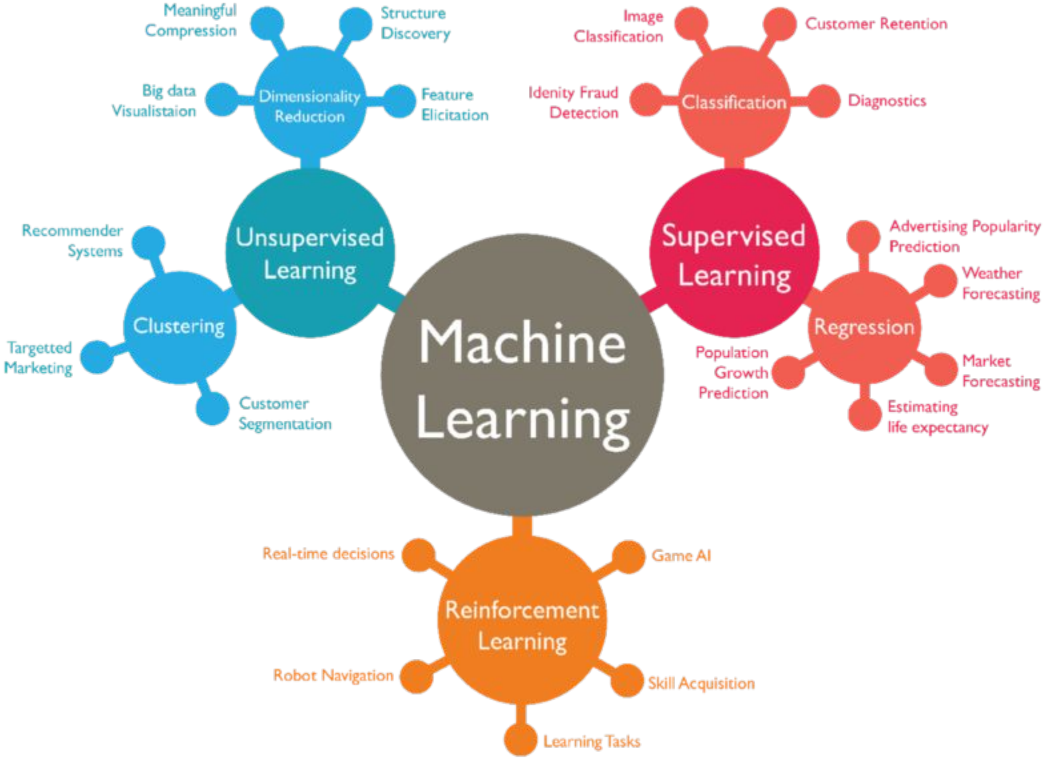

Introduction to AI and Image Recognition Using Neural Networks

Your Instructors

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Vision for a Better World

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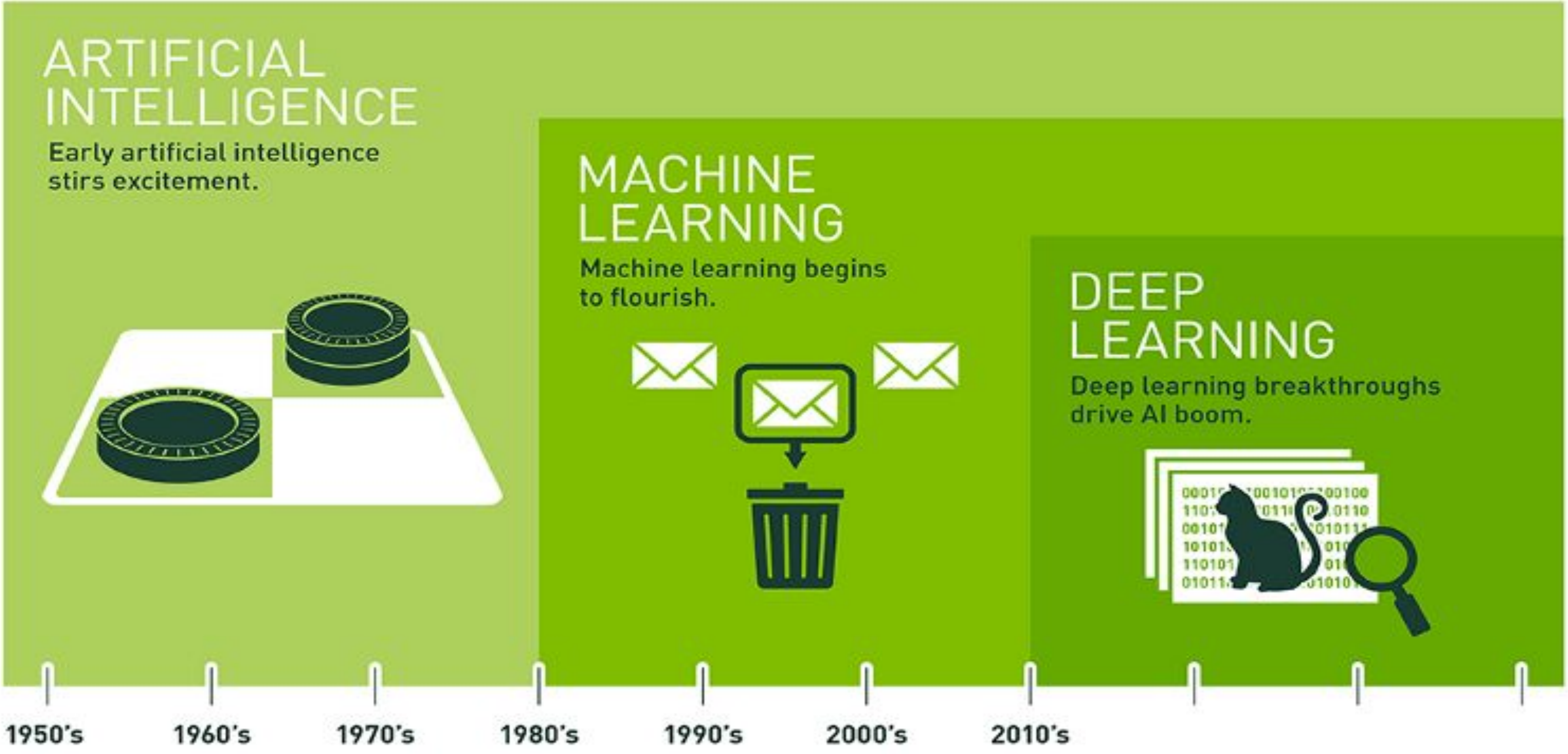
Deep Learning, Data Scientist
At athenahealth

Agenda

1. Introduction to AI and applications
2. Building intuition

3. Machine Learning fundamentals

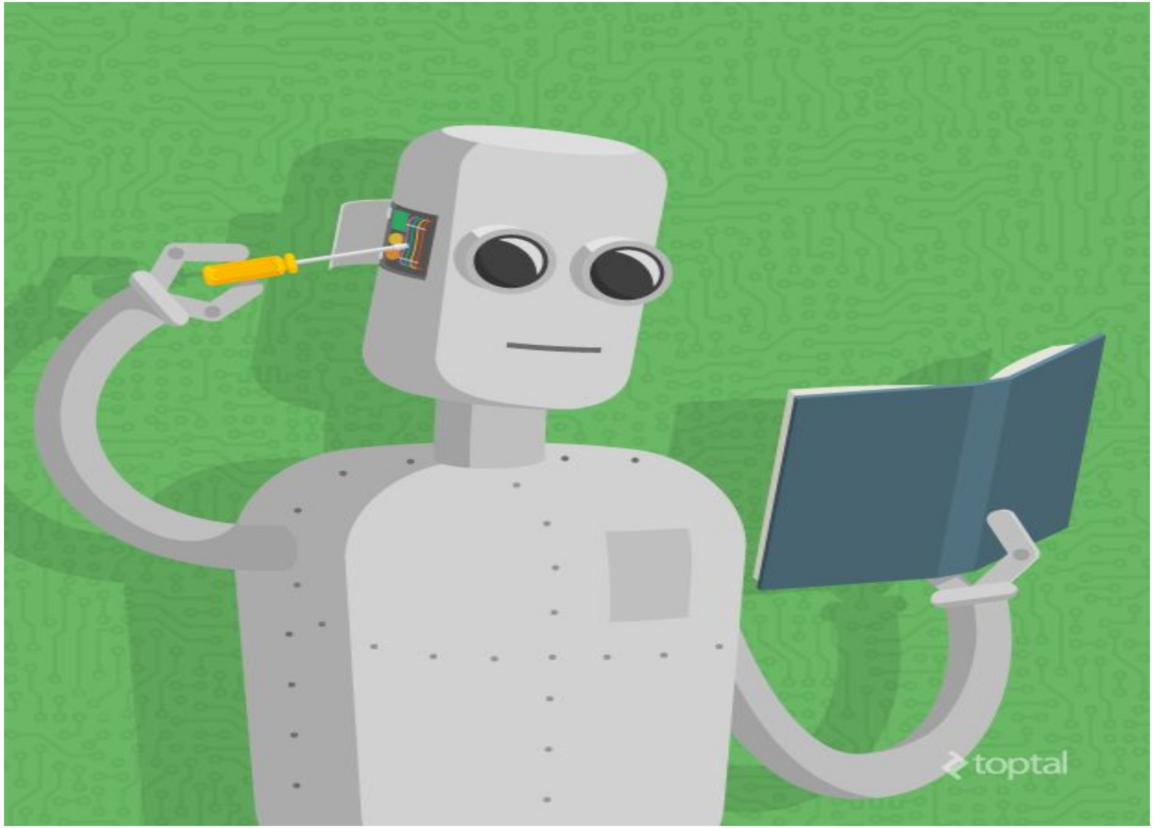
4. Convolutions and Hands-on using convolution with images
5. Deep Learning Introduction with Neural Nets and CNN
6. Hands-on with digit classification



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Source: Nvidia

Do Machines Read Books To Learn?



How Does a Child Learn?

- By examples - Showing a lot of images of dogs, chicken, parrot, gaucamole.
- By seeing patterns - eyes, nose, ears, legs...

HOW UBER'S FIRST SELF-DRIVING CAR WORKS

Top mounted **LiDAR** beams 1.4 million laser points per second to create a 3D map of the car's surroundings.

There are **20 cameras** looking for braking vehicles, pedestrians, and other obstacles.

A **colored camera** puts LiDAR map into color so the car can see traffic light changes.

