Introduction to AI

-- Sri Harsha Gajavalli

Artificial Intelligence

"The Science and Engineering of making **Intelligent** Machines"

The term artificial intelligence was first coined in 1956, at the Dartmouth conference.

“The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves.”

History of Technology

- 1771 Industrial Revolution
  - Arkwright's mill in Cramford

- 1826 Age of Steam and Railways
  - "Rocket steam" engine for Manchester railway

- 1875 Age of Steel, Electricity & Heavy Eng.
  - Carnegie Bessemer steel plant in Pittsburgh

- 1908 Age of Oil, Automobile, Mass Production
  - First model T comes out in Detroit

- 1971 Age of Information & Telecommunications
  - Intel microprocessor announced in Santa Clara

- 2017 Age of Artificial Intelligence
  - Machines, data and people connected in new era


MIND
NETWORKS
MACHINE
DEVELOPMENT
PROBLEMS
ENGINEERING
COMPUTING
MIND
NEURAL
MACHINE
TECHNOLOGY
SCIENCE
ROBOTS
INTELLIGENT
INFORMATION
REASONING
INFORMATION
THEORY
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AI?

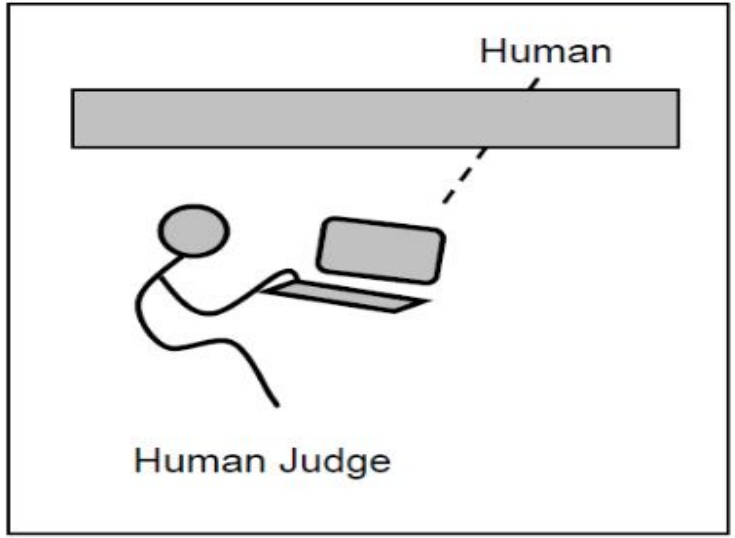
Homo sapiens (Human beings) are able to control (and exploit) other species and nature because of their thinking capability.

We call programs intelligent if they exhibit behaviours that would be regarded intelligent if they were exhibited by human beings

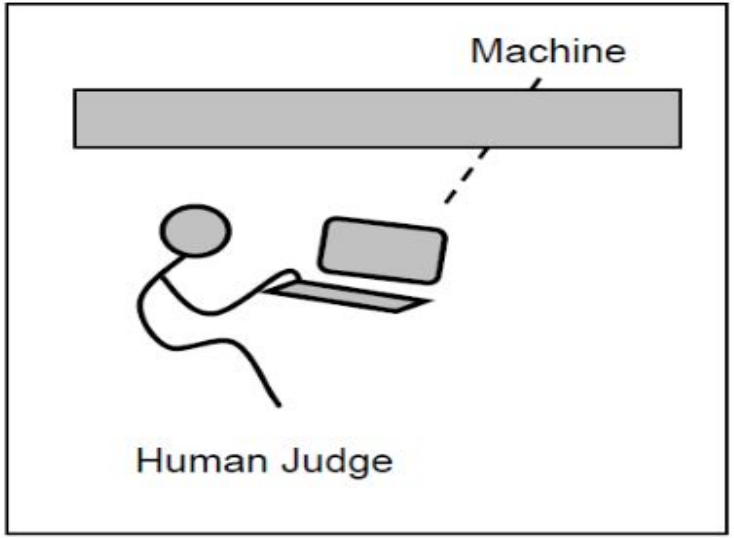
--- Herbert Simon

Human or Machine?

