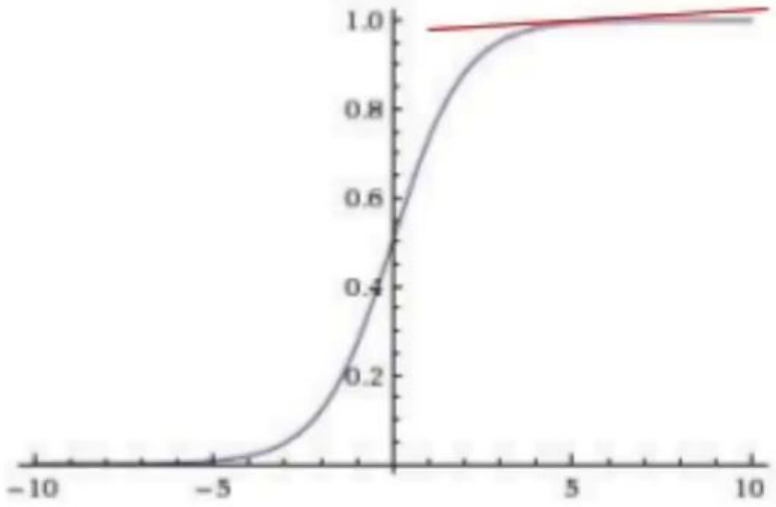
Problems with sigmoids

$$\sigma(x) = \frac{1}{1 + e^{-x}}$$

0 < output < 1

Avoid in practice

- Sigmoids saturate and kill gradients
- Sigmoids slow convergence
- Sigmoids are not zero-centered
- OK to use on last layer



NN Codelab

http://tiny.cc/ml_nn

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Sigmoid and Numpy

```
import numpy as np


def sigmoid(x):
    return 1.0/(1 + np.exp(-x))
def sigmoid_derivative(x):
    return x * (1.0 - x)
```

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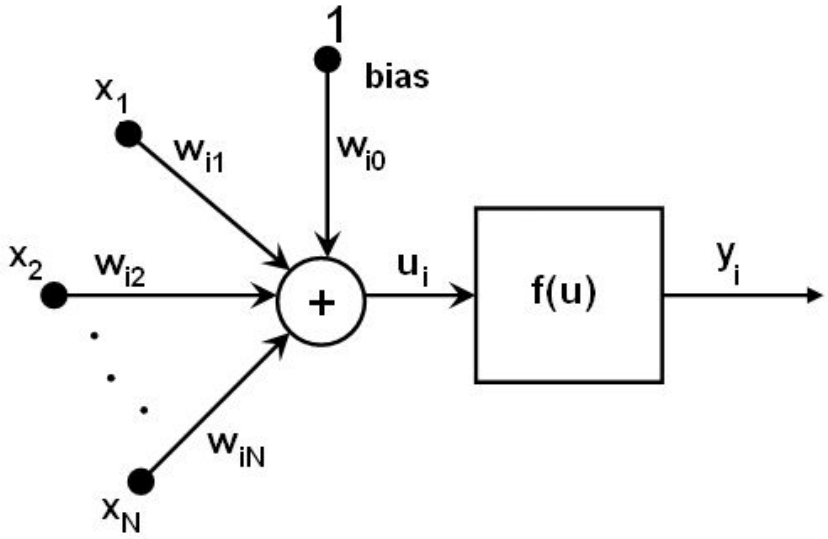
Weight and biases



Neural Network class

```
class NeuralNetwork:
  def __init__(self, x, y):
     self.input     = x
     self.weights1   = np.random.rand(self.input.shape[1],4)
     self.weights2   = np.random.rand(4,1)
     self.y              = y
     self.output      = np.zeros(self.y.shape)
```

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Training

Output of simple 2 layer neural network is:

$$Y = \sum (weight * input) + bias$$

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Feedforward

Calculating the predicted output, $\hat{y}$

$$\hat{y} = \sigma(W_2\sigma(W_1x + b_1) + b_2)$$

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Feedforward

```
def feedforward(self):
    self.layer1 = sigmoid(np.dot(self.input, self.weights1))
    self.layer2 = sigmoid(np.dot(self.input, self.weights2))
```

