PARADIGMS OF PATTERN RECOGNITION

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Different Paradigms(Models) for Pattern Recognition

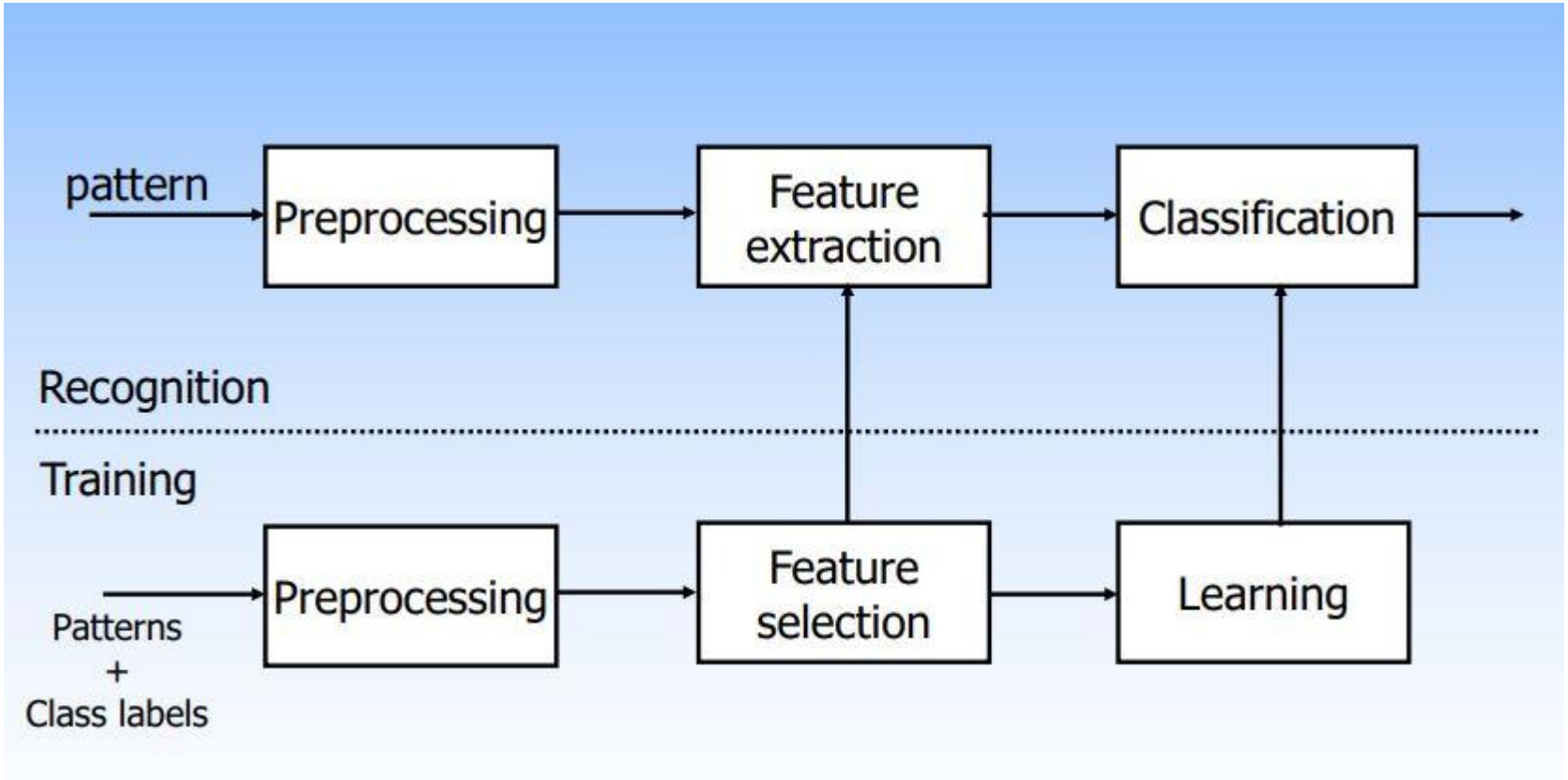
- 1. Statistical Pattern Recognition
- 2. Syntactic Pattern Recognition/Structural Pattern Recognition
- 3. Template Matching
- 4. Neural Networks

1. Statistical Pattern Recognition

- Statistical PR is more popular and has received the majority of attention in literature.
- The main reason for this is that most practical problems in this area deals with noisy data and uncertainty.
- **Statistics and probability** are good tools to deal with such problems.
- In statistical PR, we focus on the statistical properties of the pattern (generally expressed in probability densities) and this will be used in most of the real time applications.
- Here, we use vector spaces to represent patterns and classes.

Schematic Diagram :Statistical PR

Supervised Learning



Statistical PR

- The abstractions typically deal with probability density or distributions of points in multi dimensional spaces.
- Because of the vector space representation, it is meaningful to talk of sub-spaces/projections and similarity between points in terms of distance measures.
- There are several soft computing tools associated with this notion.

Soft Computing*

- Soft computing, as opposed to traditional computing, deals with approximate models and gives solutions to complex real-life problems.
- Soft computing is tolerant of imprecision, uncertainty, partial truth, and approximations. In effect, the role model for soft computing is the human mind.
- Soft computing is based on techniques such as fuzzy logic, genetic algorithms, artificial neural networks, machine learning, and expert systems.

