Introduction of Soft Computing

Introduction

What is computing?

- Before understanding soft computing and hard computing we should understand, what is computing?
- The computing in terms of computer technology is the process of accomplishing the particular task with the help of a computer or a computing device.
- There are several characteristics of the computing like it should provide precise solution, accurate and clear control actions, facilitate the solution of the problems that can be solved mathematically.

Types of Computing

There are two types of computing

1) Hard Computing
2) Soft Computing

1) Hard Computing

- **Hard computing** is the traditional approach used in computing which needs an accurately stated analytical model. `
- It was also proposed by Dr Lotfi Zadeh before soft computing.
- Hard computing approach produces a guaranteed, deterministic, accurate result and defines definite control actions using a mathematical model or algorithm.
- It deals with binary and classical logic which require the exact input data sequentially.
- However, hard computing is not capable of solving the real world problems
- **Soft computing and hard computing** are **computing** methods where **hard computing** is the conventional methodology relies on the principles of accuracy, certainty, and inflexibility.

2) Soft Computing

Soft computing is a computing model develope to solve the non-linear problems which involve uncertain, imprecise and approximate solutions of a problem.

These types of problems are considered as real-life problems where the human-like intelligence is required to solve it.

The soft computing term is define by Dr Lotfi Zadeh, according to him, soft computing is an approach which imitates the human mind to reason and learns in an environment of uncertainty and impression.

It is created through two elements adaptivity and knowledge and has a set of tools such as fuzzy logic, neural networks, genetic algorithm, etc.

The soft computing model is distinct from its model known as hard computing model because it does not work on the mathematical model of problem-solving.

Key Differences Between Soft computing and Hard computing

1. The soft computing model is imprecision tolerant, partial truth, approximation. On the other hand, hard computing does not work on the above-given principles; it is very accurate and certain.
2. Soft computing employs fuzzy logic and probabilistic reasoning while hard computing is based on binary or crisp systems.
3. Hard computing has features such as precision and categoricity. As against, approximation and dispositionality are the characteristics of soft computing.
4. Soft computing approach is probabilistic in nature whereas hard computing is deterministic.
5. Soft computing can be easily operated on the noisy and ambiguous data. In contrast, hard computing can work only on exact input data.
6. Parallel computations can be performed in soft computing. On the contrary, in hard computing sequential computation is performed on the data.
7. Soft computing can produce approximate results while hard computing generates precise results.

Comparison Chart

BASIS FOR COMPARISON	SOFT COMPUTING	HARD COMPUTING
Basic	Tolerant to imprecision, uncertainty, partial truth and approximation.	Uses precisely stated analytical model.
Based on	Fuzzy logic and probabilistic reasoning	Binary logic and crisp system
Features	Approximation and dispositionality	Precision and categoricity
Nature	Stochastic	Deterministic
Works on	Ambiguous and noisy data	Exact input data
Computation	Can perform parallel computations	Sequential
Result	Approximate	Produces precise outcome.

Methodologies of the soft computing

1. Fuzzy logic

- Fuzzy logic deals with the decision making and control system problems which cannot be converted into hard mathematical formulae.

- This basically maps the inputs to the outputs logically in a non-linear manner, the way humans does it. Fuzzy logic is used in automobile subsystem, air conditioners, cameras, etcetera.

2. Artificial neural networks

- **Artificial neural networks** perform classification, data mining and prediction process and easily manage the noisy input data by categorizing it into the groups or mapping to an expected output.

- For example, it is used in the image and character recognition, business forecasting where the patterns are learnt from the data sets and a model is created to recognize these patterns.

3. Genetic algorithms and evolutionary techniques

These are employed to solve the optimization and designs related problems where an optimal solution can be recognized but no predefined correct answer would be provided.

The real-life applications of the genetic algorithm which uses heuristic search techniques are robotics, automotive design, optimised telecommunication routing, biomimetic invention, and so on.

