Five Days FDP

On

Artificial Intelligence and Data Science: Foundations, Pedagogy, Tools, and Emerging Research Trends

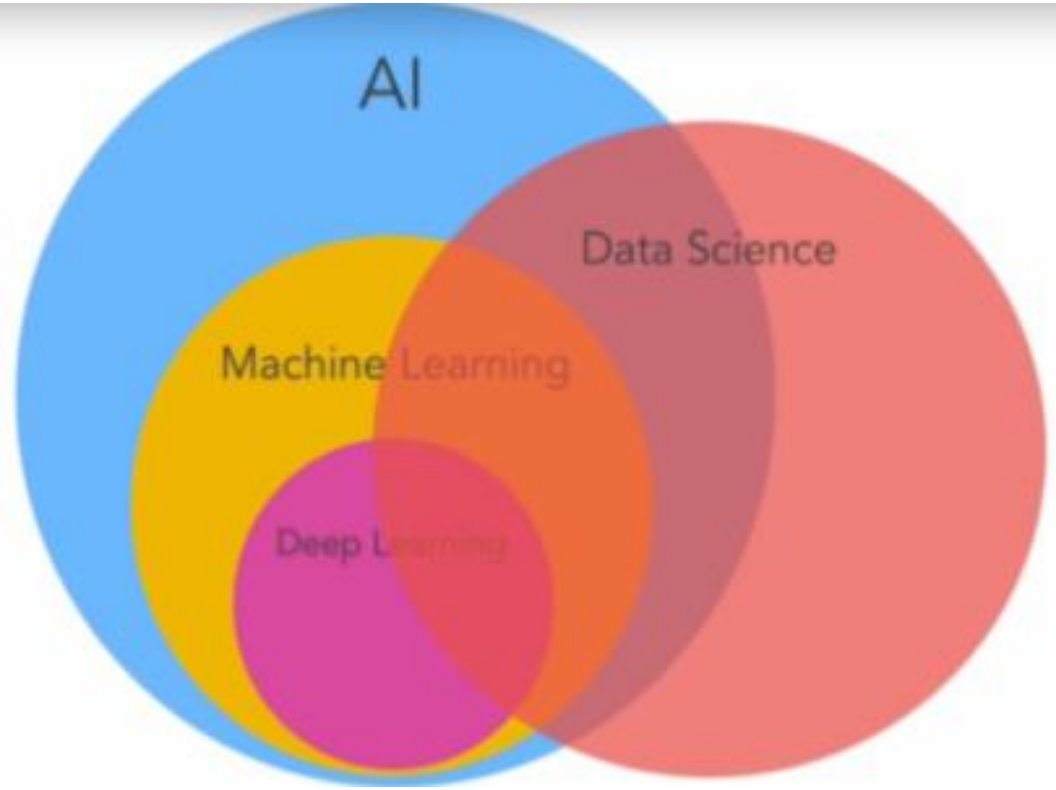
15th - 19th December, 2025

Organized by

Department of Artificial Intelligence, SVNIT
Surat

Fundamentals of Machine Learning

AI: Machine Learning



Math Essentials

- Machine learning is part of both ***statistics and computer*** science
  - Probability
  - Statistical inference
  - Validation
  - Estimates of error, confidence intervals

- Linear algebra
  - Hugely useful for compact representation of linear
  - transformations on data
  - Dimensionality reduction techniques
- Optimization theory

History

- The first neural networks was in 1943 by neurophysiologist Warren McCulloch and mathematician Walter Pitts. They decided to create a model of this using an electrical circuit.

- In 1950, Alan Turing created the world-famous Turing Test. This test is fairly simple - for a computer to pass, it has to be able to convince a human that it is a human and not a computer.

- 1952 saw the first computer program which could learn as it ran. It was a game which played checkers, created by Arthur Samuel.

History

- Frank Rosenblatt designed the first artificial neural network in 1958, called Perceptron.

- 1982 was the year in which interest in neural networks started to pick up again, when John Hopfield suggested creating a network which had bidirectional lines, similar to how neurons actually work.

- Neural networks use back propagation, and this important step came in 1986

History

- However in 1997, the IBM computer Deep Blue, which was a chess-playing computer, beat the world chess champion.

- In the year 2006, computer scientist Geoffrey Hinton has given a new name to neural net research as "**deep learning**".

