Uncertainty In AI

Week-09

Uncertainty:

- The situations that lack complete information about a particular aspect that cause ambiguity and unpredictability are considered uncertain in nature.

Examples:

- Will it rain tomorrow?
- Who will win the PSL 2030?
- What will be your CGPA when you graduate?
- Will the next card drawn from the deck of 52 cards be red or spade ?
- What will be the number when you roll the die on your next turn?
- Will it be heads on the next coin toss?
- Is the cavity caused by only toothache?

How does AI handles Uncertainty?

In order to handle uncertainty we need to have a certain degree of belief that affirms the possibility of a certain event in a quantifiable manner.

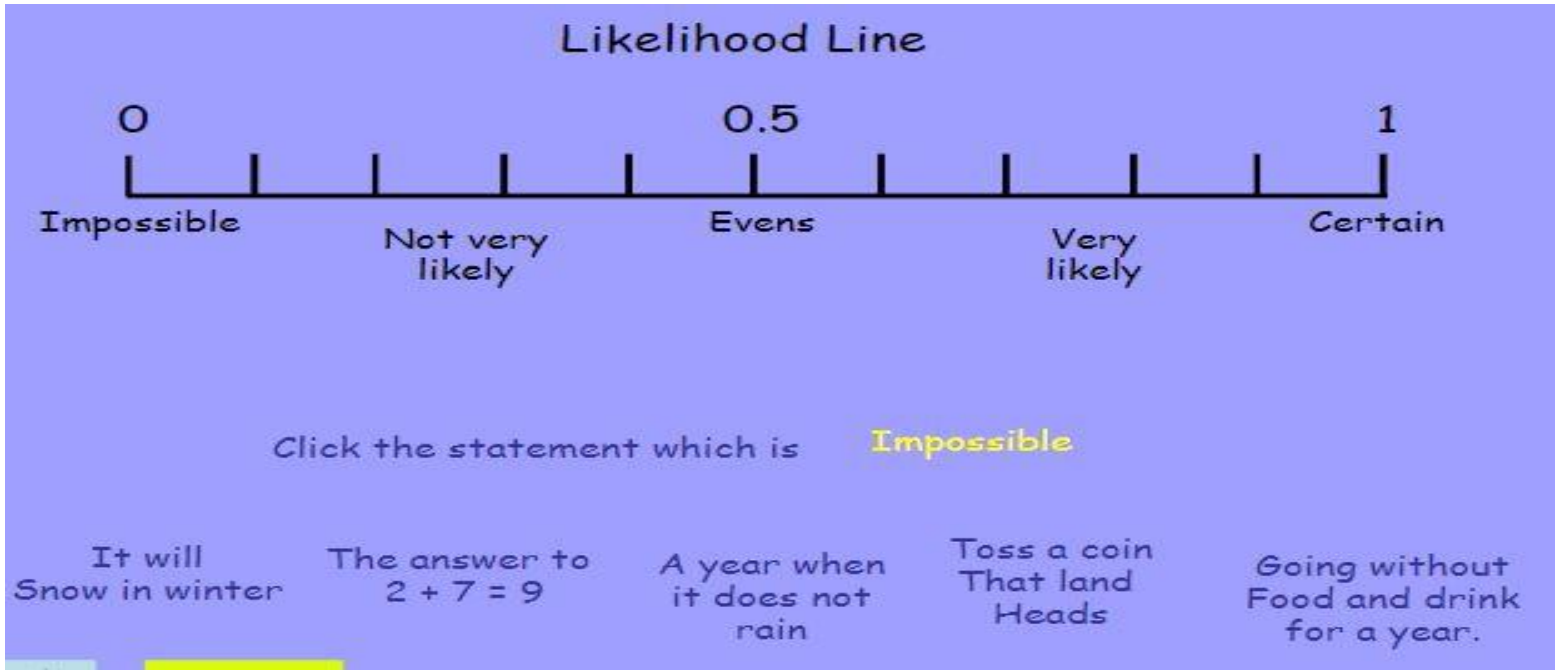
To handle uncertainty in an event, AI and Maths both work together to provide reasoning for uncertainty

How Does AI handles Uncertainty

- Probabilistic Reasoning
- Bayesian Belief Networks
- Monte Carlo Method
- Decision Theory
- Fuzzy Logic
- Qualitative Reasoning

Probability:

It is a measure of how likely the event is to happen. It lies between 0-1



Probability: Language of Proposition

- **Random Variable:** variables like die_1, *cavity* , *etc*.
- **Domain:** The set of possible values for a variable. e.g. die_1 = {1, 2, 3, 4, 5, 6}

What's the domain of *Weather* , *Cavity* , *Age*.