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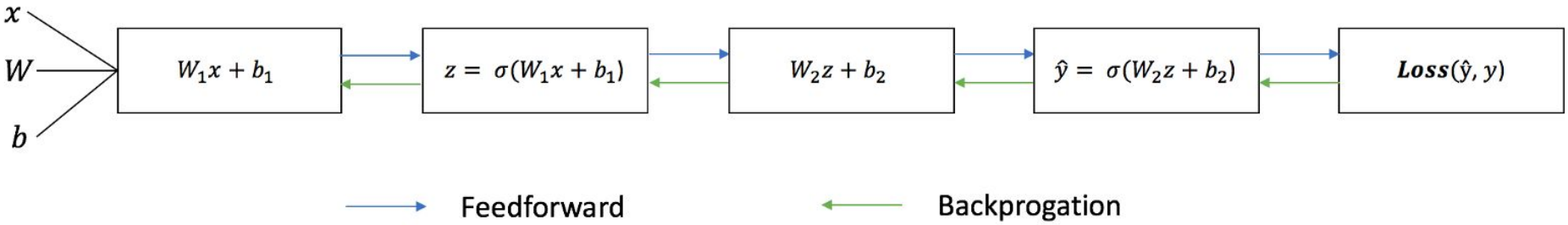
Backpropogation

Updating the weights and biases



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Loss Function

$$Sum - of - Squares\ Error = \sum_{i=1}^{n} (y - \hat{y})^2$$

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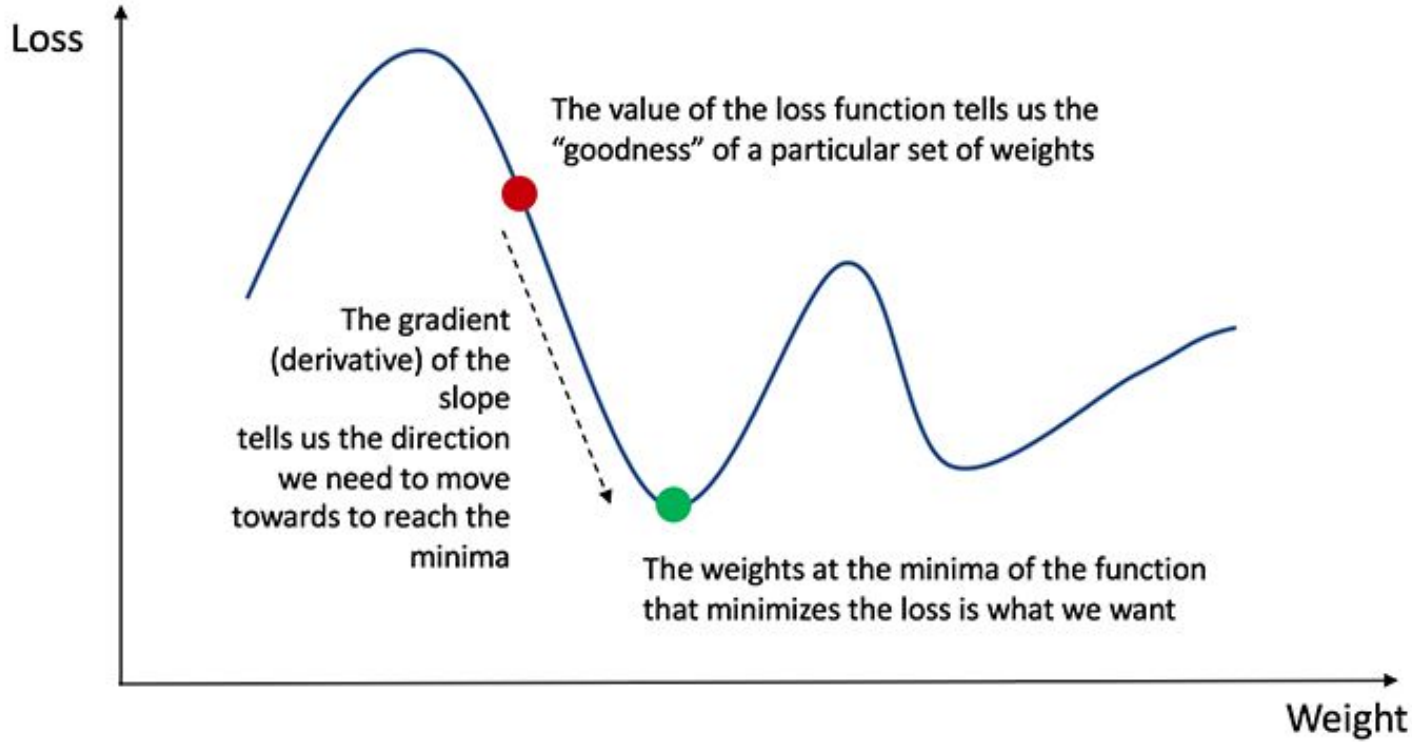
Gradient Descent Algorithm