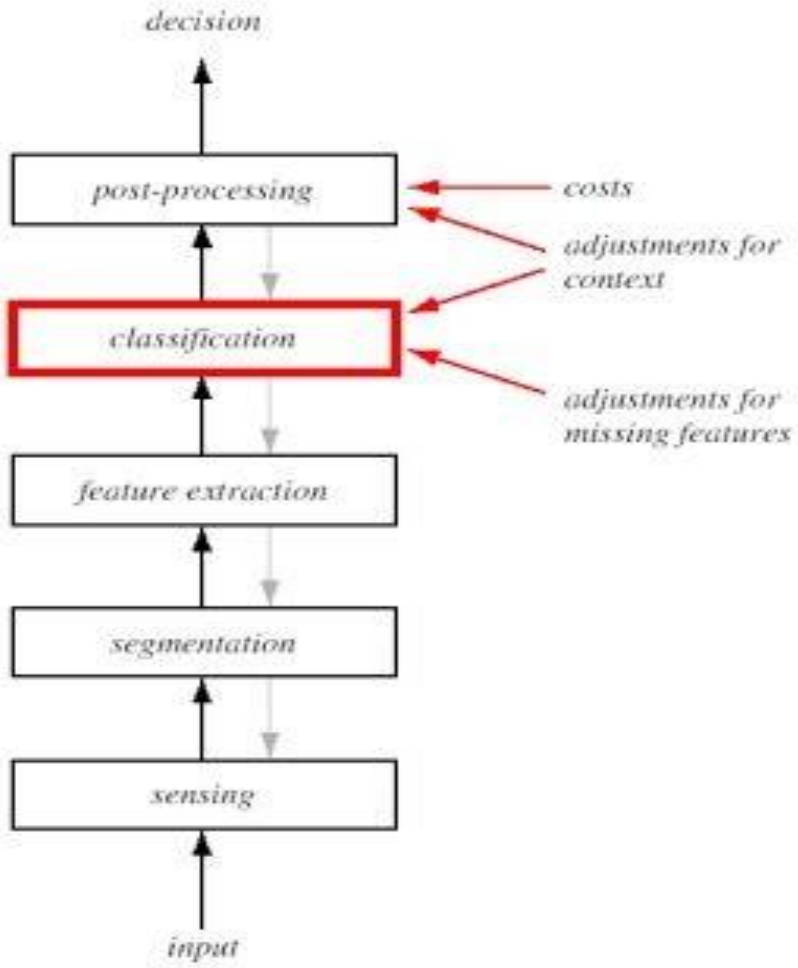
Statistical PR-Soft Computing Tools

- The Baye's Classifier characterises optimality in terms of minimum error rate classification.
- The use of Hidden Markov Model (HMM) is popular in fields like speech recognition.
- Fuzzy set and rough set based pattern recognition schemes employ vector representation of patterns and classes.

Statistical PR-Soft Computing Tools

- A decision tree is a transparent data structure which can deal with classification of patterns employing both numerical and categorical features.
- Nearest Neighbour Rule: It is the most popular and simple classifier. A new pattern is classified based on the class label of its nearest neighbour. In such a classification, we do not have a training phase.

PR System :Schematic Diagram



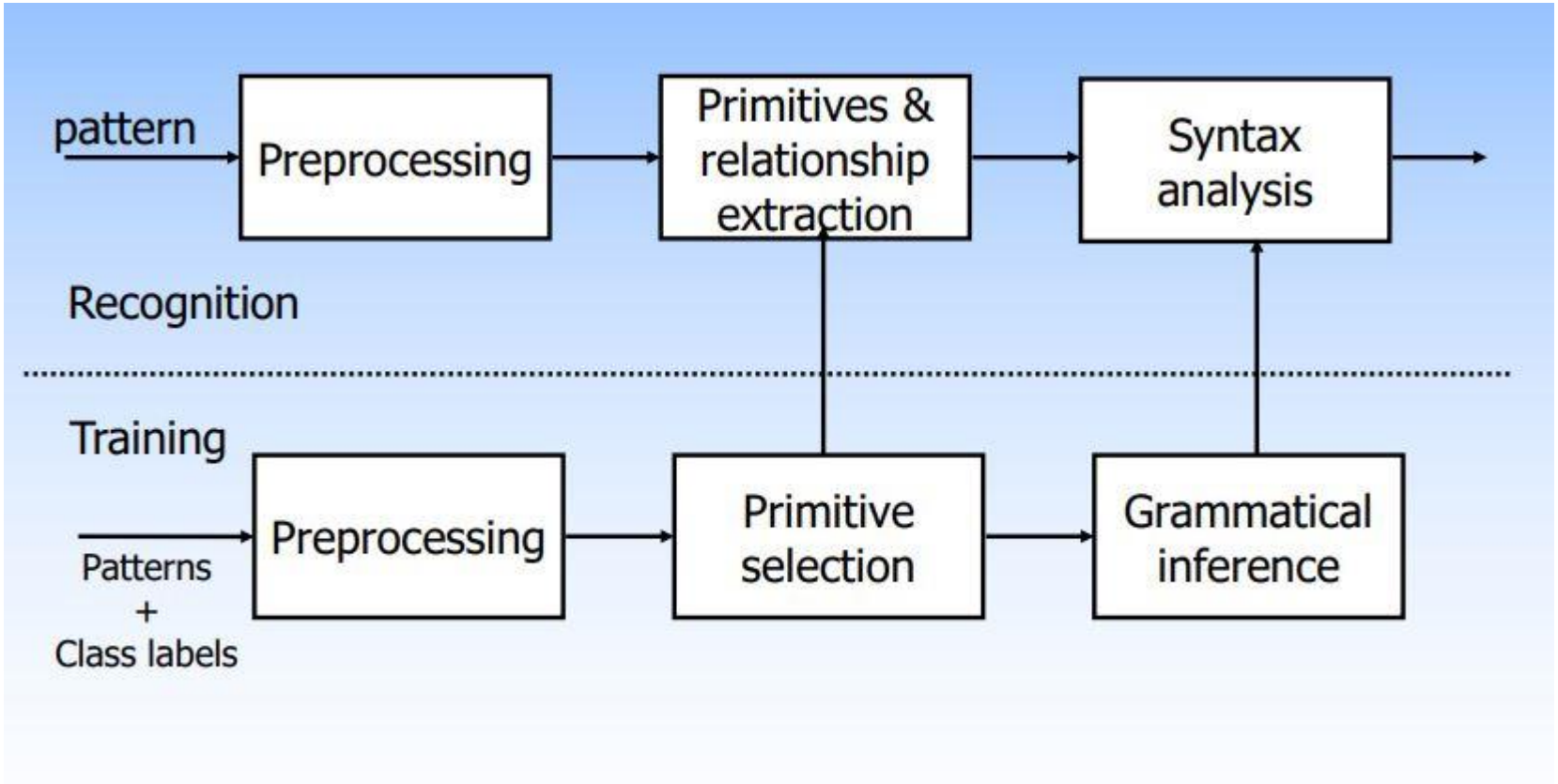
PR System

- **Sensor** converts images/sounds/physical inputs into signal data.
- **Segmentation** isolates sensed object from the background.
- **Feature extraction** measures object properties that are useful for classification.
- **Classification** assigns sensed object to a category.
- **Post processing** take into account other considerations, such as effects of context and the cost of errors to decide on the appropriate action.

2. Syntactic Pattern Recognition/Structural Pattern Recognition

- If the model consists of some set of crisp logical rules, then we employ the method of syntactic pattern recognition, where the rules or grammar describe our decision.
- Example: To classify an English sentence as grammatically correct or not, crisp rules are appropriate rather than statistical descriptions such as word frequencies or correlations.

