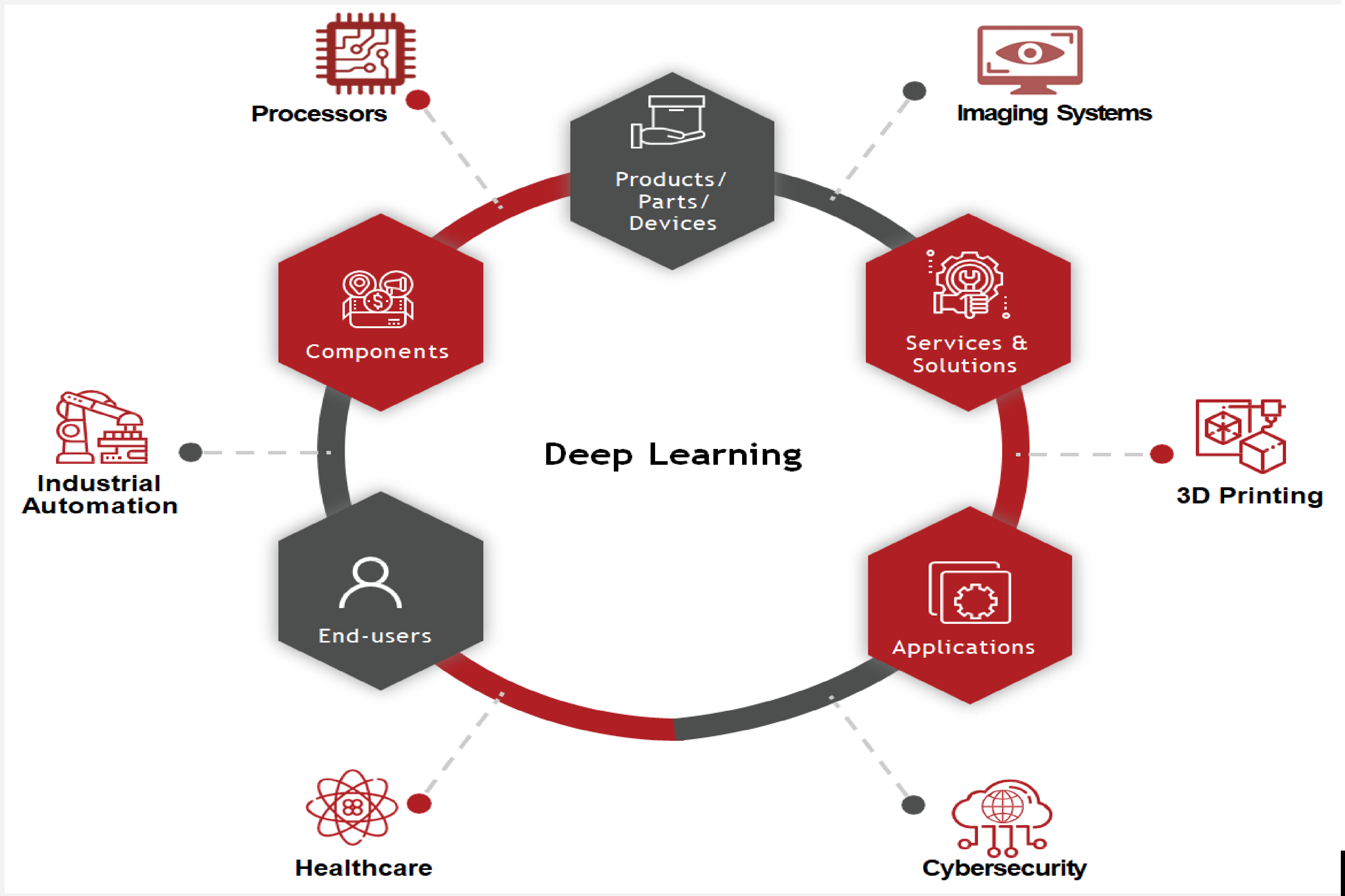
INTRODUCTION TO DEEP LEARNING WITH TENSORFLOW

- Ashwin Phadke

AI and Deep learning Engineer | Mentor | Trainer



- AllTheResearch

DEEP LEARNING

Deep learning (also known as **deep structured learning**) is part of a broader family of **machine learning** methods based on **artificial neural networks** with **representation learning**. Learning can be **supervised, semi-supervised or unsupervised**.

- Thank you Wikipedia

Architectures :

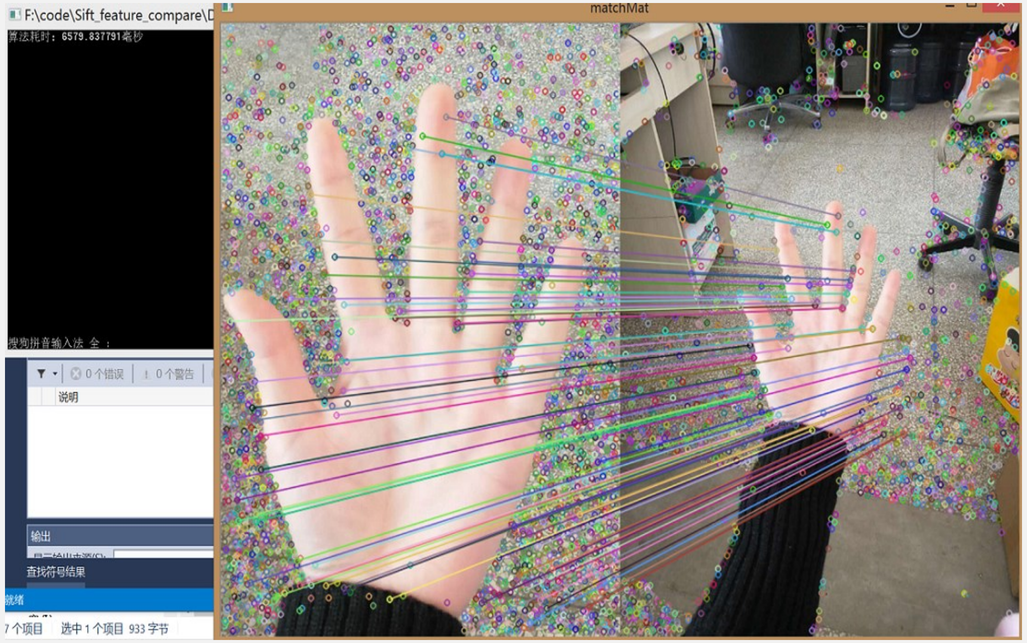
- Deep Neural networks
- Deep Belief Networks.
- Convolutional neural networks.
- Recurrent Neural Network

