Experiment 08

* Title : Write a program to implement Bayesian Belief network using python

* Objectives : To understand & implement Bayesian belief network

* Theory :

Probabilistic models can define relationships between variables & be used to calculate probabilities. As such Bayesian Model provides a useful tool to visualize the probabilistic model for a domain, review all of the relationships between the random variables, & reason about causal probabilities for scenarios given available evidence Real world applications are probabilistic in nature, & to represent the relationship between multiple events, we need a Bayesian Network. It can also be used in various tasks including prediction, anomaly detection, diagnostic automated insight, reasoning, time series prediction & decision making under uncertainity. Bayesian Network can be used for building models from data & expert opinion. & it consists of two parts:

1. Directed Acyclic Graph
2. Table of conditional probabilities

The generalized form of Bayesian network that represents & solve decision problems under certain knowledge is known as an Influence diagram

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

- Each node corresponds to the random variables, &

a variable can be continuous or discrete
- Arc or directed arrows represent the casual ~~relationship~~ relationship or conditional probabilities between random variables. These directed links are arrows connect the pair of nodes in the graph. These links represent that one node directly influence the other node, & if there is no directed link that means that nodes are independent with each other

The Bayesian network has mainly two components
- Casual components
- Actual numbers

Each node in the Bayesian Network has condition probability distribution $P(X_i \mid Parent(X_i))$, which determines the effect of the parent on that node Bayesian network is based on Joint probability distribution & conditional probability. So let's first understand the joint probability distribution:

If we have variable $x_1, x_2, x_3 \ldots x_n$, then the probabilities of a different combination of $x_1, x_2, x_3 \ldots x_n$ are known as Joint probability distribution (JPD) $P[x_1, x_2, x_3 \ldots x_n]$, it can be written as the following way in terms of J.P.D

$= P[x_1 \mid x_2, x_3 \ldots x_n] P[x_2, x_3 \ldots x_n]$

$= P[x_1 \mid x_2, x_3 \ldots x_n] P[x_2 \mid x_3 \ldots x_n] P[X_{n-1} \mid x_n] P[x_n]$

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

$P(X_i \mid X_{i-1}, \ldots x_n) = P(x_i \mid Parents(X_i))$

* Conclusion: Hence, a Bayesian belief network is studied & implemented.