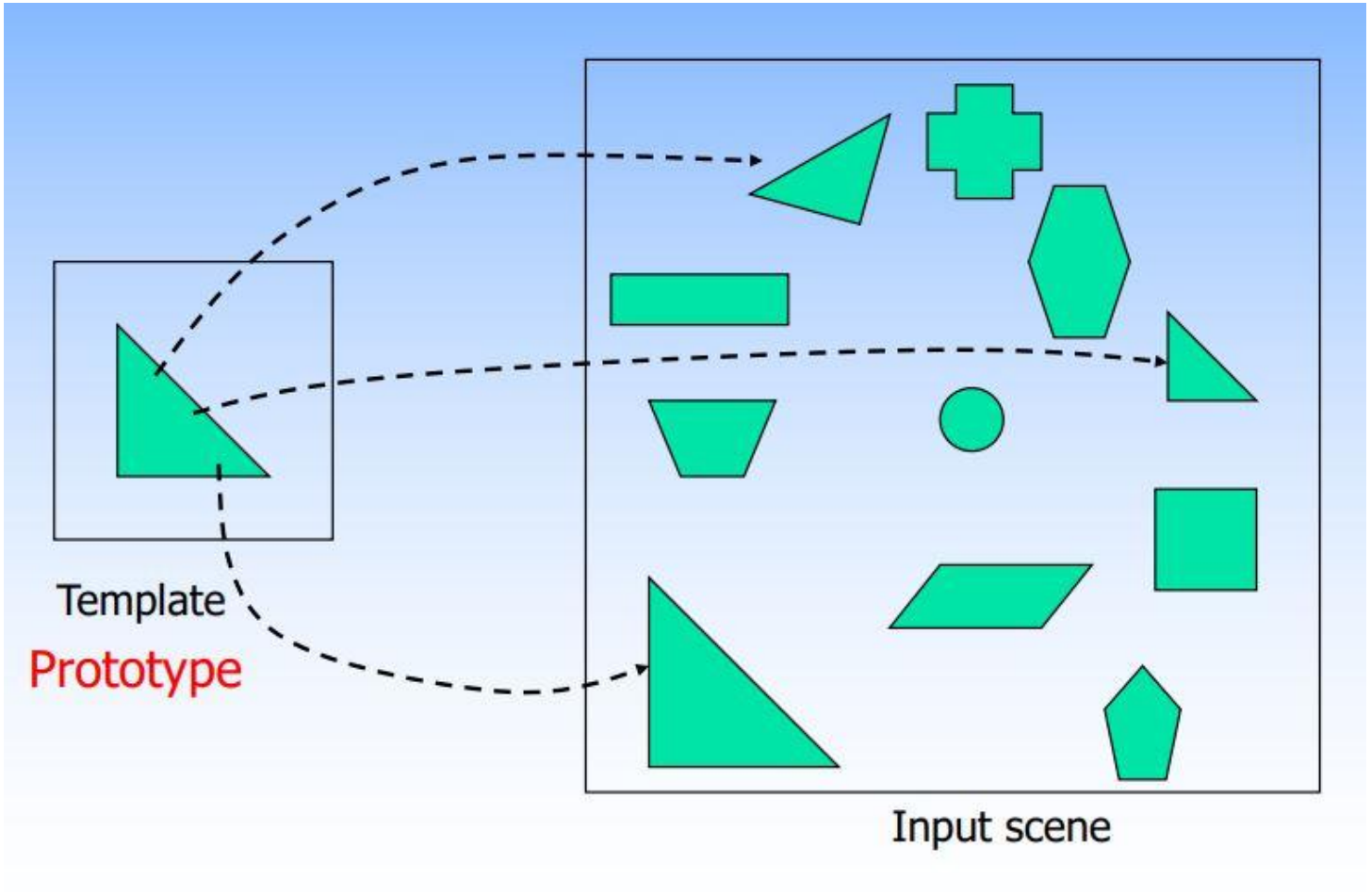
Schematic Diagram : Syntactic PR



3. Template Matching

- **Template Matching** is a method for searching and finding the location of a template image in a larger image.

3. Rigid Template Matching



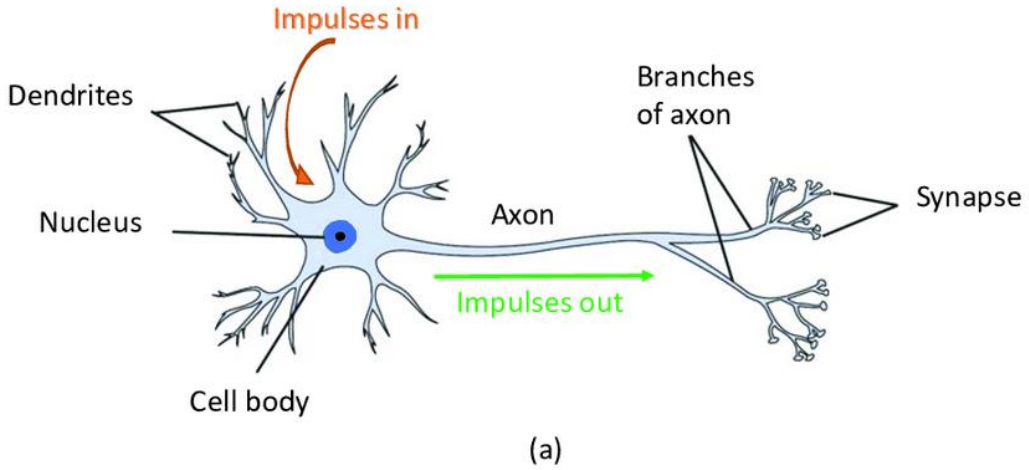
3. Template Matching- Applications

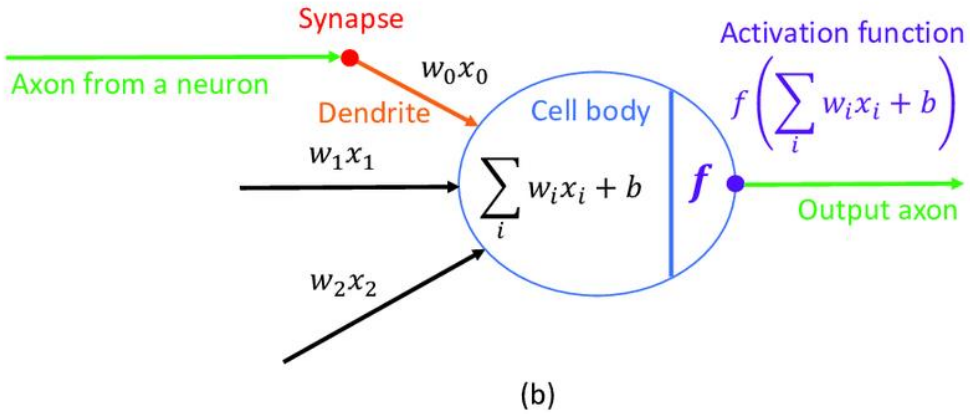
- Template matching has various applications and is used in such fields as **face recognition** and **medical image processing**.
- Systems have been developed and used in the past to **count the number of faces**