- GoogleBrain (2012) - This was a deep neural network created by Jeff Dean of Google, which focused on pattern detection in images and videos. It was later used to detect objects in YouTube videos.

History

- AlexNet (2012) - AlexNet won the ImageNet competition by a large margin in 2012.

- DeepFace (2014) - This is a Deep Neural Network created by Facebook, which they claimed can recognise people with the same precision as a human can.

- DeepMind (2014) - This company was bought by Google, and can play basic video games to the same levels as humans. In 2016, it managed to beat a professional at the game Go.

History

- OpenAI (2015) - This is a non-profit organisation created by Elon Musk and others, to create safe artificial intelligence that can benefit humanity.

- Amazon Machine Learning Platform (2015) - This is part of Amazon Web Services.

- ResNet (2015) - This was a major advancement in CNNs.
- U-net (2015) - This is an CNN architecture specialized in biomedical image segmentation.

- 2016: AlphaGo beat the world's number second player Lee sedol at Go game. In 2017 it beat the number one player of this game Ke Jie.

History

- In 2017, the Alphabet's Jigsaw team built an intelligent system that was able to learn the online trolling.

- It is present everywhere around us, such as self-driving cars, Amazon Alexa, Chatbots, recommender system, and many more.

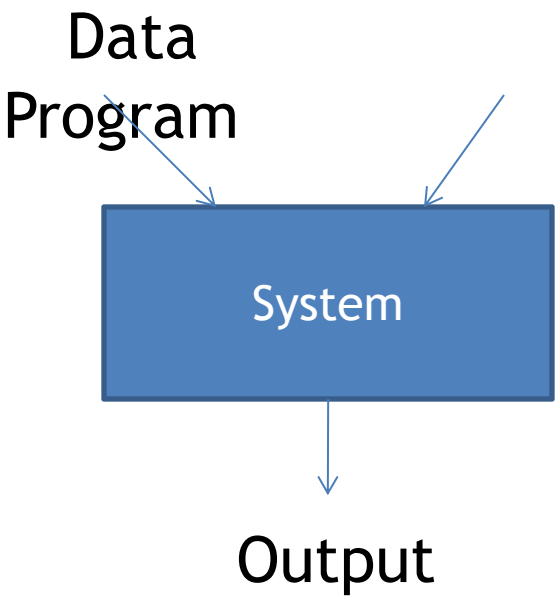
- Modern machine learning models can be used for making various predictions, including weather prediction, disease prediction, stock market analysis, etc.

History

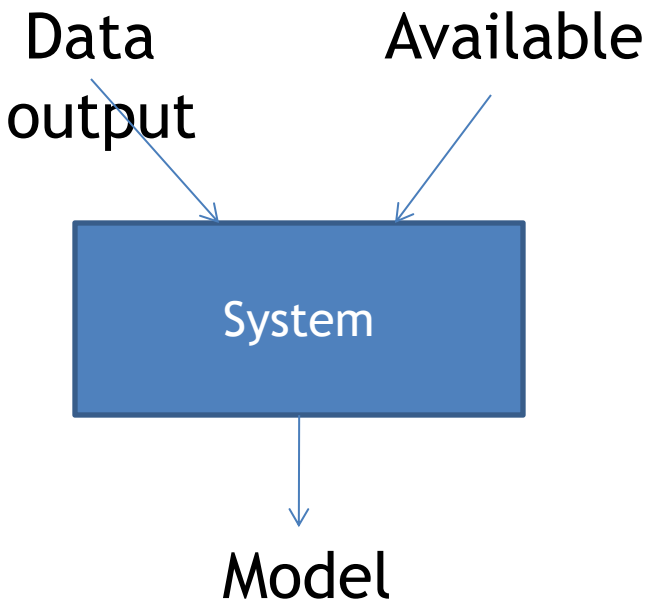
- Also progress in hardware
- **Google Tensor Processing Unit (TPU) – 2016**
- **Nvidia Tensor Cores – 2017**
- **Intel - Nervana Neural Processor - 2017**
- **DGX**
- **GPUs in Cloud Computing**

Fundamentals

Algorithm



Machine Learning



Fundamentals

- Learning: Ability to improve performance based on experience

- Definition of Machine Learning:

"A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance on tasks T as measured by P is improved with experience E. " – Tom Mitchell

- Applications: Disease prediction
  - Input: Test results, symptoms, etc.
  - Output: Set of possible diseases
  - Learn from history records for treatment of future patients

