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## PROBABILITY AND STATISTICS - INTRODUCTION

## What is Probability?

Probability denotes the possibility of the outcome of any random event. The meaning of this term is to check the extent to which any event is likely to happen. For example, when we flip a coin in the air, what is the possibility of getting a head? The answer to this question is based on the number of possible outcomes. Here the possibility is either head or tail will be the outcome. So, the probability of a head to come as a result is $1 / 2$.

The probability is the measure of the likelihood of an event to happen. It measures the certainty of the event. The formula for probability is given by;

P(E) = Number of Favourable Outcomes/Number of total outcomes
$P(E)=n(E) / n(S)$
Here,
$\mathrm{n}(\mathrm{E})=$ Number of event favourable to event E
$\mathrm{n}(\mathrm{S})=$ Total number of outcomes

## What is Statistics?

Statistics is the study of the collection, analysis, interpretation, presentation, and organization of data. It is a method of collecting and summarising the data. This has many applications from a small scale to large scale. Whether it is the study of the population of the country or its economy, stats are used for all such data analysis.

Statistics has a huge scope in many fields such as sociology, psychology, geology, weather forecasting, etc. The data collected here for analysis could be quantitative or qualitative. Quantitative data are also of two types such as: discrete and continuous. Discrete data has a fixed value whereas continuous data is not a fixed data but has a range. There are many terms and formulas used in this concept. See the below table to understand them.

## Terms Used in Probability and Statistics

## Random Experiment

An experiment whose result cannot be predicted, until it is noticed is called a random experiment. For example, when we throw a dice randomly, the result is uncertain to us. We can get any output between 1 to 6 . Hence, this experiment is random.

## Sample Space

A sample space is the set of all possible results or outcomes of a random experiment. Suppose, if we have thrown a dice, randomly, then the sample space for this experiment will be all possible outcomes of throwing a dice, such as;

Sample Space $=\{1,2,3,4,5,6\}$

## Random Variables

The variables which denote the possible outcomes of a random experiment are called random variables. They are of two types:

1. Discrete Random Variables
2. Continuous Random Variables

Discrete random variables take only those distinct values which are countable. Whereas continuous random variables could take an infinite number of possible values.

## Independent Event

When the probability of occurrence of one event has no impact on the probability of another event, then both the events are termed as independent of each other. For example, if you flip a coin and at the same time you throw a dice, the probability of getting a 'head' is independent of the probability of getting a 6 in dice.

## Mean

Mean of a random variable is the average of the random values of the possible outcomes of a random experiment. In simple terms, it is the expectation of the possible outcomes of the random experiment, repeated again and again or $n$ number of times. It is also called the expectation of a random variable.

## Expected Value

Expected value is the mean of a random variable. It is the assumed value which is considered for a random experiment. It is also called expectation, mathematical expectation or first moment. For example, if we roll a dice having six faces, then the expected value will be the average value of all the possible outcomes, i.e., 3.5.

## Variance

Basically, the variance tells us how the values of the random variable are spread around the mean value. It specifies the distribution of the sample space across the mean.

## Probability Formulas

The formula of the probability of an event is:

$$
P(A)=\frac{\text { Number of Favourable Outcome }}{\text { Total Number of F avourable Outcomes }}
$$

$\mathrm{P}(\mathrm{A})=\mathrm{n}(\mathrm{A}) / \mathrm{n}(\mathrm{S})$

Where,

- $P(A)$ is the probability of an event " $A$ "
- $n(A)$ is the number of favourable outcomes
- $\mathrm{n}(\mathrm{S})$ is the total number of events in the sample space

Note: Here, the favourable outcome means the outcome of interest.

| Probability Range | Probability of an event ranges from 0 to 1 i.e. $0 \leq P(A) \leq 1$ |
| :--- | :--- |
| Rule of Complementary Events | $P\left(A^{\prime}\right)+P(A)=1$ |
| Rule of Addition | $P(A \cup B)=P(A)+P(B)-P(A \cap B)$ |
| Mutually Exclusive Events | $P(A \cup B)=P(A)+P(B)$ |
| Independent Events | $P(A \cap B)=P(A) P(B)$ |
| Disjoint Events | $P(A \cap B)=0$ |
| Conditional Probability | $P(A \mid B)=P(A \cap B) / P(B)$ |
| Bayes Formula | $P(A \mid B)=P(B \mid A) P(A) / P(B)$ |