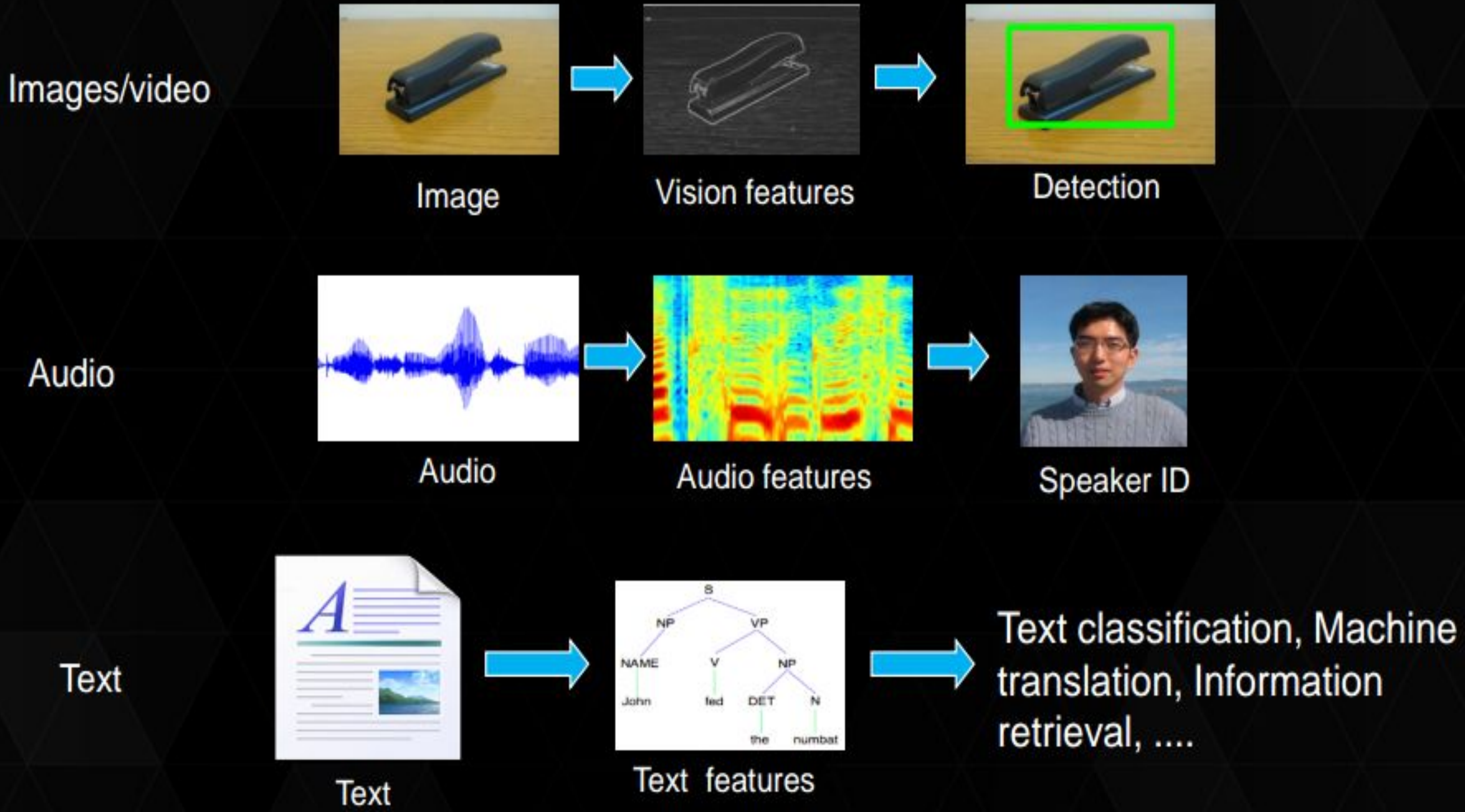
Antennae on the roof rack let the car position itself via GPS.

LiDAR modules on the front, rear, and sides help detect obstacles in blind spots.

A cooling system in the car makes sure everything runs without overheating.

SOURCE: Uber

BUSINESS INSIDER


Images/video
Image
Vision features
Detection
Audio
Audio
Audio features
Speaker ID
Text
Text
S
NP
VP
NAME
V
NP
John
fed
DET
N
the
numbat
Text features
Text classification, Machine translation, Information retrieval, ...

Applications

- Healthcare
  - Early detection of cancer!
  - Better medicines
  - Understanding DNA

- Education
  - Smart tutors
  - Automation of administrative tasks
  - Personalised learning programs

- Automobiles
  - Autonomous vehicles
  - Quadcopters

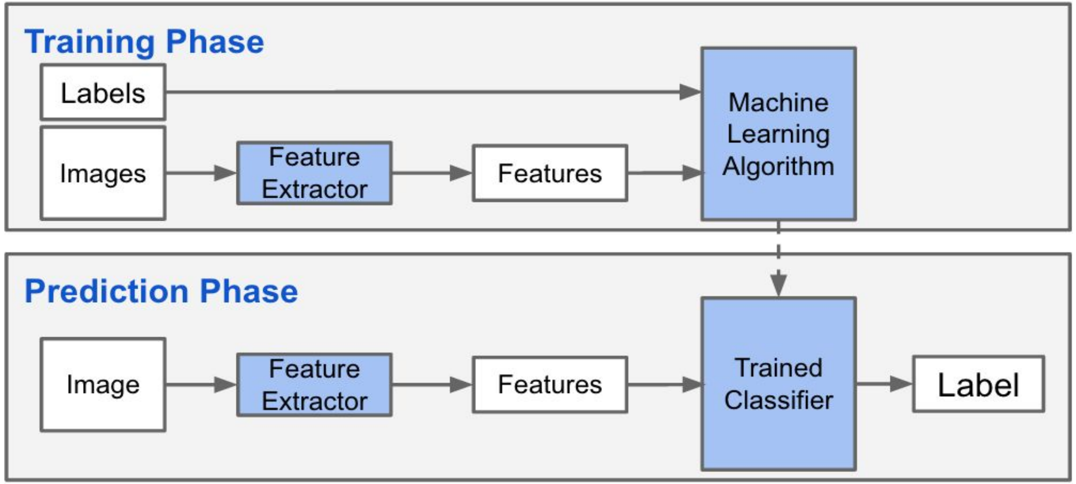
- Media and Marketing
  - Content creation
  - Recommendation Engine

- Online Retail
  - E-Commerce
  - Visual shopping

Applications are diverse but methods are generic!

ML Concepts

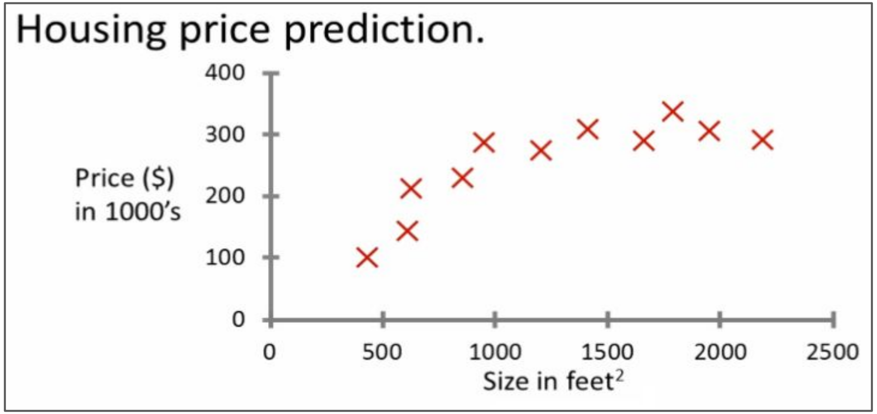
- Learning = Improving with experience at some task
  - **Improve over task, T** (e.g. spam mail classification, image classification, etc)
  - **With respect to performance measure, P** (accuracy, precision, error)
  - **Based on experience, E** (learning from samples)



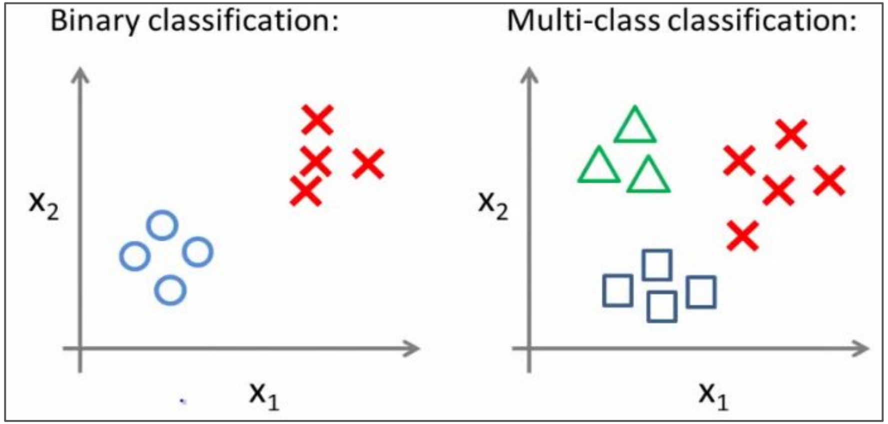
Machine Learning Phases

Common Problem Types

Regression



Classification

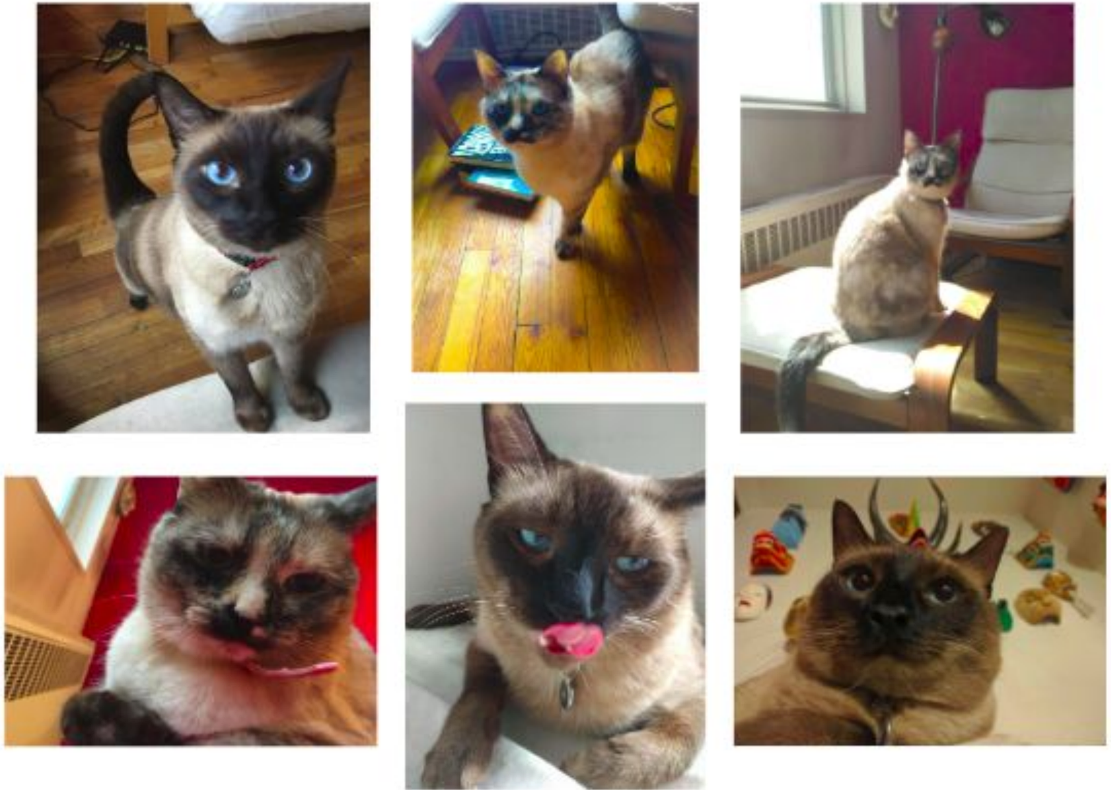


Source: cs229.stanford.edu

Supervised Learning (Classification)