The Turing Test

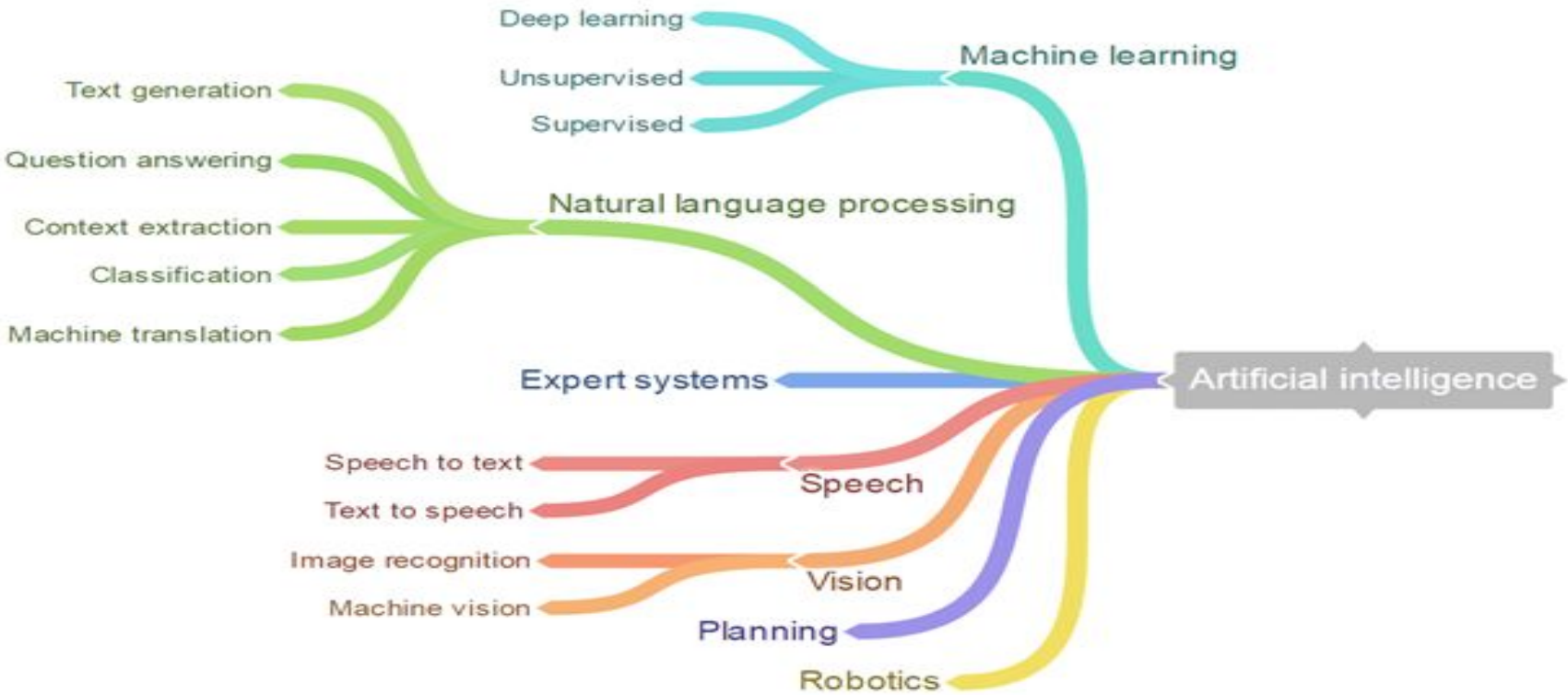


or?