Fundamentals

Steps:

- Data collection
- Data preprocessing
- Feature reduction and extraction
- Choose training set (features/parameters)
- Choose the target function by learning
- Choose representation of target function
- Choose a learning algorithm to infer the target function

Types of Learning

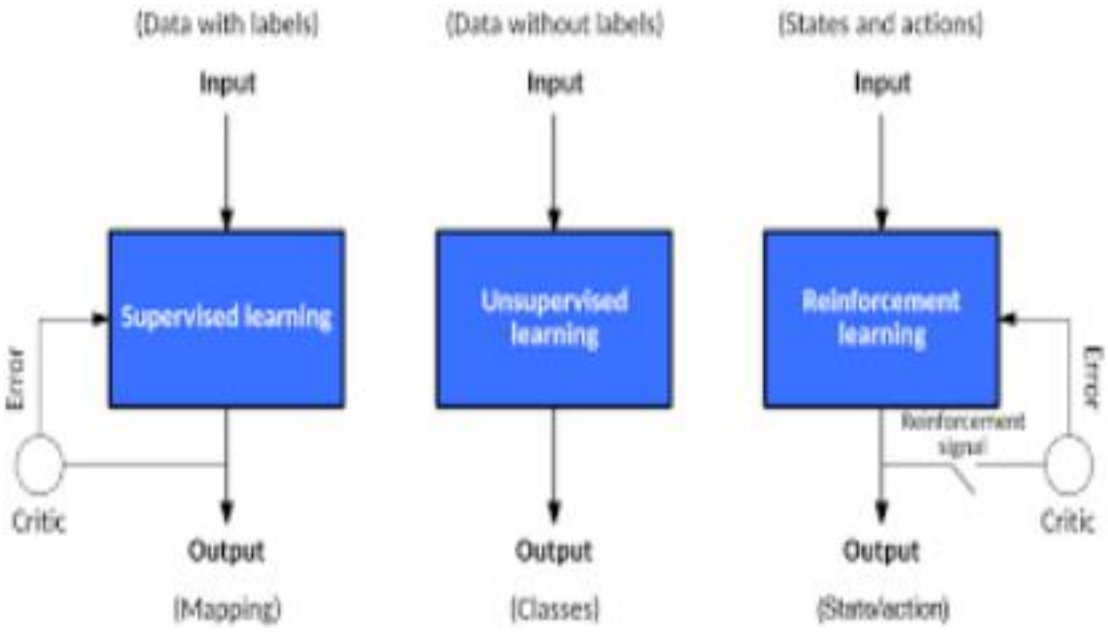
- Supervised
  - (x, y) available training data set
  - For a new data x (input), predict the label of y (output)
  - This is applicable for labeled data

- Unsupervised
  - x is only given
  - Cluster the data based on x
  - This is applicable for unlabeled data

Types of Learning

- Reinforcement
  - Learning made by rewards or penalty
- Semi-supervised
  - Combination of supervised and unsupervised learning
  - Applicable when partial data is labeled and remaining data is unlabeled

Types of Learning



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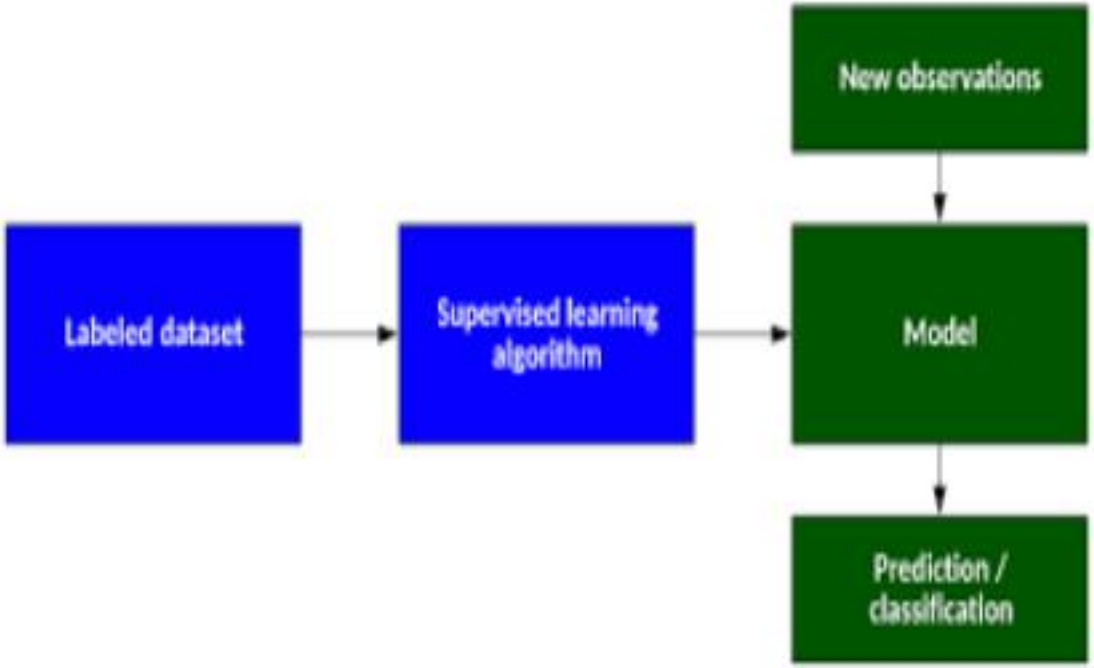
Supervised learning



