Introduction to ML

Data Analysis Club, IIT-PKD

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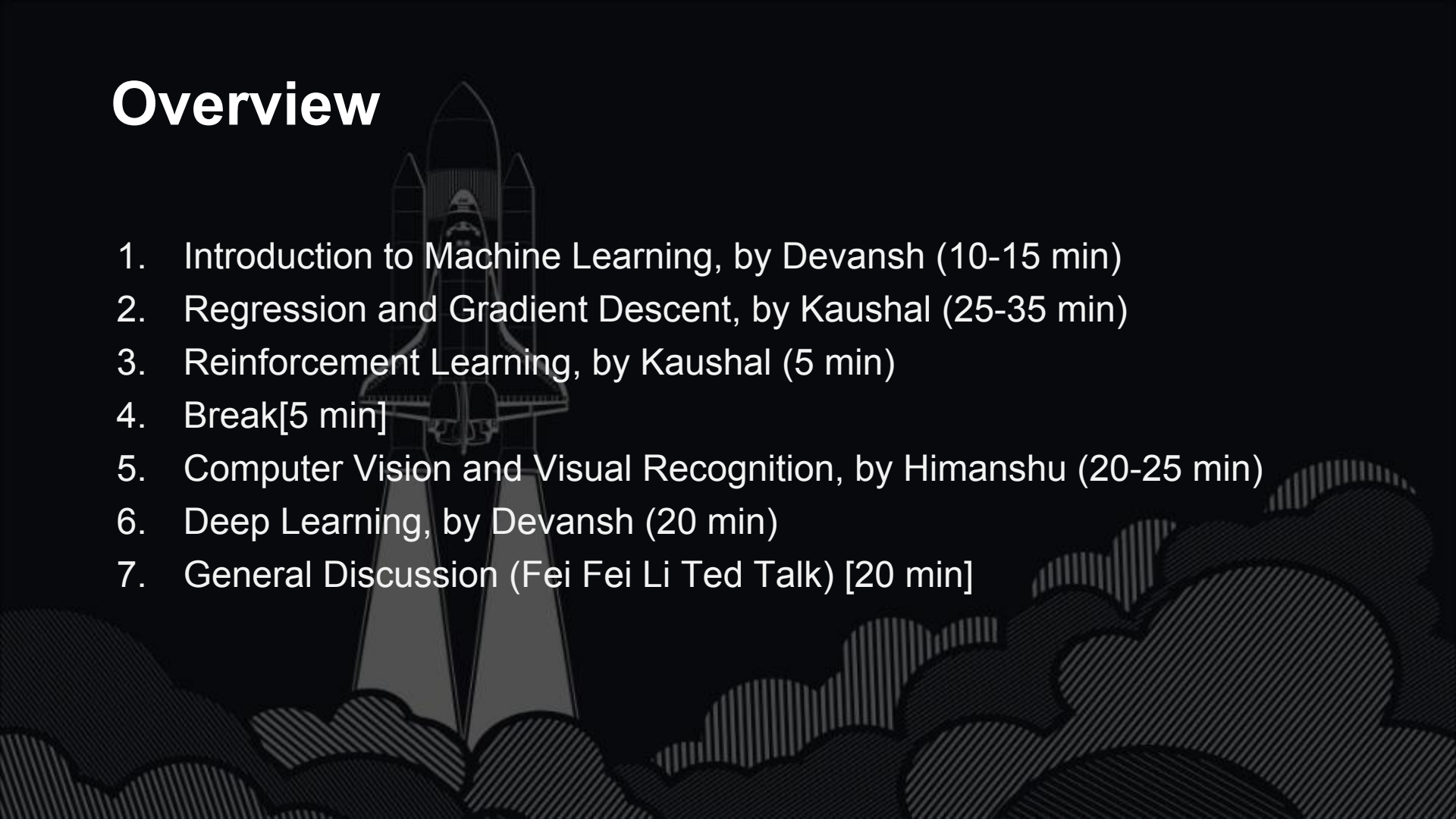
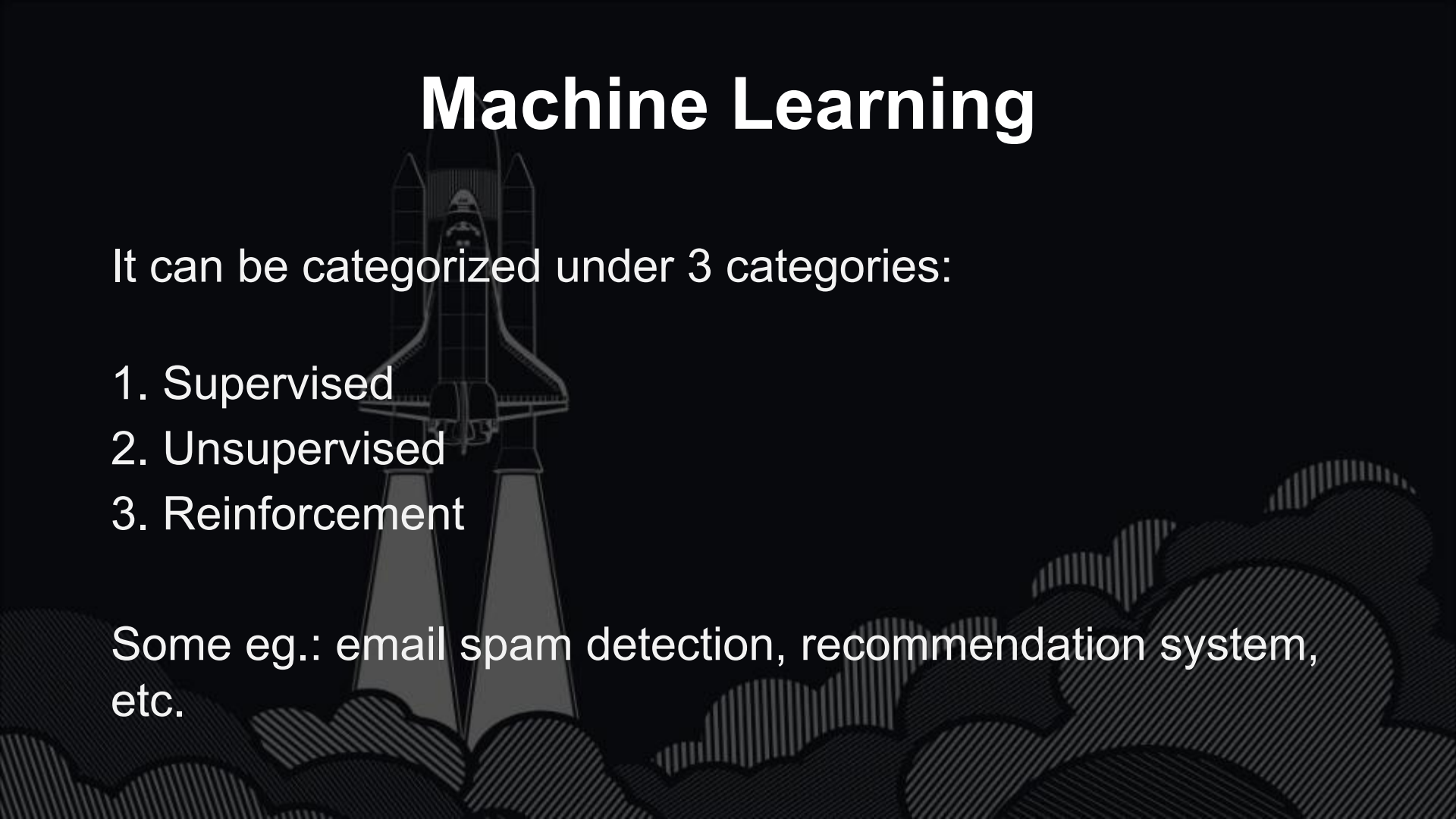
Overview



1. Introduction to Machine Learning, by Devansh (10-15 min)
2. Regression and Gradient Descent, by Kaushal (25-35 min)
3. Reinforcement Learning, by Kaushal (5 min)
4. Break[5 min]
5. Computer Vision and Visual Recognition, by Himanshu (20-25 min)
6. Deep Learning, by Devansh (20 min)
7. General Discussion (Fei Fei Li Ted Talk) [20 min]

Machine Learning



It can be categorized under 3 categories:

1. Supervised
2. Unsupervised
3. Reinforcement

Some eg.: email spam detection, recommendation system, etc.

Supervised Learning:

The computer is presented with example inputs and their desired outputs (for training the machine), given by a "teacher"/”trainer”, and the goal is to learn a general rule that maps inputs to outputs. Further this map will be used to predict the outputs for other inputs.

Eg., Regression, Classification, Support Vector Machine

Unsupervised Learning:

No labels are given to the learning algorithm, leaving it on its own to find structure in its input. Unsupervised learning can be a goal in itself (discovering hidden patterns in data) or a means towards an end (feature learning).

Eg.