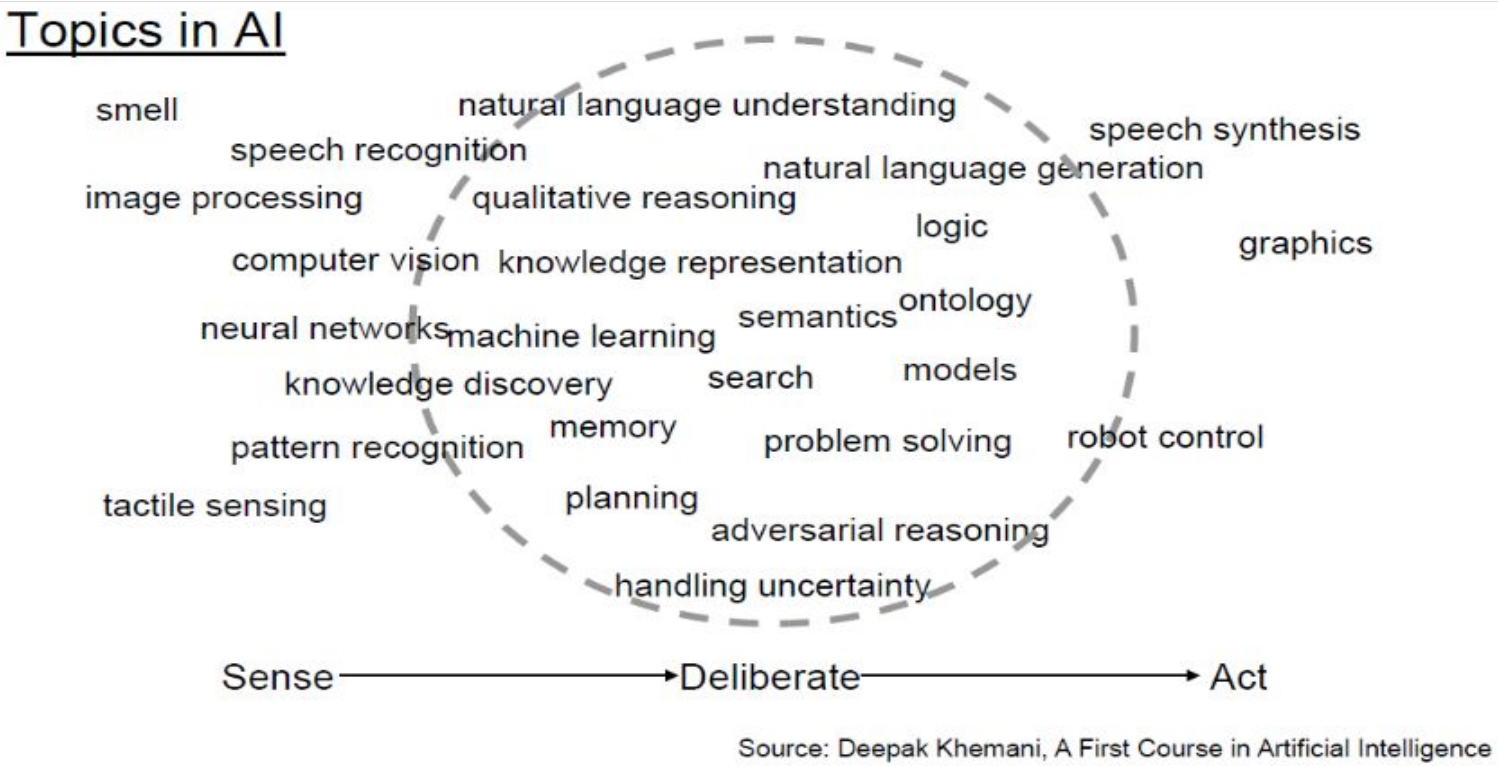


The Loebner Prize – an **annual competition** where **chatbots** are judged for **human like** response. The **grand prize** of USD 100,000 is still open.

Topics in AI:


Deep learning
Unsupervised
Supervised
Machine learning
Text generation
Question answering
Context extraction
Classification
Machine translation
Natural language processing
Expert systems
Artificial intelligence
Speech to text
Text to speech
Speech
Image recognition
Machine vision
Vision
Planning
Robotics