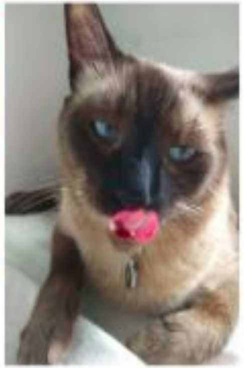
https://towardsdatascience.com/explaining-supervised-learning-to-a-kid-c2236f423e0f

Unsupervised Learning



https://hackernoon.com/unsupervised-learning-demystified-4060eecedeaf

Unsupervised Learning

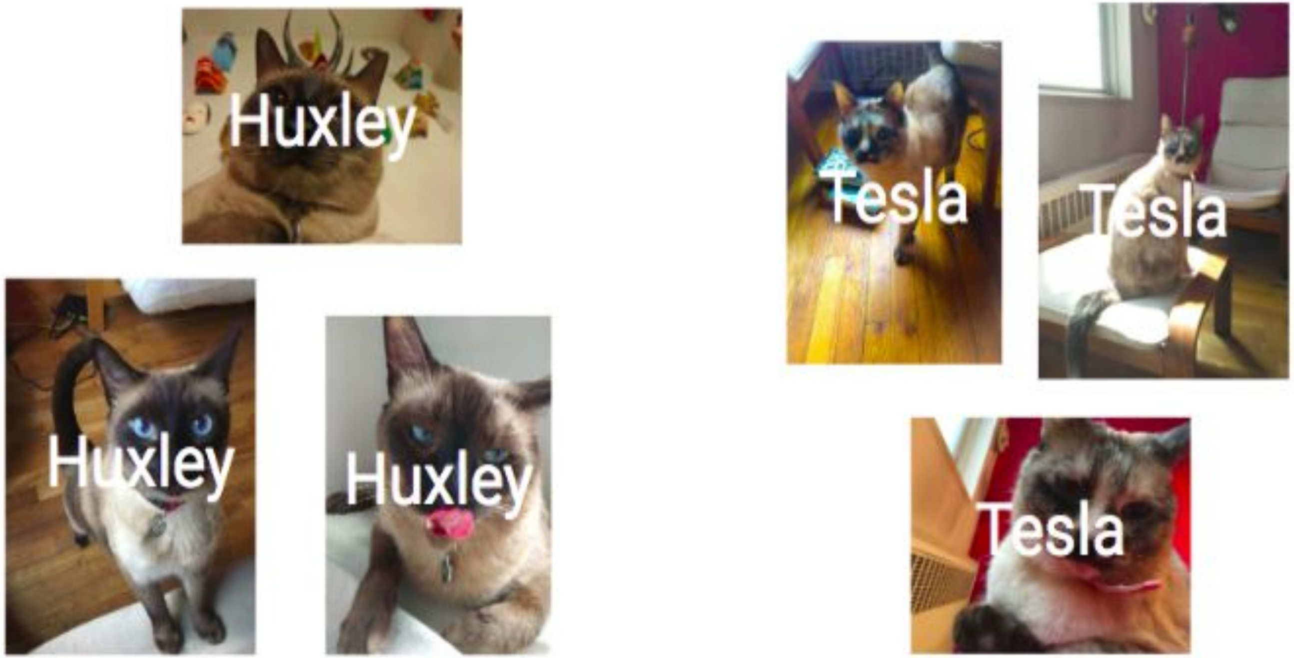



Sitting

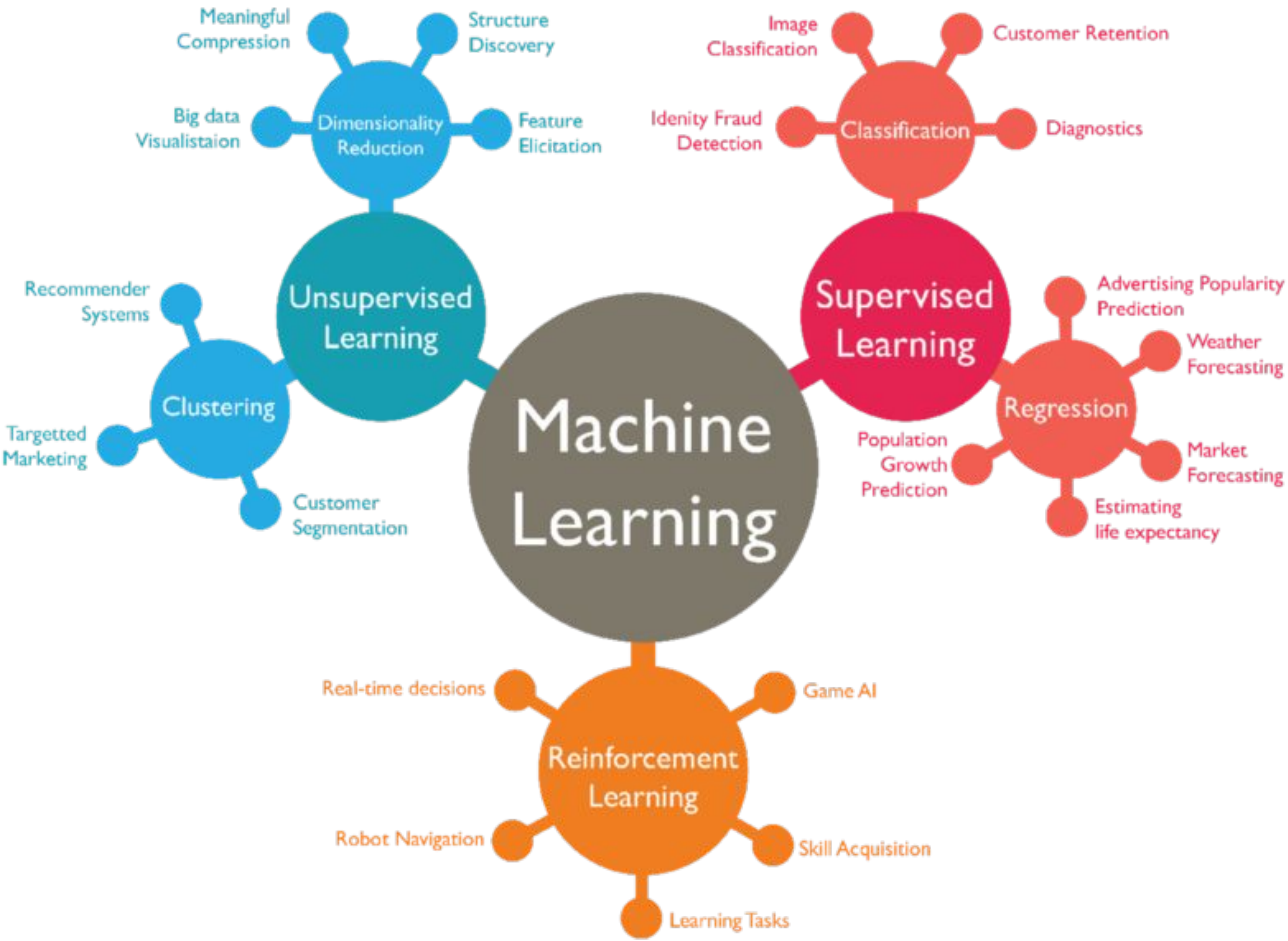

Standing

https://hackernoon.com/unsupervised-learning-demystified-4060eecedeaf

Unsupervised Learning (Clustering)



https://hackernoon.com/unsupervised-learning-demystified-4060eecedeaf


Machine Learning
Unsupervised Learning
Dimensionality Reduction
Meaningful Compression
Structure Discovery
Big data Visualistaion
Feature Elicitation
Clustering
Recommender Systems
Targetted Marketing
Customer Segmentation
Supervised Learning
Classification
Image Classification
Customer Retention
Idenity Fraud Detection
Diagnostics
Regression
Advertising Popularity Prediction
Weather Forecasting
Population Growth Prediction
Market Forecasting
Estimating life expectancy
Reinforcement Learning
Real-time decisions
Game AI
Robot Navigation
Skill Acquisition
Learning Tasks

Key Takeaways

Consider ML when:

1. Hand written rules and equations are too complex
   a. Face recognition
   b. Speech recognition
   c. Pattern recognition
2. Rules of a task are constantly changing
   a. Fraud detection from transactions
   b. Anomaly in sensor data
3. Nature of the data changes and the program needs to adapt
   a. Automated trading
   b. Energy demand forecasting
   c. Predicting shopping trend

Let’s Get Our Hands Dirty!

Equation Formulation by Intuition

What is the missing value?

- 3 => 9
- 4 => 16
- 8 => 64
- 9 => ???

What is the underlying equation?

