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Probability

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Abstract
Probability is the possibility of an event to happen in future. In this paper, different types of events and their respective probabilities are discussed. There is also a description of various types of probability distributions, and the examples are discussed.

Keywords: Probability, possibility

Introduction

Probability: It is a mathematical function that tells about the possibility of an event to occur. It is a measure of the likelihood of the occurrence of the event.
Probability = Desired outcomes / Total number of outcomes

Example: A coin is tossed and player P asks for head, the desired outcome is 1(head) and total number of outcomes are 2 (head and tail). So the probability of player P winning the toss is
P (head) = ½ = 0.5
Value of probability always lies between 0 and 1.
Event: An event is any process like tossing a coin for which we determine the probability of a head and tail to occur or rolling dice, for which we determine probability of occurance of any number from 1 to 6.
If the probability of an event is 1, then it will always occur .If the probability of an event is 0, it will never happen.

Types of events:

- Dependent events: When the outcome of one event directly affects the outcome of the second event, then both the events are said to be dependent events.

Example: If two cards are drawn from a pack of cards, then the probability of bith cards being red is -
P (R and R) = 26/52 *25/51 = 25/102

- Independent events: If there is no influence of outcome of first event on the outcome of the second event, then the events are said to be independent events.

P (A and B) = P (A) * P (B)

Example: If a coin is tossed, then the probability of two successive heads to occur is -
P (H and H) = ½ * ½ = ¼

- Inclusive events: Those events which can occur at the same time are known as inclusive events.

Example: If a dice is rolled what the probability of the number is being odd or 3 is -
P (odd or 3) = P (odd) + P (3) - P (odd and 3) = 3/6 +1/6 -1/6 = 1/2

- Mutually exclusive events: Those events which cannot happen at the same time are known as the mutually exclusive events. The probability of either of the two mutually exclusive events to occur can be calculated as the sum of their individual probabilities.
  P(A and B) = 0.

Example: If a dice is rolled, the probability of 3 or 4 occurring on the top face of dice is -
P (3 or 4) = P (3) + P (4) = 1/6 + 1/6 = 2/6 = 1/3

Conditional probability: Conditional probability for an event Y is the probability that event Y will occur provided that event X has already happened.
P (Y|X) = P (X and Y) / P (X)

Example: If two cards are drawn simultaneously, if the first one is a spade then the probability of the second card also being a spade
P (Y|X) = 12/51

Inverse probability: It is calculated by applying Baye's rule.
Baye's theorem: Baye's theorem can be used to tell the probability of an event by using the already available knowledge related to the event.
P (A|B) = P(B|A) P(A) / P (B)

Example: In any hospital, A means patient has lung cancer, 10% of patients have heart disease. P (A) = 0.10.
B means patient is a smoker, 5% of total patients are smokers.
Among the patients diagnosed with lung cancer, 7% are smokers.
By applying Baye's theorem
P (B|A) = (0.07 * 0.1) / 0.05 = 0.14

- If the person is a smoker, there is 14% of chance that he/she may has lung cancer.

Probability distribution: It tells about the probability of different outcomes to occur in an experiment.

- Binomial distribution: It is the discrete probability distribution. Total n number of independent experiments is conducted and a variable p stores the count of successful experiment.

$^nC_k\ (p^k)\ (q)^{n-k}$. Here, p is the probability of the occurrence of the event and q= 1-p.

Example: A coin is tossed 8 times; the probability of getting head 4 times is –
$^8C_4\ (½)^4\ (½)^4 = 35/128$
When n = 1, i.e., for a single experiment Binomial probability Distribution becomes Bernoulli's probability distribution.
Poisson probability distribution: It is a discrete probability distribution which tells about number of events happening in a given period, given the event occurs with a constant rate over that period.

Conditions

- During the period event can occur any number of times.
- Events are independent of each other. So the occurrence of one event does not affect the probability of occurrence of another event
- The rate of occurrence does not change with time.