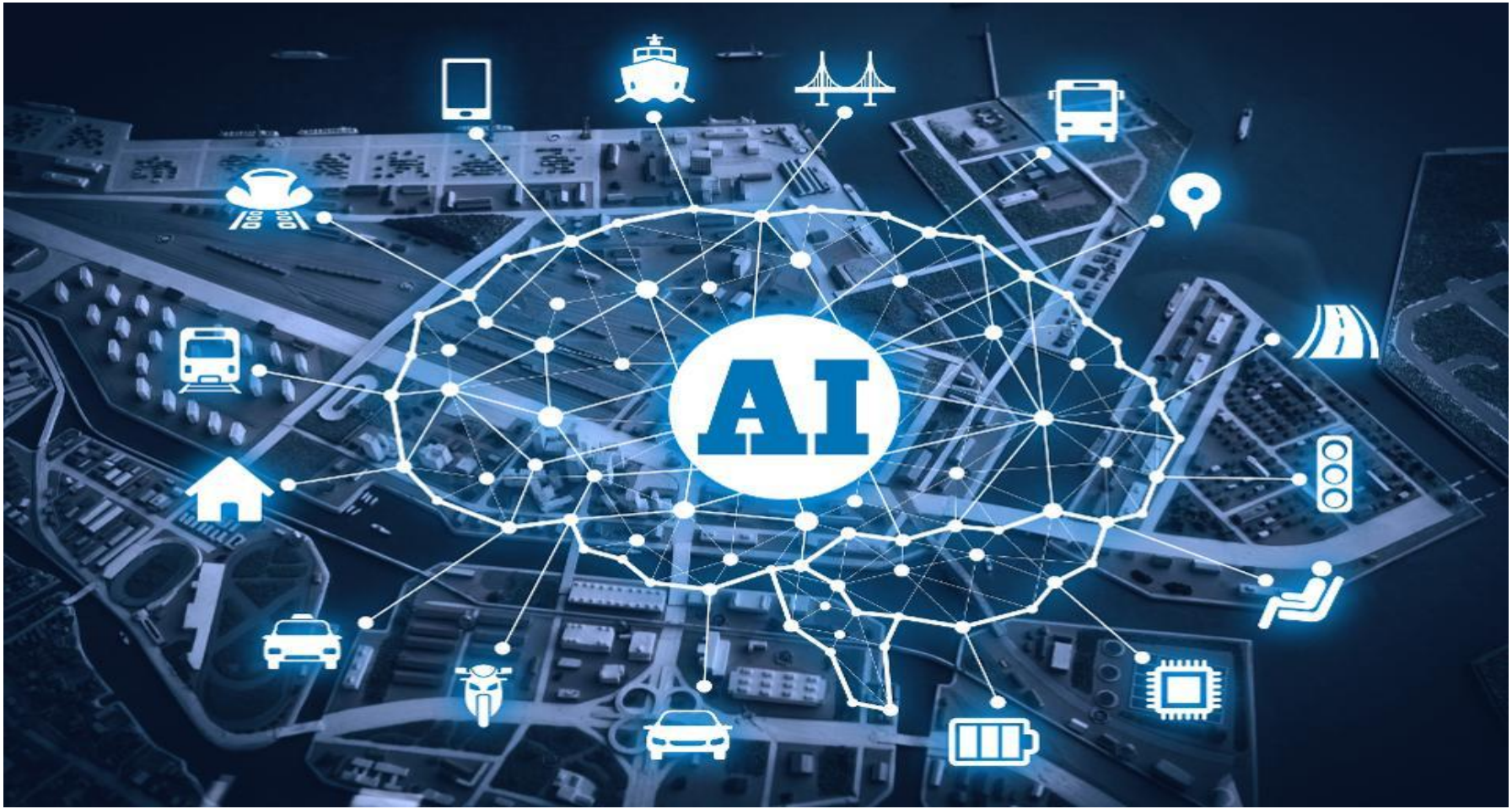
Topics in AI



Source: Deepak Khemani, A First Course in Artificial Intelligence

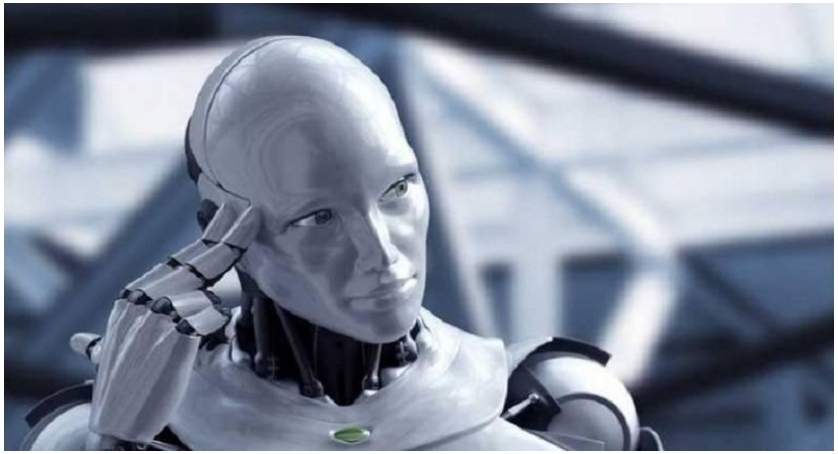
Where are we?


Computer vision
Machine learning
Natural language processing
Speech recognition
Optimization
Rules-based systems
Robotics
Planning & scheduling


AI

Future Prospects

- Outperform Human in
  - Translating Languages
  - Writing High School essays
  - Driving a truck
  - Working in retail
  - Writing a best-selling book
  - Working as a surgeon
  - Automation of jobs



What is Machine Learning?
What is Deep Learning?