- Clustering: Google News, Facebook Friend Suggestions
- Anomaly Detection
- Dimensionality Reduction: Image compression

Reinforcement Learning:

A computer program interacts with a dynamic environment in which it must perform a certain goal (such as driving a vehicle or playing a game against an opponent[5]:3). The program is provided feedback in terms of rewards and punishments as it navigates its problem space.

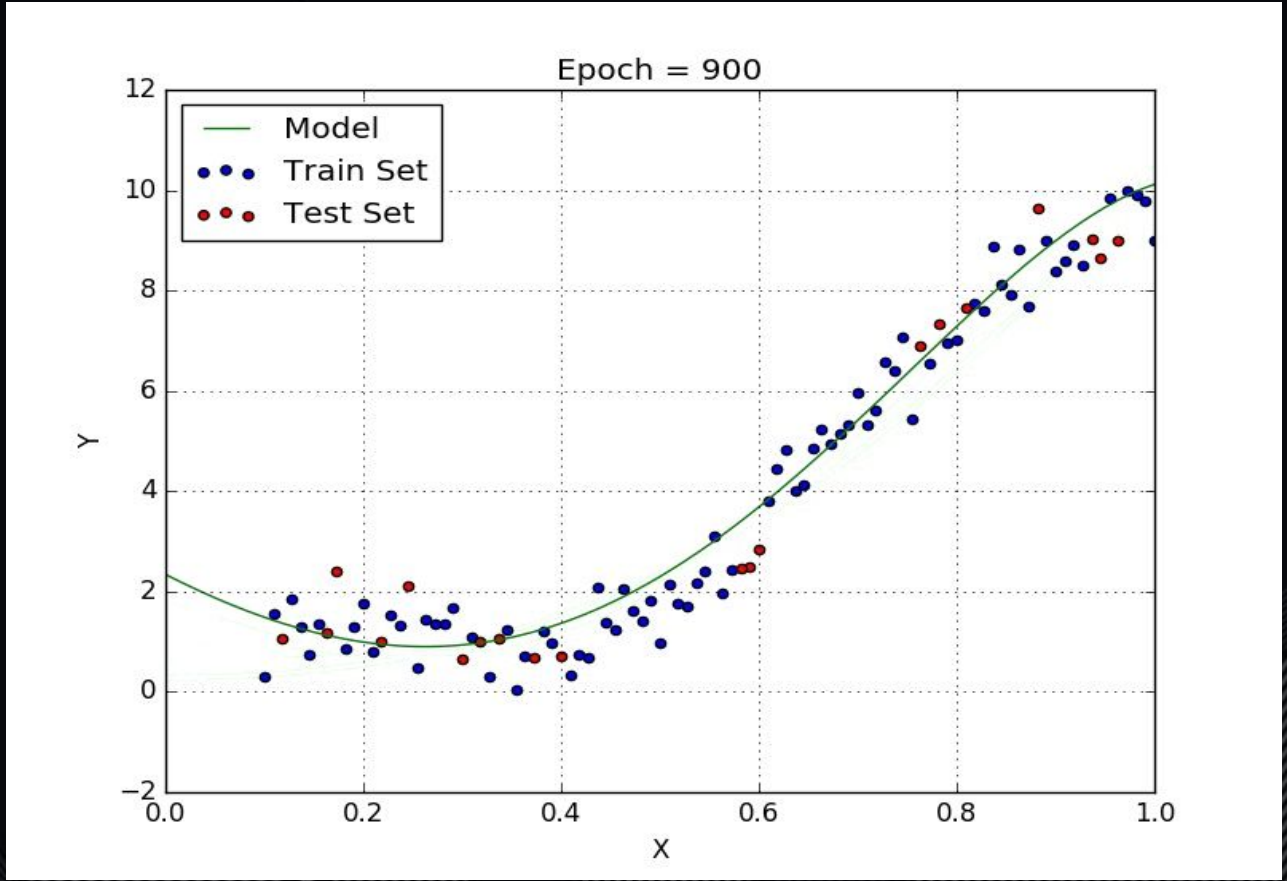
Eg.Computer Games, Vehicular Navigation

Regression

Regression is a method that enables you to determine the relationship between a continuous process output (Y) and some factor (X) .

Types:

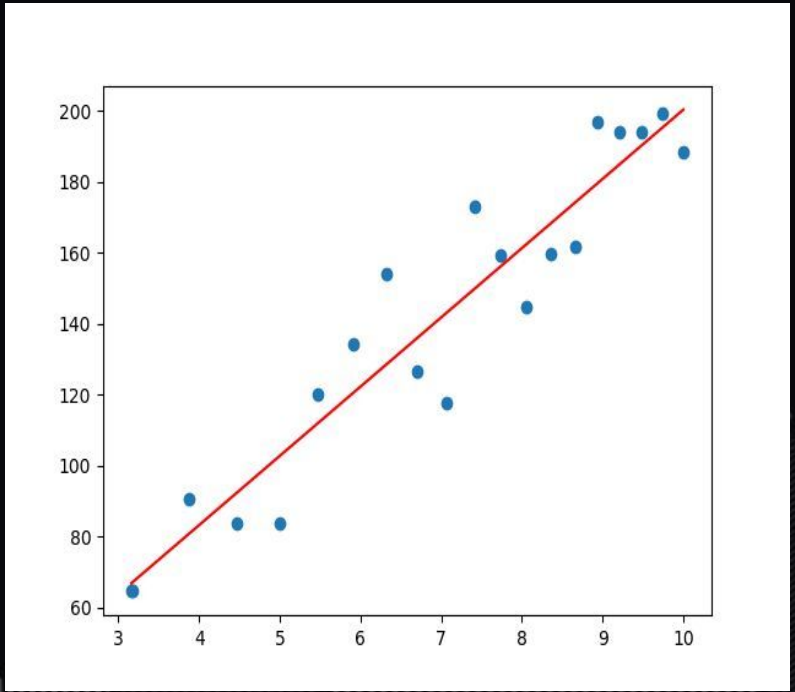
- Linear Regression
- Polynomial Regression
- Non-Linear Regression
- Generalized Regression


Epoch = 900
Model
Train Set
Test Set
12
10
8
6
4
2
0
−2
Y
0.0
0.2
0.4
0.6
0.8
1.0
X

Linear Regression

Linear Regression is a type of regression in which output(Y) can be expressed as linear function of input(X):

$Y = \Theta.X + C;$



Gradient Descent

Gradient: The gradient is a vector which points in the direction of greatest rate of increase of the function.

1. f (x, y) increases most rapidly in the direction of its gradient.
2. f (x, y) decreases most rapidly in the opposite direction of its gradient
3. Magnitude of gradient is rate of increase

Magnitude of gradient for a function y=f(x) for any certain value of x is the slope of the tangent for the function at the point (x , f(x)).

Gradient Descent(2D):

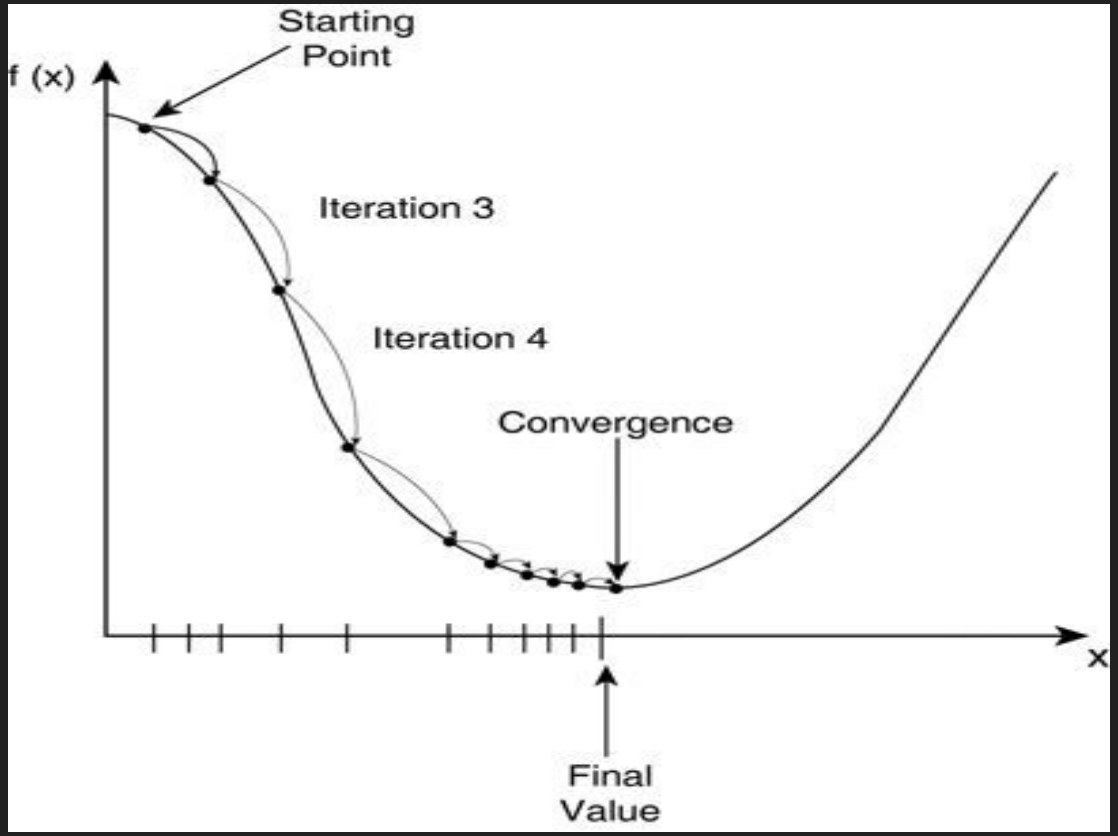
Let f(x) is a convex function. A convex function has only global minimum.