Probability: Language of Proposition

- **A *random variable* can take on one of a set of different values, each with an associated probability. Its value at a particular time is *subject to random variation*.**
  - *Discrete* random variables take on one of a discrete (often finite) range of values
  - Domain values must be *exhaustive* and *mutually exclusive*

- **For us, random variables will have a discrete, countable (usually finite) domain of *arbitrary values*.**
  - Mathematical statistics usually calls these *random elements*

  - **Example: Weather is a discrete random variable with domain {sunny, rain, cloudy, snow}.**
  - ***Example: A Boolean random variable* has the domain {true,false},**

Probability: Language

Let's consider *Weather* = {*sunny* , *rainy* , *cloudy* , *snow* }

- *P*(*sunny*) = 0.6; *P*(*rain*) = 0.1; *P*(*cludy*) = 0.29; *P*(*snow*) = 0.01
- *P*(*Weather*) is a probability distribution.
- *P*(*Weather*) =

sunny	rainy	cloudy	snow
0.6	0.1	0.29	0.01

- *P*(*Weather*) =< 0.6, 0.1, 0.29, 0.01 > for short

Probability: Concepts:

- **Sample Space**: All possible worlds
  - dice roll: Ω = (1, 6)
  - Ω = all possible worlds; ω = one world
- $0 \leq P(\omega) \leq 1$ for every ω
- $\sum_{\omega \in \Omega} P(\omega) = 1$

Probability =No: of Favorable events/Total no; of events

What's the possibility of obtaining a head in a coin toss? 1/2
Possibility of odd numbers in Die? = 3/6

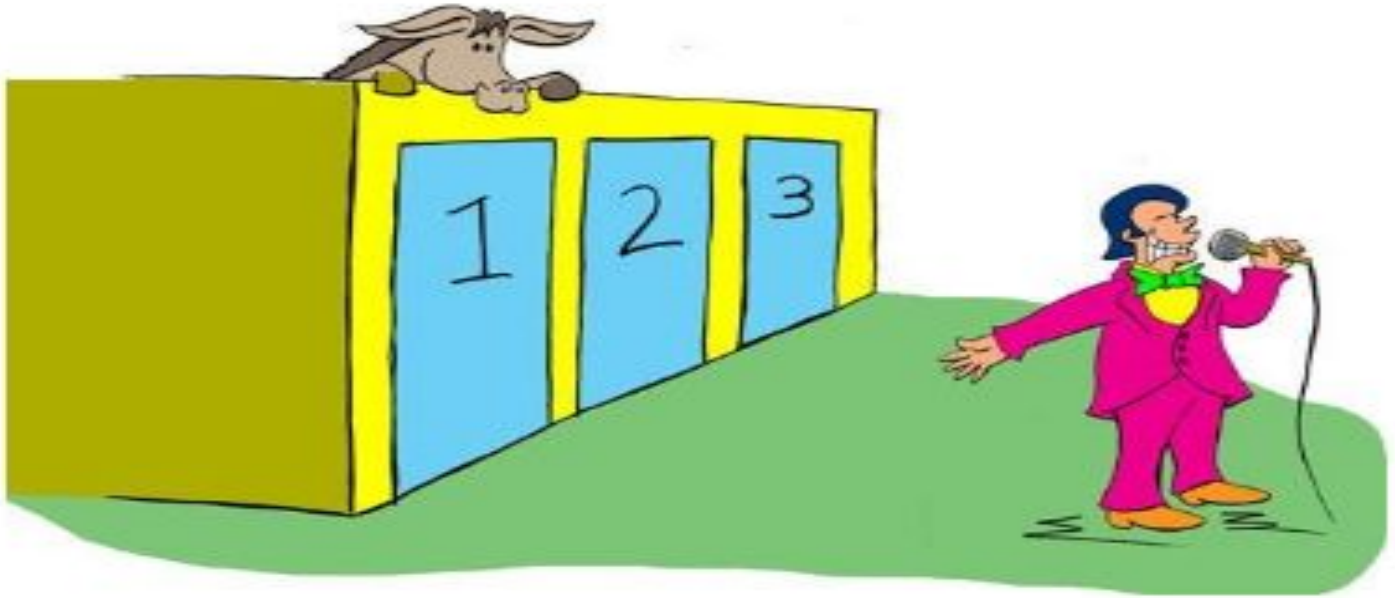
e.g., P(1)=P(2)=P(3)=P(4)=P(5)=P(6)=1/6.

Probability: Axioms

Kolmogorov's axioms

- $0 \leq P(\omega) \leq 1$ for every ω and $\sum_{\omega \in \Omega} P(\omega) = 1$
- $P(\neg a) = \sum_{\omega \in \neg a} P(\omega)$
- $P(\neg a) = 1 - P(a)$
- $P(a \vee b) = P(a) + P(b) - P(a \wedge b)$

Monty Hall Problem



The Monty Hall Problem