Note
Soft Computing is based on biological induced methods such as genetics, development, and behavior, the warm of particles, the human nervous system,

Today,**Soft computing** is miracle solution because when we have not any mathematical modeling for problem-solving such as (many types algorithms), which are using in real

Goal of soft computing

The main goal of **soft computing** is to develop intelligent machines to provide solutions to real world problems, which are not modeled, or too difficult to model mathematically.

Applications of Soft Computing

- Agricultural Production Engineering
- Medicine and Biology Application
- Construction and Design Engineering
- Computer Engineering
- Computational Process
- Natural Environmental Engineering
- Fault-Tolerance
- Machine Learning
- Signal processing
- Mechanical engineering
- Materials Engineering
- Disease diagnosis
- Nano Technology
- Pattern Recognition

Advantages of Soft Computing

These are many **Advantages of Soft Computing** are:

- Work as human being reasoning
- Nearest human thinking
- Biological inspiration
- Tolerance to imprecision
- Can be captured uncertainty and vagueness values
- Perceive Linguistic Variables
- Work in equations and conditions

Classification

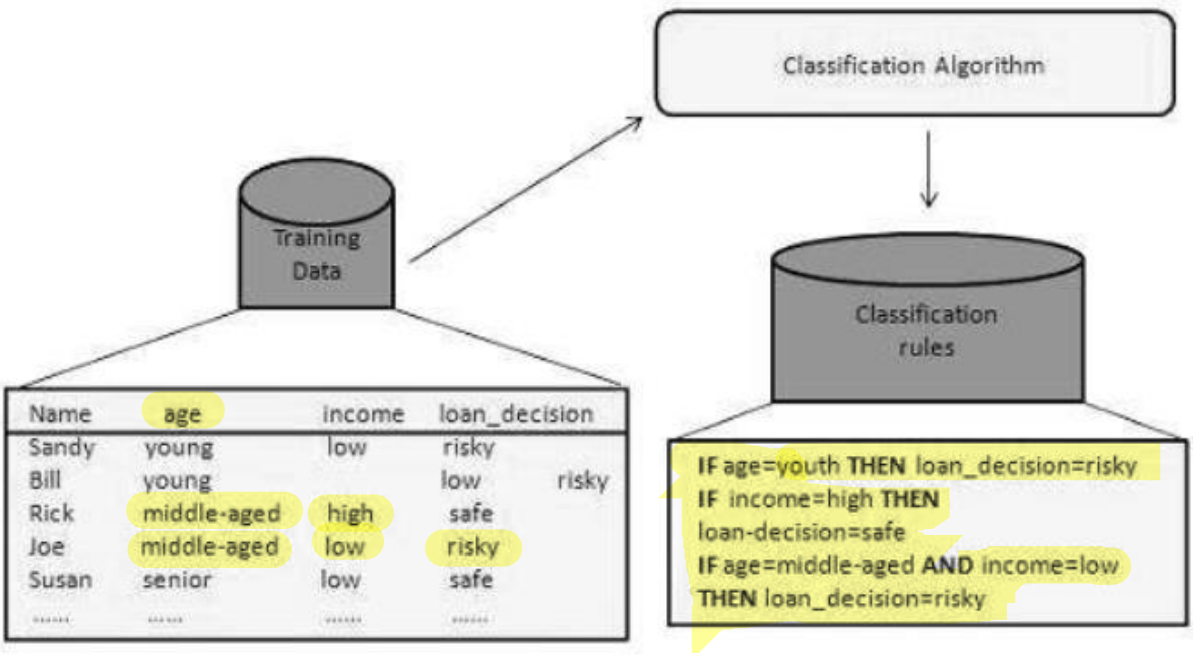
- **Classification** is a **technique** where we categorize data into a given number of classes.
- The main goal of a **classification** problem is to identify the category/class to which a new data will fall under. ...
- Classifier: An algorithm that maps the input data to a specific category.
- **Classification** is a **data** mining technique that assigns categories to a collection of**data** in order to aid in more accurate predictions and **analysis**.
- Also called sometimes called a Decision Tree, **classification** is one of several methods intended to make the **analysis** of very large datasets effective
- There are two forms of data analysis that can be used for extracting models describing important classes or to predict future data trends.