Machine Learning:

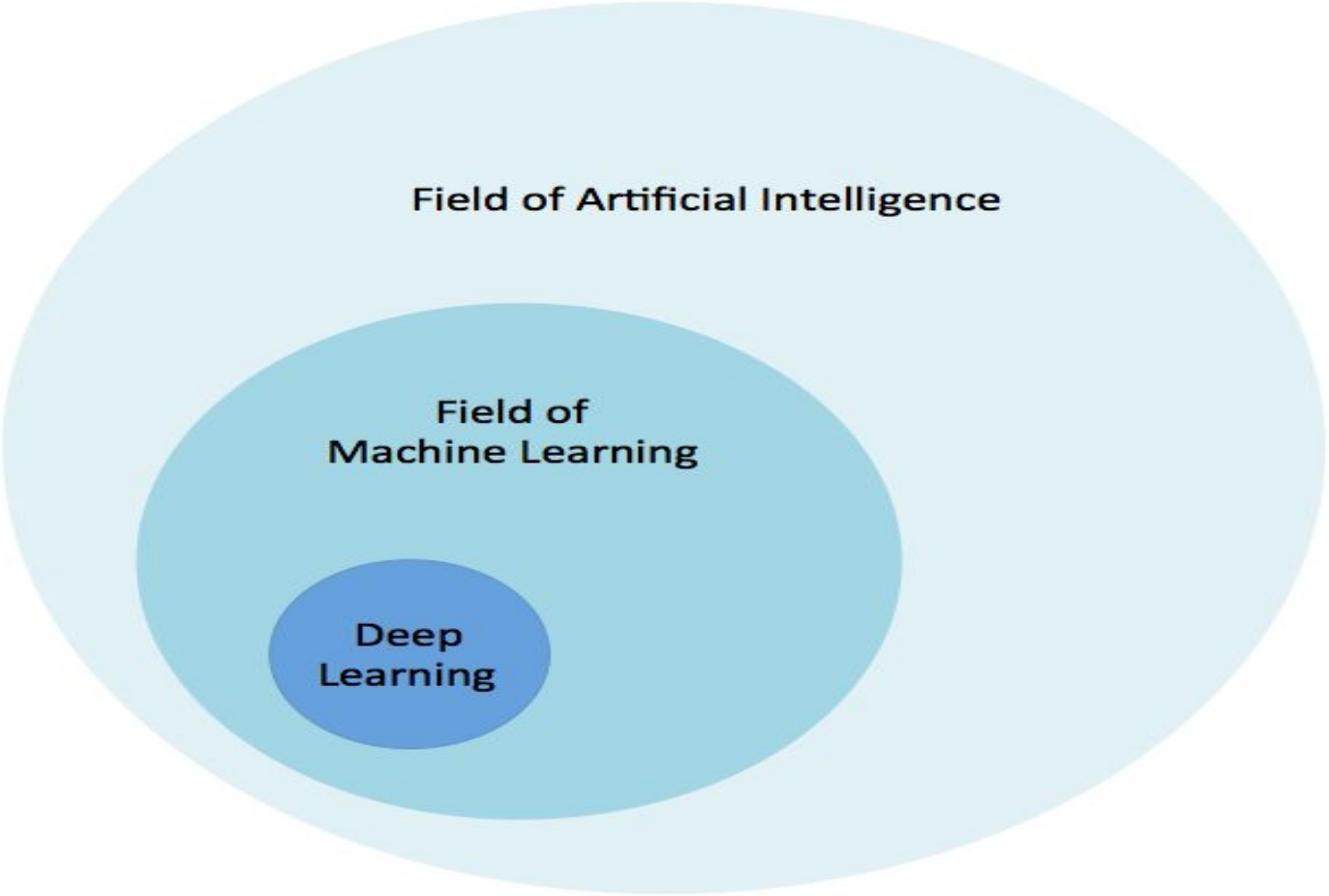
Ability of computers to learn without being explicitly programmed.

---- Wikipedia

My View: Making the machines more experienced by training with enough data instead of programming them explicitly to handle each and every scenario.

Deep Learning:

Deep Learning is a subfield of machine **learning** concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.


Field of Artificial Intelligence
Field of
Machine Learning
Deep
Learning

What is this?

What is this?

Apple. Red Apple, Indeed

What is this?

Apple. Red Apple, Indeed

How do we know?

What is this?

Apple. Red Apple, Indeed

How do we know?

Features:

- Color : Red
- Taste: Sweet
- Shape etc.,

Oooopss… What is this?