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Derivative of Loss

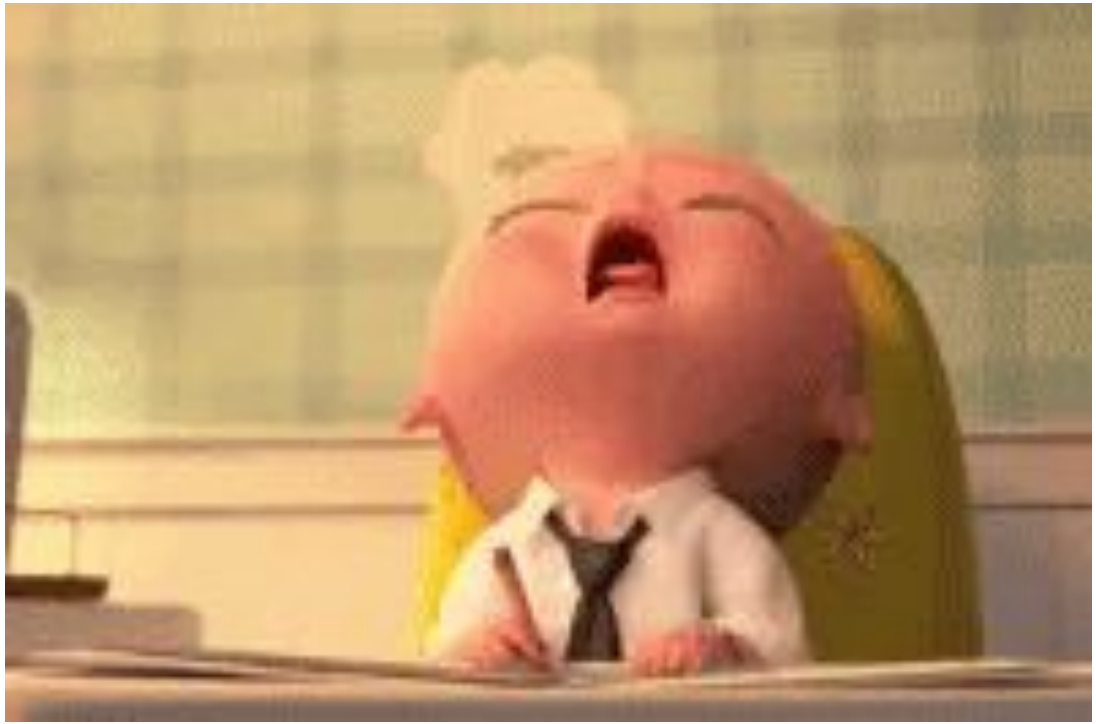
$$Loss(y, \hat{y}) = \sum_{i=1}^{n} (y - \hat{y})^2$$

$$\frac{\partial\, Loss(y,\hat{y})}{\partial W} = \frac{\partial Loss(y,\hat{y})}{\partial \hat{y}} * \frac{\partial \hat{y}}{\partial z} * \frac{\partial z}{\partial W} \qquad \text{where } z = Wx + b$$

$$= 2(y - \hat{y}) * \text{derivative of sigmoid function} * x$$

$$= 2(y - \hat{y}) * z(1\text{-}z) * x$$

I know, math sucks



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Backpropogation

```
def backprop(self):
  d_weights2 = np.dot(self.layer1.T,
                      (2*(self.y - self.output) * sigmoid_derivative(self.output)))
  d_weights1 = np.dot(self.input.T,
                      (np.dot(2*(self.y - self.output) * sigmoid_derivative(self.output),
                      self.weights2.T) * sigmoid_derivative(self.layer1)))

  self.weights1 += d_weights1
  self.weights2 += d_weights2
```

Don’t worry, I’ve already wrote this code for you guys in notebook ☻

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ML in real life?