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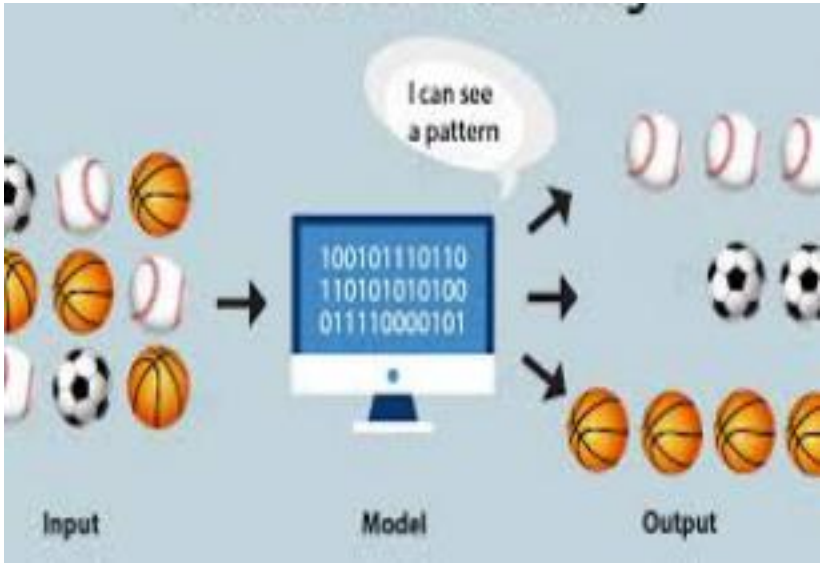
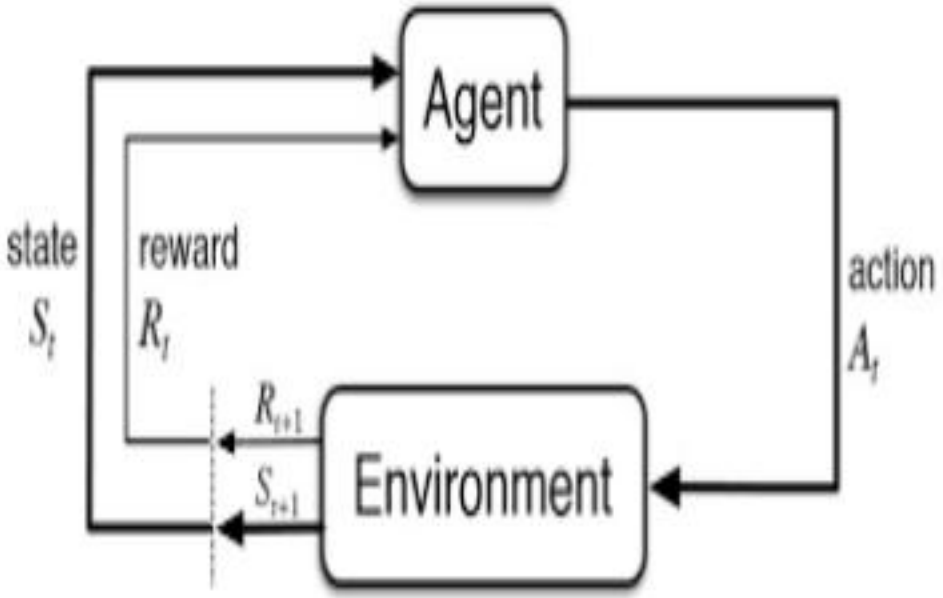
Unsupervised learning