$P (X = k) = \lambda^k e^{-\lambda} / k!$, where
X is the discrete random variable that tells about the number of events observed in a given time period.
λ is the average or expected value
Example: If a person travels 2 km per day, the probability that 3 km are travelled by him in a day is –
$P (3;2) = (2.71)^{-2}\ (2)^3 / 3! = 0.180$

- Normal probability distribution: It is a continuous probability distribution. They are used in statistics to represent random variables having real values. It is also known as the Gaussian distribution. It shows that data far from the mean is less frequent while the data near the mean is more frequent.

$$y = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

$$\begin{aligned} \mu &= \text{ Mean} \\ \sigma &= \text{ Standard Deviation} \\ \pi &\approx 3.14159\cdots \\ e &\approx 2.71828\cdots \end{aligned}$$

Most common examples of normal probability distribution are

- Height of people
- Marks in test
- Size of cricket bats

Example: 95% of people walk between 1.1k m and 1.7 km. Assuming that data is normally distributed, mean and standard deviation is calculated as:
Mean = (1.1 + 1.7) /2 = 1.4 km
Standard deviation = (1.7 – 1.1) / 4 = 0.15 km.
Discrete and continuous probability distributions:
Discrete probability distribution: The variable takes only specified values.
The most common example for it can be of a coin flip. Discrete probability distribution is used for specific business applications. Most common of them are:

- Binomial Discrete probability distribution
- Poisson Discrete probability distribution
- Geometric Discrete probability distribution

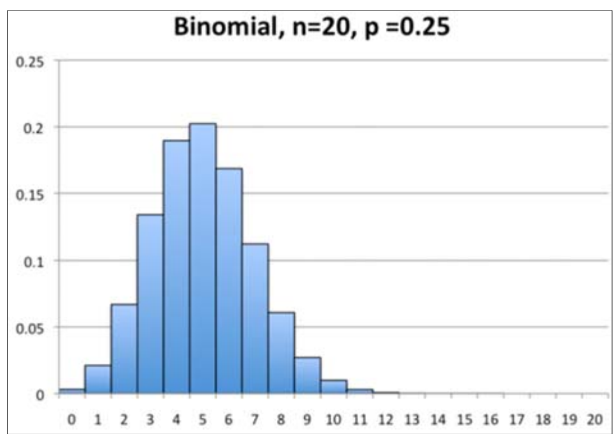

Fig 1: Binominal

Continuous probability distribution: The variable can take any value between the specified values. Continuous probability distribution is also used for business purposes. Most common of them are:

- Uniform Continuous probability distribution
- Normal Continuous probability distribution

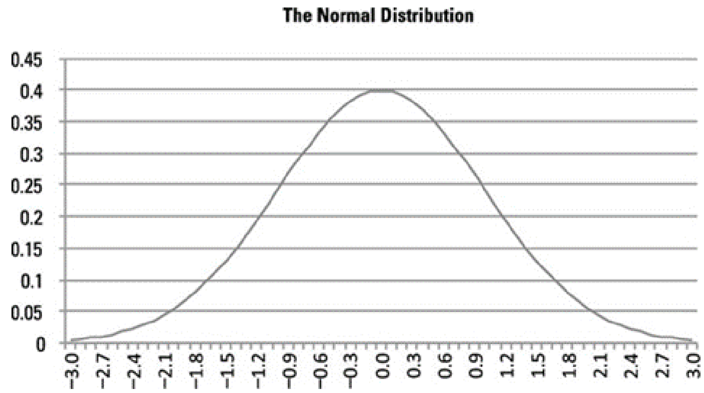

Fig 2: The Normal Distribution

Application areas: The concept of probability is used in the area of mathematics, statistics, computer science, finance, gambling, physics, game theory, machine learning, artificial intelligence etc. It is used to draw inferences about the expected frequency of events. It is also used in mechanics and complex numbers.

Conclusion

Though probability cannot provide the precise results in many of the real life situations, but it can provide with the approximate idea of the outcomes. It is widely used in all fields like study, business, sports and media.

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