Subject Name: **Artificial Intelligence**

Subject Code: **IT-7005**

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UNIT III

Probabilistic reasoning and Baye's Theorem
An important goal for many problem solving systems is to collect evidence as the system goes along and to modify its behavior on the basis of evidence. To model this behavior we need a statistical theory of evidence.

- Bayesian statistics is such a theory. The fundamental notion of Bayesian statistics is that of conditionprobability.

- Read the expression as the probability of Hypothesis H given that we have observed evidenceE.

- To compute this, we need to take into account the prior probability of H (the probability that we would assign to H if we had no evidence) & the extent to which E provides evidence ofH.

- To do this we need to define a universe that contains an exhaustive, mutually exclusive set of Hi's, among which we are trying todiscriminate.

  P(Hi\E) = The probability that hypothesis Hi is true given evidence E.

  P(E\Hi) = The probability that we will observe evidence E given that hypothesis i is true.

  P(Hi) = The a priori probability that hypothesis i is true in the absence of any specific evidence.These   probabilities are called priorprobabilities.

  K = The number of possible hypothesis.

Bayesian Networks

- It is an alternative approach to what we did in the previoussection.

- The idea is to describe the real world, it is not necessary to use a huge joint probability table in which we list the probabilities of all combinations, because most eventsare independent of each other, there is no need to consider the interactions betweenthem.

- We will use a more local representation in which we will describe clusters of events that interact.

- Let us consider an example as shown in Fig:-3.1

S: sprinkler was on last night
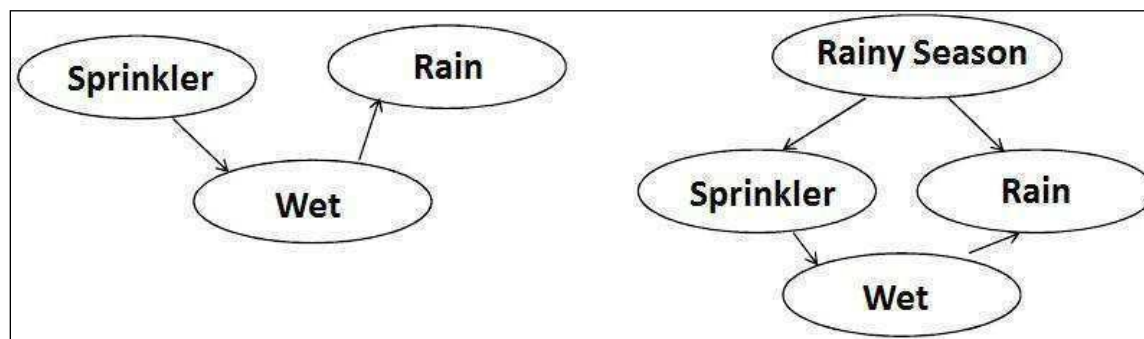
W: grass is wet

R: it rained last night

Fig:-3.1- Bayesian Networks

There are two different ways that propositions can influence the likelihood of each other.

1. The first is that causes influence to the likelihood of theirsymptoms.

2. The second is that observing a symptom affects the likelihood of all its possiblecauses.

- The main idea behind the Bayesian network structure is to make a clear distinction between these two kinds ofinfluences.

- The Graph in above figure is known as DAG (Directed A cyclic Graph) that represents causality relationships among thevariables.

- However, we need more information. In particular, we need to know, for each value of a parent node, what evidence is provided about the values that the child node can take on.

- We create a probability table forthat.

- When the most genuine reasoning does not seem true then we need to use an undirected graph in which the arcs can be used to transmit probabilities in either direction, depending upon where the evidence camefrom.

- We have to ensure that there is no cycle that exists between theevidences.

- Algorithms are available for doing thesecomputations.

1. A message-passingmethod.

2. A variety of stochasticalgorithms.

- The message-passing approach is based on the observation that to compute the probability of a node A given what is known about other nodes in thenetwork.

- It is necessary to know threethings.

  - The total support arriving at A from itsparents.

  - The total support arriving at A from itschildren.

  - The entry in the fixed condition probability matrix that relates A to itscauses.

Semantic networks

A semantic net (or semantic network) is a knowledge representation technique used for propositional information. So it is also called a propositional net. It is a Knowledge Representation formalism that allows representing knowledge as a graph where the nodes represent concepts .The edges (directed) represent relations among concepts .They are a constrained version of predicate calculus language The goal of this formalism is to represent declaratively the elements of a domain. Some specific mechanisms of reasoning can be defined to make some queries about the knowledge that arerepresented.

