AI

Unit - 5 - Uncertainty.

Q1] Discuss how to resolve the issue of uncertain knowledge. And different source of uncertainity.

Ans The different source of Uncertainty in AI

Main source:
1) Uncertain inputs (Missing data, noisy data)
2) uncertain knowledge.
3) uncertain outputs.

There are several sources of uncertainty in AI that can impact the reliability and effectiveness of AI system.

1] Data Uncertainity:
→ AI modle are trained on data, the quality and accuracy of data can affect the performance of model. Noise and incomplete data can lead to uncertain prediction or decision made by AI system.

2] Model Uncertainty:-
→ AI models are complex and can have various parameters and hyperparameters that need to be tuned. The choice of model architectures, optimization algorithm, and hyperparameters can significantly impact the performance of model.

3] Environmental Uncertainity :-

→ AI system can operate in dynamic environment, and changes in environment can affect the performance of system.

Ex :- An autonomous vechicle may encounter the unexpected weather condition or road construction that can impact the ability to navigate safely.

4] Human uncertainity :-

→ AI system can Interact with humans either as the user or part of decision-making process. Human behaviour and preferencence cannot be predict leading in uncertainity of use and adoption of AI system.

5] Ethical uncertainity :-

→ AI system often raise ethical concerns such as privacy, bias and transparency. These concerns can lead to uncertainity in development and deployment of AI system.

6] Uncertainity in AI reasoning :-

→ AI system use reasoning techniques to make decisions or predictions. The reasoning technique can be uncertain due to complexity of the problem.

// search how to resolve the issue of uncertain knowledge

Q 2] Describe Bayesian Network with suitable example. Explain the utility of Bayesian networks in handling uncertainity with example.

Ans. 1) Bayesian belief Network is key computer technology for dealing with probabilistic events and to solve a problem which has uncertainity.

2) The Bayesian Network is a graphical model that represent the set of variables and their conditional dependencies using directed acyclic graph.

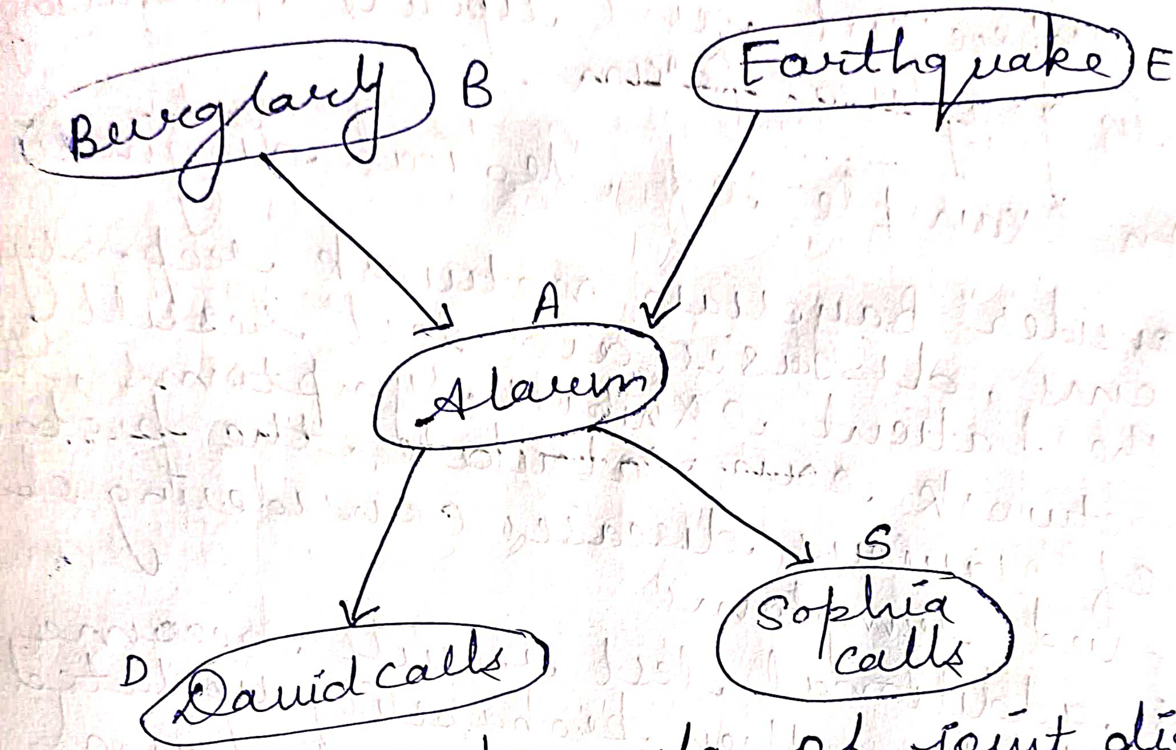
3) Ex :- calculate the probability that alarm has sounded, but there is neither a burglary, nor an earthquake occurred, and David and Sophia both called the Harry.