Reinforcement learning

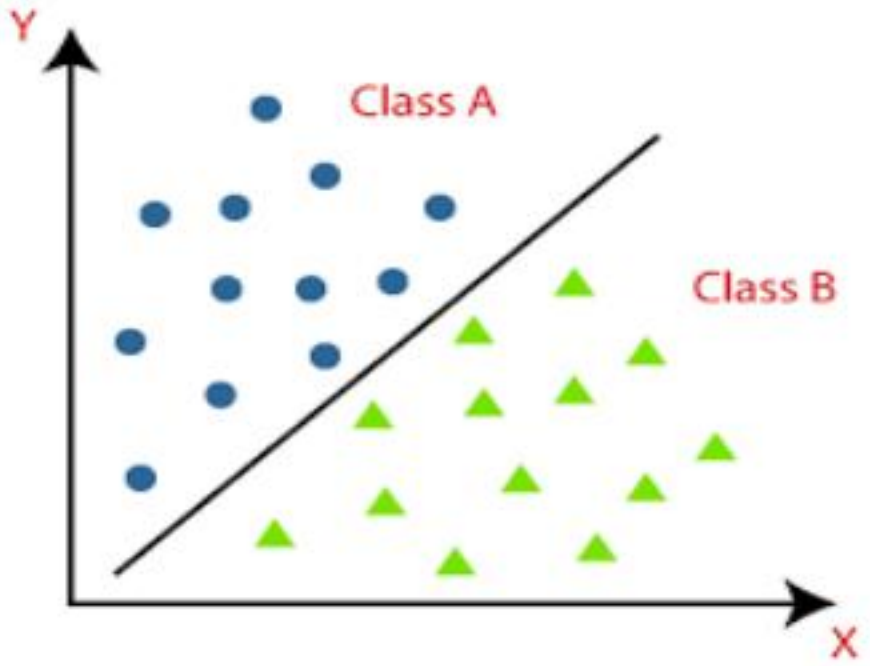


Discussion: Supervised learning

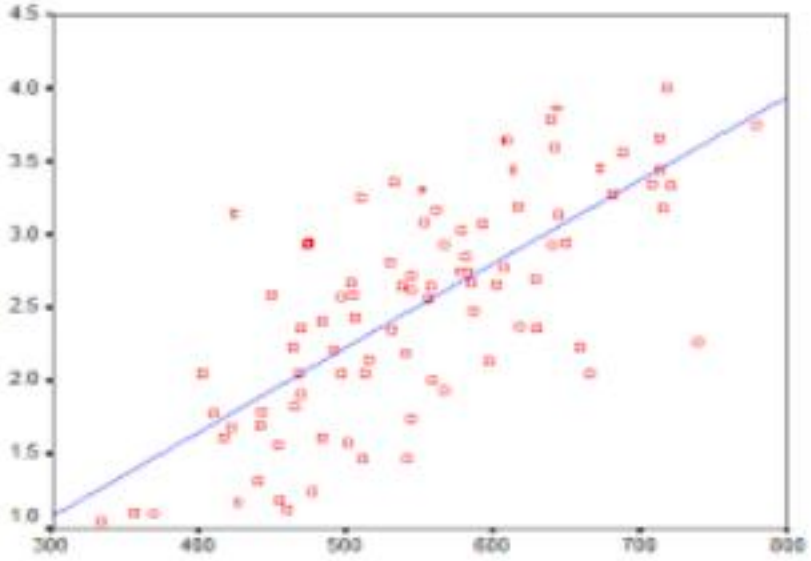
- A set of input features is given x1, x2,…, xn
- A target feature y
- For a set of new examples, x along with corresponding y values are given
- Predict the value y for the given x
  - Classification: discrete data
  - Regression: continuous data

	X1	X2	.	-	Xn	Y
I1	A11	A12	.	.	A1n	Y1
I2	A21	A22	.	.	A2n	Y2
.	.	.	.	.	.	.
.	.	.	.	.	.	.
Im	Am1	Am2	.	.	Amn	Ym