Aim: To find X at which value of function f(x) is minimum.
Algorithm:

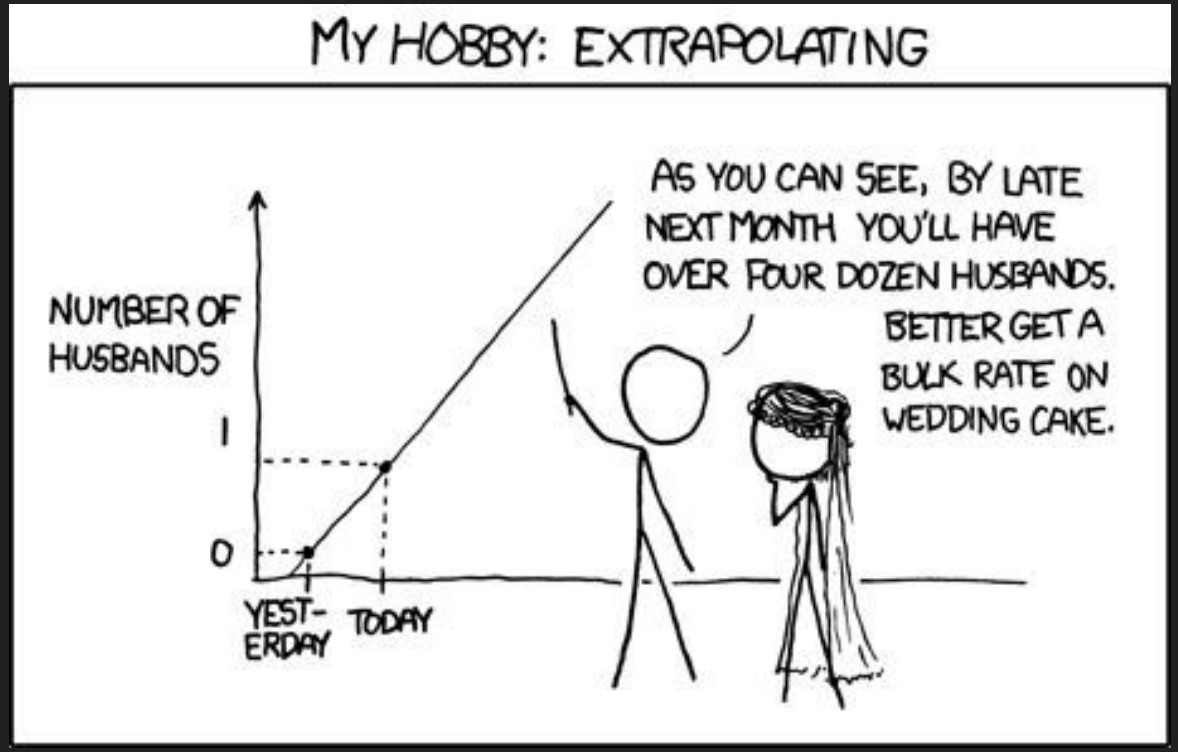
```
Repeat till you reach minimum {
    X := X - α*(slope)
}
```

α is a very small constant and it is called as learning rate.

Representation for Gradient Descent:



Machine Learning ….



Not everywhere


COMPUTER
VISION

What is Computer Vision?

- Computer Vision is field that includes methods for acquiring, processing, analyzing and understanding images.
- Duplicate the ability of human vision by electronically perceiving and understanding an image.
- Image can be of many forms such as video sequence, depth images.

Computer Vision

Humans use their eyes and their brains to see and visually sense the world around them. Computer vision is the science that aims to give a similar, if not better, capability to a machine or computer.

Believe me, making a computer understand what it see is the most difficult task.

Computer Vision

Applications:

- Object Detection
- Object Recognition
- Motion Analysis
- Scene Reconstruction
- Image Compression
- Augmented Reality

Computer Vision

- Object Detection Demo
- Pedestrian Detection Demo
- Object Recognition Demo

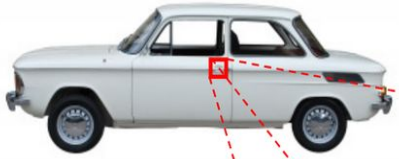
Image Processing

- Analysis and manipulation of digitized image
- May be done in order to improve the quality
- May be done to extract the information

What you see vs What computer sees

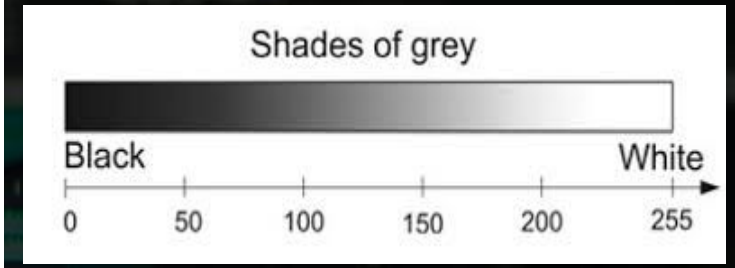
What is this?

You see this:

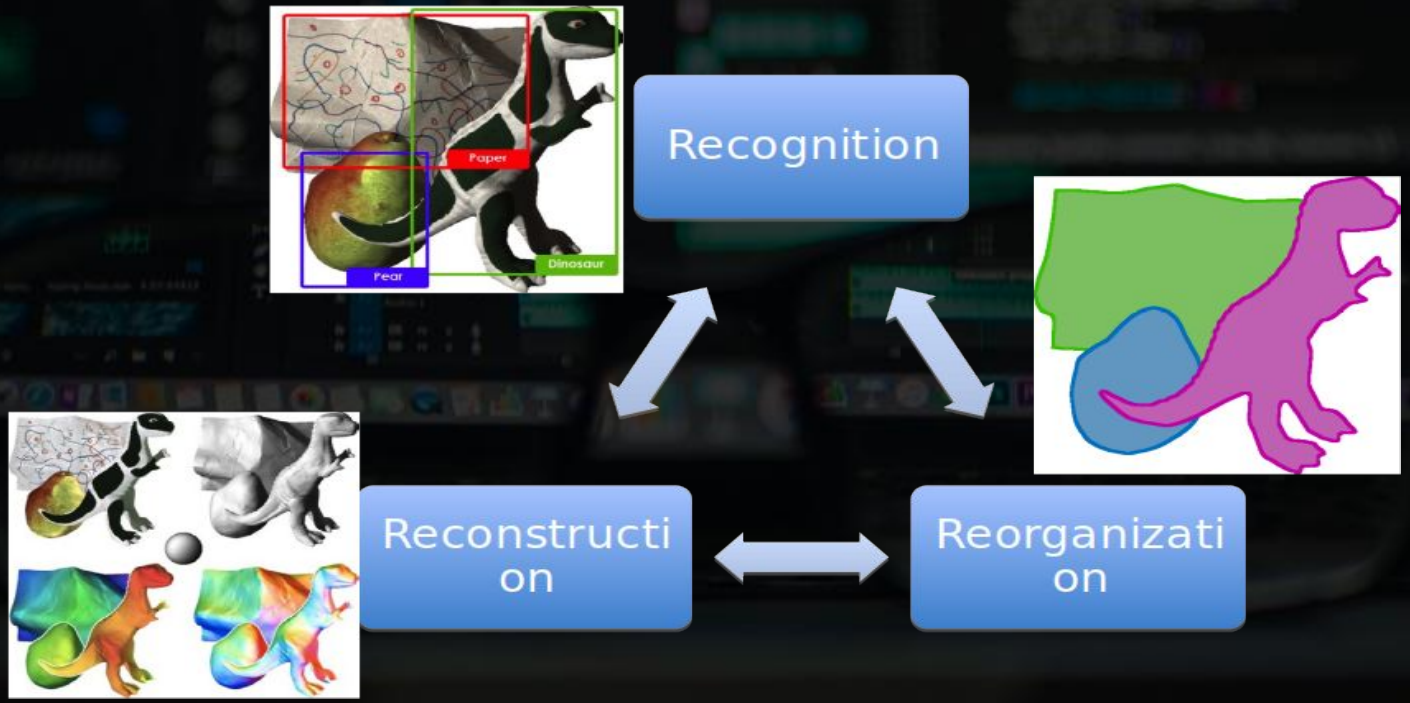


But the camera sees this:

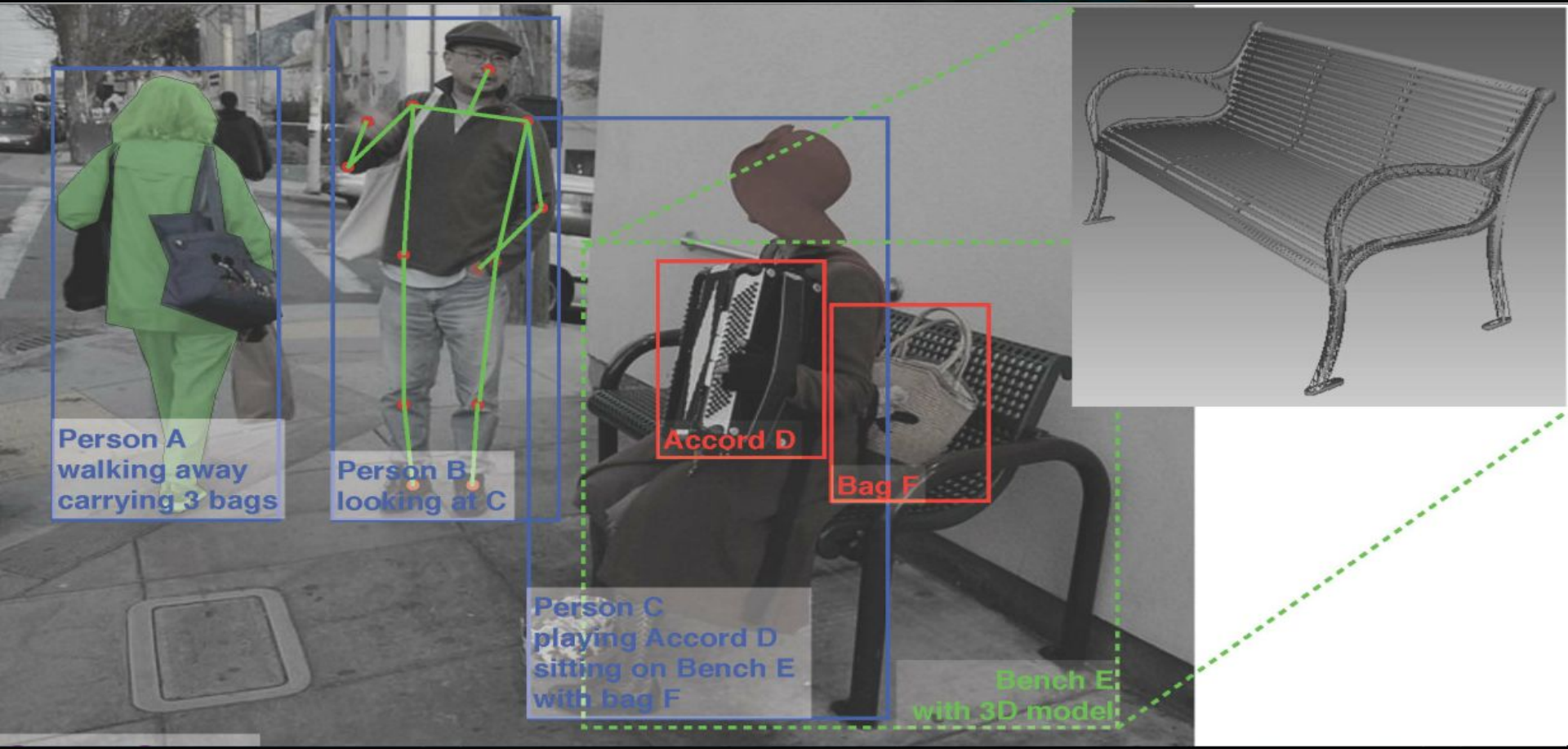
194	210	201	212	199	213	215	195	178	158	182	209
180	189	190	221	209	205	191	167	147	115	129	163
114	126	140	188	176	165	152	140	170	106	78	88
87	103	115	154	143	142	149	153	173	101	57	57
102	112	106	131	122	138	152	147	128	84	58	66
94	95	79	104	105	124	129	113	107	87	69	67
68	71	69	98	89	92	98	95	89	88	76	67
41	56	68	99	63	45	60	82	58	76	75	65
20	43	69	75	56	41	51	73	55	70	63	44
50	50	57	69	75	75	73	74	53	68	59	37
72	59	53	66	84	92	84	74	57	72	63	42
67	61	58	65	75	78	76	73	59	75	69	50



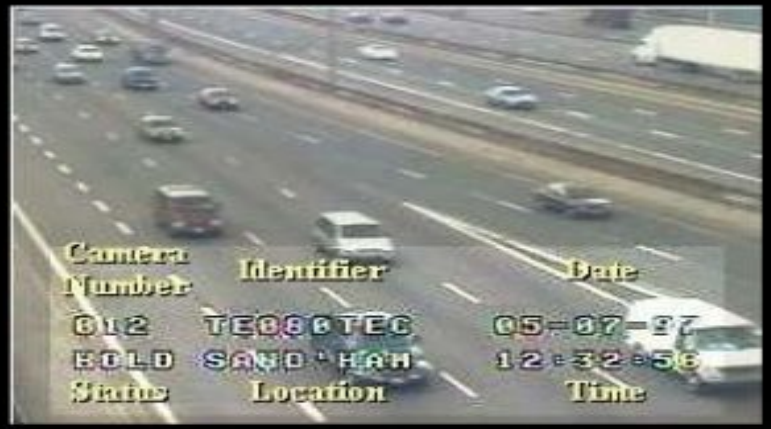
RECOGNITION RECONSTRUCTION REORGANISATION