It’s showtime

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Search your photos

Videos

Movies

Animations

Collages

SHOW MORE

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Once upon a time...

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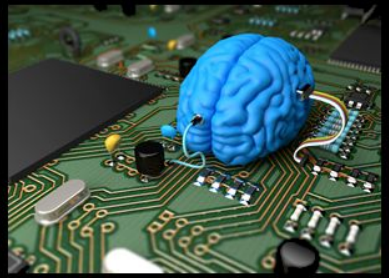
Deep Learning

What society thinks I do



What my friends think I do

What other computer scientists think I do

What mathematicians think I do

What I think I do

```
In [1]:
import keras
Using TensorFlow backend.
```

What I actually do

Keras Basic

- High level neural network API
- Capable of running on top of -
  - Tensorflow
  - CNTK
  - Theano

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Sequential Model

```
from keras.models import Sequential

model = Sequential()
```

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Add more layers?

```
from keras.layers import Dense

model.add(Dense(units=64, activation='relu', input_dim=100))
model.add(Dense(units=10, activation='softmax'))
```

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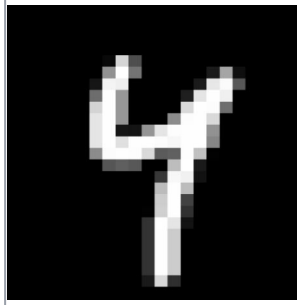
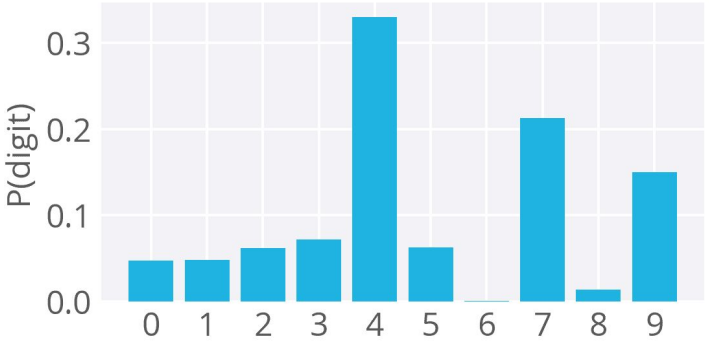
WTH is Softmax?

- Sigmoid is kind of Multi Class Sigmoid



$$\sigma(z)_j = \frac{e^{z_j}}{\sum_{k=1}^{K} e^{z_k}}$$



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Compile

```
model.compile(loss='categorical_crossentropy',
        optimizer='sgd',
        metrics=['accuracy'])
```

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Train and Test

```
model.fit(x_train, y_train, epochs=5, batch_size=32)
loss_and_metrics = model.evaluate(x_test, y_test, batch_size=128)
```

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Epoch & Batch size

- Epoch:
  - One forward and one backward pass of all the training samples.

- Batch size:
  - Number of training samples in one epoch.

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Handwritten Digit Classification