Supervised learning: classification



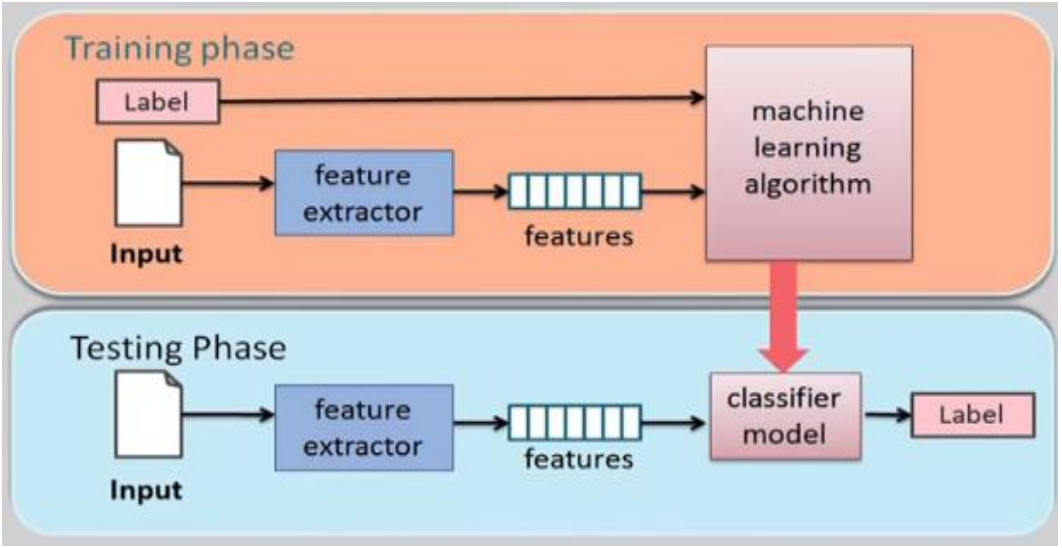
Supervised learning: Regression



- Predict CGPA of an semester with respect to marks
- X: marks
- Y: CGPA
- Y=f(X)
- If there are multiple parameters in X, then, function would be
  - Y=f(X,a), where a represents parameters/features of X

Features

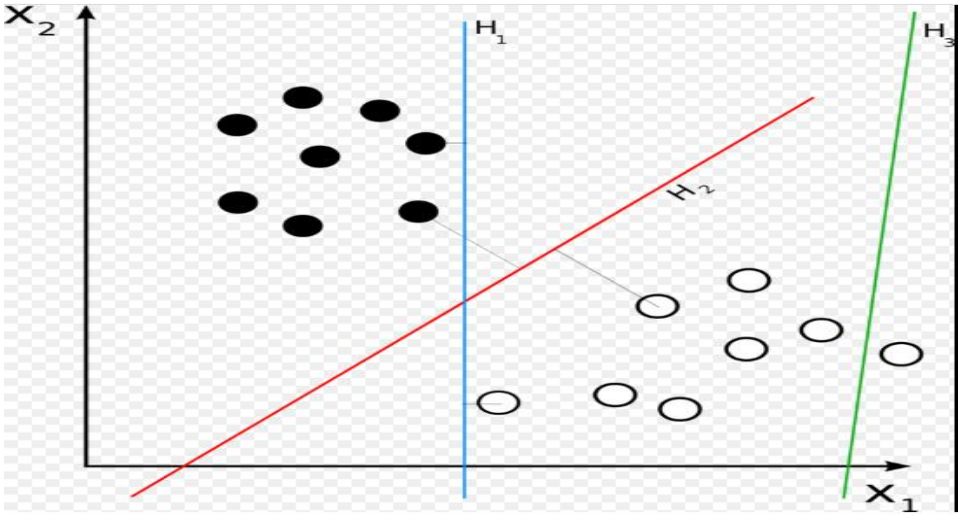
- Types:
  - Categorical: Blood group
  - Real valued: Height, weight
  - Integer valued: No. of stocks, no. of words in a document
  - Ordinal: High, Medium, Low