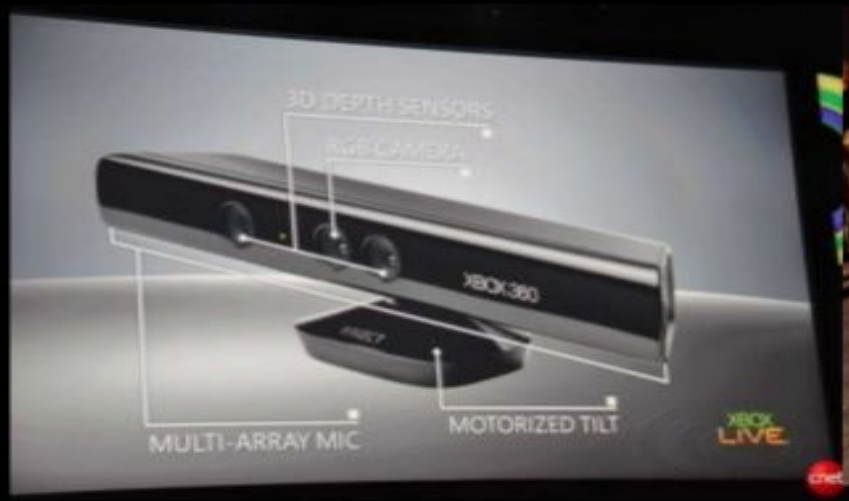
What we would like to infer



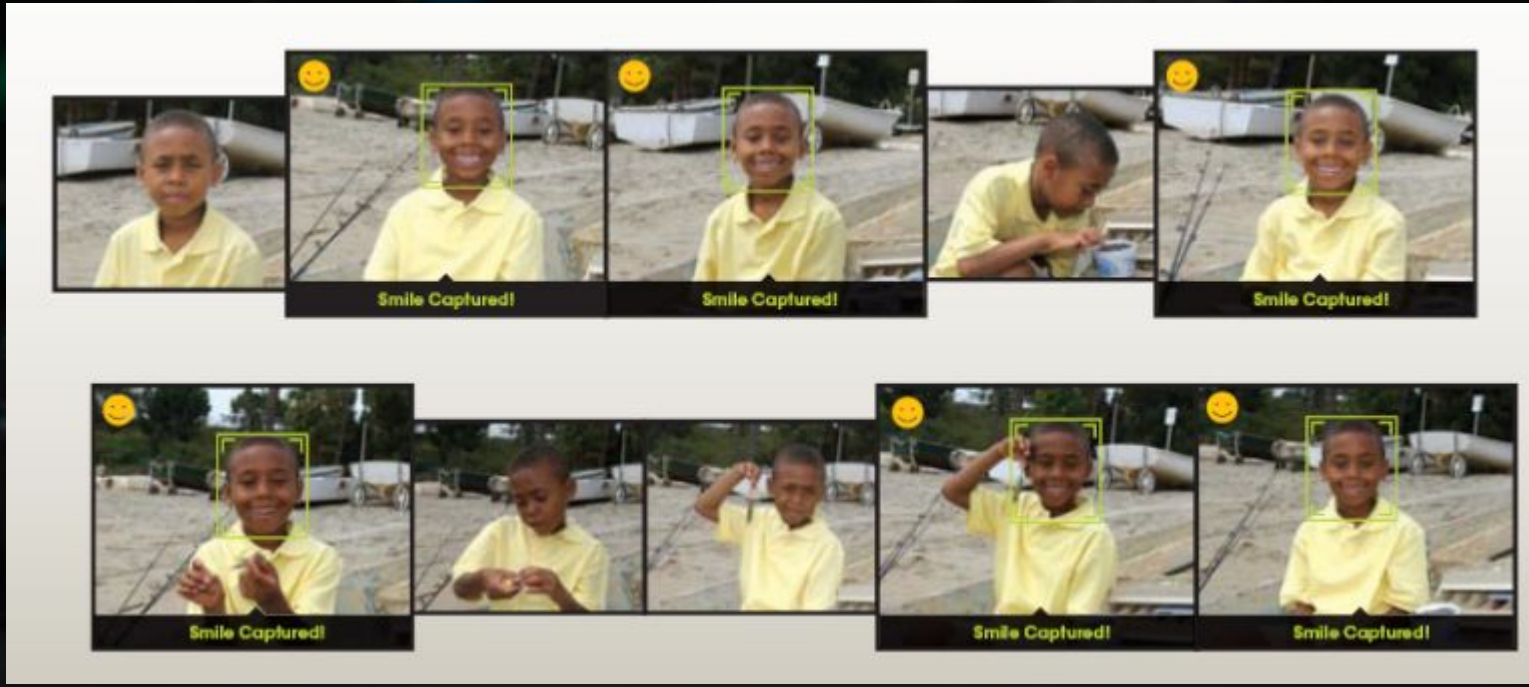
TRAFFIC MONITORING



INTERACTIVE GAMES



SMILE DETECTION



FACE DETECTION

Different aspects of Vision

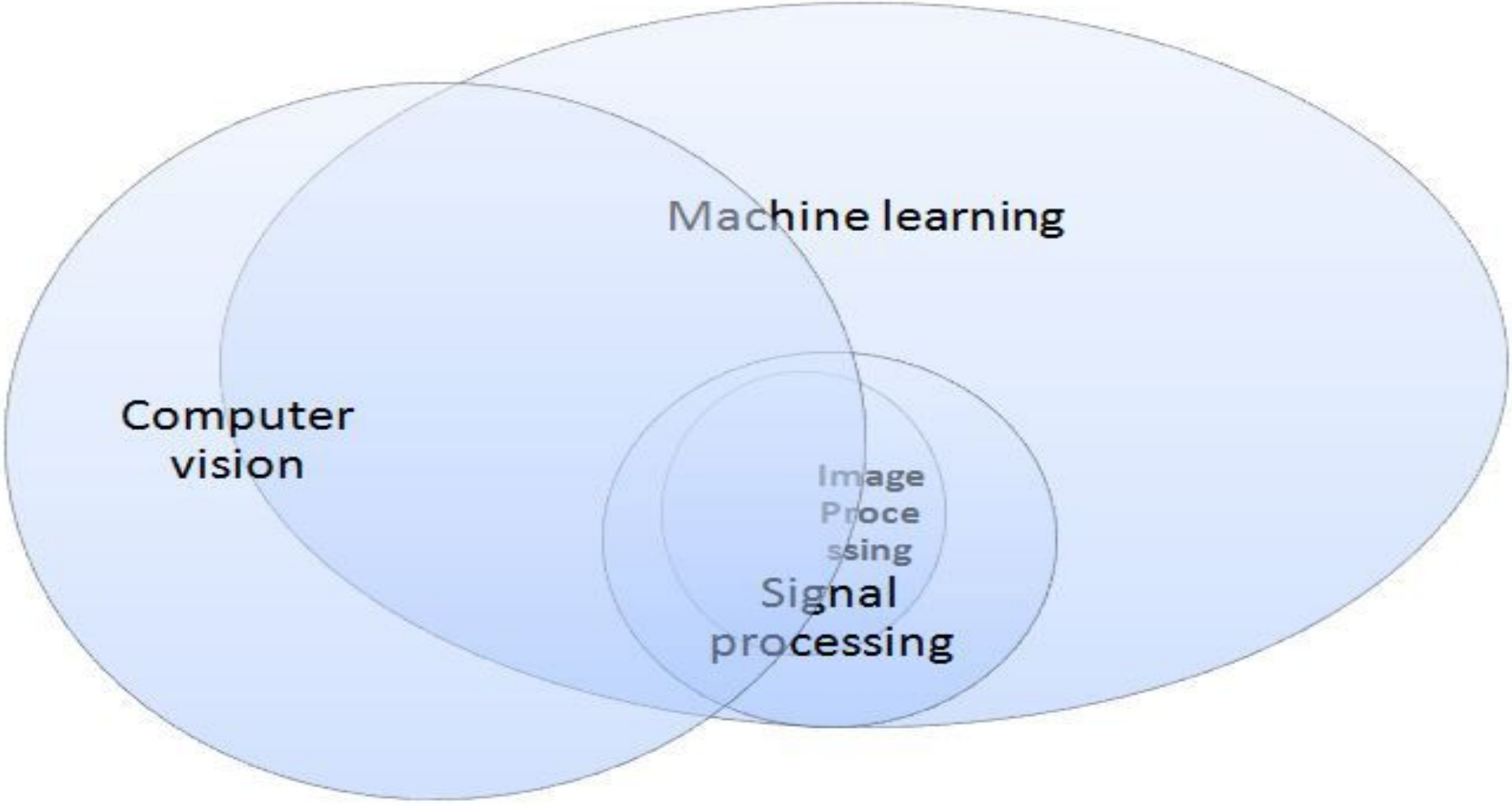
- Predict what a human would perceive in an image
- How do we interpret that image in our brain
- What all results do we extract from that image

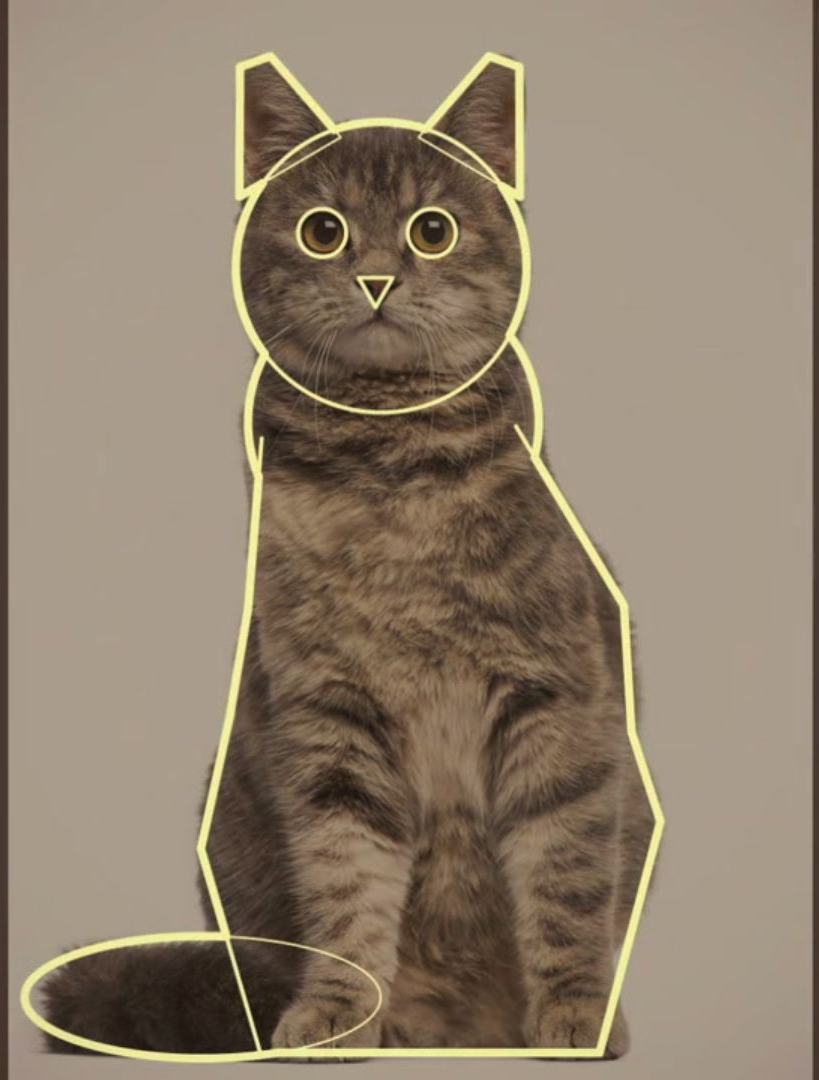
Difference b/w Image Processing & Computer Vision

- Image Processing is a part of Computer Vision
- Computer Vision uses Image Processing algorithms to get information from the image and then it interprets that information to achieve its target.
- The main difference is in goals not in methods.