Y = mx + c … Straight line equation

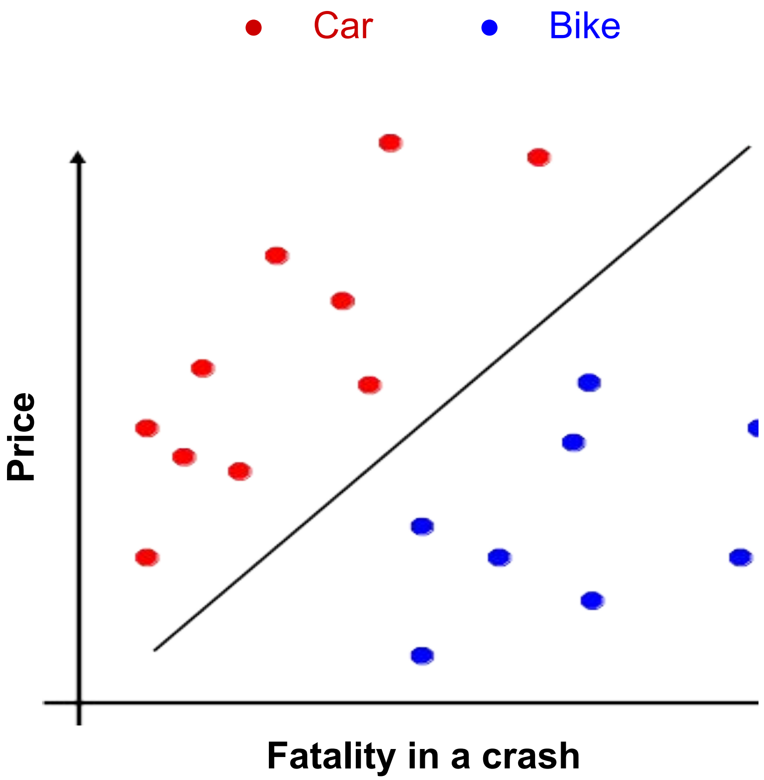
Y = a*x1 + b*x2 + c ... Straight line with 2 parameters

For a **car vs bike** example,

X1: Input 1 (No of wheels)
X2: Input 2 (Price)
a, b: Parameters/Importance (θ)

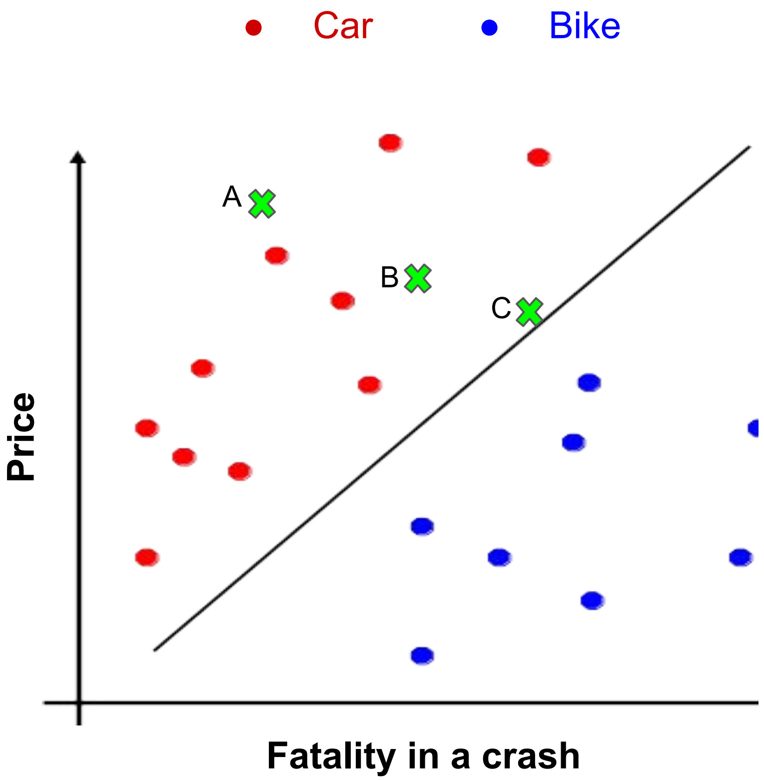
Decision Boundary

Classification problem using linear equation

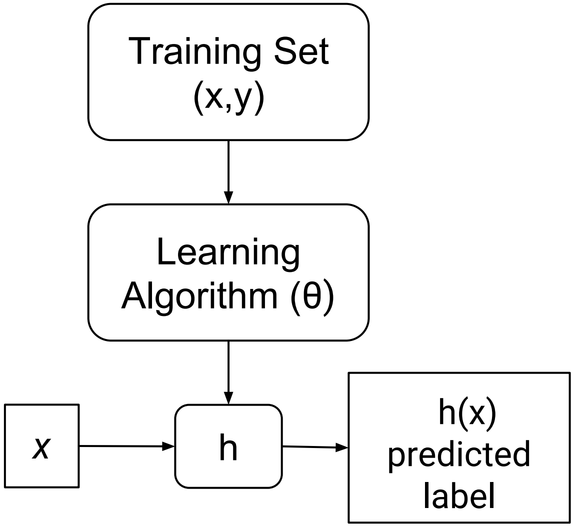


Margins and Confidence

Among A, B and C, which data point would you confidently classify as a Car?



Procedure



Learning

X - Input data   Y - Labels   h(x) = Predicted label

- Hypothesis/Activation function $h_\theta(x) = g(\theta^T x) = \frac{1}{1+e^{-\theta^T x}}$
- Cost function $J(\theta) = \frac{1}{2}\sum_{i=1}^{m}(h_\theta(x^{(i)}) - y^{(i)})^2$

  If you got it wrong, by how much?

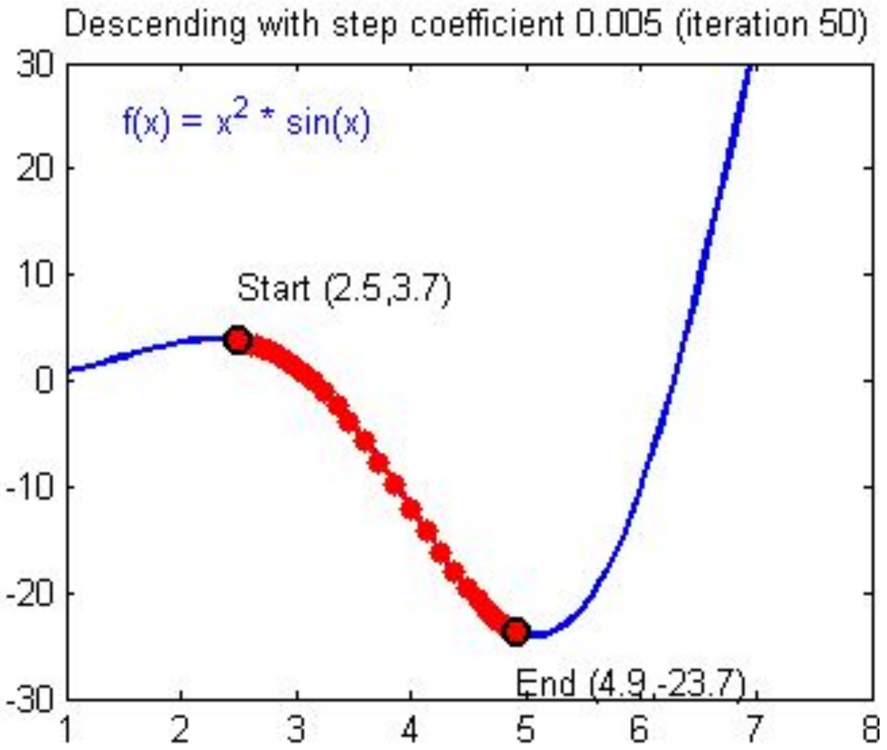
- Update Rule $\theta_j := \theta_j - \alpha\frac{\partial}{\partial\theta_j}J(\theta).$

  Aim: Minimise the **cost function** using **update rule (gradient descent)**

Gradient Descent

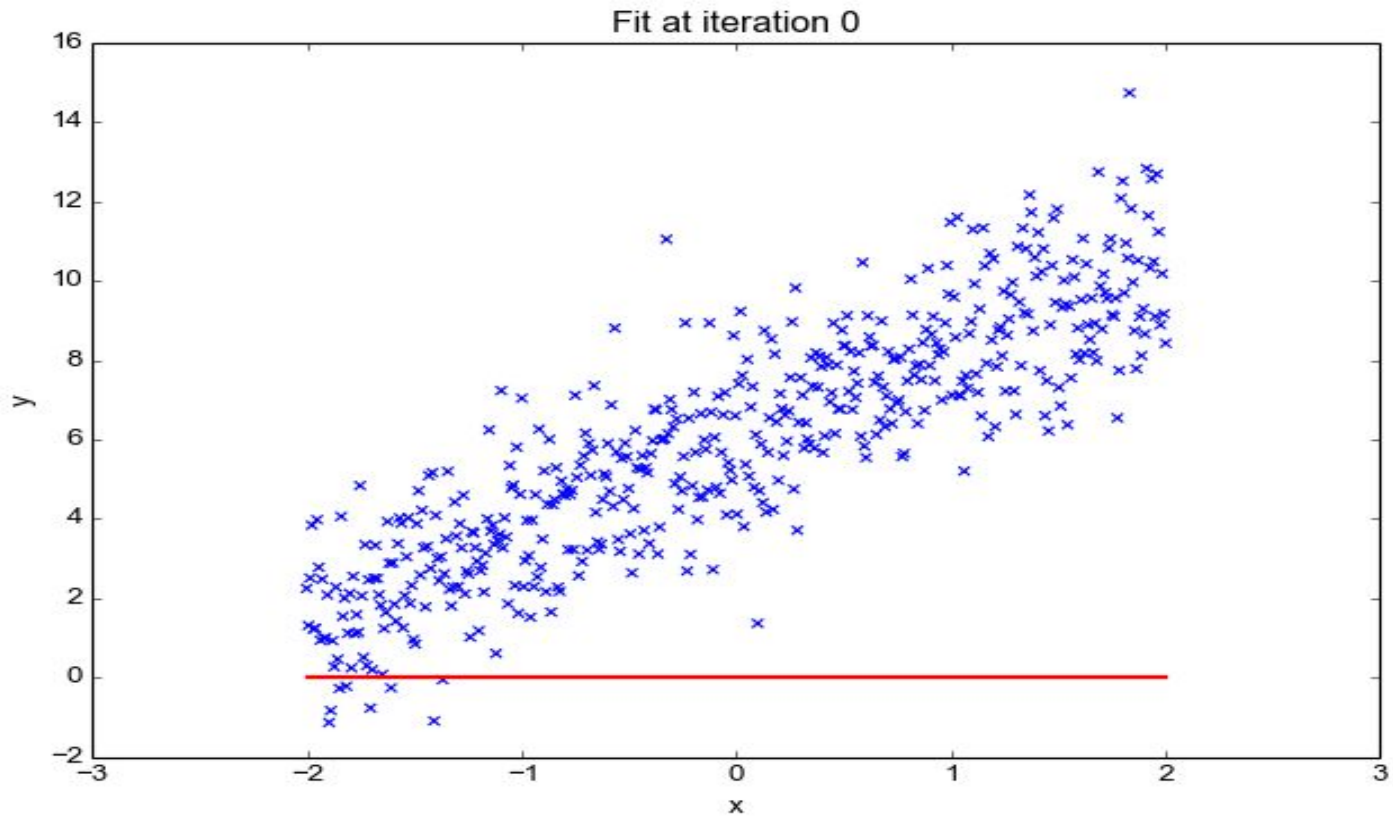
- Start with some initial value of θ and repeatedly performs update such that loss decreases!
- The magnitude of the update is proportional to the error term