with CNN

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http://tiny.cc/ml_digit

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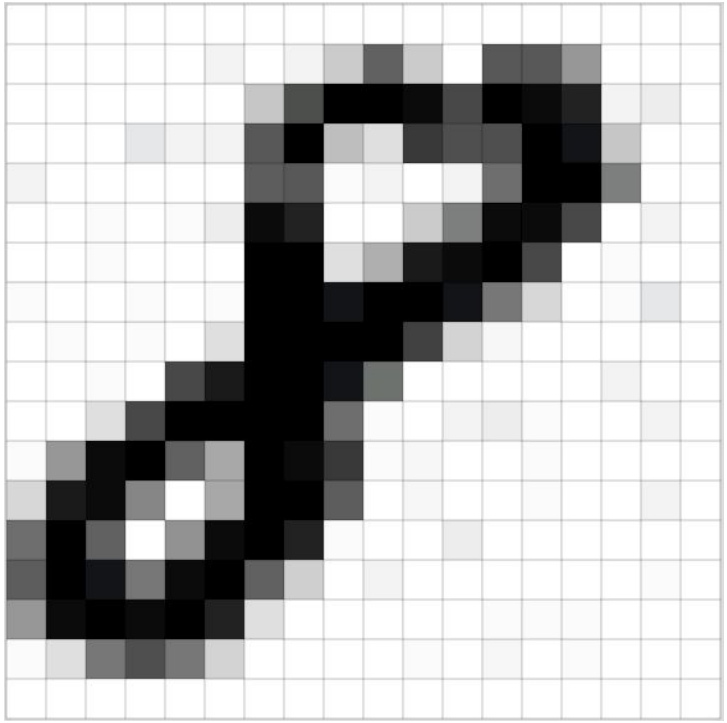
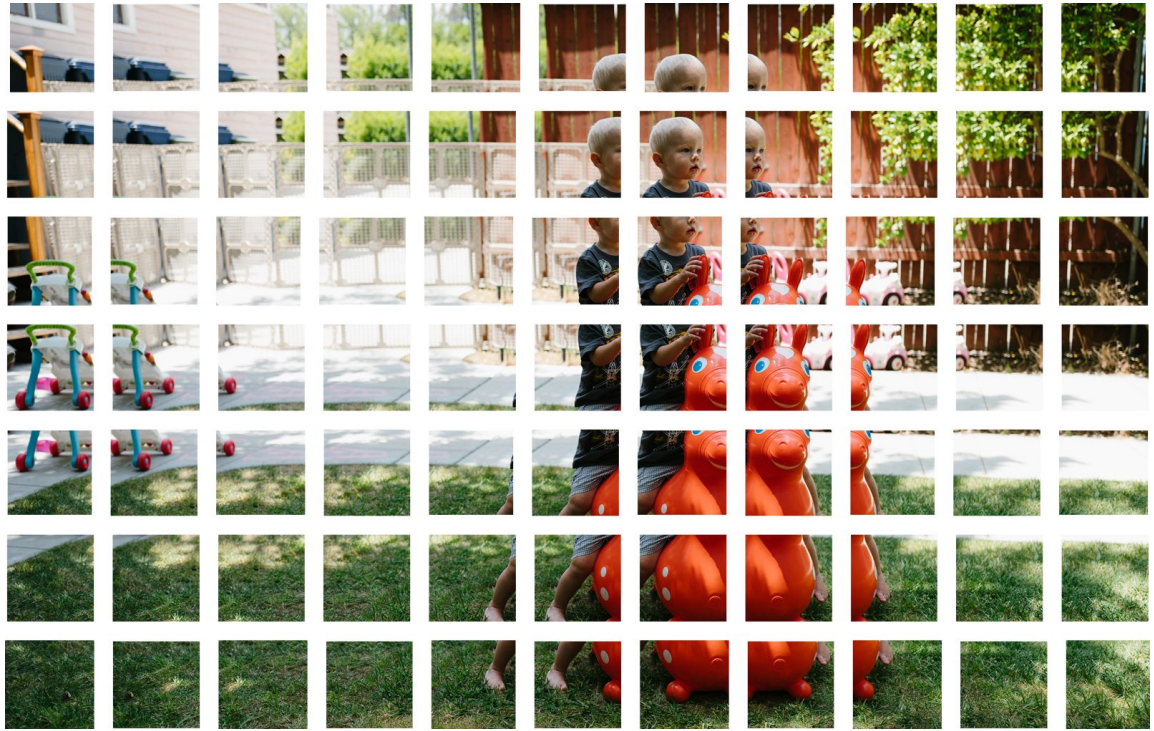
MNIST



Convolution

Convolution



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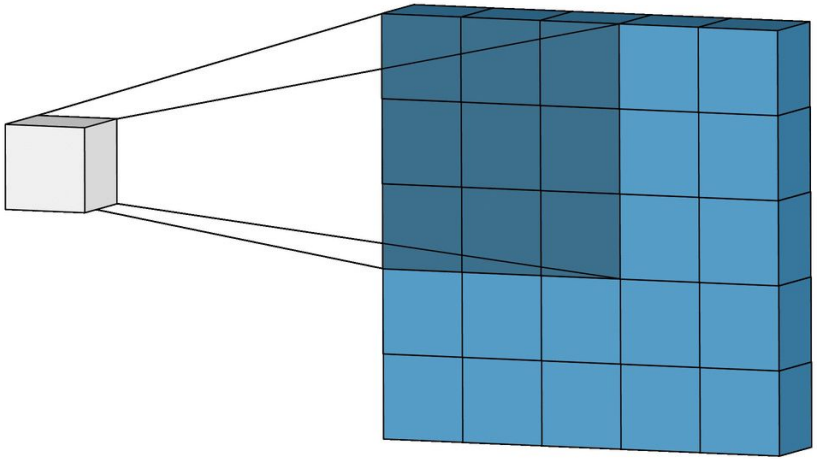
Convolution