HISTORY : IT WAS NOT EASY BUT THEY DID IT

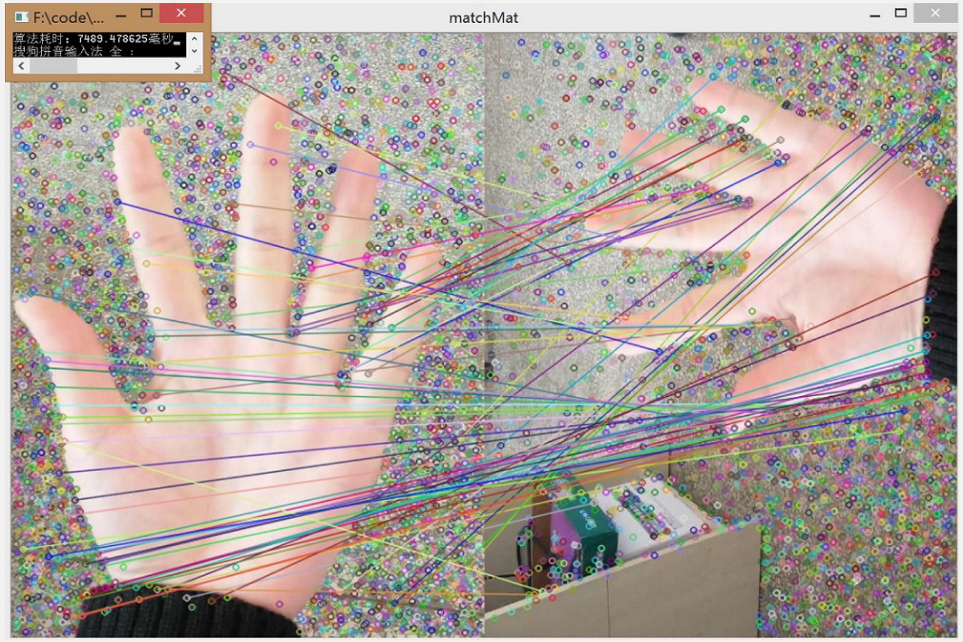
- From having a summer project to learn the mapping of visual systems[1966] to a breakthrough by Viola – Jones in 2001 in face detection with the help of AdaBoost algorithm.

- Fujifilm rolls out first camera with face detection capabilities in 2006.

- SIFT and Object recognition – David Lowe 1999



```
算法耗时：6579.837791毫秒
搜狗拼音输入法 全 ：
```



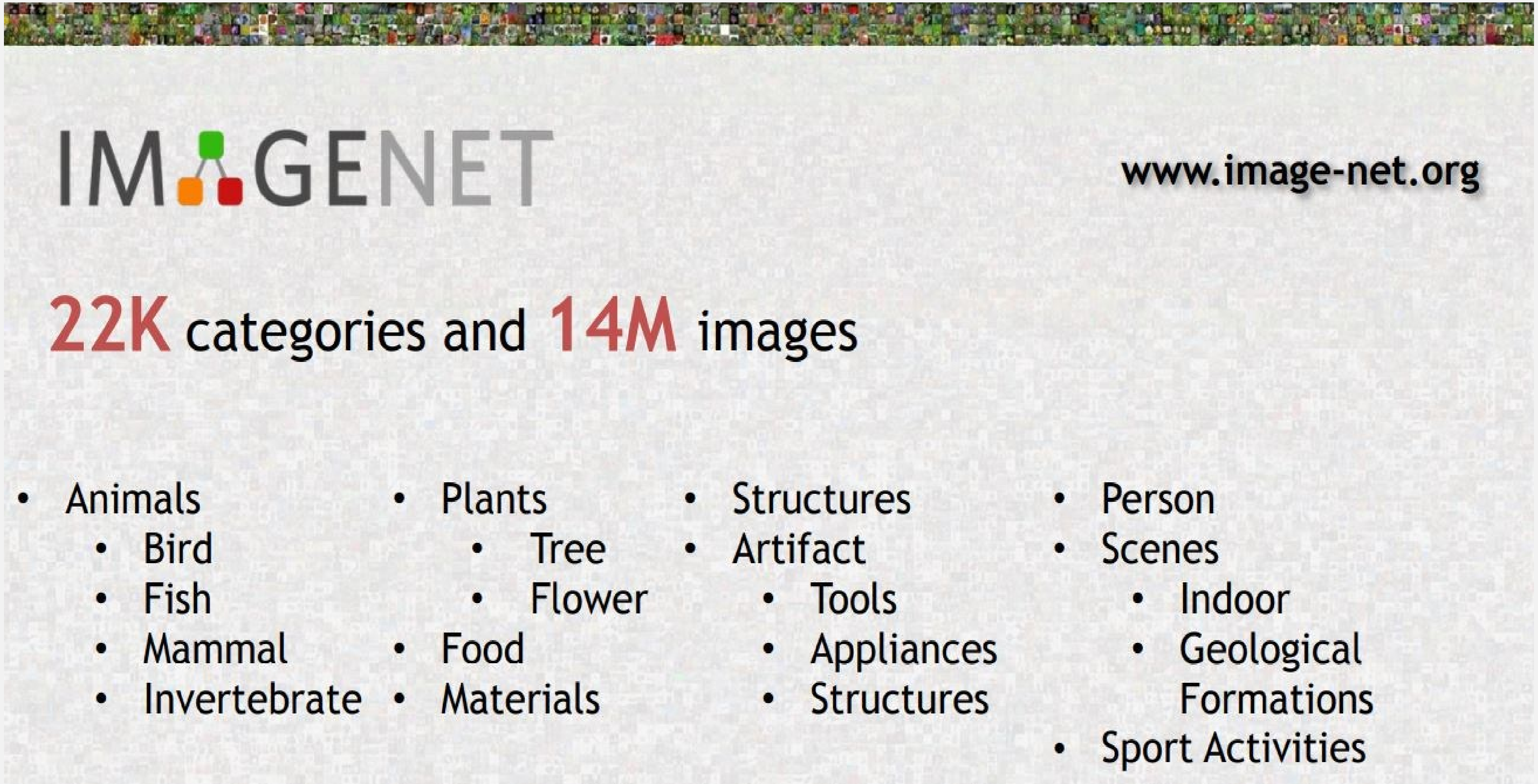
```
算法耗时：7489.478625毫秒
搜狗拼音输入法 全 ：
```

- Programmer help

THE CHALLENGE

Total number of images: 14,197,122

Paved the way by AlexNet



IMAGENET

www.image-net.org

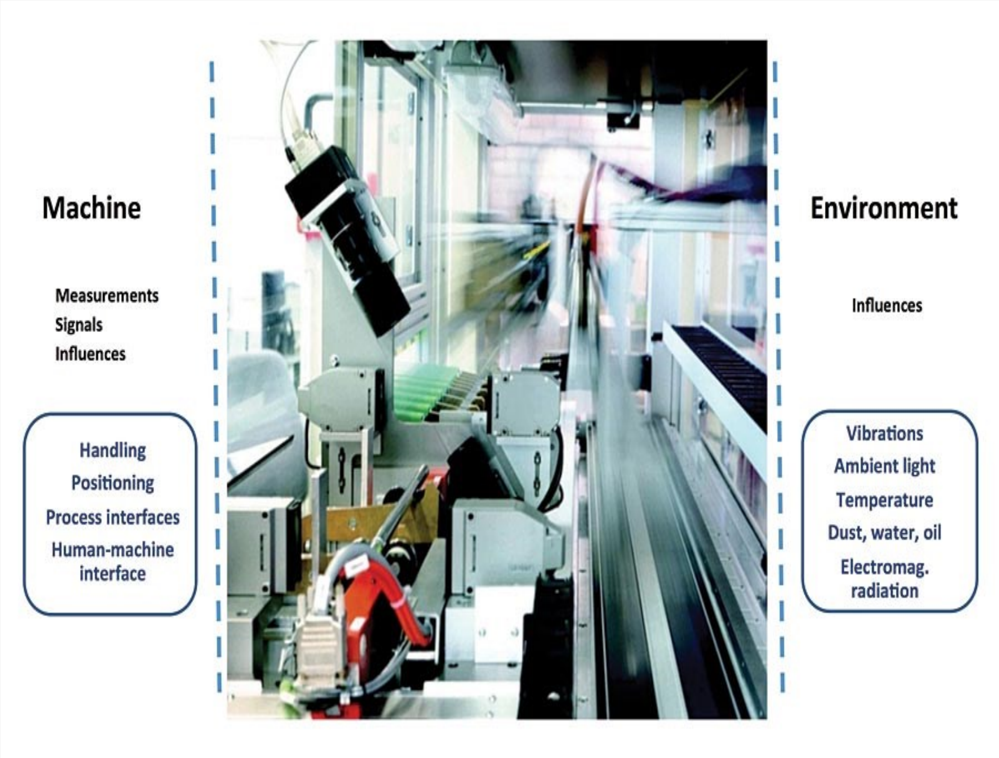
22K categories and 14M images

- Animals
  - Bird
  - Fish
  - Mammal
  - Invertebrate
- Plants
  - Tree
  - Flower
- Food
- Materials
- Structures
- Artifact
  - Tools
  - Appliances
  - Structures
- Person
- Scenes
  - Indoor
  - Geological Formations
- Sport Activities