## Statistics Formula

| Mean | $\bar{x}=\frac{\sum \mathrm{x}}{\mathrm{n}}$ | x = Observations given <br> $\mathrm{n}=$ Total number of observations |
| :---: | :---: | :---: |
| Median | If n is odd, then $\mathrm{M}=\left(\frac{n+1}{2}\right)^{t h}$ term If n is even, then $\mathrm{M}=\frac{\left(\frac{n}{2}\right)^{\text {th }} \text { term }+\left(\frac{n}{2}+1\right)^{\text {th }} \text { term }}{2}$ | $\mathrm{n}=$ Total number of observations |
| Mode | The value which occurs most frequently |  |
| Variance | $\sigma^{2}=\sum_{\mathrm{n}}(x-\bar{x})^{2}$ | $\begin{array}{\|l} \hline \frac{\mathrm{x}}{\bar{x}}=\text { Observations given } \\ \mathrm{n}=\text { Total number of observations } \end{array}$ |
| Standard Deviation | $S=\sigma=\sqrt{ } \sum_{\mathrm{n}}\left(x_{\mathrm{x}}-\bar{x}\right)^{2}$ | $\begin{array}{\|l} \hline \frac{\mathrm{x}}{\bar{x}}=\text { Observations given } \\ \mathrm{n}=\text { Total number of observations } \end{array}$ |

## Solved Examples

Example 1: Find the mean and mode of the following data: 2, 3, 5, 6, 10, 6, 12, 6, 3, 4.

## Solution:

Total Count: 10
Sum of all the numbers: $2+3+5+6+10+6+12+6+3+7=60$
Mean = (sum of all the numbers)/(Total number of items)
Mean $=60 / 10=6$
Again, Number 6 is occurring for 3 times, therefore Mode $=6$. Answer

Example 2: A bucket contains 5 blue, 4 green and 5 red balls. Sudheer is asked to pick 2 balls randomly from the bucket without replacement and then one more ball is to be picked. What is the probability he picked $\mathbf{2}$ green balls and $\mathbf{1}$ blue ball?

Solution: Total number of balls $=14$
Probability of drawing
1 green ball = 4/14
another green ball $=3 / 13$
1 blue ball =5/12
Probability of picking 2 green balls and 1 blue ball $=4 / 14 * 3 / 13 * 5 / 12=5 / 182$.

Example 3: What is the probability that Ram will choose a marble at random and that it is not black if the bowl contains $\mathbf{3}$ red, $\mathbf{2}$ black and 5 green marbles.

Solution: Total number of marble $=10$
Red and Green marbles $=8$
Find the number of marbles that are not black and divide by the total number of marbles.
So P(not black) = (number of red or green marbles)/(total number of marbles)
$=8 / 10$
$=4 / 5$

Example 4: Find the mean of the following data:
55, 36, 95, 73, 60, 42, 25, 78, 75, 62
Solution: Given,

Sum of observations $=55+36+95+73+60+42+25+78+75+62=601$
Number of observations $=10$
Mean $=601 / 10=60.1$

Example 5: Find the median and mode of the following marks (out of 10) obtained by 20 students:
$4,6,5,9,3,2,7,7,6,5,4,9,10,10,3,4,7,6,9,9$
Solution: Given,
$4,6,5,9,3,2,7,7,6,5,4,9,10,10,3,4,7,6,9,9$
Ascending order: $2,3,3,4,4,4,5,5,6,6,6,7,7,7,9,9,9,9,10,10$
Number of observations $=\mathrm{n}=20$
Median $=(10$ th +11 th observation $) / 2$
$=(6+6) / 2$
$=6$
Most frequent observations $=9$
Hence, the mode is 9 .

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