$1_{\times 1}$	$1_{\times 0}$	$1_{\times 1}$	0	0
$0_{\times 0}$	$1_{\times 1}$	$1_{\times 0}$	1	0
$0_{\times 1}$	$0_{\times 0}$	$1_{\times 1}$	1	1
0	0	1	1	0
0	1	1	0	0

Image

4		

Convolved Feature

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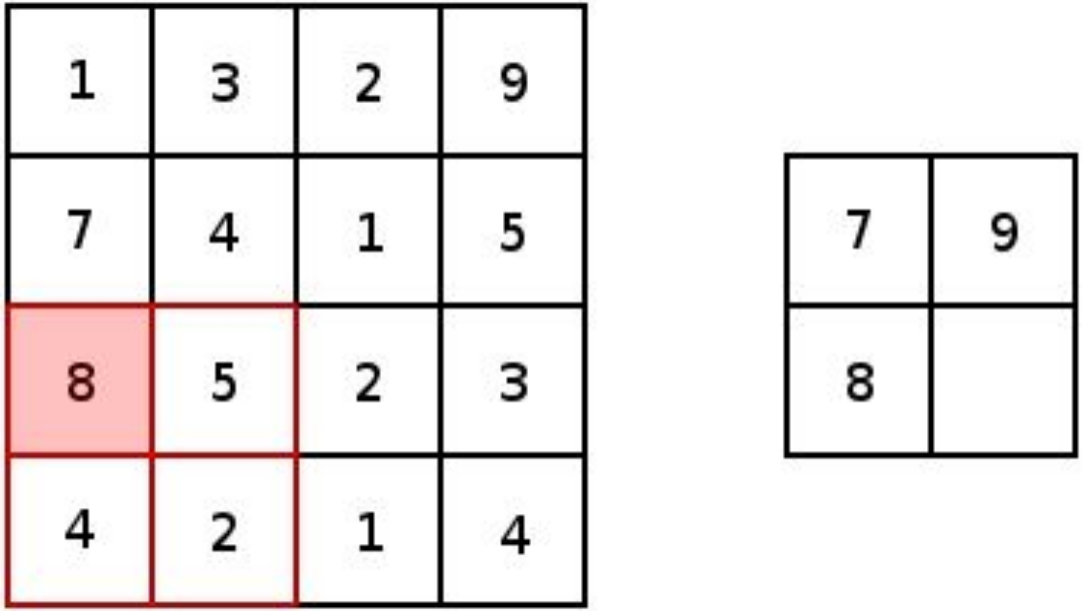
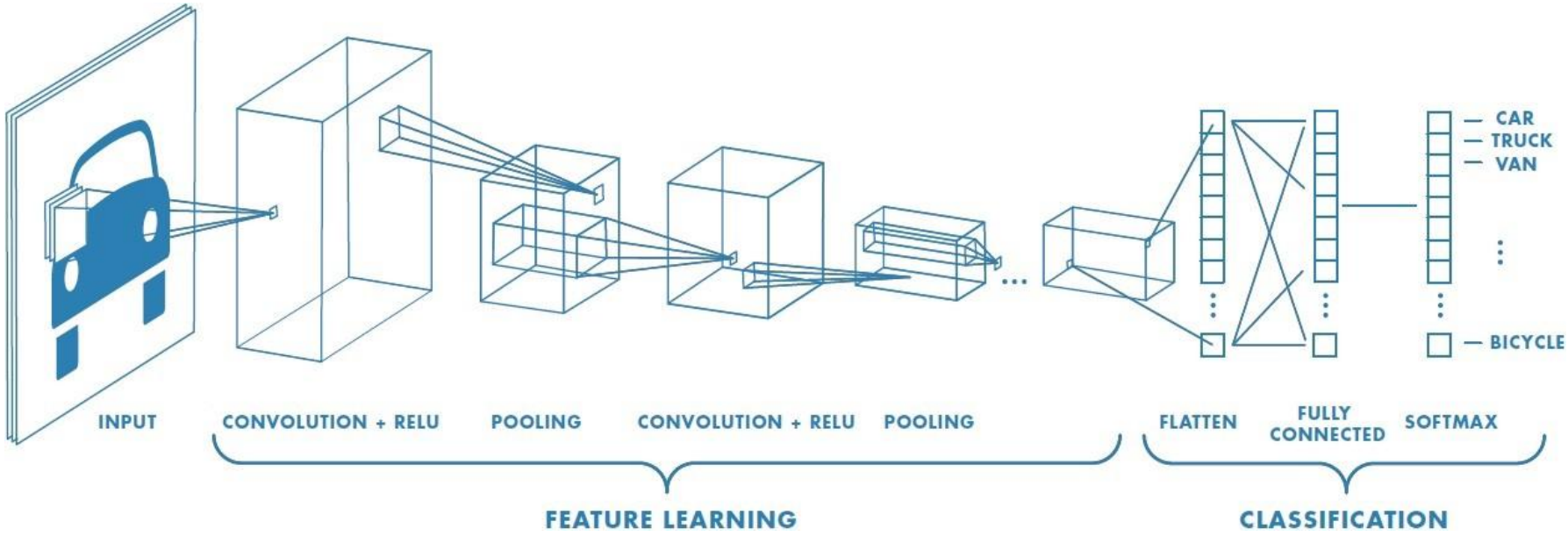
MaxPooling