DATA THAT WE NEED – NOW WE HAVE IT

Camera based devices have increased exponentially and the internet traffic is to be dominated by large amount of video content.

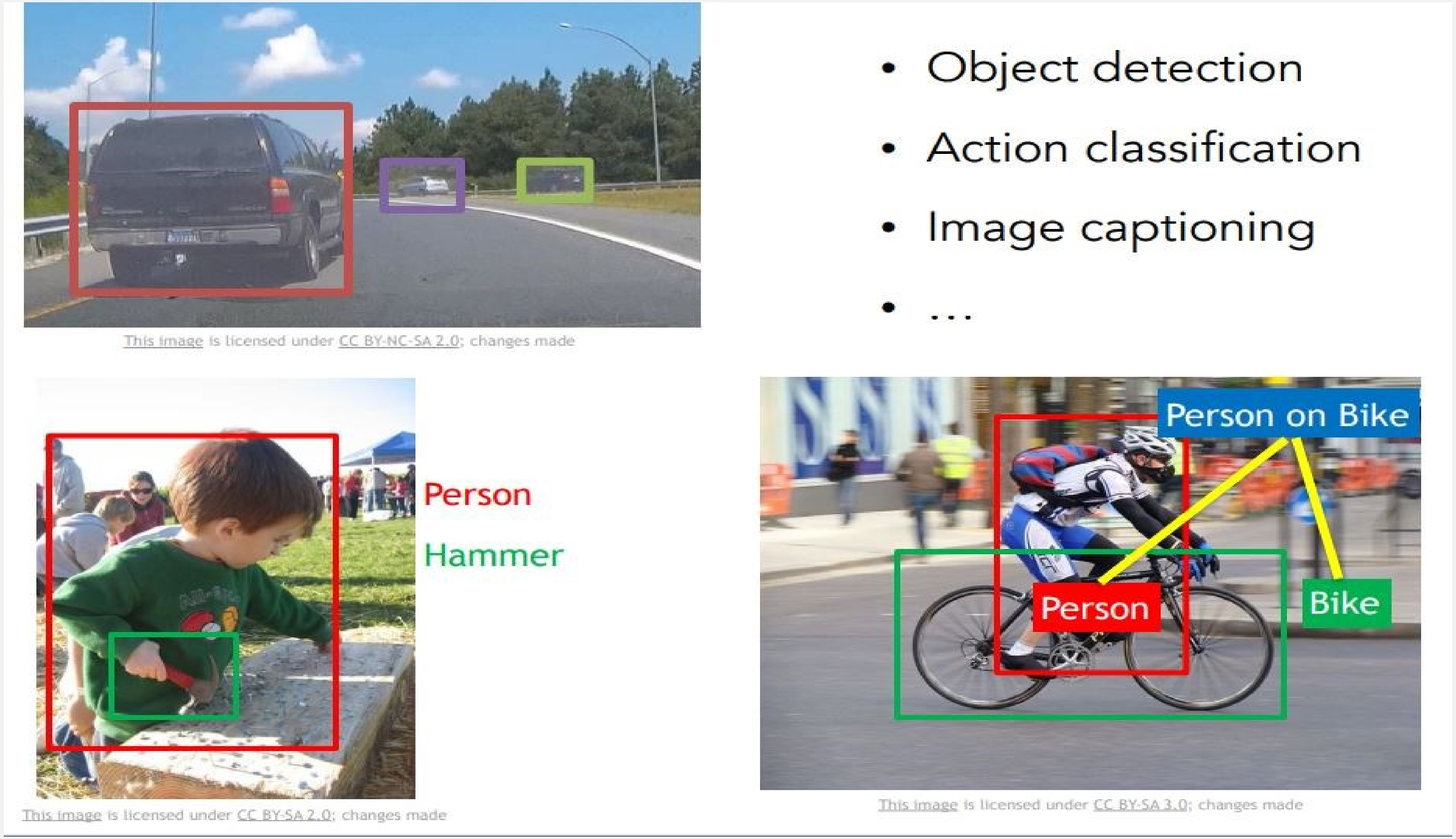
- Citrus minds



- Quality magazine

TASKS

Numerous tasks can be performed by getting visual data from all around the environment we live in.



- Object detection
- Action classification
- Image captioning
- ...

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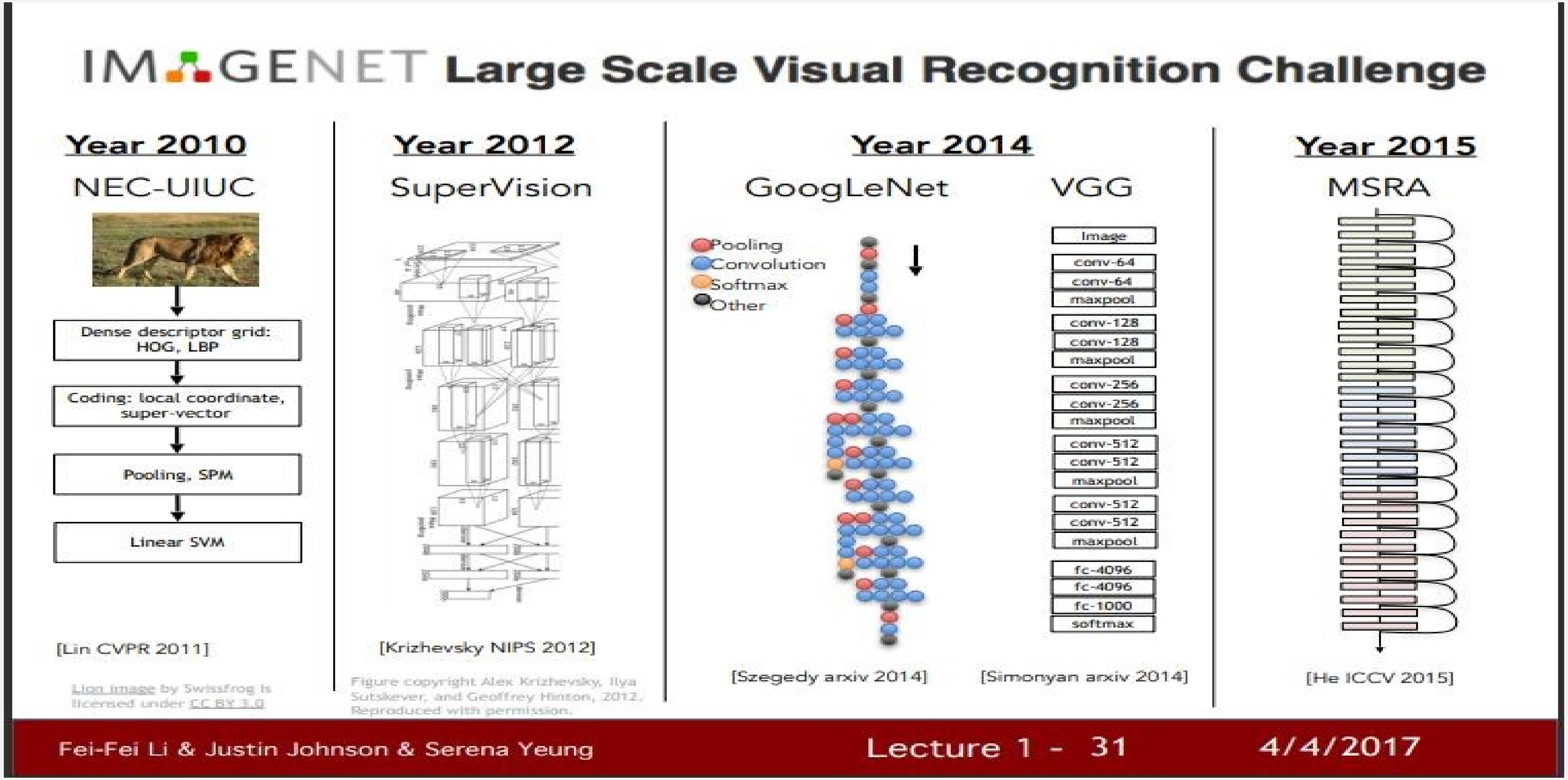
This image is licensed under CC BY-SA 3.0; changes made