Soluⁿ → List of event occuring in network

- Burglary (B)
- Earthquake [E]
- Alarm (A)
- David calls (D)
- Sophia calls (S)

We can write the event of problem statements in form of probability P[D, S, A, B, E] can rewrite above probability statements using joint probability distribution.

$$P[D,S,A,B,E] = P[D|S,A,B,E] \cdot P[S,A,B,E]$$
$$= P[D|S,A,B,E] \cdot P[S|A,B,E] \cdot P[A,B,E]$$
$$= P[D|A] \cdot P[S|A,B,E] \cdot P[A,B,E]$$
$$= P[D|A] \cdot P[S|A] \cdot P[A|B,E] \cdot P[B,E]$$
$$= P[D|A] \cdot P[S|A] \cdot P[A|B,E] \cdot P[B|E] \cdot P[E]$$



From the formula of joint distribution, we can write the problem statement in form of

$$P(S, D, A, \neg B, \neg E) = P(S|A) * P(D|A) * P(A|\neg B \wedge \neg E) * P(\neg B) * P(\neg E)$$

$$\boxed{= 0.00068}$$

Hence, a Bayesian network can answer any query about the domain of by using joint distribution.

• The utility of Bayesian Network in handling uncertainity

→ Bayesian network are powerful tool for handling uncertainity by modeling and updating probabilities based on available evidence. They used to represent and update knowledge in graphical form.

* An example of Medical diagnosis :-

→ consider Bayesian network rep. symptoms, diseases and test result. If the patient exhibits symptoms, the network can calculate the probability of various diseases considering observed symptoms.

As additional test result become available, then probability updated. allowing for more accurate and dynamic assessment of patient condition, even in the presence of uncertainity.

Q3] Distinguish between Bayes theorem and belief network with example.

Ans * Bayes theorem

1) Bayes theorem is also knowns as Bayes's rule, Bayes law which determine the probability with uncertain knowledge

2) In probability theory, it relates the conditional probability and marginal probability of two random event.

3) Bayes theorem allow updating the probability prediction of an event by observing new information of real world.

4) Ex :- What is the probability of that a patient has diseases meningitis with stiff neck?

soln -> Given data :-

A doctor is aware that disease meningitis causes a patient to have stiff neck, and it occurs 80% of time. He also aware of some more facts which are given as follows.

1] The known prob. that patients has meningitis diseases is $\frac{1}{30,000}$.

2] The known prob. that patient has a stiff neck is 2%.

Let a = Proposition of patient that have stiff neck.

b = proposition that patient has meningitis.

$P(a|b) = 0.8$

$P(b) = \frac{1}{30,000}$

$P(a) = 0.02$

$$P(b|a) = \frac{P(a|b) \times P(b)}{P(a)} = \frac{0.8 \times \frac{1}{30,000}}{0.02}$$

$= 0.0013$

Hence, we can assume that 1 patient has meningitis out of 750 patients has meningitis diseases with stiff neck.

// write belief Network with ex from ques ②.

Q4] Illustrate the concept of Bayes theorem with suitable example and why there is need of Bayes theorm in AI.

Ans // For illustrate concept refer ques ③. with example

* Need of Bayes theorem in AI:-

1) Probabilitic reasoning:-

→ AI often deals with uncertain information and incomplete data. Bayes theo. provide the framework for updating probabilities based on new evidence.

2) Decision Making:-

→ Bayes theorem is crucial for decision-making under uncertainity. AI system can use this theorem to calculate the probability of different outcome.

3) Natural language processing:-

→ In language understanding and processing dealing with ambiguity and undertainity is common. Bayes theorem help to manage uncertianity and refining language models based on observed pattern.