These two forms are as follows –

- Classification
- Prediction
- Classification models predict categorical class labels; and prediction models predict continuous valued functions.
- For example, we can build a classification model to categorize bank loan applications as either safe or risky, or a prediction model to predict the expenditures in dollars of potential customers on computer equipment given their income and occupation.

What is prediction?

- Following are the examples of cases where the data analysis task is Prediction –
- Suppose the marketing manager needs to predict how much a given customer will spend during a sale at his company.
- In this example we are bothered to predict a numeric value.
- Therefore the data analysis task is an example of numeric prediction.
- In this case, a model or a predictor will be constructed that predicts a continuous-valued-function or ordered value.



Clustering

- **Clustering** is the process of making a group of abstract objects into classes of similar objects.
- A **cluster** of **data** objects can be treated as one group.
- While doing **cluster** analysis, we first partition the set of **data** into groups based on **data** similarity and then assign the labels to the groups.

- The prior **difference between classification and clustering** is that **classification** is used in supervised learning technique where predefined labels are assigned to instances by properties, on the contrary.

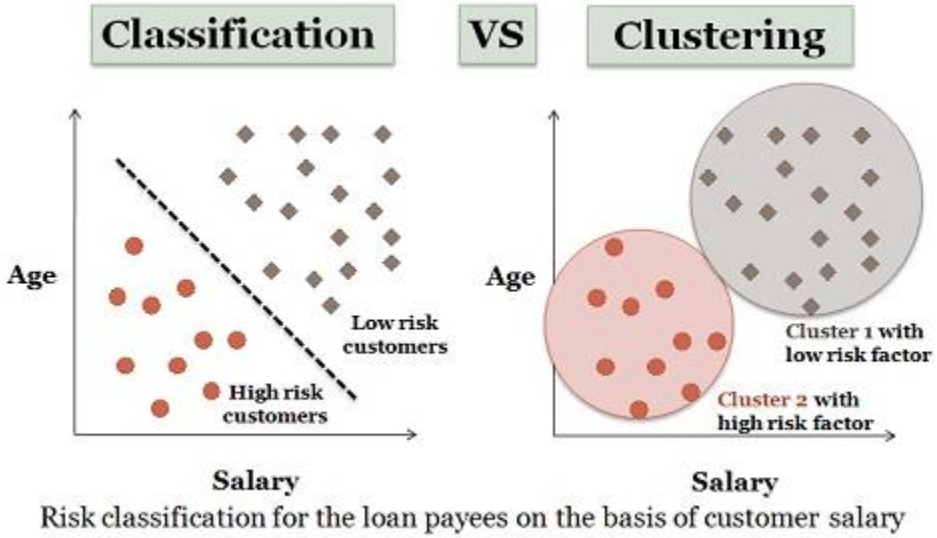
- **clustering** is used in unsupervised learning where similar instances are grouped, based on their features.

- Classification and Clustering are the two types of learning methods which characterize objects into groups by one or more features.

- These processes appear to be similar, but there is a difference between them in context of data mining.

Comparison Chart

BASIS FOR COMPARISON	CLASSIFICATION	CLUSTERING
Basic	This model function classifies the data into one of numerous already defined definite classes.	This function maps the data into one of the multiple clusters where the arrangement of data items is relies on the similarities between them.
Involved in	Supervised learning	Unsupervised learning
Training sample	Provided	Not provided



Risk classification for the loan payees on the basis of customer salary

Probabilistic reasoning:

- Probabilistic reasoning is a way of knowledge representation where we apply the concept of probability to indicate the uncertainty in knowledge.
- In probabilistic reasoning, we combine probability theory with logic to handle the uncertainty.
- We use probability in probabilistic reasoning because it provides a way to handle the uncertainty that is the result of someone's laziness and ignorance.
- In the real world, there are lots of scenarios, where the certainty of something is not confirmed, such as "It will rain today," "behavior of someone for some situations," "A match between two teams or two players." These are probable sentences for which we can assume that it will happen but not sure about it, so here we use probabilistic reasoning.