Neural Networks

- It is a computational model which tries to approximate the biological neural networks in the human brain
- Biological neural networks consists of number of cells (neurons). A neuron consists of dendrites, cell body and axon

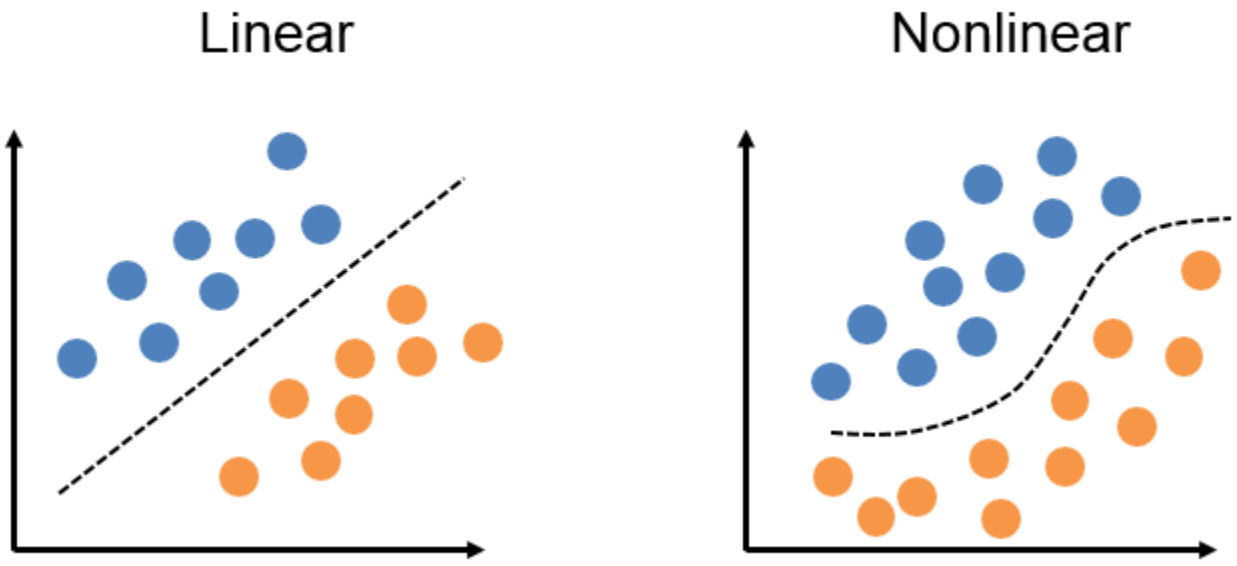
Neural networks





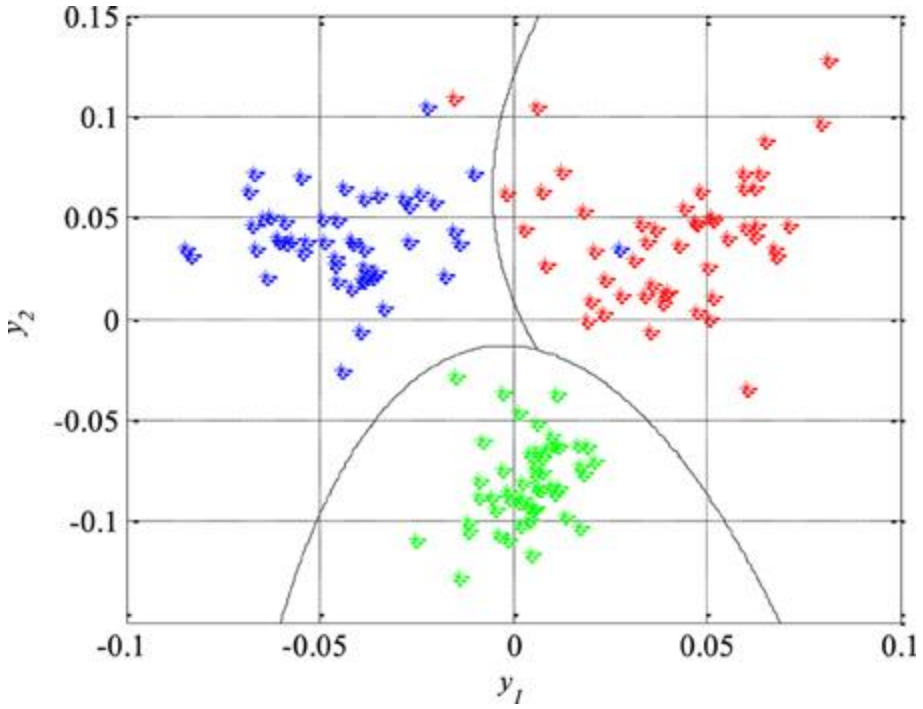
Linear and non-linear classifier

- Linear Classifiers- It separates by linear equation
- Non linear cases it minimize sum of squared error.



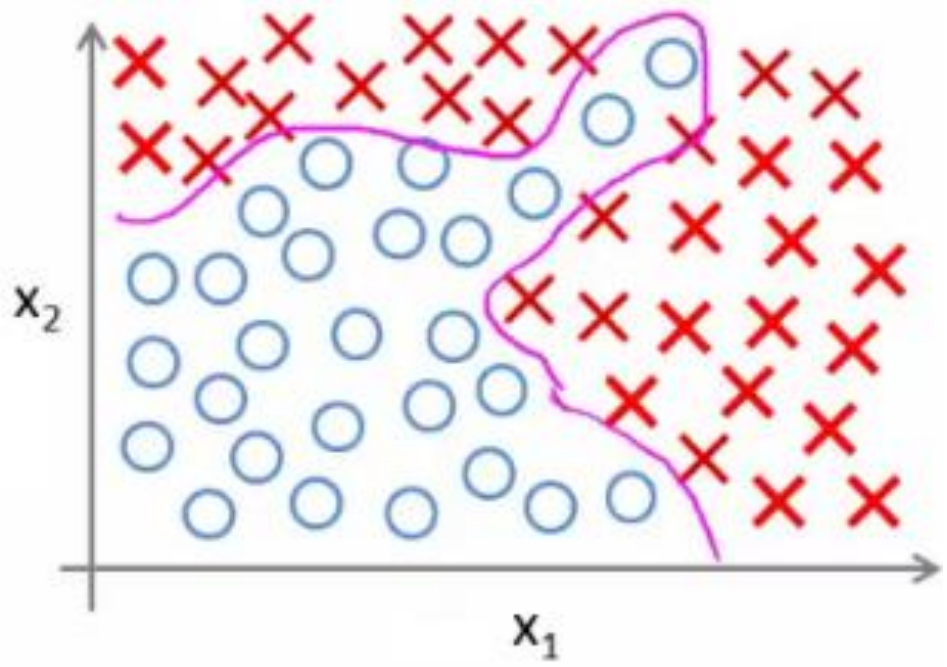
Non linear classifier

- The most non linear classifiers are
  - Quadratic classifier
  - Cubic classifier