- CS231N online

CONVOLUTIONAL NEURAL NETWORKS

Convolutional neural networks has helped many, to breakthrough in solve the image classification challenge



IMAGENET Large Scale Visual Recognition Challenge

Year 2010

NEC-UIUC

Dense descriptor grid: HOG, LBP

Coding: local coordinate, super-vector

Pooling, SPM

Linear SVM

[Lin CVPR 2011]

Lion image by Swissfrog is licensed under CC BY 3.0

Year 2012

SuperVision

[Krizhevsky NIPS 2012]

Figure copyright Alex Krizhevsky, Ilya Sutskever, and Geoffrey Hinton, 2012. Reproduced with permission.

Year 2014

GoogLeNet

● Pooling
● Convolution
● Softmax
● Other

[Szegedy arxiv 2014]

VGG

Image
conv-64
conv-64
maxpool
conv-128
conv-128
maxpool
conv-256
conv-256
maxpool
conv-512
conv-512
maxpool
conv-512
conv-512
maxpool
fc-4096
fc-4096
fc-1000
softmax

[Simonyan arxiv 2014]

Year 2015

MSRA

[He ICCV 2015]

Fei-Fei Li & Justin Johnson & Serena Yeung   Lecture 1 - 31   4/4/2017

UNDERSTANDING AN IMAGE

Understanding the image is possibly the extremely important task that needs to be solved. No matter how the object to be classified appears it still is that same image and needs to be classified it that way. Issues like camera angle variation, illumination, deformation, occlusion, image variations.

Cat

Still a cat

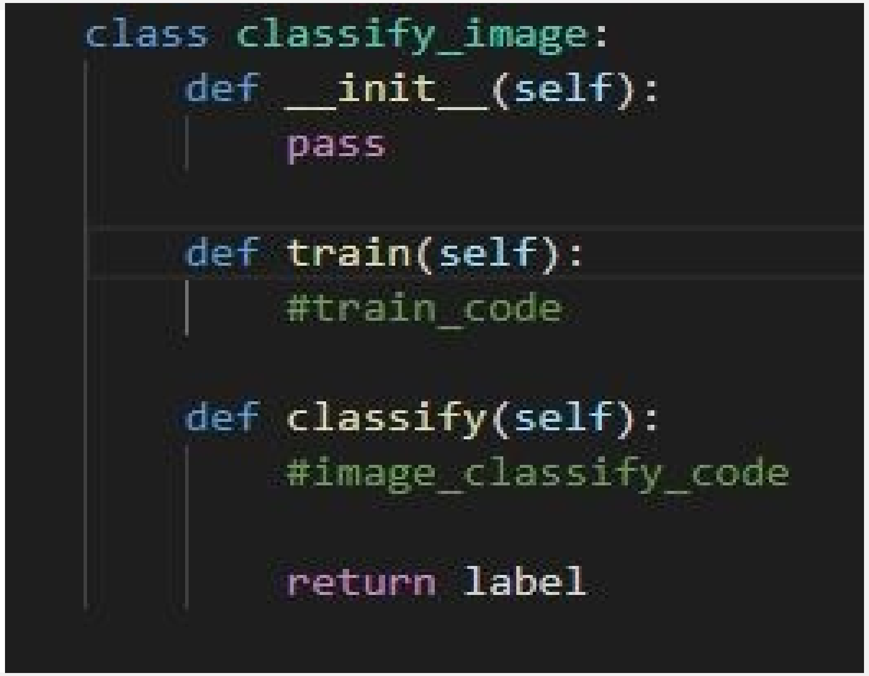
They do come in all variations, don’t they

- Pixabay

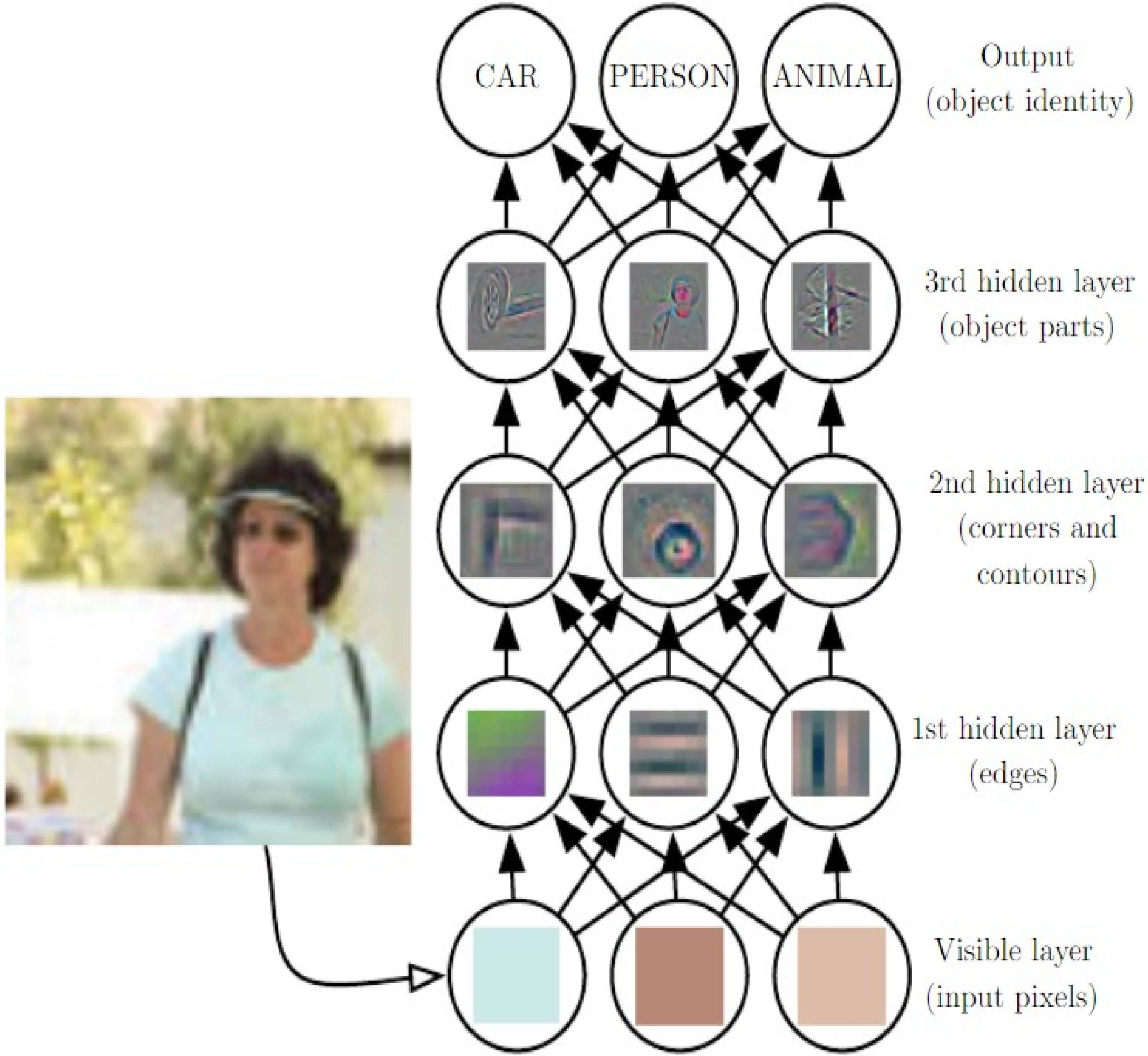
OKAY SO HOW DO WE DO IT?