Convolutional Neural Network (CNN)



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Load Data

```
img_rows, img_cols = 28, 28
batch_size = 128
num_classes = 10
epochs = 12

(x_train, y_train), (x_test, y_test) = mnist.load_data()
```

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Plot Images and Labels

```
plt.subplot(221)
plt.imshow(x_train[0], cmap=plt.get_cmap('gray'))
plt.title(y_train[0])
```

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Preprocess Input Data

- Reshape
- Convert data type to float32
- Normalize to the range [0,1]

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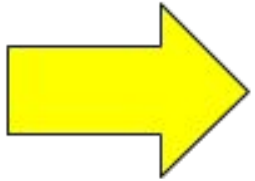
One Hot Encoder

Color
Red
Red
Yellow
Green
Yellow



Red	Yellow	Green
1	0	0
1	0	0
0	1	0
0	0	1

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Preprocess Class Labels

y_train = keras.utils.to_categorical(y_train, num_classes)

y_test = keras.utils.to_categorical(y_test, num_classes)

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Model Architecture

```
model = Sequential()

model.add(Conv2D(32, kernel_size=(3, 3),
                 activation='relu',
                 input_shape=input_shape))

model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
```

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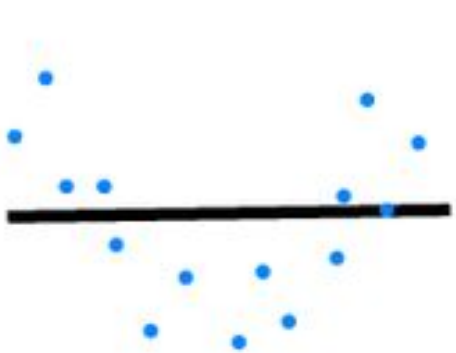
Overfitting



Underfitting

Desired

Overfitting

Model Architecture

```
model.add(Dropout(0.25))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))

print(model.summary())
```

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Deploy

- REST API
- Tensorflow Serving
- Tensorflow Extended (TFX)

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Recap

- Basic Machine Learning
- Applications of Machine Learning
- Neural Network
- Image Classification
- Deployment

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Too much ML?

Now what?

http://tiny.cc/ml_learn

- Machine Learning Crash Course, a course from Google that introduces machine learning concepts.
- CS 20: Tensorflow for Deep Learning Research, notes from an intro course from Stanford.
- CS231n: Convolutional Neural Networks for Visual Recognition, a course that teaches how convolutional networks work.
- Machine Learning Recipes, a video series that introduces basic machine learning concepts with few prerequisites.
- Deep Learning with Python, a book by Francois Chollet about the Keras API, as well as an excellent hands on intro to Deep Learning.
- Hands-on Machine Learning with Scikit-Learn and TensorFlow, a book by Aurélien Geron's that is a clear getting-started guide to data science and deep learning.
- Deep Learning, a book by Ian Goodfellow et al. that provides a technical dive into learning machine learning.

GDG RAJKOT

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NO QUESTIONS PLEASE 👽