  $(y(i) - h\,\theta\,(x\,(i)\,))$



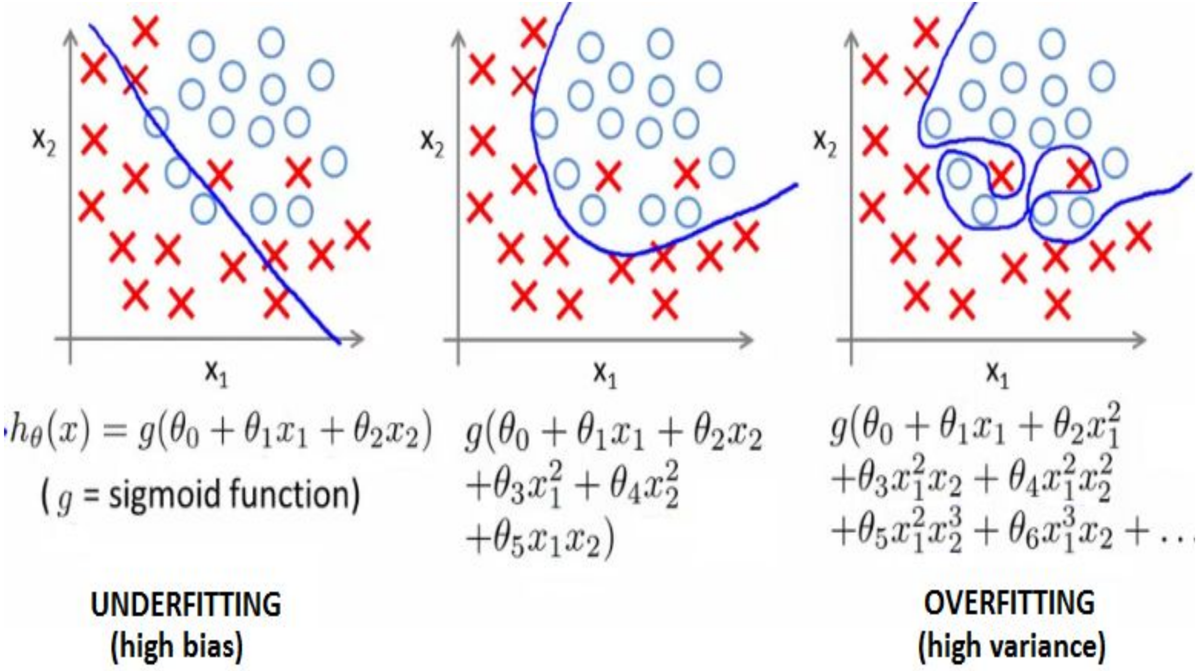
https://giphy.com/gifs/gradient-6QlTwkigqg4yk https://hackernoon.com/life-is-gradient-descent-880c60ac1be8

Fit



Source: https://towardsdatascience.com/linear-regression-the-easier-way-6f941aa471ea

Underfitting and Overfitting

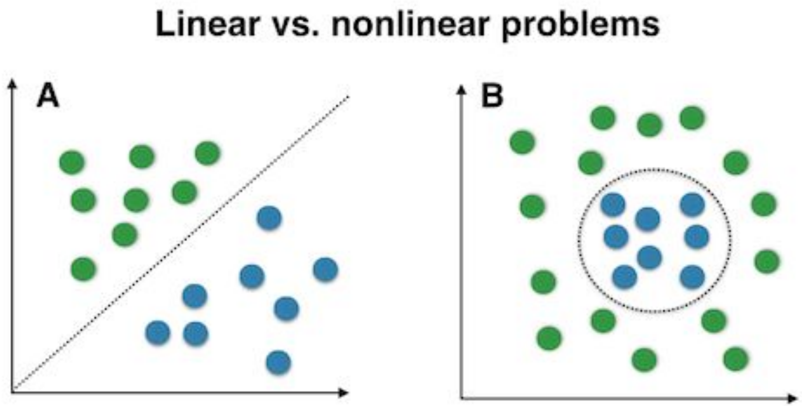


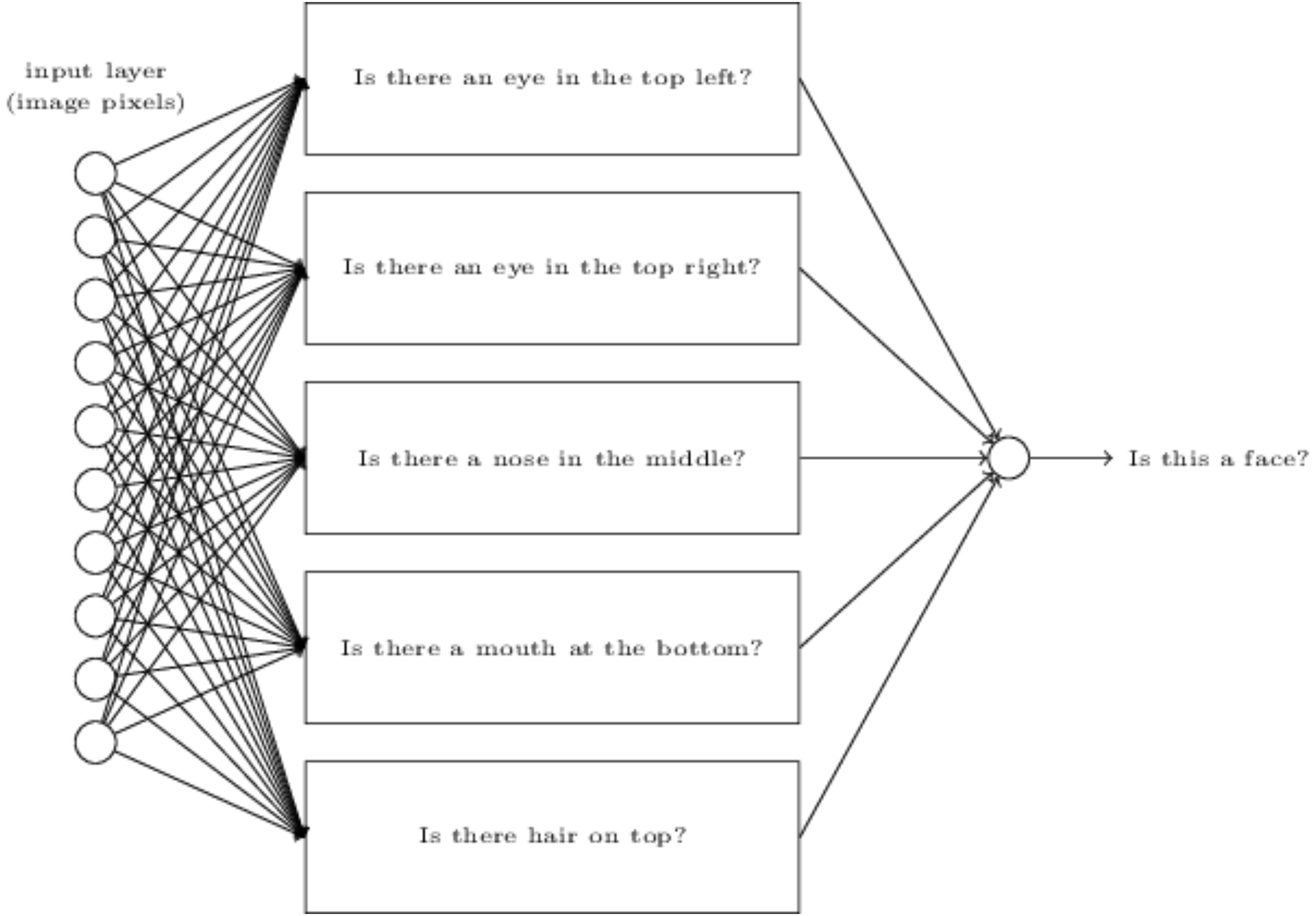
Fixing the fit

1. Cross validation
2. Feature selection
3. Regularization
4. Dropout
5. Batch Normalisation

Problem of Linear Separability

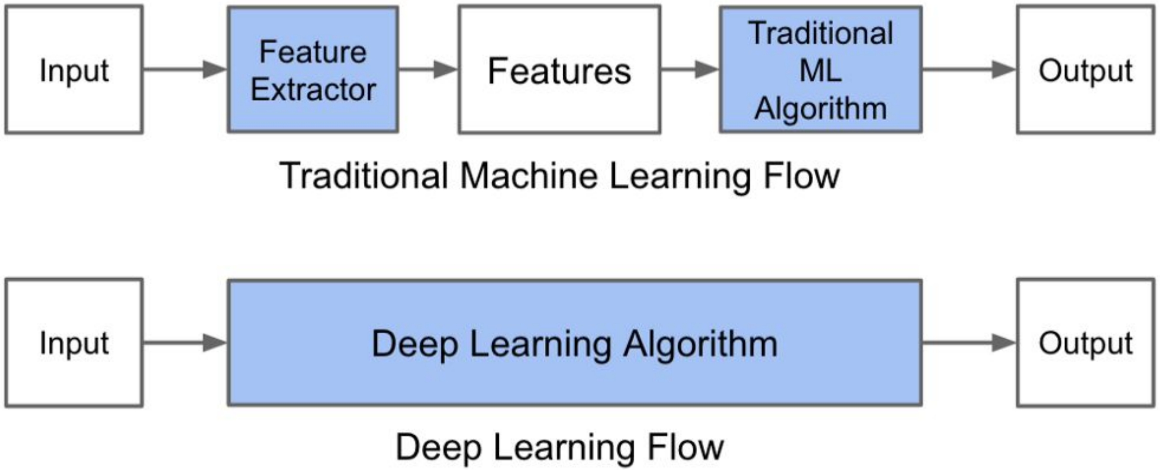
- Can this model provide solutions to all kinds of data patterns we might encounter in practice?
- **Key observation** - Cannot directly classify data. Convert the data to a new feature space to classify
- **Nonlinearities** should be included in the network!





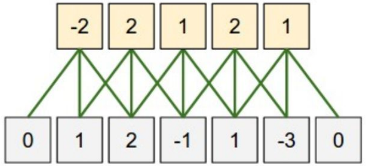
Deep Learning Starts!