We keep saying `data data` everywhere, now’s the time to actually use it.

- Collect a large dataset of images and labels that you need or wish to classify.
- Train a classifier using machine learning(yes) techniques.
- Evaluate on a completely new set of images.



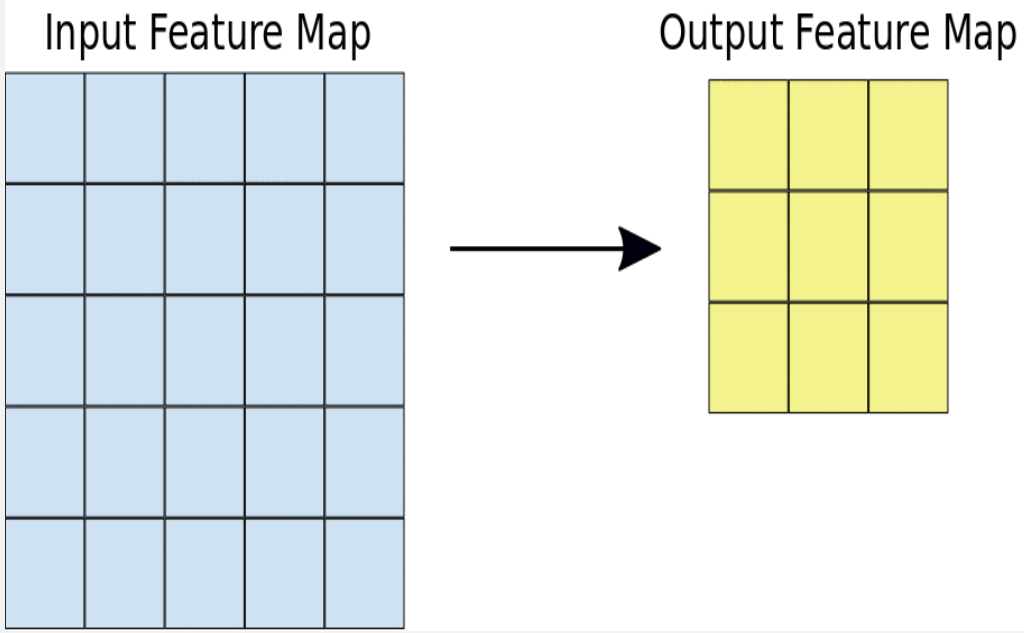
```
class classify_image:
    def __init__(self):
        pass

    def train(self):
        #train_code

    def classify(self):
        #image_classify_code

        return label
```

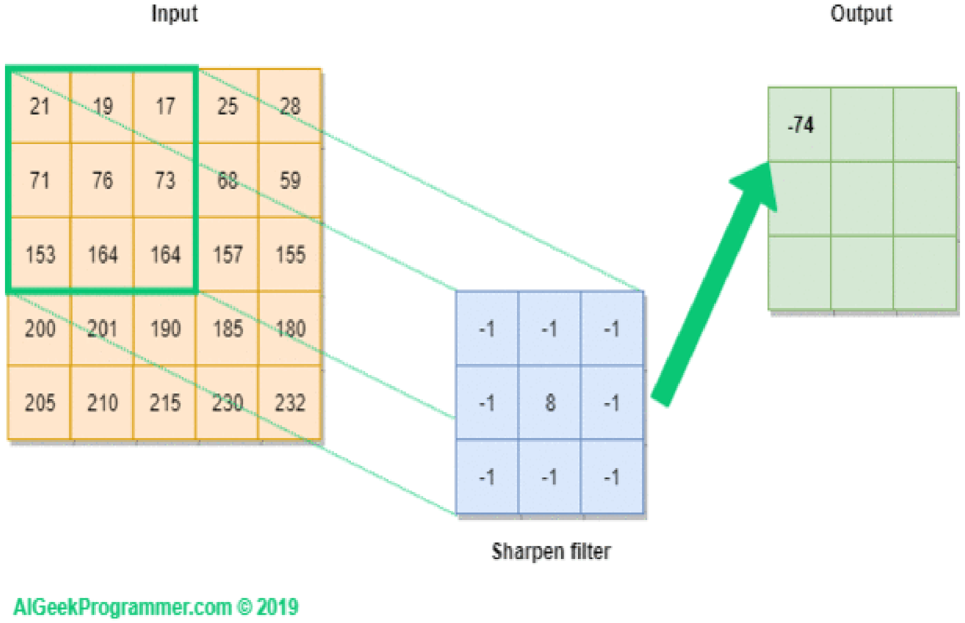


Deep Learning – Ian Goodfellow, Yoshua Bengio, et.al

CONVOLUTIONAL NEURAL NETWORKS – CONVOLUTION OPERATION

Let's go ahead and know the convolutional operation ourseleves.