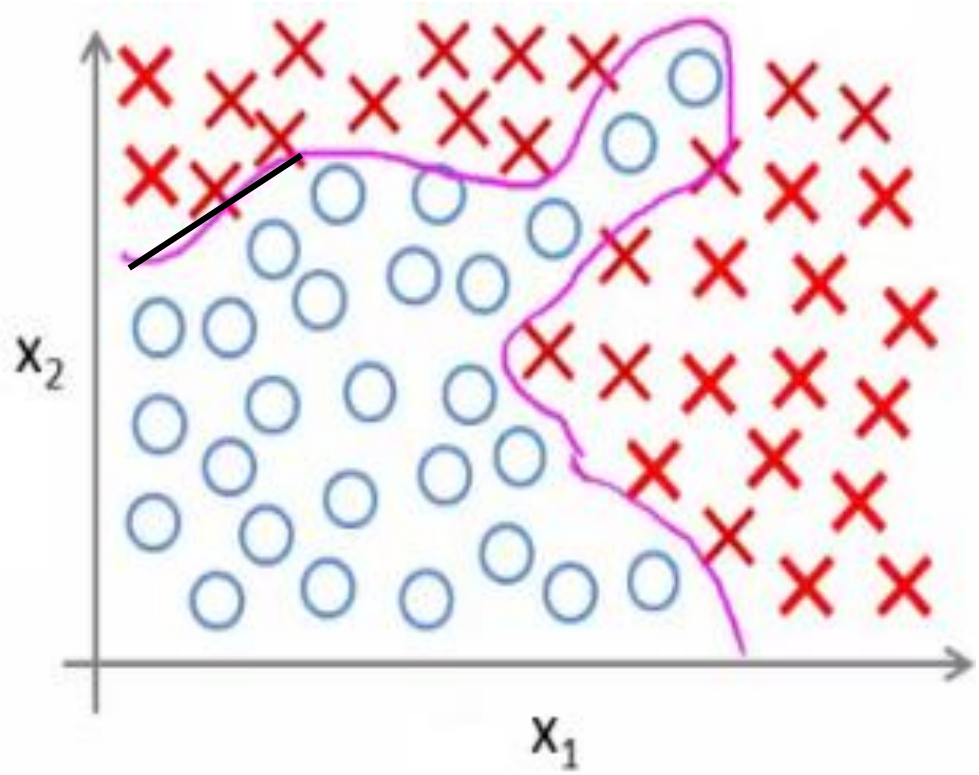
Complex nonlinear decision boundary

- The decision boundary is so complicated and it becomes much more complicated if the number of classes becomes more than two
- The kind of approach, that people take in such complicated cases is to make use of neural networks



Complex nonlinear decision boundary(3)

- Collection of such straight lines actually model such complicated non-linear decision boundary



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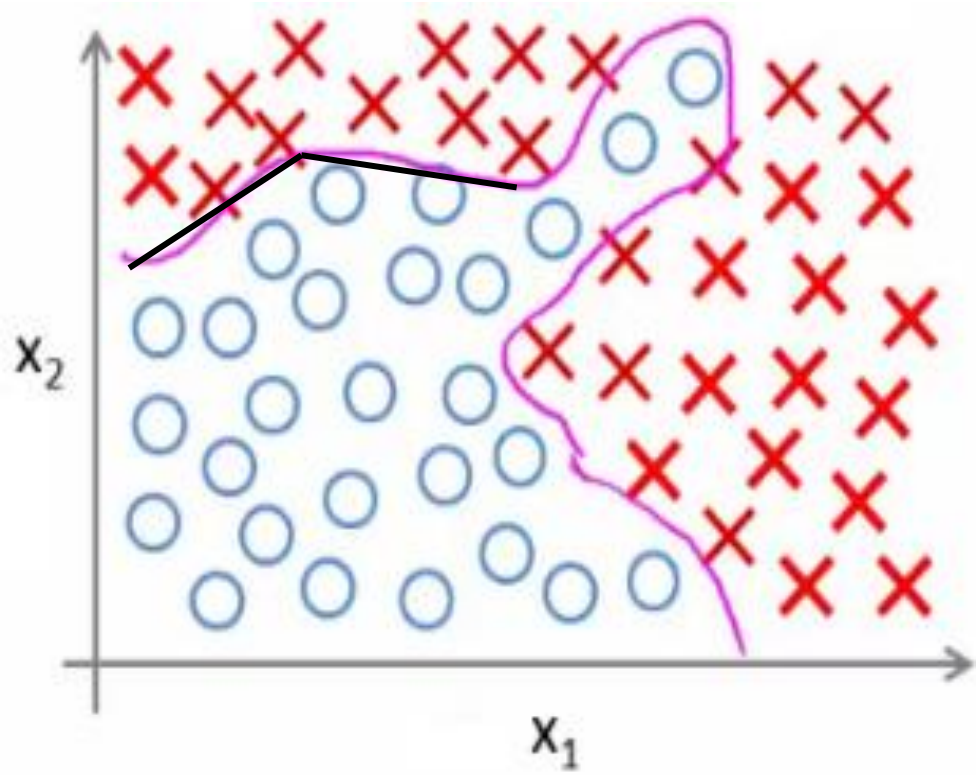