Oooopss… What is this?

Green Apple!

Deductive vs Inductive Learning:

- Deductive
  - Rules of the game are (hard coded) given ahead.
  - Eg: An algorithm to do multiplication of numbers is given. Given any two numbers you can apply this and get the answer.
- Inductive
  - We are given with examples (not the concept). We need to learn the mapping from i/p to o/p.
  - Supervised learning problems in AI comes under this

Learning Strategies:

- Supervised
  - Classification, Regression, …
- Unsupervised
  - Clustering, density estimation
- Reinforced
  - A robot navigating through obstacles
- Learn the good features (attributes)
  - Feature extraction

Classification Problem?

- Let there are two classes of objects.
  - Class 1: Set of dog pictures
  - Class 2: Set of cat pictures
- Problem is –
  - Given a picture, you should say whether it is cat or dog.
  - For a human being it is easy…, but for a machine it is a non-trivial problem.

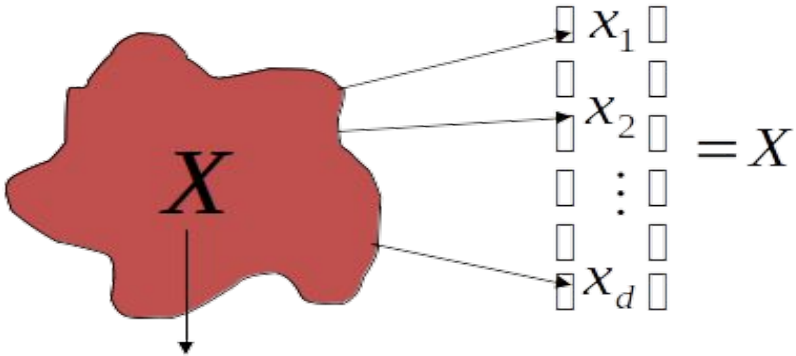
Training/Learning Phase:

Testing:

This picture as it is may not be in the training set

What is learning?

- Child has learnt what is it that is common among dogs … and, what is it that is common among cats… also, what are the distinguishing features/attributes.
- Child has learnt the pattern (regularity) behind all dogs and the pattern behind all cats.
- Child then recognized a test image as having a particular pattern that is unique to dogs.



$X \in \chi$

X

χ

Class to which X belongs is $y \in Y$

-Needs to be estimated, based on training set.

Task

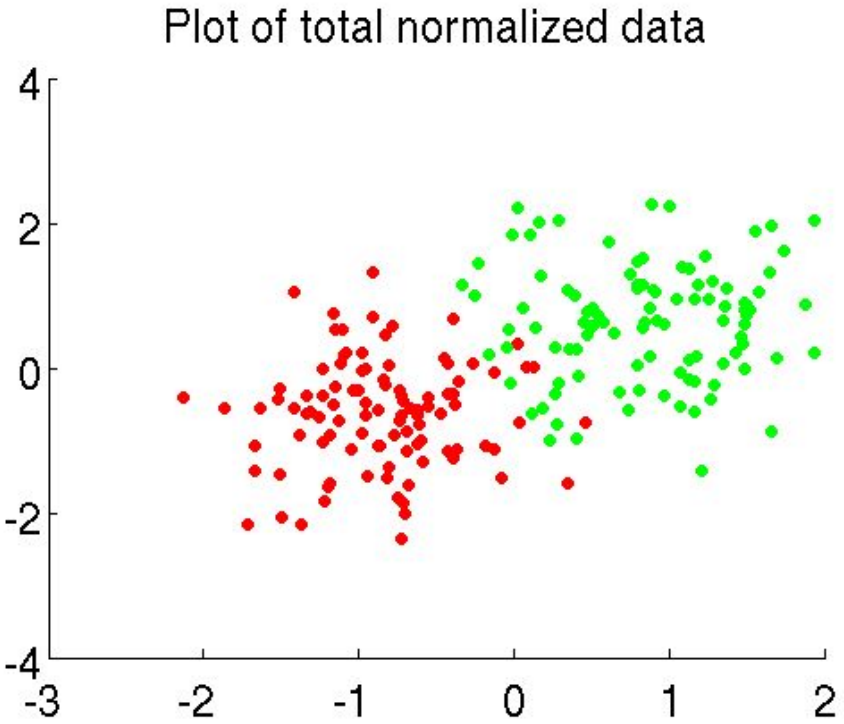
- To design a classifer (decision rule) $f : \chi \rightarrow Y$ which decides about the class label based on X.