21	19	17	25	28
71	76	73	68	59
153	164	164	157	155
200	201	190	185	180
205	210	215	230	232

-1	-1	-1
-1	8	-1
-1	-1	-1

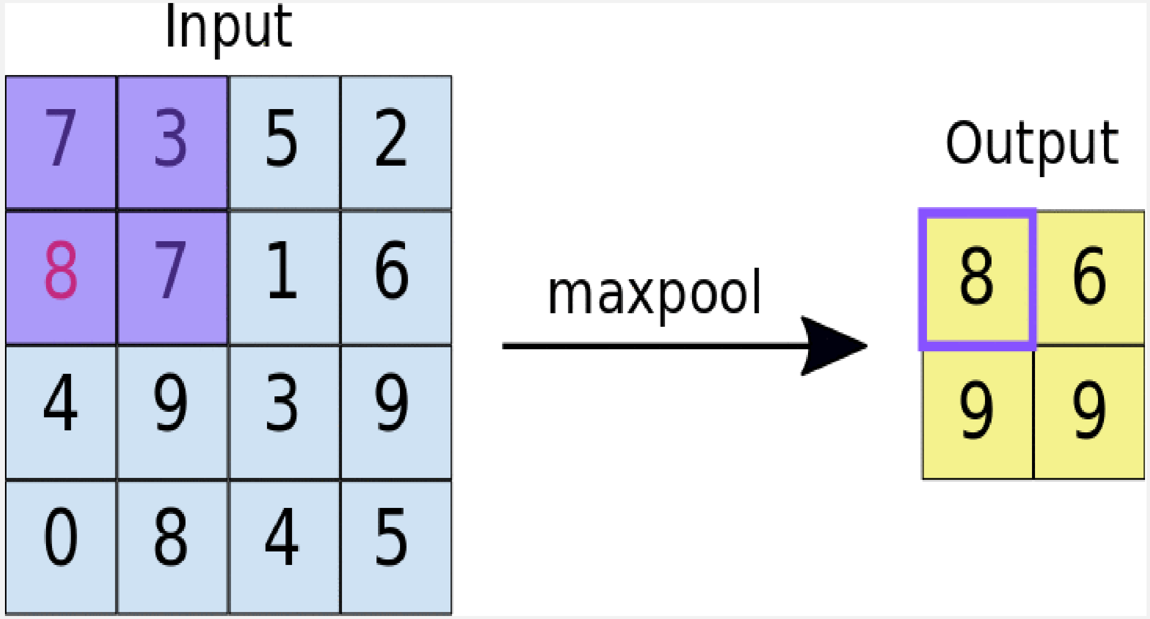
-74		

- Representations:
  - Blue : Input to the convolutional layer. (5 X 5)
  - Red : Filter being applied over the input. (3 X 3). These are learned filters. Like sharpen filter etc. Different size filter different size features.
  - Yellow : Resulting convolutional output. (3 X 3)

- ML Practicum
- AIGeekProgrammer

CONVOLUTIONAL NEURAL NETWORKS – MAX POOLING

Well the earlier we convolved over the image and scanned through each piixel



7	3	5	2
8	7	1	6
4	9	3	9
0	8	4	5

8	6
9	9

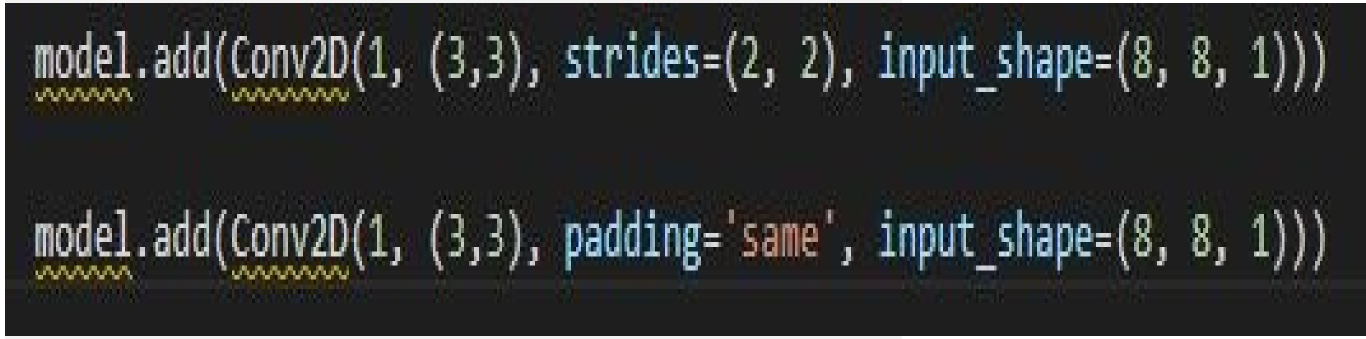
- Why use max ppoling?
  - Faster to compute as reduced computations.
  - Maximum pixel value stored hence sense or meaning of the image doesn’t necessarily change that much.
  - Applied as 2X2 with stride of 2.
  - Average pooling and Max pooling.

CONVOLUTIONAL NEURAL NETWORKS – STRIDES AND PADDING

We have done convolution and also formed a simplified computation using max pool, but do we directly apply these operations over the image?

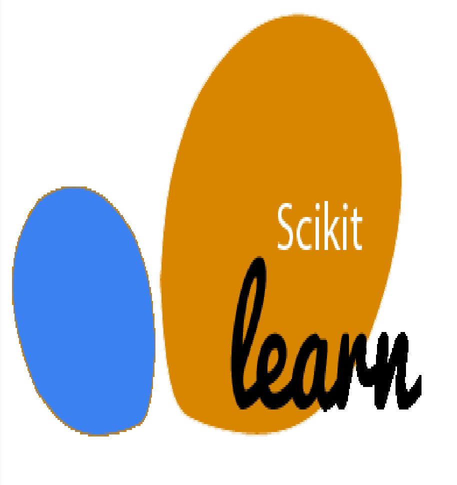
- Strides :
  - The amount of movement between applications of the filter to the input image is referred to as the stride, and it is almost always symmetrical in height and width dimensions.

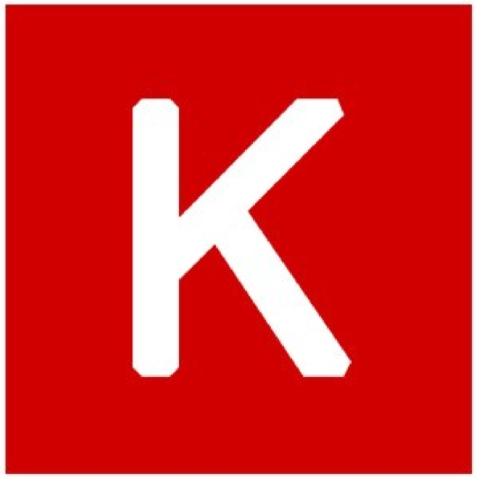
- Padding :
  - Filter start at left
  - No surrounding pixels.
  - Pad values to add for border pixel values so they are at the center.
  - padding=‘same’ makes sure output shape is same as input.



```
model.add(Conv2D(1, (3,3), strides=(2, 2), input_shape=(8, 8, 1)))

model.add(Conv2D(1, (3,3), padding='same', input_shape=(8, 8, 1)))
```

