Experiment Number: 9

Aim:

Study of Bayes Belief Network

Theory:

Bayesian belief network is key computer technology for dealing with probabilistic events and to solve a problem which has uncertainty. We can define a Bayesian network as:

"A Bayesian network is a probabilistic graphical model which represents a set of variables and their conditional dependencies using a directed acyclic graph."

It is also called a **Bayes network, belief network, decision network**, or **Bayesian model**. Bayesian networks are probabilistic, because these networks are built from a **probability distribution**, and also use probability theory for prediction and anomaly detection.

Real world applications are probabilistic in nature, and to represent the relationship between multiple events, we need a Bayesian network. It can also be used in various tasks including prediction, anomaly detection, diagnostics, automated insight, reasoning, time series prediction, and decision making under uncertainty.

Bayesian Network can be used for building models from data and experts opinions, and it consists of two parts: Directed Acyclic Graph and Table of conditional probabilities.

The generalized form of Bayesian network that represents and solve decision problems under uncertain knowledge is known as an Influence diagram.

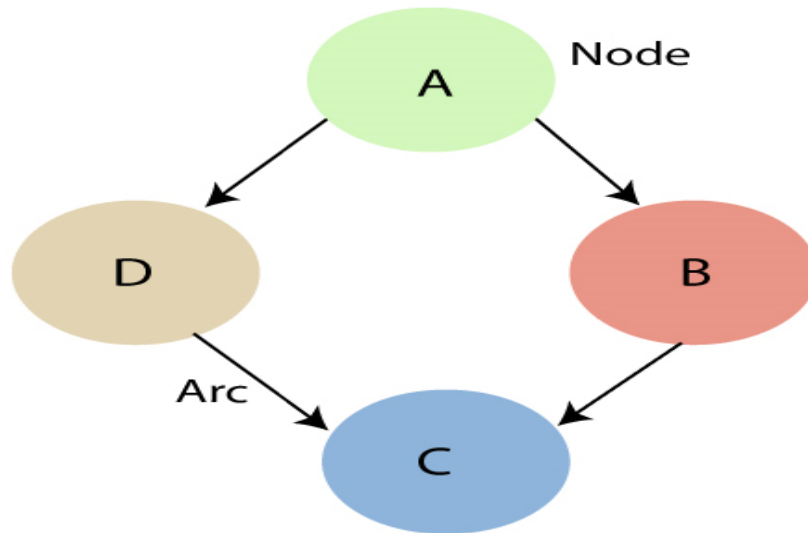A Bayesian network graph is made up of nodes and Arcs (directed links), where:

Fig 9.1 Graph

o Each **node** corresponds to the random variables, and a variable can be **continuous** or **discrete**.

o **Arc or directed arrows** represent the causal relationship or conditional probabilities between random variables. These directed links or arrows connect the pair of nodes in the graph. These links represent that one node directly influence the other node, and if there is no directed link that means that nodes are independent with each other

   o **In the above diagram, A, B, C, and D are random variables represented by the nodes of the network graph.**

   o **If we are considering node B, which is connected with node A by a directed arrow, then node A is called the parent of Node B.**

   o **Node C is independent of node A.**

The Bayesian network has mainly two components:

o **Causal Component**

o **Actual numbers**

Each node in the Bayesian network has condition probability distribution $P(X_i |Parent(X_i))$, which determines the effect of the parent on that node.

Bayesian network is based on Joint probability distribution and conditional probability. So let's first understand the joint probability distribution:

Joint probability distribution:

If we have variables x1, x2, x3,....., xn, then the probabilities of a different combination of x1, x2, x3.. xn, are known as Joint probability distribution.

$P[x_1, x_2, x_3,....., x_n]$, it can be written as the following way in terms of the joint probability distribution.

- $P[x_1| x_2, x_3,....., x_n]P[x_2, x_3,....., x_n]$
- $P[x_1| x_2, x_3,....., x_n]P[x_2|x_3,....., x_n]....P[x_{n-1}|x_n]P[x_n].$

In general for each variable Xi, we can write the equation as:

$P(X_i|X_{i-1},........., X_1) = P(X_i |Parents(X_i))$

Conclusion: Thus, we have studied Belief networks.