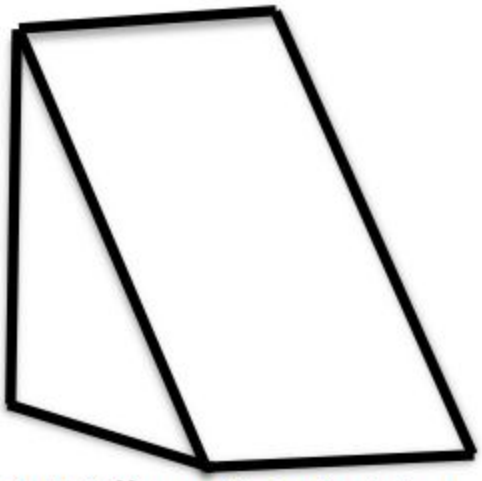
Recognition Clues

- Colour
- Texture
- Pattern
- Shape
- Association


Machine learning
Computer vision
Image Proce ssing
Signal processing



(a) Original picture



(b) Differentiated picture

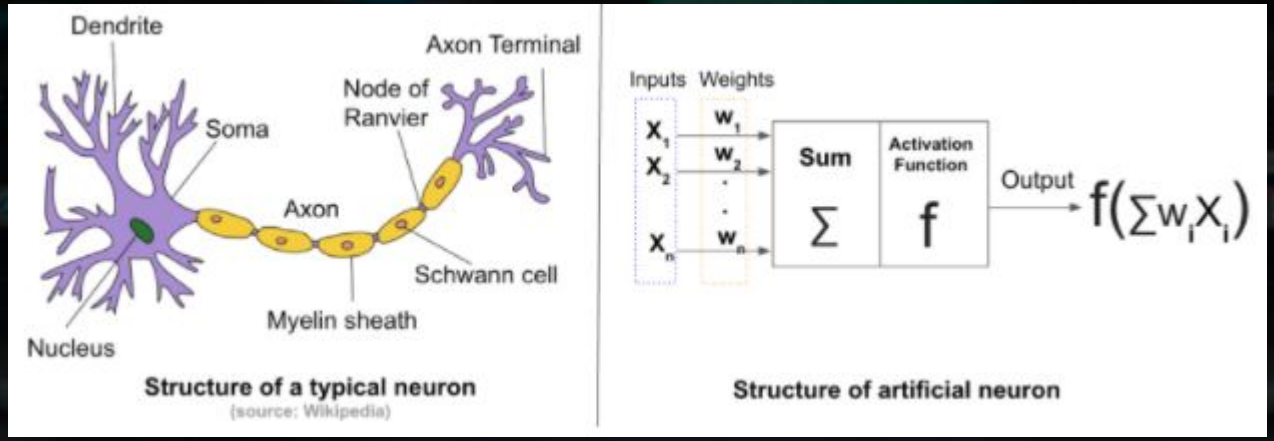
(c) Feature points selected

Now when we have got the feature points now it is the time to identify the object.

For this we will learn an important algorithm of machine learning known as “Neural Networks”.

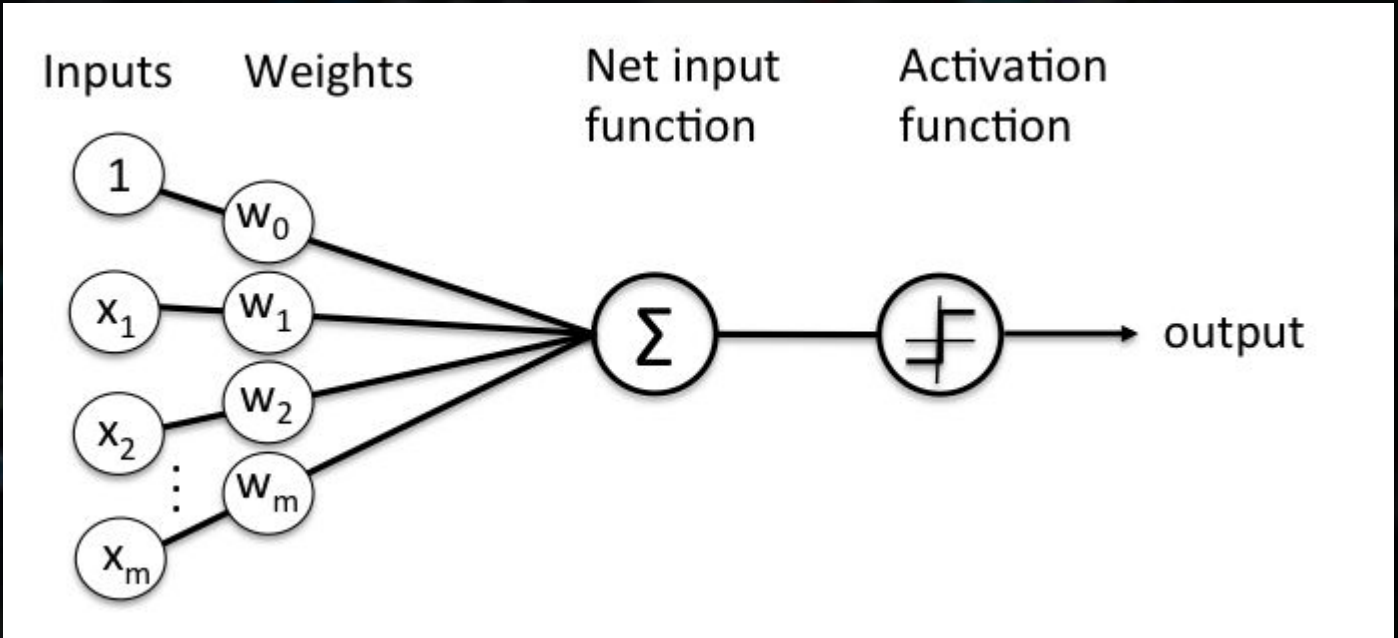
Brain Neurons

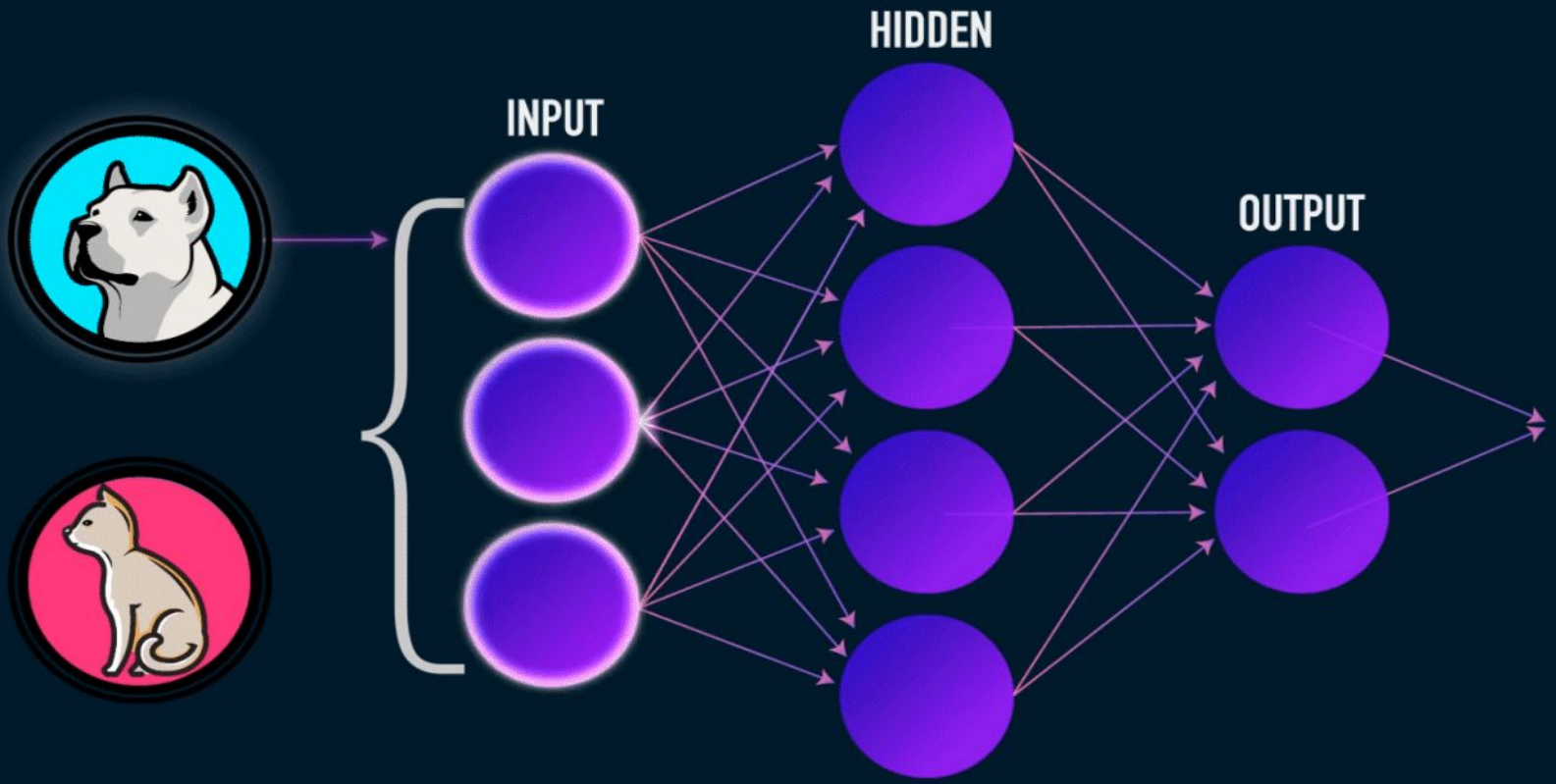
- Many neurons possess structures known as dendrites which receives the information and and manipulate with it before passing it to terminal
- Some neurons interacts by one synapses some by thousands.