Most popular frameworks for data science



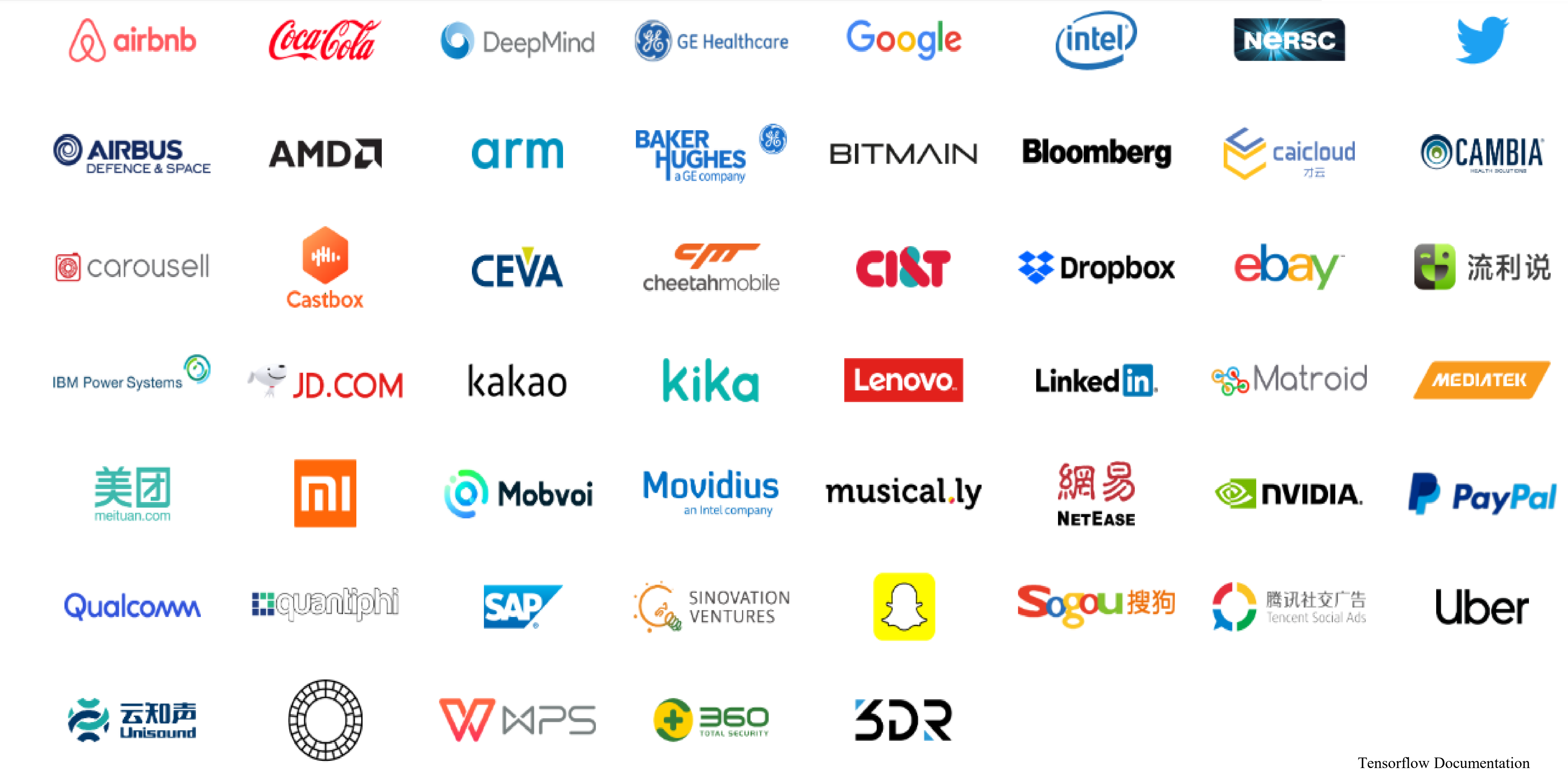


TENSORFLOW : INTROCUCTION AND BASICS

We need some good libraries i.e base code to do amazing operations of convolutions over image, videos etc.

- Developed by Google Brain team and released in 2015.
- Available as:
  - TensorFlow
  - TensorFlow Lite
  - TensorFlow JS
  - TensorRT (Nvidia).
- The name TensorFlow derives from the operations that such neural networks perform on multidimensional data arrays, which are referred to as *tensors*.
- TensorFlow computations are expressed as stateful dataflow graphs. A familiar dataflow programming language example can be VHDL.
- You can do following :
  - Preprocessing
  - Building models.
  - Evaluate , test and deploy models to production.

Companies using Tensorflow :



Tensorflow Documentation

OVERVIEW OF TENSORFLOW AND IT'S FUNCTIONS

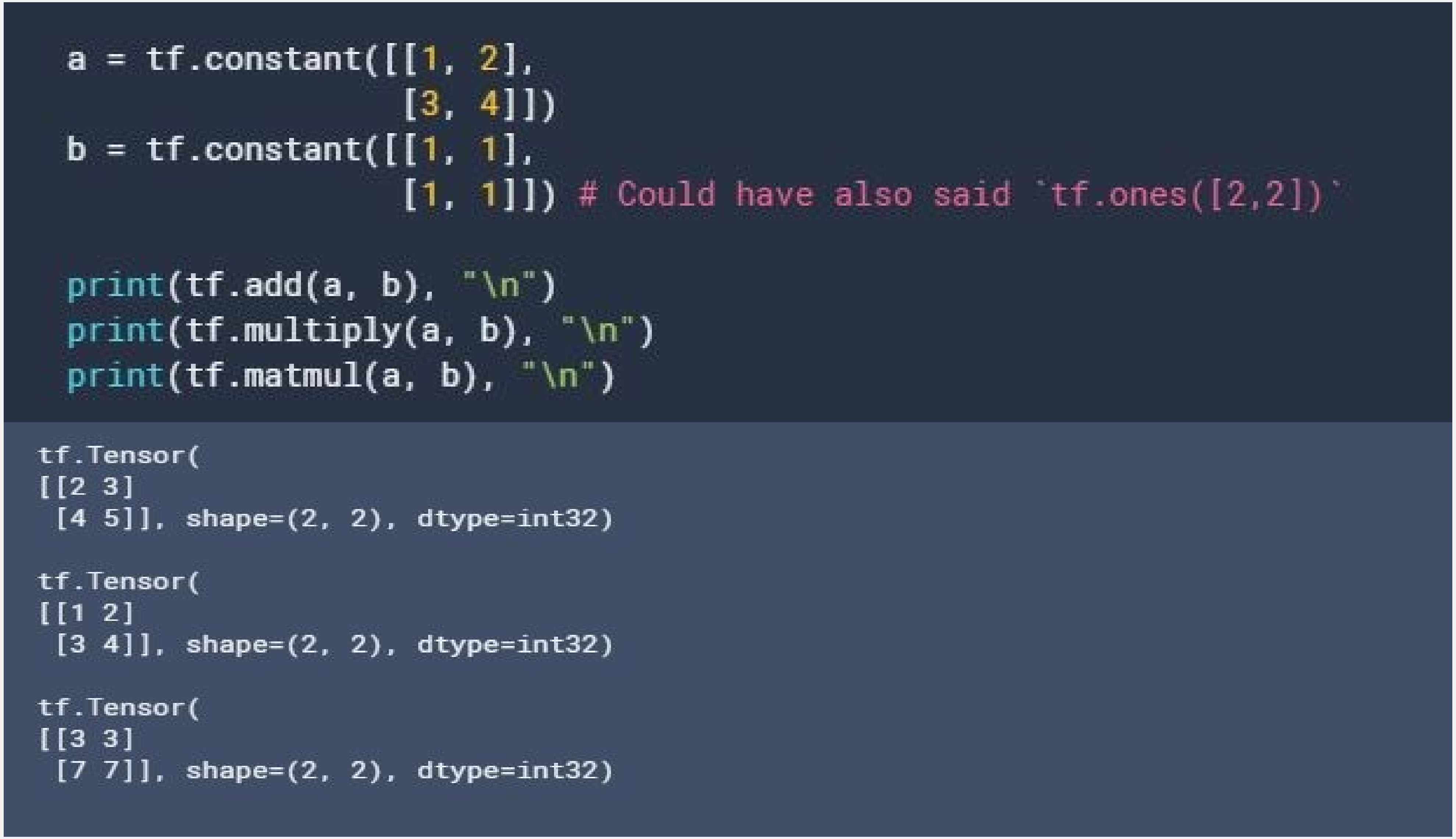
Here we look at what some basic and common functions and operations mean while using TensorFlow

- Tensor :
  - A tensor is a **vector** or **matrix** of n-dimensions that represents all types of data.
  - Kind of np.arrays().
  - They have identical data type ans hsape is the shape of the array.
- Graph :
  - In TensorFlow, all the operations are conducted inside a **graph**. The graph is a set of computation that takes place successively. Each operation is called an **op node** and are connected to each other.
  - The graph outlines the ops and connections between the nodes
  - All the computations in the graph are done by connecting tensors togetherA tensor has a node and an edge.
  - The node carries the mathematical operation and produces an endpoints outputs.
  - The edges the edges explain the input/output relationships between nodes.