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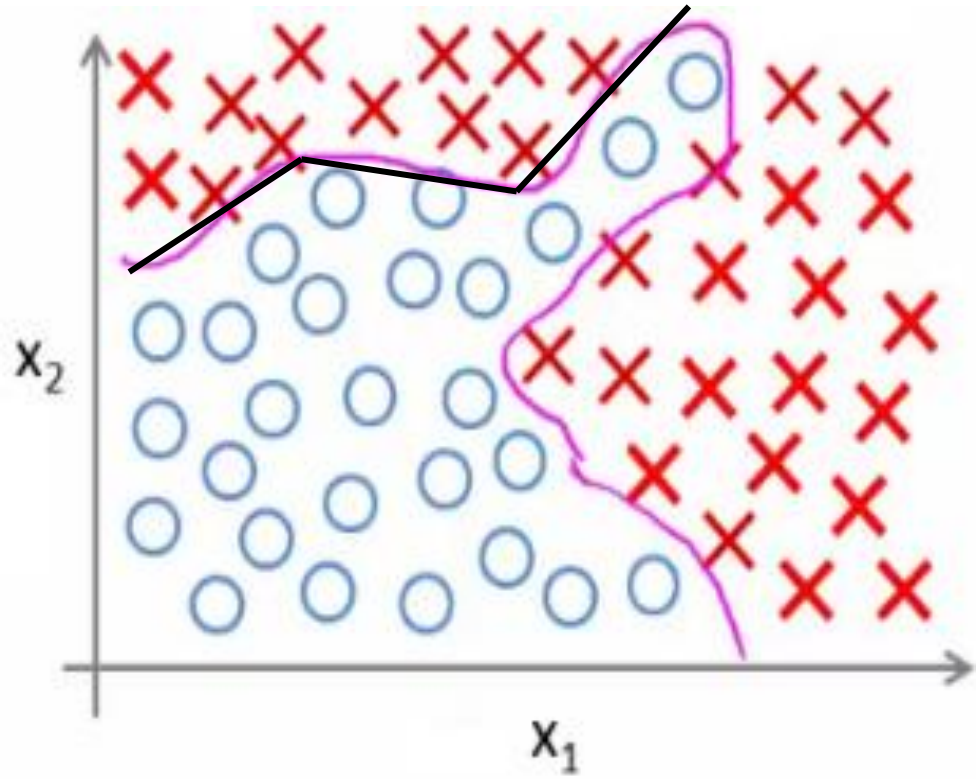

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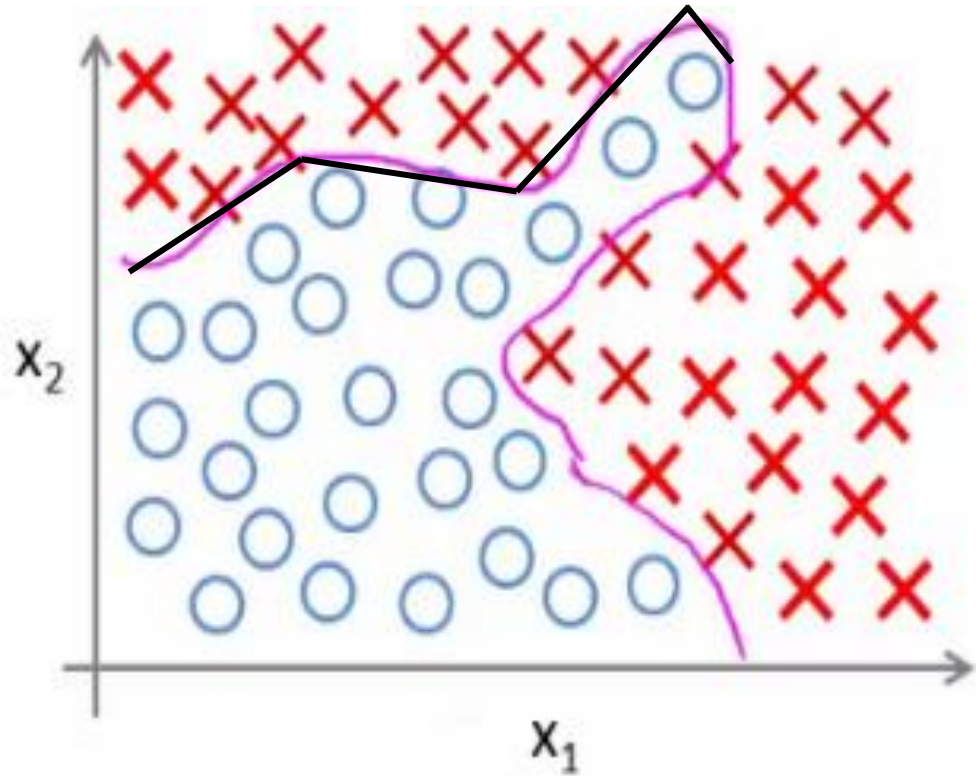

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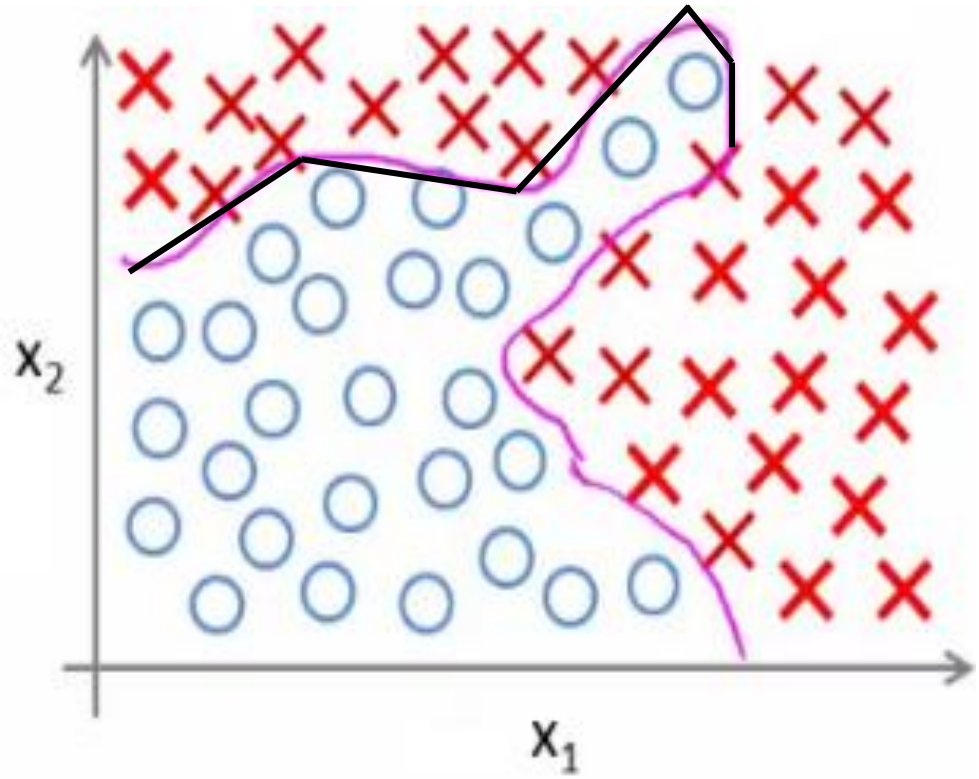