Brain Neurons

Neural Network



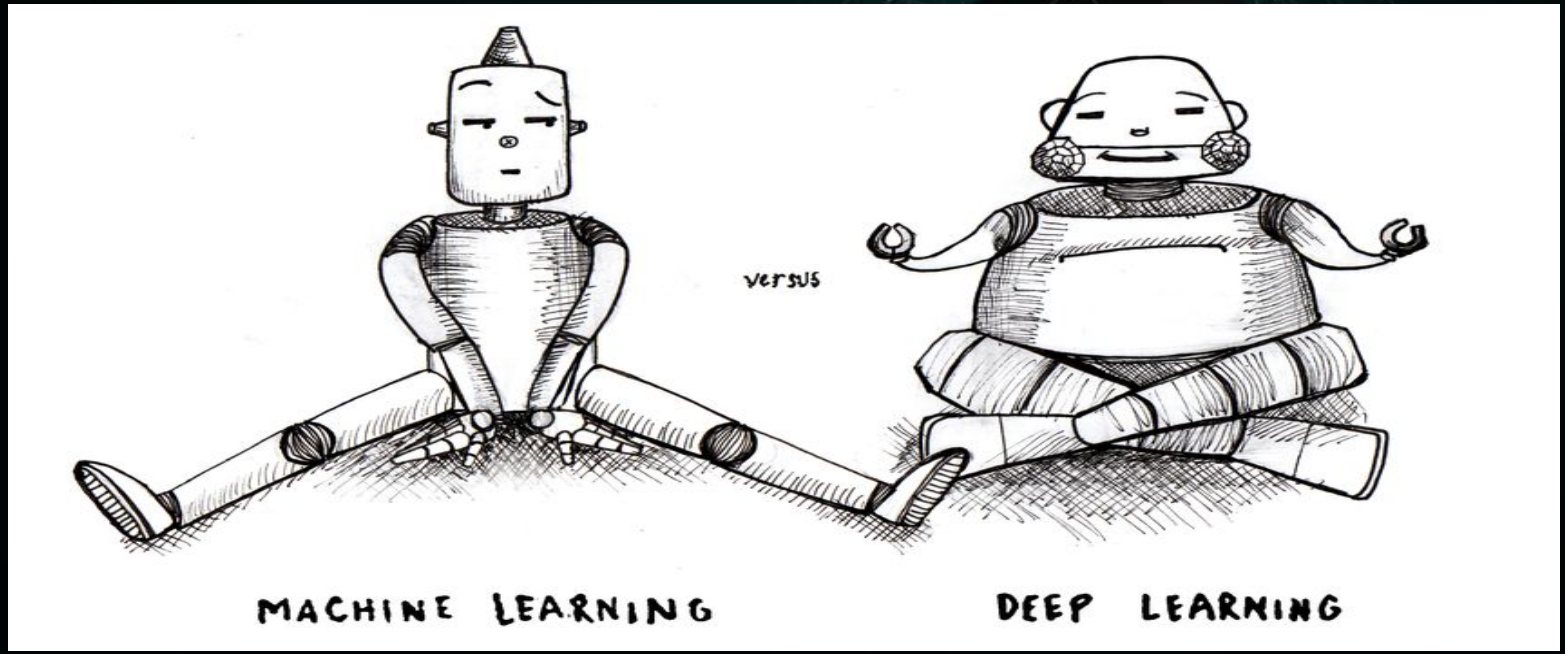

HIDDEN
INPUT
OUTPUT

MACHINES CAN'T REPLICATE HUMAN IMAGE RECOGNITION

THANK YOU

Deep Learning

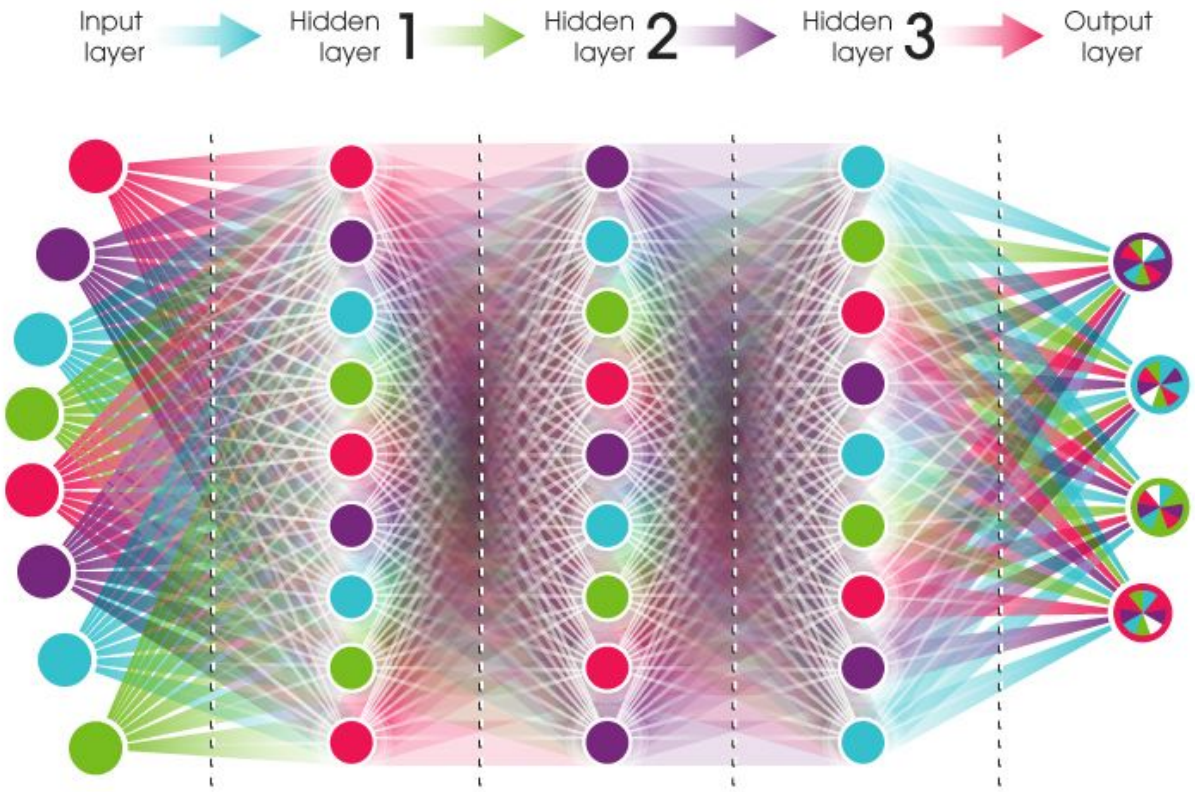
What do you think Deep Learning would be?



Deep learning (DL) is part of a broader family of machine learning methods based on learning data representations. DL uses architectures consisting of multiple nonlinear transformations.

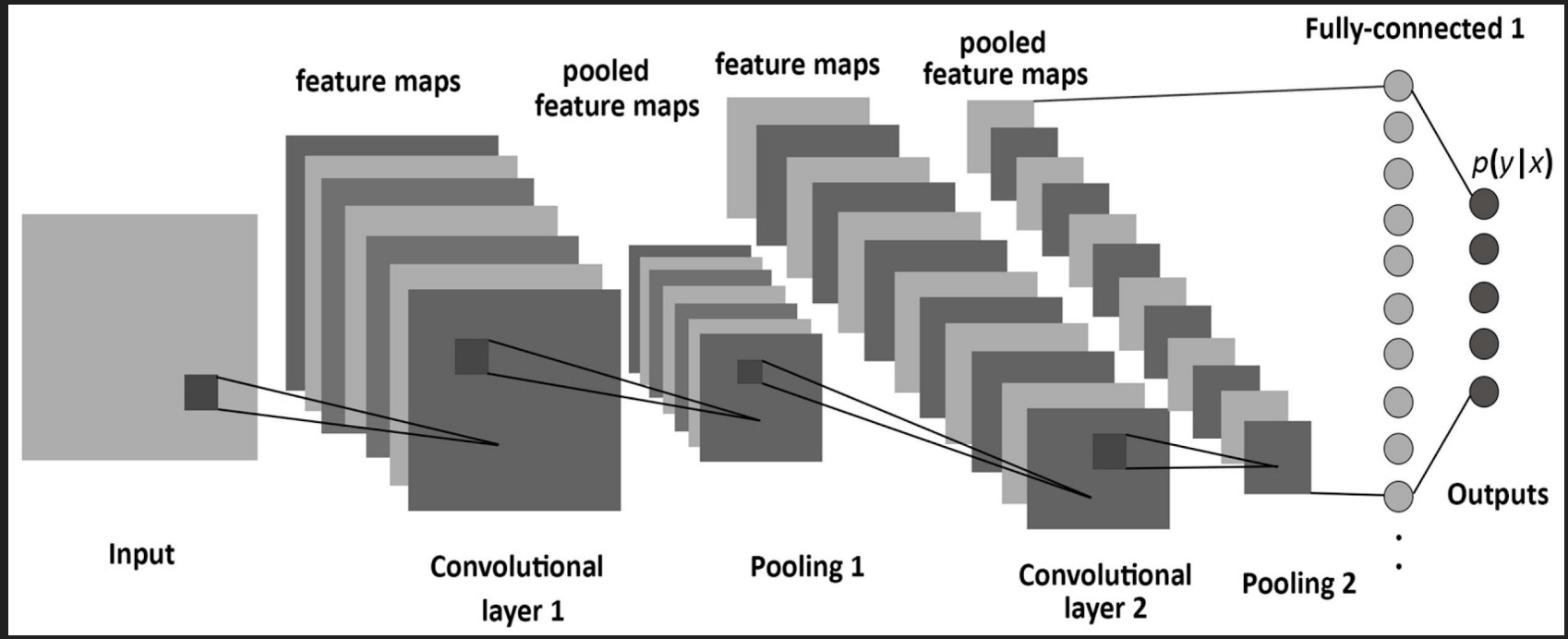
DL involves use of denser neural networks to derive high - level intelligence in systems.