- Guru99

EXAMPLE USAGE

Here is an example of how a tensor is initialized and how various operations are done on the defined tensors



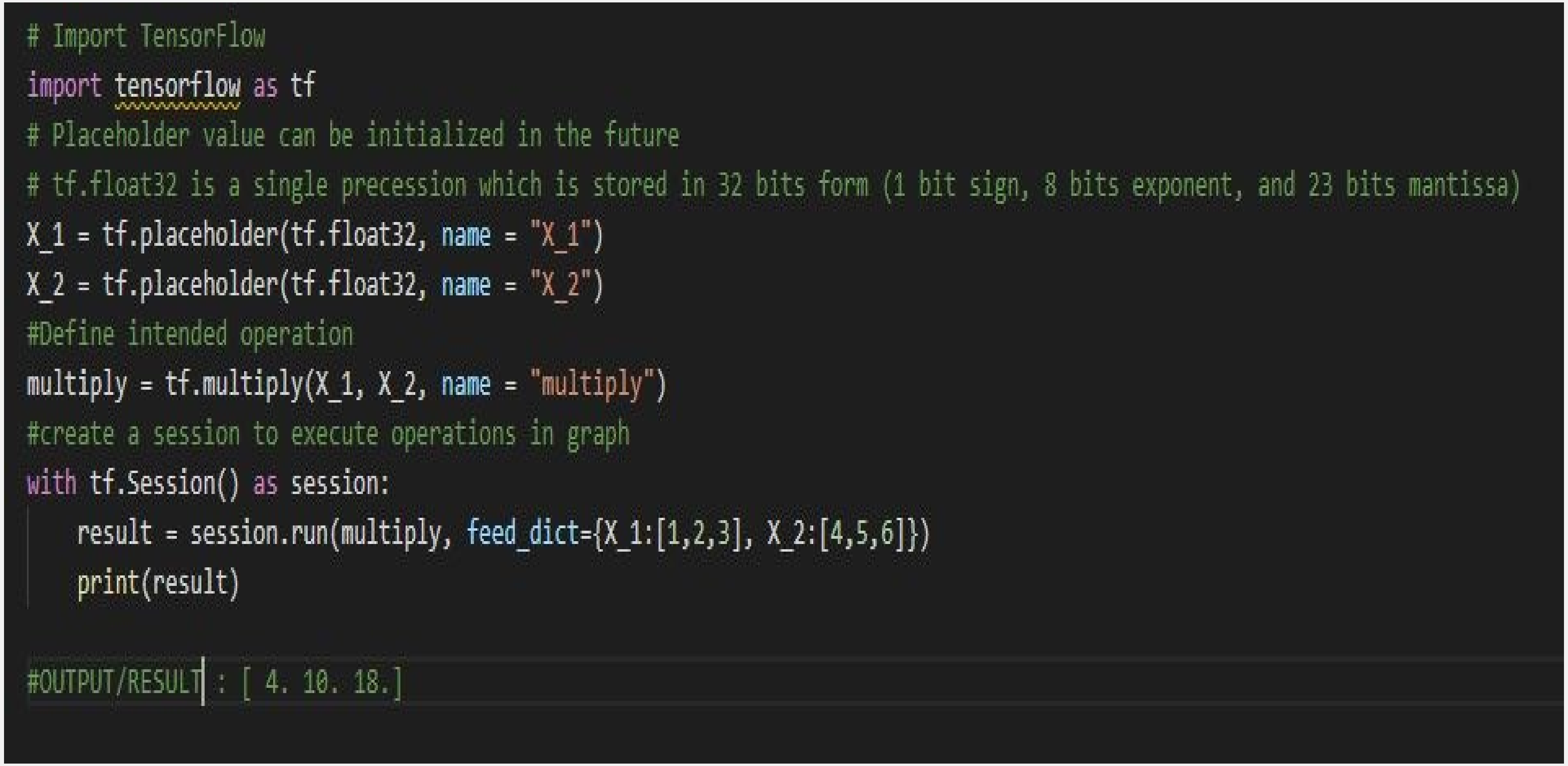
```
a = tf.constant([[1, 2],
                 [3, 4]])
b = tf.constant([[1, 1],
                 [1, 1]]) # Could have also said `tf.ones([2,2])`

print(tf.add(a, b), "\n")
print(tf.multiply(a, b), "\n")
print(tf.matmul(a, b), "\n")
```

```
tf.Tensor(
[[2 3]
 [4 5]], shape=(2, 2), dtype=int32)

tf.Tensor(
[[1 2]
 [3 4]], shape=(2, 2), dtype=int32)

tf.Tensor(
[[3 3]
 [7 7]], shape=(2, 2), dtype=int32)
```

- TensorFlow documentation

EXAMPLE USAGE USING TENSORFLOW SESSIONS

Here we use TensorFlow sessions in order to properly streamline TensorFlow operations. These sessions are required to run operations on computational graphs.



```
# Import TensorFlow
import tensorflow as tf
# Placeholder value can be initialized in the future
# tf.float32 is a single precession which is stored in 32 bits form (1 bit sign, 8 bits exponent, and 23 bits mantissa)
X_1 = tf.placeholder(tf.float32, name = "X_1")
X_2 = tf.placeholder(tf.float32, name = "X_2")
#Define intended operation
multiply = tf.multiply(X_1, X_2, name = "multiply")
#create a session to execute operations in graph
with tf.Session() as session:
    result = session.run(multiply, feed_dict={X_1:[1,2,3], X_2:[4,5,6]})
    print(result)

#OUTPUT/RESULT : [ 4. 10. 18.]
```

- TF Documentation
- Guru99
- Quora

Machine Learning

Deep Learning

Computer Vision

NLP

Credits to all Github awesome lists ma [redacted]

FIRST UP CONSULTANTS

SOME HANDS ON

Alright! Get your laptops out and be quick.

Colab Notebook:

- Simple example
- Build and train you own CNN with basic layers.
- Link to Colab Notebook

REFERENCES :

Here are references that helped me a lot and you should give it a try if I may suggest.

- Deep Learning book : https://deeplearningbook.org, Goodfellow et.al
- Tensorflow Documentation.
- ML Practicum by Google
- Cs231n.
- OpenCV and SIFT
- https://machinelearningmastery.com/
- Andrej Kaarpathy blog : http://karpathy.github.io/
- Basics of classic CNN : https://towardsdatascience.com/basics-of-the-classic-cnn-a3dce1225add
- Coursera : Neural netowrks, Introduction to Tensorflow, Laurence Moroney
- People to follow on LinkedIn : Dat Tran, Jason Mayes, Yogesh Kulkarni, Rahee Agate-Walambe, Usha Rangarajan, Laurence Moroney
- Powerpoint Template : Powerpoint template store.
- Google image and GIF search.

THANK YOU