4) Risk Assessment:-

→ AI application related to risk management and Bayes theorem aids in assessing and updating risk probabilities based on evolving situations.

Q5] consider XYZ the college, 60%

soln → Let H : student selected is a hostler.
D : student slected is a day scholar.
A : student has a 'A' grade.

we need to find the probability that the students selected is a hostler, if he has an 'A' grade.

i.e $P(H|A)$

$$\text{so, } P(H|A) = \frac{P(H) \times P(A|H)}{P(D) \cdot P(A|D) + P(H) \cdot P(A|H)}$$

$P(H)$ = Probability that student is Hostler

$= 60\% = \frac{60}{100} = \underline{0.6}$

$P(D)$ = Prop that student a day scholar

$= 40\% = \frac{40}{100} = \underline{0.4}$.

$P(A|H)$ = Prob that student with gets 'A' grade, if hostler.

$= 30\% = \frac{30}{100} = \underline{0.3}$.

$P(A|D)$ = Prop that student get 'A' grade if day scholar

$= 20\% = \frac{20}{100} = \underline{0.2}$

Putting values in formula.

$$P(H|A) = \frac{0.6 \times 0.3}{0.4 \times 0.2 + 0.6 \times 0.3}$$

$$= \frac{0.18}{0.26} = \frac{9}{13}.$$

∴ Required Probability is $\boxed{\frac{9}{13}}$

Q6] From the pack of 52 cards ----

Soluⁿ Let E_1, E_2, E_3, E_4, A be the event as defined below:

E_1 = the missing card is diamond.
E_2 = the missing card is heart
E_3 = the missing card is spade.
E_4 = the missing card is club.
A = drawing 2 diamonds cards from the remaining cards.

The $P(E_1) = \frac{13}{52} = \frac{1}{4}$, $P(E_2) = \frac{13}{52} = \frac{1}{4}$

$P(E_3) = \frac{13}{52} = \frac{1}{4}$, $P(E_4) = \frac{13}{52} = \frac{1}{4}$

$P\left(\frac{A}{E_1}\right)$ = Prob of drawing two diamond car given that a card is missing.

$= \frac{{}^{12}C_2}{{}^{51}C_2}$

$P\left(\frac{A}{E_2}\right)$ = Prob of drawing two diamond cards given that one heart card is missing $= \frac{{}^{13}C_2}{{}^{51}C_2}$

||ly $P\left(\frac{A}{E_3}\right) = \frac{{}^{13}C_2}{{}^{51}C_2}$ and

$P\left(\frac{E_1}{A}\right) = \frac{{}^{13}C_2}{{}^{31}C_2}$

By Baye's rule;

$$P\left(\frac{E_1}{A}\right) = \frac{P(E_1)\,P\left[\frac{A}{E_1}\right]}{P[E_1]P\left[\frac{A}{E_1}\right] + P[E_2]P\left(\frac{A}{E_2}\right) + P(E_3)P\left[\frac{A}{E_3}\right.}$$

$$\boxed{= \frac{11}{50}}.$$

Q7) Explain the Axioms of probability used for rep. of uncertain knowledge in details.

Ans :- There are three Axioms of probability that make the foundation of probability theory -

Axiom 1 : Probability of Event.
Axiom 2 : Probability of Sample space
Axiom 3 : Mutually exclusive event.

① Probability of Event.

1) The probability of any event is between 0 and 1.

$$\boxed{E,\ 0 \leq P(E) \leq 1}$$

2) we known that the formula of probability is.