Need of probabilistic reasoning in AI:

- When there are unpredictable outcomes.
- When specifications or possibilities of predicates becomes too large to handle.
- When an unknown error occurs during an experiment.

Bayesian Networks (BN)

- These are the graphical structures used to represent the probabilistic relationship among a set of random variables.

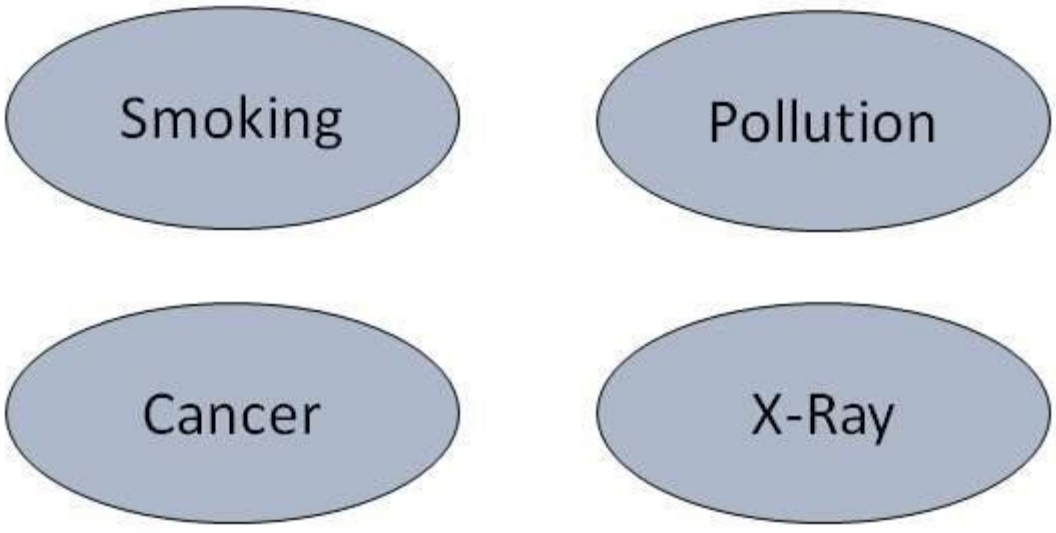
- Bayesian networks are also called **Belief Networks** or **Bayes Nets.**BNs reason about uncertain domain.
- In these networks, each node represents a random variable with specific propositions.
- For example, in a medical diagnosis domain, the node Cancer represents the proposition that a patient has cancer.
- The edges connecting the nodes represent probabilistic dependencies among those random variables.
- If out of two nodes, one is affecting the other then they must be directly connected in the directions of the effect.
- The strength of the relationship between variables is quantified by the probability associated with each node.

- There is an only constraint on the arcs in a BN that you cannot return to a node simply by following directed arcs. Hence the BNs are called Directed Acyclic Graphs (DAGs).

Gather Relevant Information of Problem

- Is the patient a smoker? If yes, then high chances of cancer and bronchitis.
- Is the patient exposed to air pollution? If yes, what sort of air pollution?
- Take an X-Ray positive X-ray would indicate either TB or lung cancer.
- Possible nodes and values for the lung cancer example −

Node Name	Type	Value
Polution	Binary	{LOW, HIGH, MEDIUM}
Smoker	Boolean	{TRUE, FASLE}
Lung-Cancer	Boolean	{TRUE, FASLE}
X-Ray	Binary	{Positive, Negative



Create Arcs between Nodes

- Topology of the network should capture qualitative relationships between variables.
- For example, what causes a patient to have lung cancer? - Pollution and smoking. Then add arcs from node *Pollution* and node *Smoker* to node *Lung-Cancer.*
- Similarly if patient has lung cancer, then X-ray result will be positive. Then add arcs from node *Lung-Cancer* to node *X-Ray*