Deep Learning Vs Machine Learning

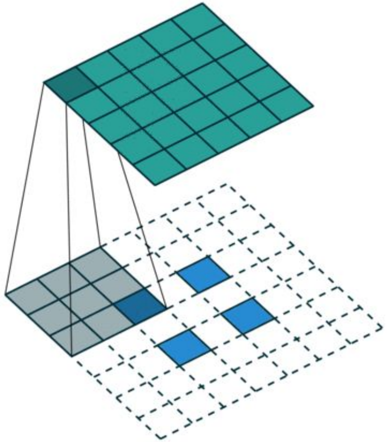


Convolutions

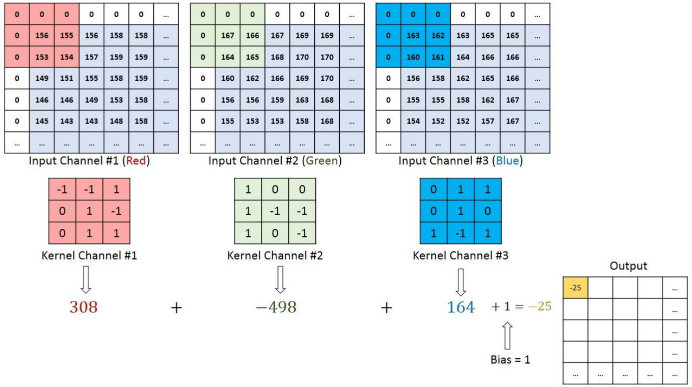
1D

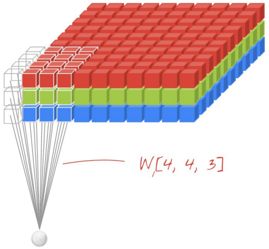


2D



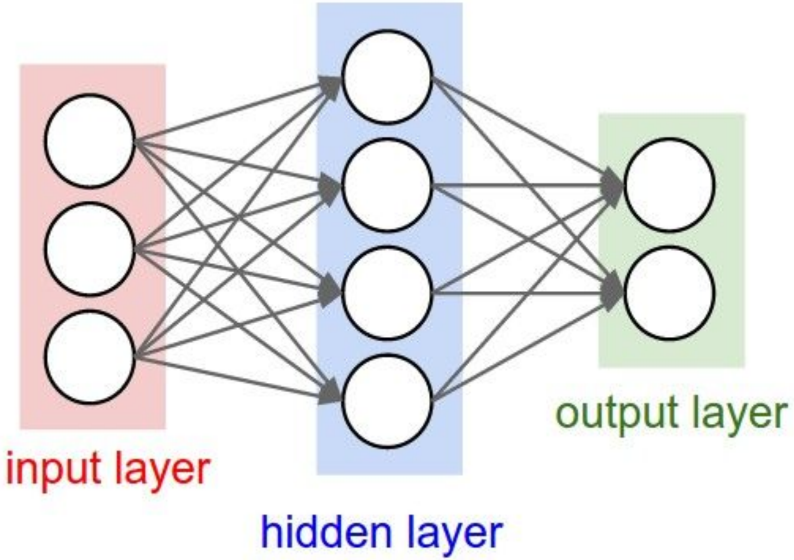
3D

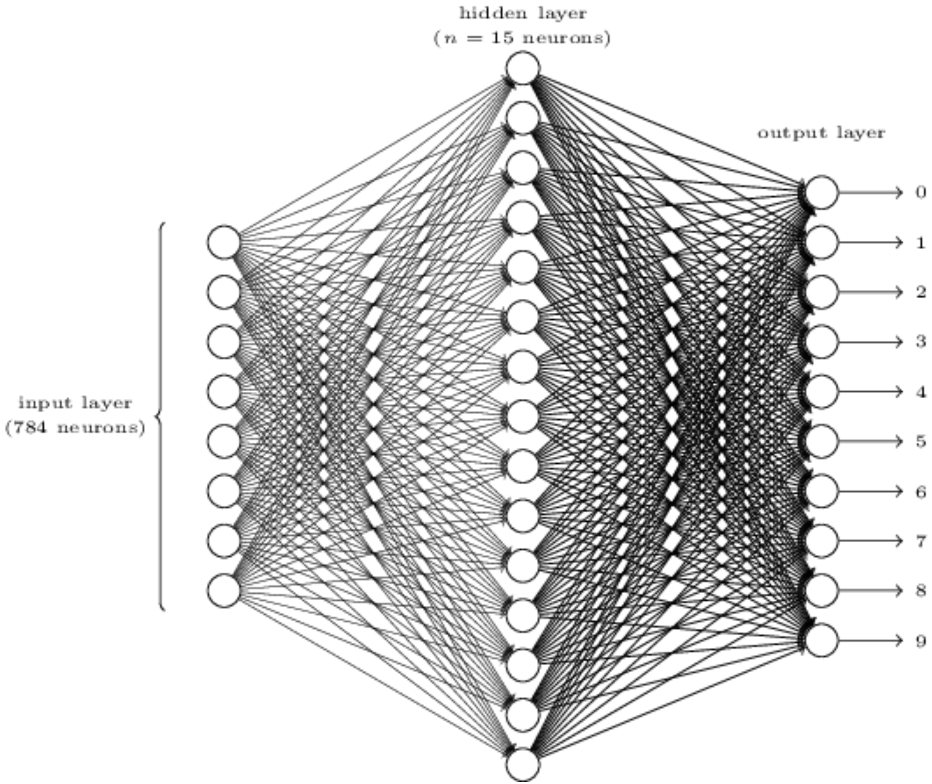




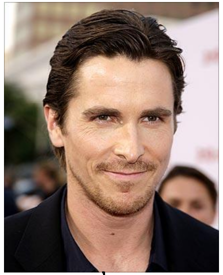
*Ref-http://cs231n.stanford.edu/
*Ref-https://sites.google.com/site/nttrungmtwiki/home/it/data-science---python/tensorflow/tensorflow-and-deep-learning-part-3
*Ref-https://towardsdatascience.com/types-of-convolutions-in-deep-learning-717013397f4d

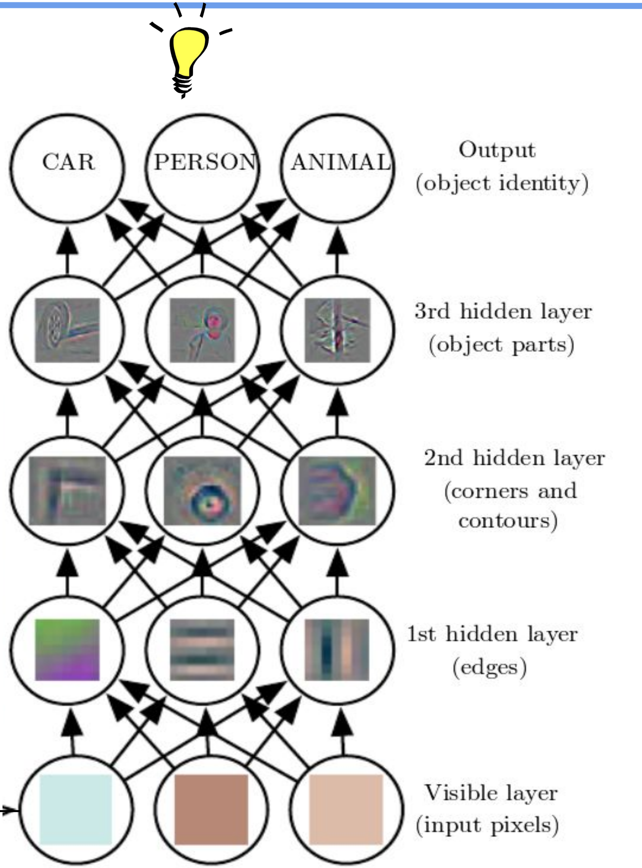
Layers

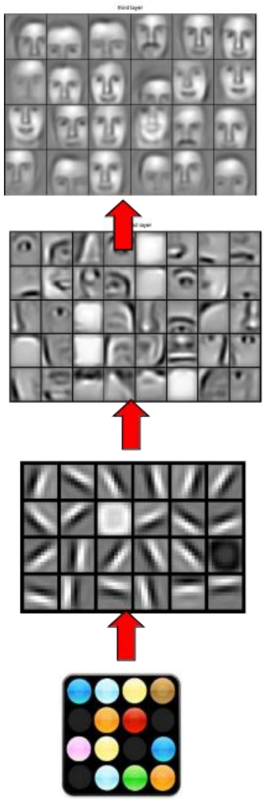

input layer
hidden layer
output layer


hidden layer
(n = 15 neurons)
output layer
input layer
(784 neurons)
0
1
2
3
4
5
6
7
8
9

What Do CNNs Learn?

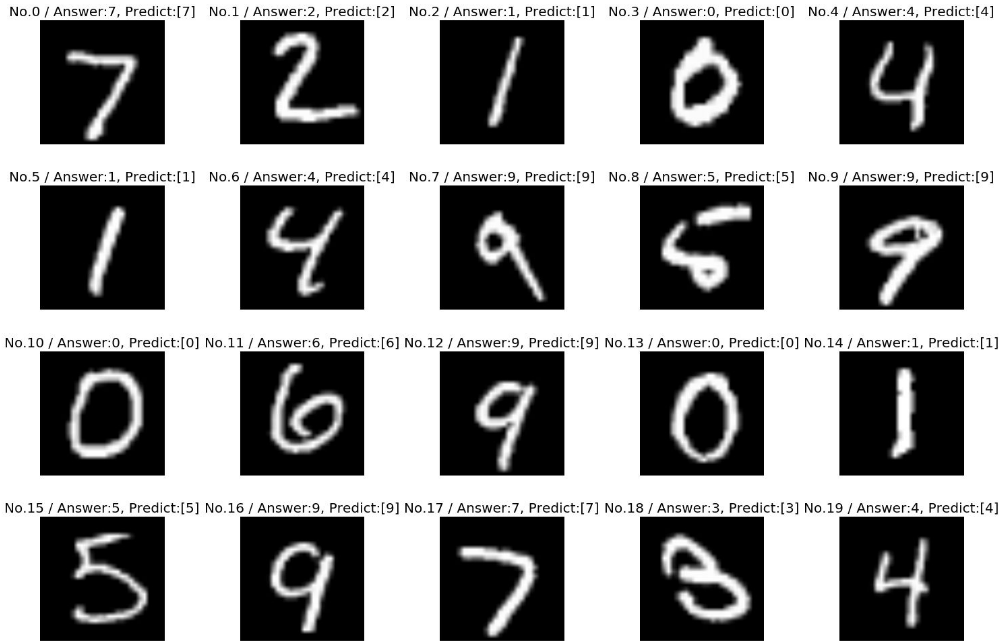






MNIST

- A database of images of handwritten numerals
- Objective: To identify the digit
- [MNIST Demo]



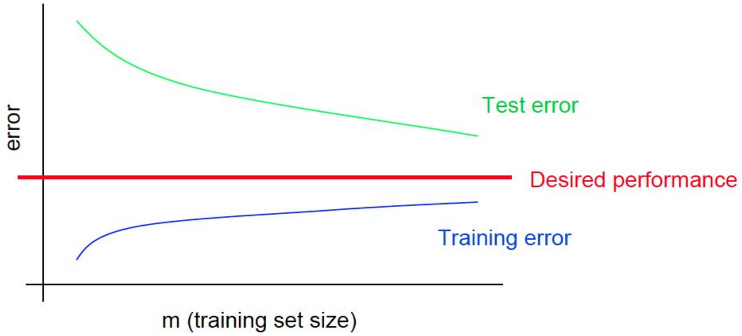
Next Steps For You!