Feature extraction:

Good Features:

- Objects from same class have similar feature values
- Objects from different classes have different values

Feature Space



Training Set is shown

Learning Steps:

- **Feature extraction:**
  - This is an important step. Good features are needed.
  - This is a lower level step. Normally done by techniques like image processing, speech processing, video processing, etc.
- **Training set:**
  - Set of feature vectors along with their class labels.
  - An expert can see a few examples and give labels to them based on his experience.
- Build the classifier by using the training set.

Classification Problem

- Given a training set, build the classifier.
- One has to evaluate, how good is the built classifier.
  - Of course, it has to agree with the training set
    - Is this 100% true?
  - But, it should do more than this.
  - The behavior of the classifier when it is asked to classify some thing which is not in the training set determines the quality.

An easy, but bad classifier

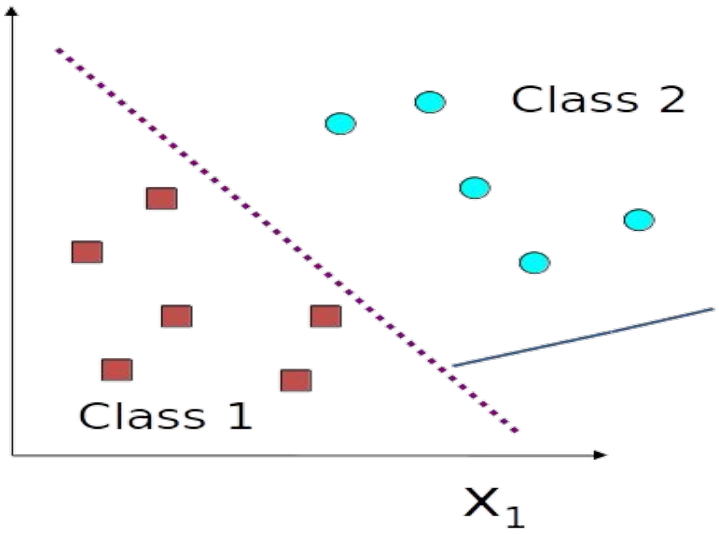
- Remember the training set.
- See whether the given feature vector to be classified is available in the training set.
- If yes, then return the label of that training example.
- Else return a random class label.

This is called Rote learning

A few classifiers:

- KNN Classifier
- Decision Trees
- Random Forests
- Bayes Classifier, Naive Bayes classifier
- Artificial Neural Networks
- SVM
- ……

Linear Classifier



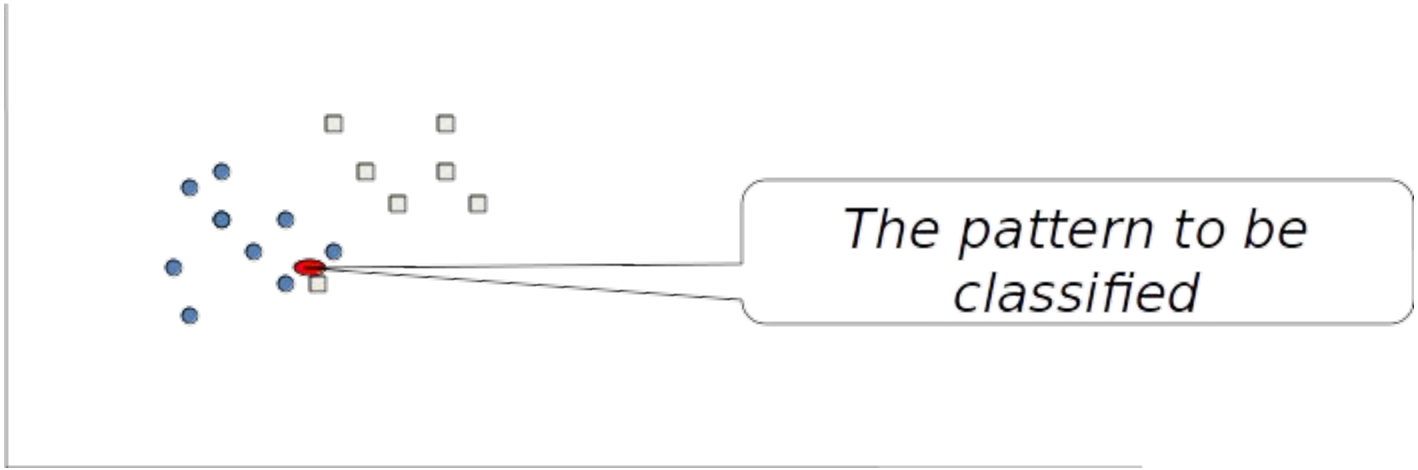
Classifier:

If $f(x_1,x_2) < 0$ assign Class 1;

If $f(x_1,x_2) > 0$ assign Class 2;

$$f(x_1,x_2) = w_1x_1+w_2x_2+b = 0$$

KNN Classifier:

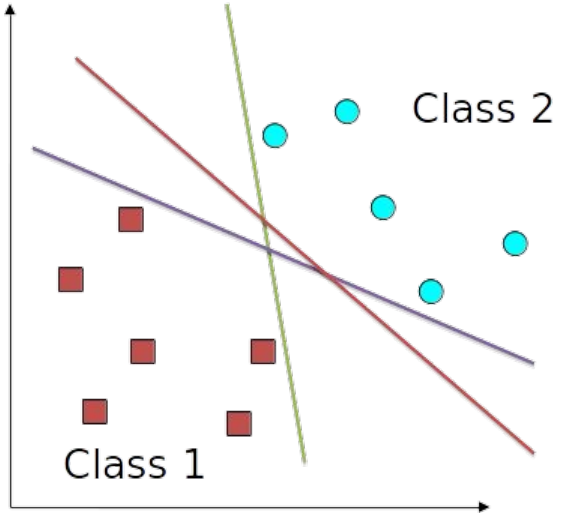


Perceptron

- Perceptron is the name given to the linear classifier.
- If there exists a Perceptron that correctly classifies all training examples, then we say that the training set is linearly separable.
- In 1960s Rosenblatt gave an algorithm for Perceptron learning for linearly separable data.

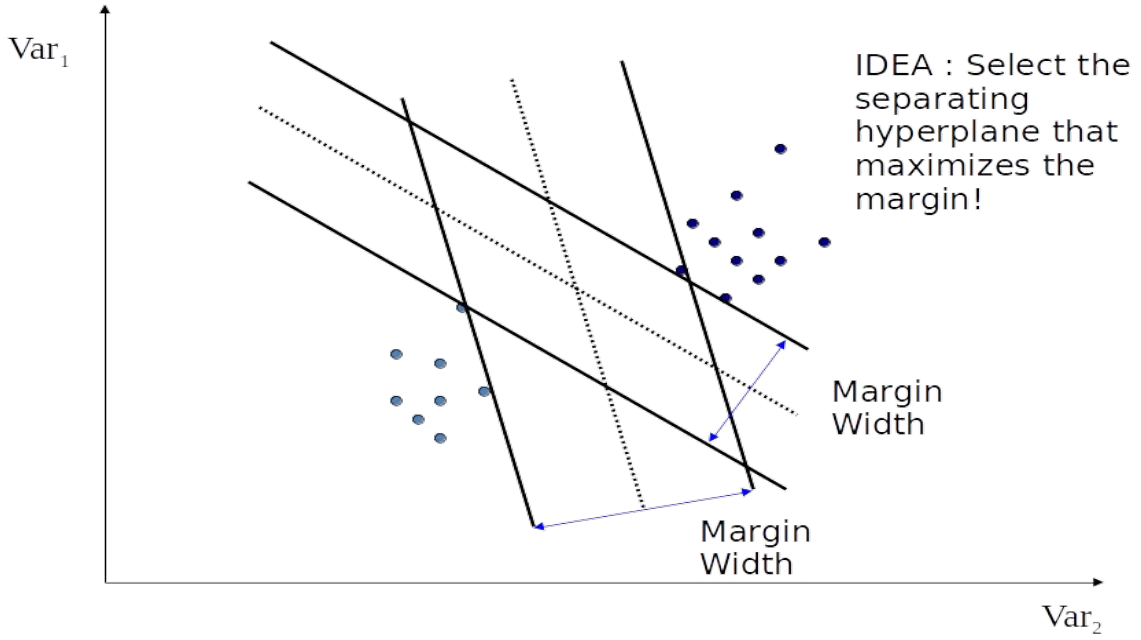
Perceptron

- For linearly separable data many classifiers are possible.



All being doing equally good on training set, which one is good on the unseen test set?

Maximising the margin SVM



Let’s get started with KNN

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