Scripts

A script is a structure that prescribes a set of circumstances which could be expected to follow on from one another. It is similar to a thought sequence or a chain of situations which could be anticipated. It could be considered to consist of a number of slots or frames but with more specializedroles.

Scripts are beneficial because:

- Events tend to occur in known runs orpatterns.

- Causal relationships between eventsexist.

- Entry conditions exist which allow an event to takeplace

- Prerequisites exist upon events takingplace.

  e.g. when a student progresses through a degree scheme or when a purchaser buys a house.

Script Components

Each script contains the following main components:

- Entry Conditions: Must be satisfied before events in the script canoccur.

- Results: Conditions that will be true after events in scriptoccur.

- Props: Slots representing objects involved in theevents.

- Roles: Persons involved in theevents.

- Track: Specific variation on more general pattern in the script. Different tracks may share many components of the same script but notall.

- Scenes: The sequence of events that occur. Events are represented in conceptual dependencyform.

Advantages of Script

- Capable of predicting implicitevents

- Single coherent interpretation may be build up from a collection ofobservations.

Disadvantage of Script

- More specific (inflexible) and less general thanframes.

- Not suitable to represent all kinds ofknowledge.

- To deal with inflexibility, smaller modules called memory organization packets (MOP) can be combined in a way that is appropriate for thesituation.

Schema

Schema can refer to several things in computing. The "schema" refers to an XML schema that specify the ontologies needed for the agents to communicate and cooperate. More generally, "schema" can refer to any formal description of a system, or a blueprint for one.

Frame

A Frame is a collection of attributes and the description of their characteristics The relations connect frames There is an explicit separation between relations and attributes. Relations and attributes have also properties to describe their semantics. A frame represents a concept .It has a declarative part (attributes) and a procedural part (methods) the declarative part allows to

describe the semantics of the concept (characteristics). The procedural part allows defining how to obtain information or to perform computations related to its attributes or to its relations with other frames. A frame is described by a name, a list of attributes and a list of methods.

Conceptual Dependency (CD)

Conceptual Dependency originally developed to represent knowledge acquired from natural language input. The goals of this theory are:

➢ To help in the drawing of inference fromsentences.

➢ To be independent of the words used in the originalinput.

➢ That is to say: For any 2 (or more) sentences that are identical in meaning there should be only one representation of thatmeaning.

It has been used by many programs that portend to understand English (MARGIE, SAM, PAM).

Conceptual Dependency (CD) provides:

1. A structure into which nodes representing information can beplaced.
2. A specific set ofprimitives.
3. A given level ofgranularity.

Conceptual Dependency (CD) is based upon events and actions. Every event (if applicable) has:

▪ an ACTOR
▪ an ACTION performed by theActor
▪ an OBJECT that the action performson
▪ a DIRECTION in which that action isoriented

These are represented as slots and fillers. In English sentences, many of these attributes are left out.

Fuzzy Logic

Fuzzy logic is a form of many-valued logic in which the truth values of variables may be any real number between 0 and 1.By contrast, in Boolean logic, the truth values of variables may

only be the integer values 0 or 1.

- Fuzzy logic has been employed to handle the concept of partial truth, where the truth value may range between completely true and completelyfalse.
- When linguistic variables are used, these degrees may be managed by specific (membership) functions.
- In the standard Boolean definition for tall people are either tall or not and there must be a specific height that defines theboundary.
- Once set membership has been redefined in this way, it is possible to define a reasoning system based on the techniques for combining distributions. Such methods have been used in control systems for devices like trains and washingmachines.

Forward chaining

Forward Chaining is one of the two main methods of reasoning when using an inference engine and can be described logically as repeated application of modus ponens. Forward chaining is a popular implementation strategy for expert systems, business and production rule systems. Forward chaining starts with the available data and uses inference rules to extract more data (from an end user, for example) until a goal is reached. An inference engine using forward chaining searches the inference rules until it finds one where the antecedent (If clause) is known to be true. When such a rule is found, the engine can conclude, or infer, the consequent (Then clause), resulting in the addition of new information to its data.

Backward Chaining:

Backward chaining (or backward reasoning) is an inference method that can be described (in lay terms) as working backward from the goal(s). It is used in automated theorem provers, inference engines, proof assistants and other artificial intelligence applications.

In game theory, its application to (simpler) sub games in order to find a solution to the game is called backward induction. In chess, it is called retrograde analysis, and it is used to generate table bases for chess endgames for computer chess.

Backward chaining is implemented in logic programming by SLD resolution. Both rules are based on the modus pollens inference rule. It is one of the two most commonly used methods of reasoning with inference rules and logical implications – the other is forward chaining.

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