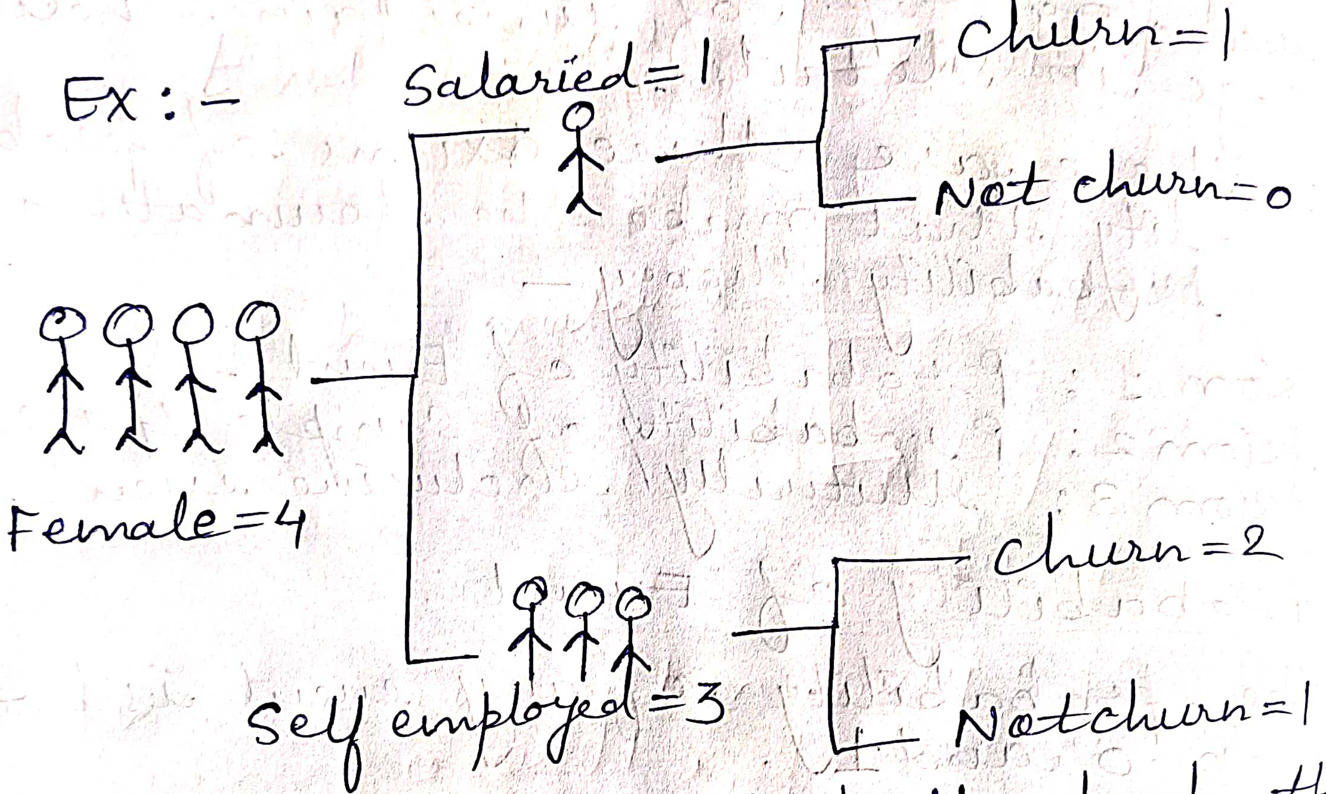
$$P(\text{event}) = \frac{\text{count of outcome in Event}}{\text{count of outcomes in sample space}}.$$

So the event cannot have more outcome than sample space, clearly the value is going to be between 0 and 1, since denominator is greater than numerator.

② Probability of Sample Space

1) The probability of entire sample space is 1. i, e $P(S) = 1$.

2) Ex:-



If we want to find the prob. that

$P(\text{Salaried churn}) = \frac{1}{4} = 0.25$

$P(\text{Salaried not churn}) = 0 \rightarrow 0$

$P(\text{self emp. churn}) = \frac{2}{4} = 0.5$

$P(\text{Self not churn}) = \frac{1}{4} = 0.25$

If we sum of them.

$0.25 + 0.5 + 0.25 + 0 = \boxed{1}$.

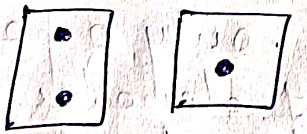
③ Mutually exclusive event :-

1) $P(A \cup B) = P(A) + P(B)$ for mutually ex.

2) mutually exclusive means such event cannot occur together or in other word they don't have common values or we can say their intersection is zero / null.

3) Event A :- is getting a number greater than 4 after rolling die.

Event B :- is getting number less than 3



clearly both event A and B are not having any common outcome, but they are mutually exclusive with one ~~ontle~~ other.

Q8] Interpret the concept of fuzzy logic with example. Also its role, application advantage and disadvantage in AI.