DEEP NEURAL NETWORK



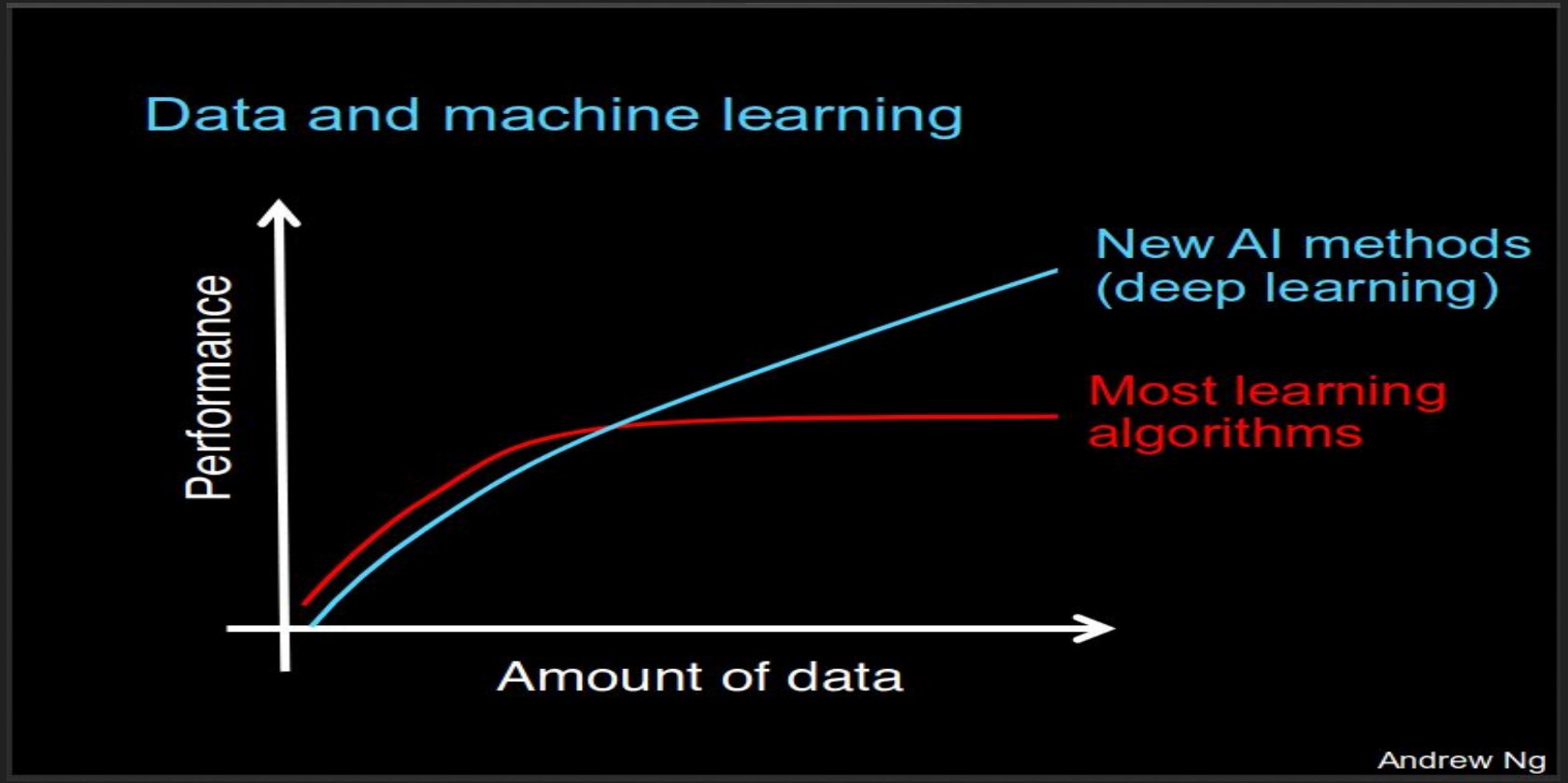
neuralnetworksanddeeplearning.com - Michael Nielsen, Yoshua Bengio, Ian Goodfellow, and Aaron Courville, 2016.

By “denser network”, I meant..



And this can be upto 150 layers (approx., build and used successfully) !!

Benefits of DL over other algorithms:

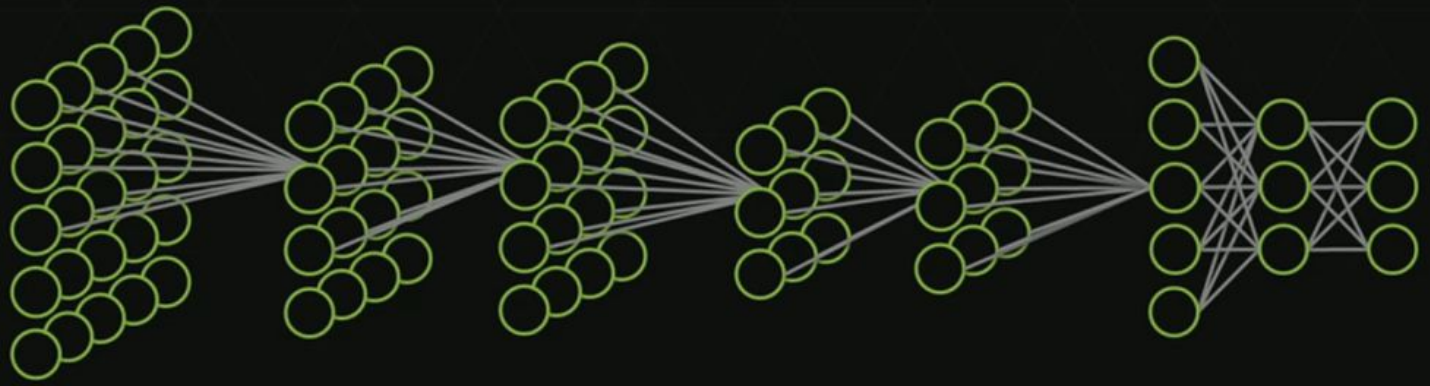


DL vs. ML

- DL requires a lot of unlabeled training data to make concise conclusions while ML can use small data amounts provided by users.
- Unlike ML, DL needs high-performance hardware.
- ML requires features to be accurately identified by users while DL creates new features by itself.
- In comparison with ML, DL needs much more time to train.
- Unlike DL, ML can provide enough transparency for its decisions.

HOW A DEEP NEURAL NETWORK SEES

Image



"Audi A7"

Image source: "Unsupervised Learning of Hierarchical Representations with Convolutional Deep Belief Networks" ICML 2009 & Comm. ACM 2011. Honglak Lee, Roger Grosse, Rajesh Ranganath, and Andrew Ng.

https://youtu.be/aircAruvnKk

Hype or Reality?

Quotes

I have worked all my life in Machine Learning, and I've never seen one algorithm knock over benchmarks like Deep Learning
– Andrew Ng (Stanford & Baidu)

Deep Learning is an algorithm which has no theoretical limitations of what it can learn; the more data you give and the more computational time you provide, the better it is *– Geoffrey Hinton (Google)*

Human-level artificial intelligence has the potential to help humanity thrive more than any invention that has come before it *– Dileep George (Co-Founder Vicarious)*

For a very long time it will be a complementary tool that human scientists and human experts can use to help them with the things that humans are not naturally good *– Demis Hassabis (Co-Founder* DeepMind)


Thanks!