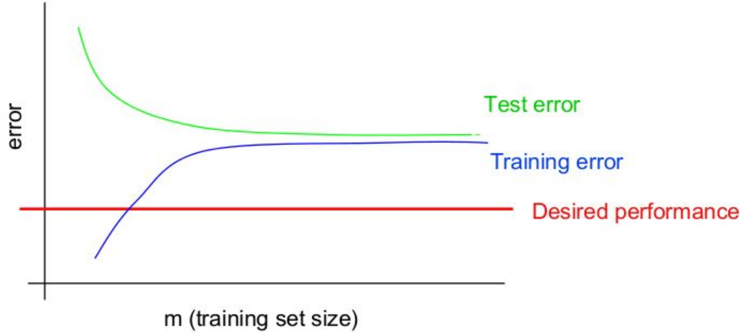
- Stay updated - ideas, tools, research
- Online communities
- Meetups
- Courses and workshops
- Projects
- Internships/Jobs/Startup
- Reach out to us!

ML Advice - Diagnostics

Try getting more training examples	Fixes high Variance
Try a smaller set of features	Fixes high Variance
Try a larger set of features	Fixes high Bias
Try changing features (e.g, email header features)	Fixes high Bias
Run gradient descent for more iterations	Fixes optimization algorithm
Try Newton's method	Fixes optimization algorithm
Use a different value for λ	Fixes optimization objective
Try using an SVM	Fixes optimization objective

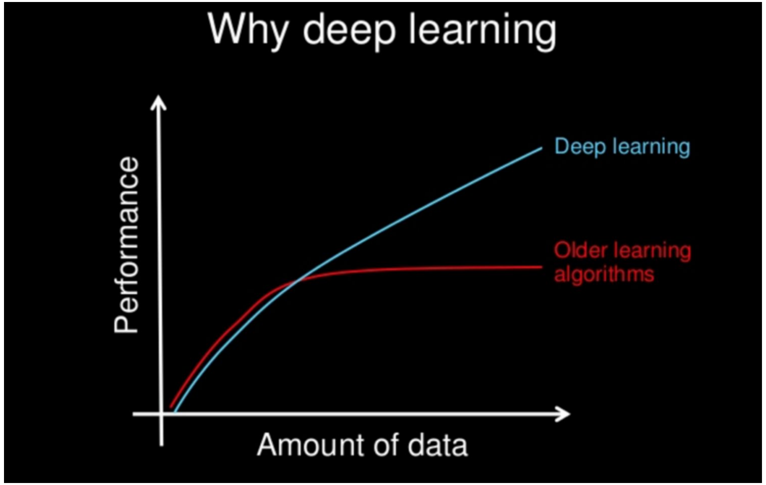
Credits: cs229, Andrew Y. Ng

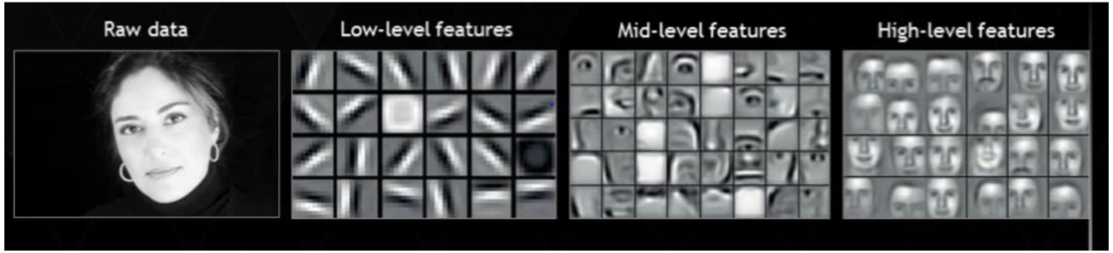


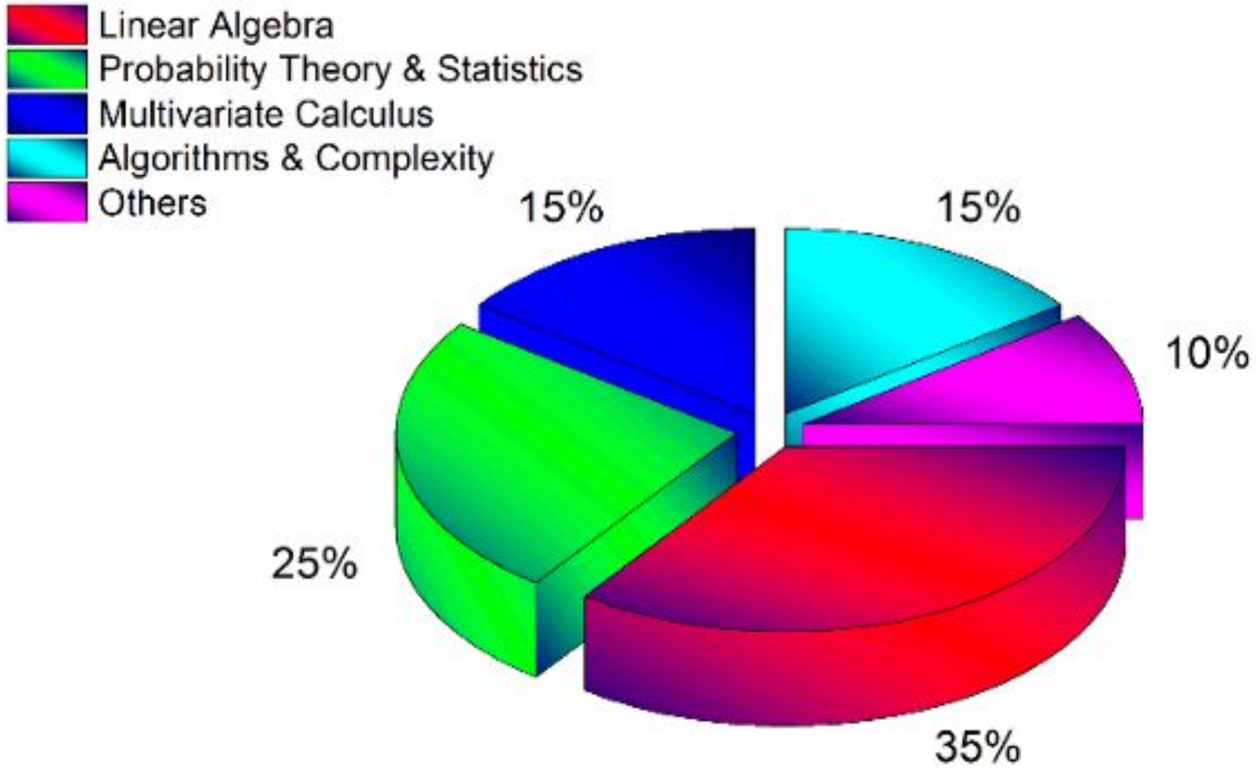


Advantages of DL Over CV and ML

1. Automatic feature selection
2. Easy approach to build a system when huge amount of data is available

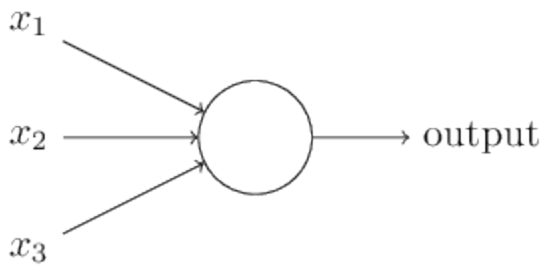






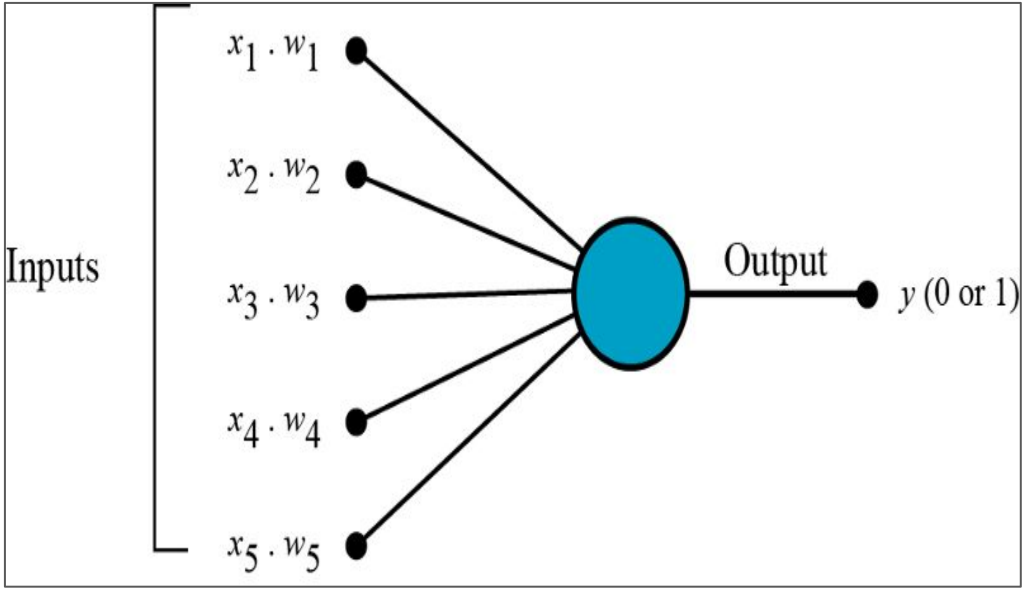
Importance of Maths Topics Needed For Machine Learning

Simple Model (Neuron/Perceptron)