Representation

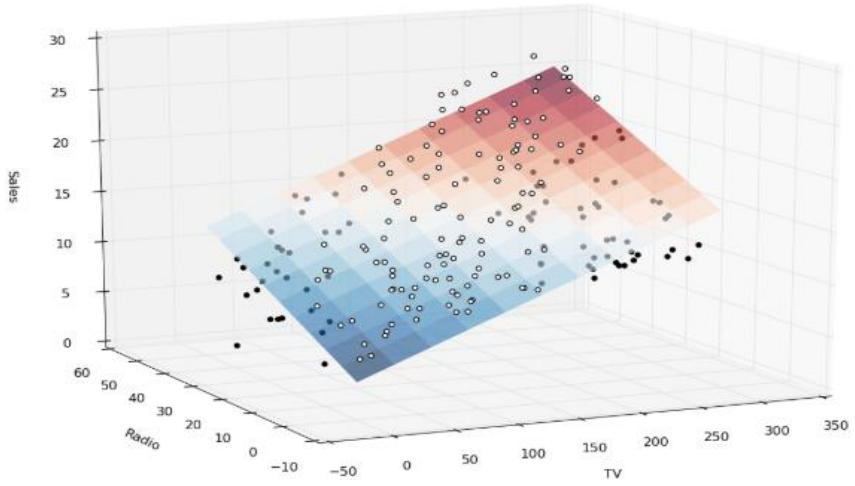
- Decision Tree

- Linear function

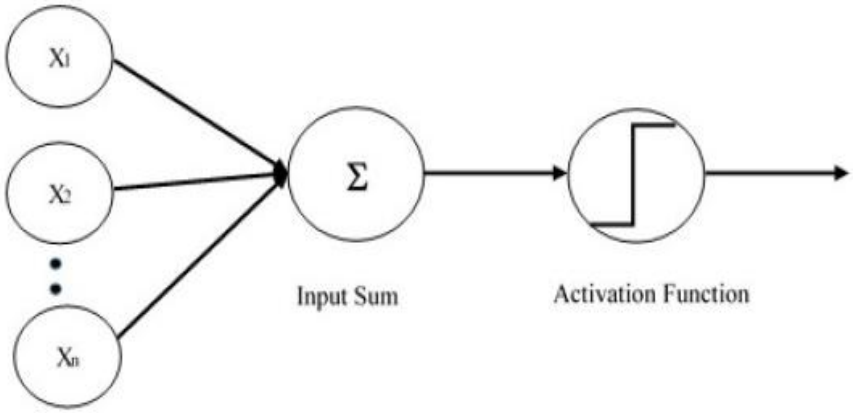


Representation

- Multivariate linear function

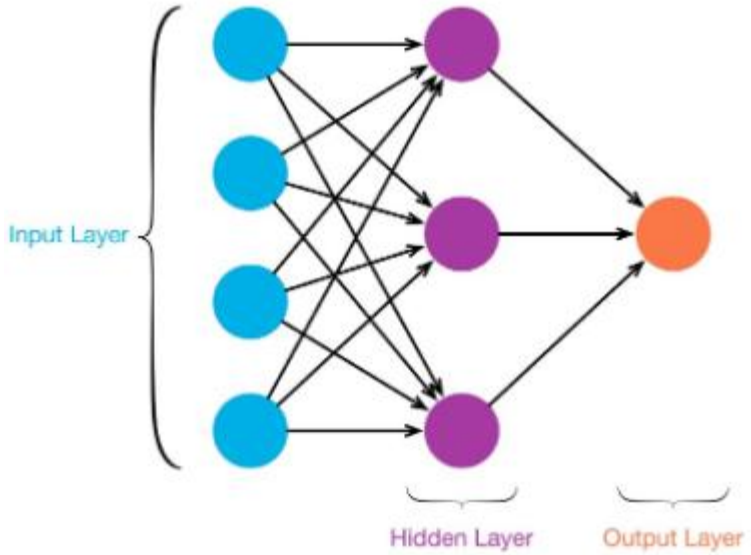


- Single layer perceptron



Representation

- Multi-layer neural network



Terminology

- Features
- Feature vector
- Instance space
- Examples
- Target function
- Training data
- Validation data
- Testing data

Applications

- Computer Vision
  - Detect object in an image
  - Detect location of an object in an image
  - Convert handwritten characters to text form
- Robot navigation
  - Automated robot navigation
- Natural Language Processing
  - Recommendation systems
  - Fraud news detection
  - Fact identification from a content
- Machine translation
- Speech recognition
- Financial
  - Stock prediction
- Sentiment Analysis
- Internet of Things

Thank You