Ans. 1] The 'fuzzy' word means the things that are not clear or are vague. Sometimes we cannot decide in real life that the given problem statement is either true or false. At that time the concept provides many values between the true & false and give the flexibility to find the best solution to that problem

• Example of fuzzy logic

Is it hot water? → Yes/1
→ No/0
} Boolean logic

Is it hot water? → very much/0.9
→ little/0.25
→ very less/0.1
} fuzzy logic

In boolean system, only 2 possibilities either 0 or 1, 1 denotes true and 0 denotes false but in fuzzy logic it lies between 0 & 1 which is partially false or true.

• Roles of fuzzy logic

1) This concept is flexible and we can easily understand and implement it
2) It is used for helping the minimization of the logic created by the humans.
3) Best method to find the solution of those problems which are based on approximation and uncertainty.

• Application :-

1) It is used in Business for decision making
2) It is used in Automotive System for controlling the traffic and Speed.
3) Used in Defence for the underwater target reconglition.
4) It is widely used in Pattern Recognition and classification in the form of fuzzy logic based recognition.
5) Fuzzy logics systems also used in Securities.

• Advantages :-

1) Easy understanding.
2) work similarly as human reasoning.
3) Does not need large memory.
4) It is widely used in field of lifes provide effective solution.
5] Due to flexibility, any user can easily add and delete rules in FLS system.

• Disadvantages :-

1) The run time is slow.
2) user can understand it easily if they are simple.
3) It needs lot of testing for verification and validation.

Q10] Harry installed a new burglar...

Soln→ List all the event occuring in the network:-

1] Burglary (B)
2] Earthquake [E]
3] Alarm [A]
4] David call [D]
5] Sophia call [S]

We can write the event of problem statements in the form of probability P [D, S, A, B, E], can rewrite the above prop. statements using joint prop. distribution.

$$P[D,S,A,B,E] = P[D|S,A,B,E] \cdot P[S,A,B,E]$$
$$= P[D|S,A,B,E] \cdot P[S|A,B,E] \cdot P[A,B,E]$$
$$= P[D|A] \cdot P[S|A,B,E] \cdot P[A,B,E]$$
$$= P[D|A] \cdot P[S|A] \cdot P[A|B,E] \cdot P[B,E]$$
$$= P[D|A] \cdot P[S|A] \cdot P[A|B,E] \cdot P[B] \cdot P[E]$$

Let observed the probability of Burglary and earthquake components:-

~~we or~~ $P(B = True) = 0.02$, prob of burglary

$P(B) = False = 0.998$, which is prob of no burglary.

$P[E = True] = 0.001$, which is prop of minor earthquake

P[E= false] = 0.999 ; which is prob that earthquake not occurred.

By provide the conditional prop. as per the below tables:-

1) conditional prob of Alarm A depend on Burglar and earthquake.
// see from question.

2) conditional prob table from david call
// see from question.

3) conditional prob. table for sophia call
// see from question

From the formula of joint distribution -

$$P[S, D, A, \neg B, \neg E) = P(S|A) * P(D|A) * P(A|\neg B \wedge \neg E) * P(\neg B) * P(\neg E)$$

$$= 0.75 * 0.91 * 0.001 * 0.999 * 0.998$$

$$\boxed{= 0.00068.}$$

Q9].

solⁿ→ Let A_1 = It rain on Shaym wedding

A_2 = It does not rain on Shaym wedding.

B = weatherman predicts rain.

$$P(A_1) = \frac{7}{365} = 0.019$$

$$P(A_2) = \frac{358}{365} = 0.980.$$

$$P(B/A_1) = 60\% = \frac{60}{100} = 0.6.$$

$$P(B/A_2) = 40\% = 0.4.$$

By Bayes theorem we get.

$$P[A_1|B] = \frac{P(A_1) \cdot P(B|A_1)}{P(A_1) \cdot P(B/A_1) + P(A_2) \cdot P(B/A_2)}$$

$$= \frac{0.019 \times 0.6}{0.019 \times 0.6 + 0.98 \times 0.4}$$

$$= \frac{0.0114}{0.019 \times 0.6 + 0.980 \times 0.4}$$

$$\boxed{= 0.0282.}$$

Note the somewhat unintuitive result Even when the weatherman predict rain, it rain only about 2.8%. There is good chances that Shaym can get married.