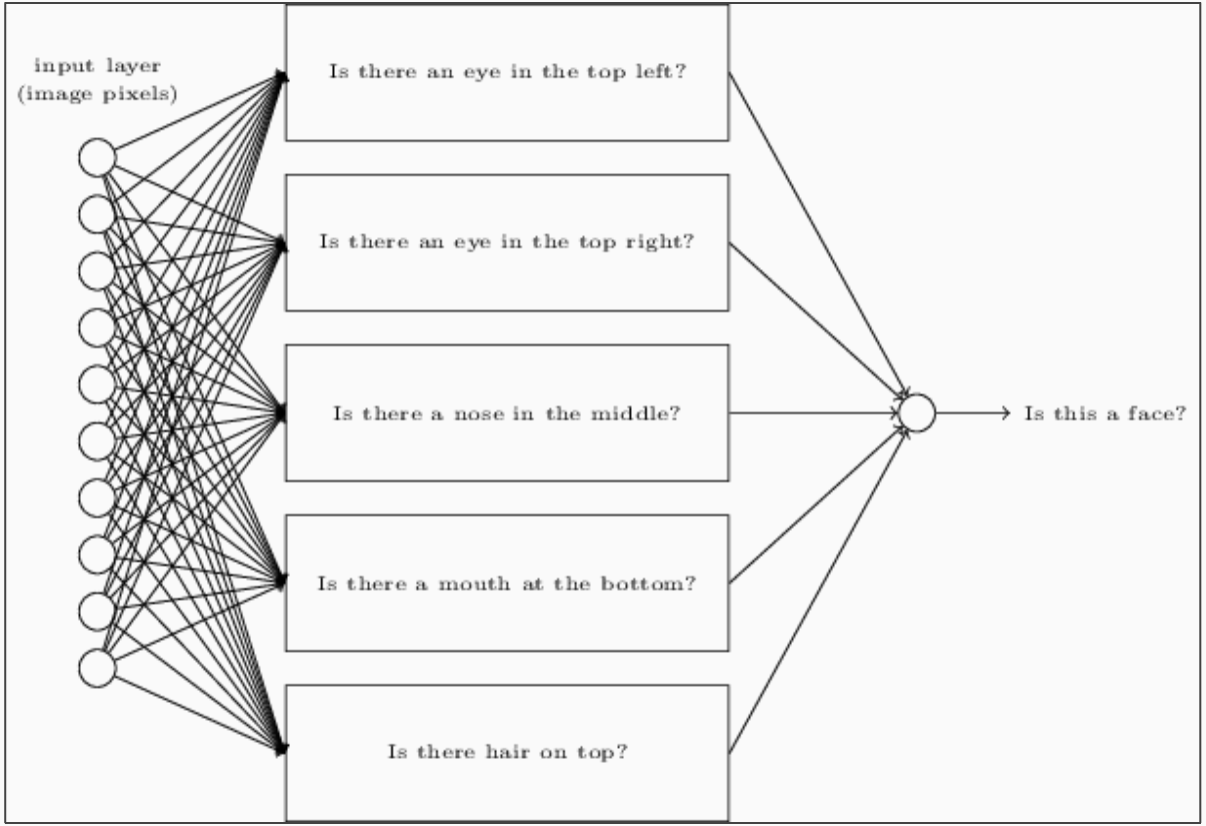
x1, x2, x3 -> **Inputs** (pixels/data points)

w -> **Parameters** (Trained by algorithm)

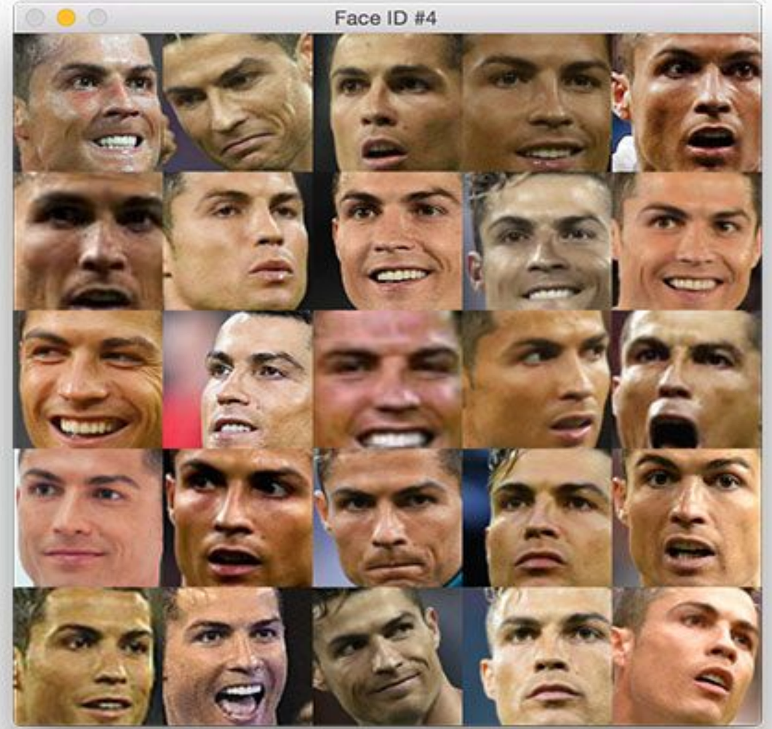


What does Deep Learning learn?

- [Tensorflow Playground]()

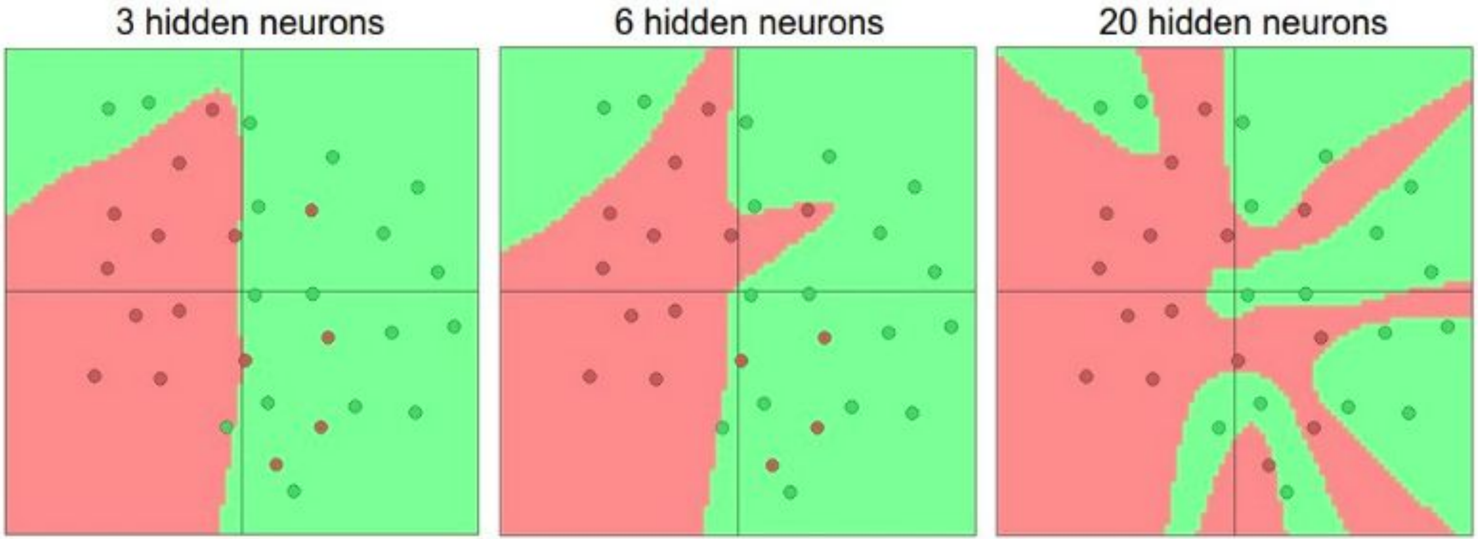


Ref: http://neuralnetworksanddeeplearning.com/chap1.html



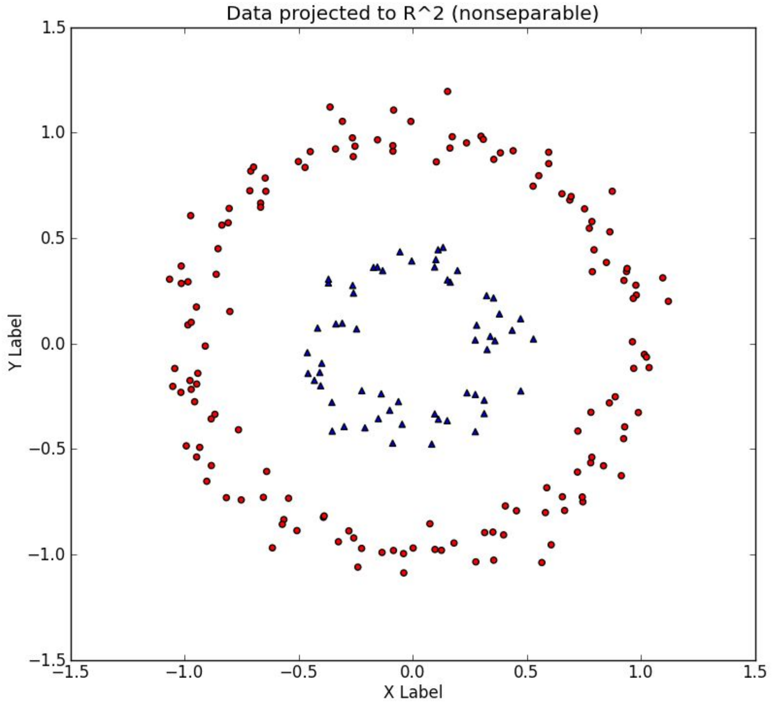
https://www.pyimagesearch.com/2018/07/09/face-clustering-with-python/

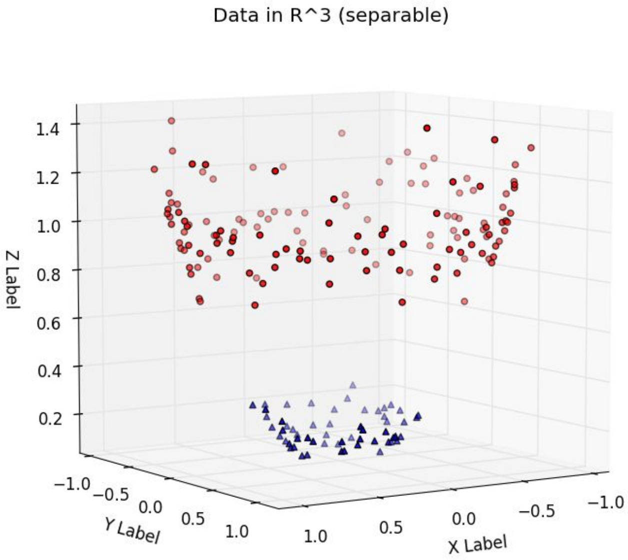
How Does Depth Help?



Larger Neural Networks can represent more complicated functions. The data are shown as circles colored by their class, and the decision regions by a trained neural network are shown underneath. You can play with these examples in this ConvNetsJS demo.

Transformations





Source: eric-kim.net