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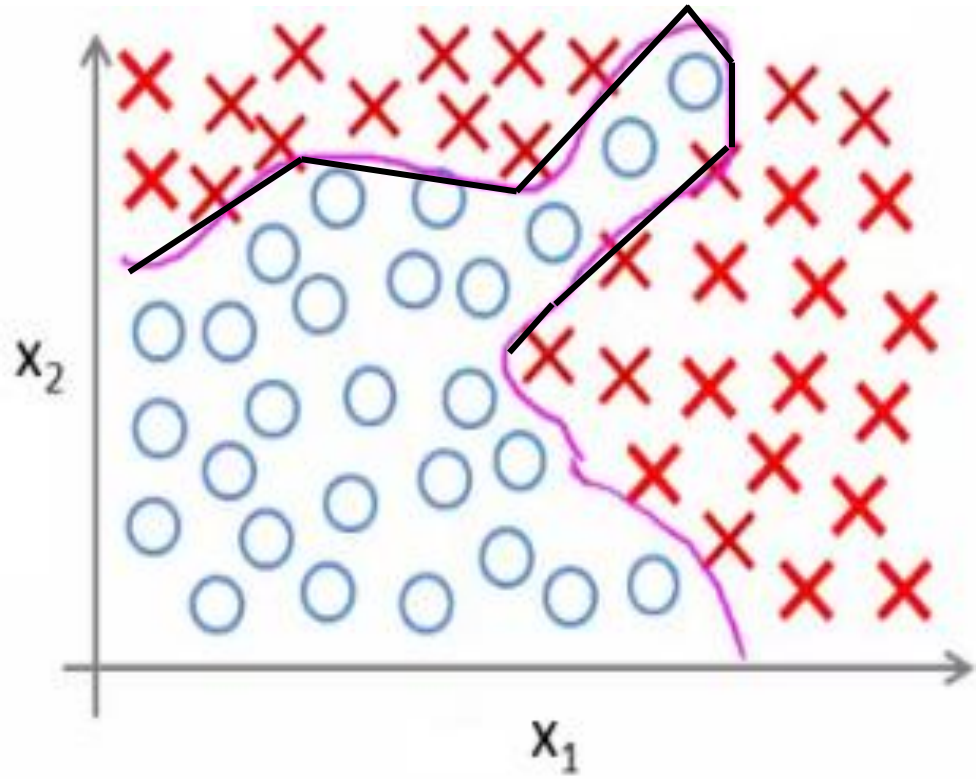

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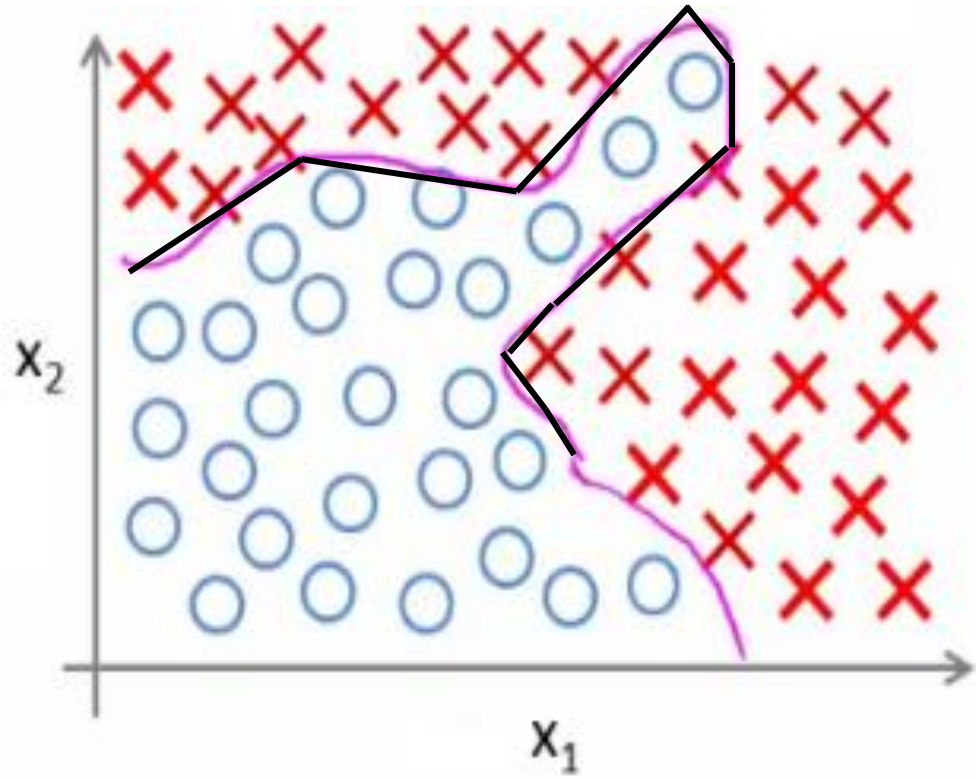

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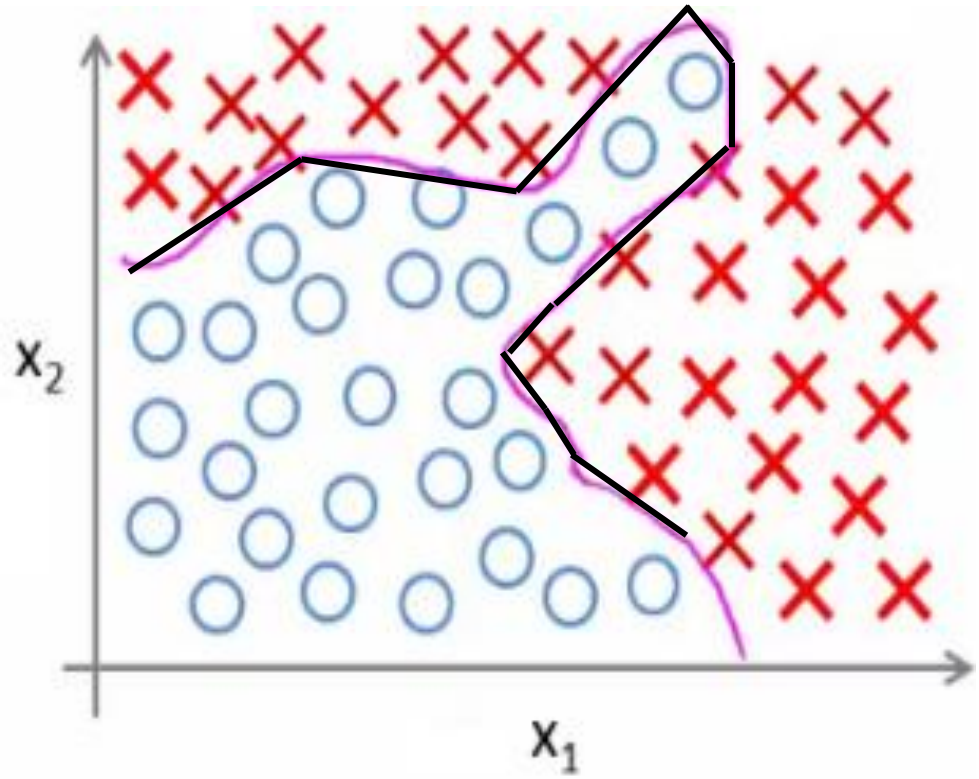
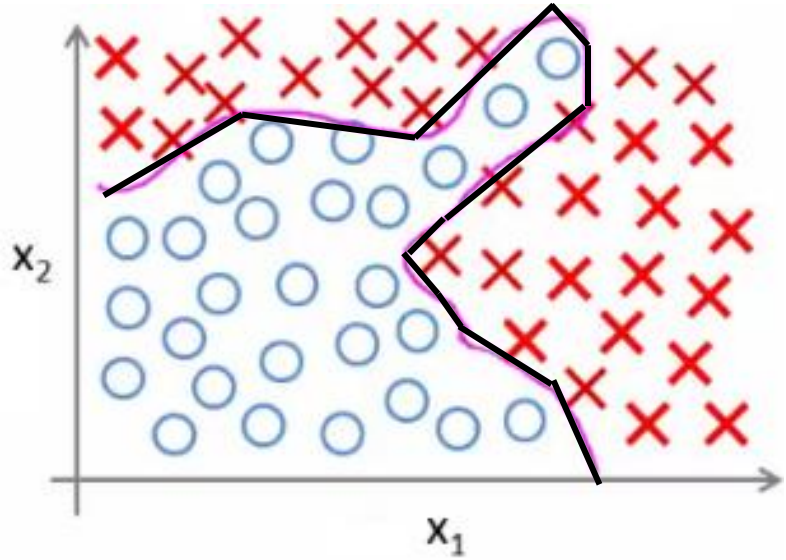


Complex nonlinear decision boundary(2)

- Though it is a complicated non linear decision boundary we can have a piece wise linear approximation of straight line as below
- A neural network in the simplest form actually tries to form a collection of such straight line boundaries



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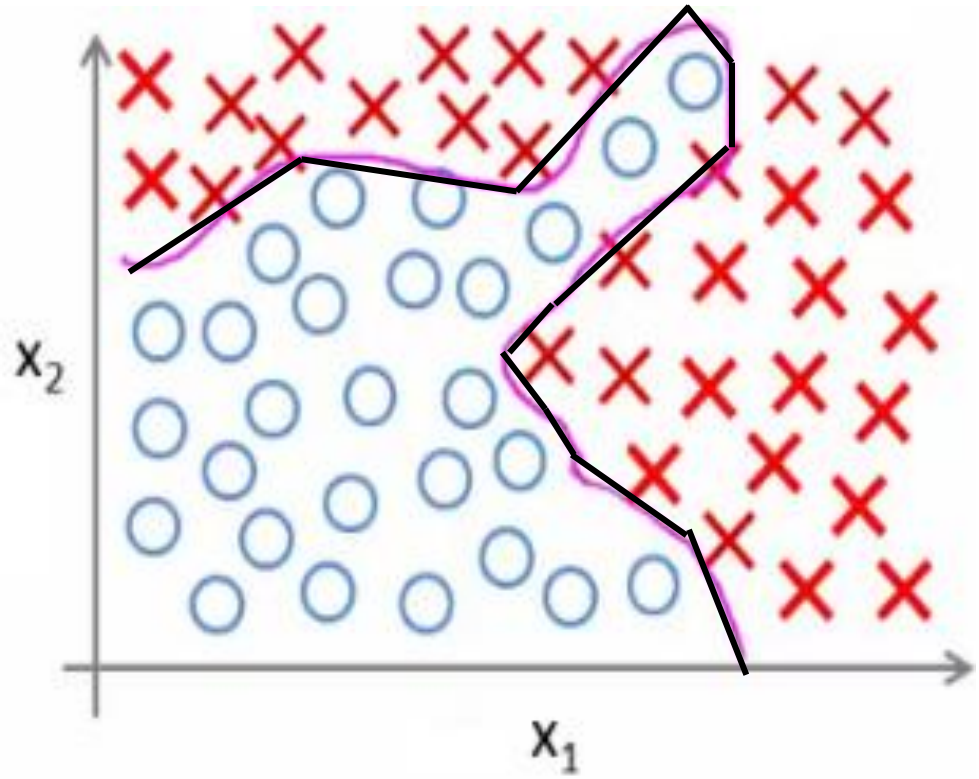


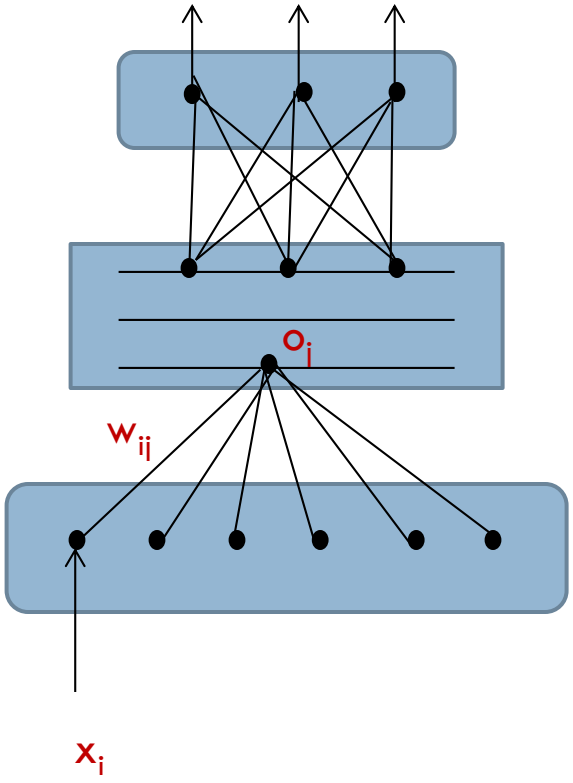
What does neural networks have?

Output layers

None or more no of hidden layers

Input layer

What does neural networks have?



$O_j = f(\Sigma w_{ij} x_i)$

Summary

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THANK YOU