What is Probability? Babed iv sem economics **By Yashwant sharma**

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 air, what is the possibility of coming 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.

Formula for Probability

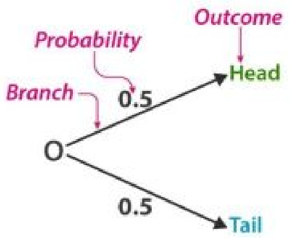
The probability formula is defined as the possibility of an event to happen is equal to the ratio of the number of favourable outcomes and the total number of outcomes.

Probability of event to happen P(E) = Number of favourable outcomes/Total Number of outcomes

Sometimes students get mistaken for "favourable outcome" with "desirable outcome". This is the basic formula. But there are some more formulas for different situations or events.

Probability Tree

The **tree diagram** helps to organize and visualize the different possible outcomes. Branches and ends of the tree are two main positions. Probability of each branch is written on the branch, whereas the ends are containing the final outcome. Tree diagram used to figure out when to multiply and when to add. You can see below a tree diagram for the coin:



Types of Probability

There are three major types of probabilities:

- Theoretical Probability
- Experimental Probability
- Axiomatic Probability

Theoretical Probability

It is based on the possible chances of something to happen. The theoretical probability is mainly based on the reasoning behind probability. For example, if a coin is tossed, the theoretical probability of getting head will be ½.

Experimental Probability

It is based on the basis of the observations of an experiment. The experimental probability can be calculated based on the number of possible outcomes by the total number of trials. For example, if a coin is tossed 10 times and heads is recorded 6 times then, the experimental probability for heads is 6/10 or, 3/5.

Axiomatic Probability

In axiomatic probability, a set of rules or axioms are set which applies to all types. These axioms are set by Kolmogorov and are known as **Kolmogorov's three axioms.** With the axiomatic approach to probability, the chances of occurrence or non-occurrence of the events can be quantified. The axiomatic probability lesson covers this concept in detail with Kolmogorov's three rules (axioms) along with various examples.

Conditional Probability is the likelihood of an event or outcome occurring based on the occurrence of a previous event or outcome.

Probability of an Event

Assume an event E can occur in r ways out of a sum of n probable or possible **equally likely ways**. Then the probability of happening of the event or its success is expressed as;

P(E) = r/n

The probability that the event will not occur or known as its failure is expressed as:

P(E') = n-r/n = 1-r/n

E' represents that the event will not occur.

Therefore, now we can say;

P(E) + P(E') = 1

This means that the total of all the probabilities in any random test or experiment is equal to 1.

What are Equally Likely Events?

When the events have the same theoretical probability of happening, then they are called equally likely events. The results of a sample space are called equally likely if all of them have the same probability of occurring. For example, if you throw a die, then the probability of getting 1 is 1/6. Similarly, the probability of getting all the numbers from 2,3,4,5 and 6, one at a time is 1/6. Hence, the following are some examples of equally likely events when throwing a die:

- Getting 3 and 5 on throwing a die
- Getting an even number and an odd number on a die
- Getting 1, 2 or 3 on rolling a die

are equally likely events, since the probabilities of each event are equal.

Complementary Events

The possibility that there will be only two outcomes which states that an event will occur or not. Like a person will come or not come to your house, getting a job or not getting a job, etc. are examples of complementary events. Basically, the complement of an event occurring in the exact opposite that the probability of it is not occurring. Some more examples are:

- It will rain or not rain today

- The student will pass the exam or not pass.
- You win the lottery or you don't.
- **Multiplication Rule of Probability** Multiplication
- The multiplication rule of probability explains the condition between two events. For two events A and B associated with a sample space S, the set $A \cap B$ denotes the events in which both event A and event B have occurred. Hence, $(A \cap B)$ denotes the simultaneous occurrence of the events A and B. The event $A \cap B$ can be written as AB. The probability of event AB is obtained by using the properties of conditional probability.

Multiplication Rule of Probability Statement and proof

We know that the conditional probability of event A given that B has occurred is denoted by $P(A|B)$ and is given by:

$P(A|B) = P(A \cap B)P(B)$
Where, $P(B) \neq 0$

$P(A \cap B) = P(B) \times P(A|B)$ ……………………………………………..(1)

$P(B|A) = P(B \cap A)P(A)$
Where, $P(A) \neq 0$.

$P(B \cap A) = P(A) \times P(B|A)$

Since, $P(A \cap B) = P(B \cap A)$

$P(A \cap B) = P(A) \times P(B|A)$ ……………………………………………(2)

From (1) and (2), we get:

$P(A \cap B) = P(B) \times P(A|B) = P(A) \times P(B|A)$ where,

$P(A) \neq 0, P(B) \neq 0$.

The above result is known as multiplication rule of probability.

For independent events A and B, $P(B|A) = P(B)$. The equation (2) can be modified into,

$P(A \cap B) = P(B) \times P(A)$

Multiplication Theorem in Probability

We have already learned the multiplication rules we follow in probability, such as;

$P(A \cap B) = P(A) \times P(B|A)$; if $P(A) \neq 0$

$P(A \cap B) = P(B) \times P(A|B)$; if $P(B) \neq 0$

Let us learn here the multiplication theorems for independent events A and B.

If A and B are two independent events for a random experiment, then the probability of simultaneous occurrence of two independent events will be equal to product of their probabilities. Hence,

$P(A \cap B) = P(A).P(B)$

Now, from multiplication rule we know;

$P(A \cap B) = P(A) \times P(B|A)$

Since A and B are independent, therefore;

$P(B|A) = P(B)$

Therefore, again we get;

P(A∩B) = P(A).P(B)

Hence, proved.

Example

Illustration 1: An urn contains 20 red and 10 blue balls. Two balls are drawn from a bag one after the other without replacement. What is the probability that both the balls drawn are red?

Solution: Let A and B denote the events that first and second ball drawn are red balls. We have to find P(A∩B) or P(AB).

P(A) = P(red balls in first draw) = 20/30

Now, only 19 red balls and 10 blue balls are left in the bag. Probability of drawing a red ball in second draw too is an example of conditional probability where drawing of second ball depends on the drawing of first ball.

Hence Conditional probability of B on A will be,
P(B|A) = 19/29

By multiplication rule of probability,

P(A∩B) = P(A) × P(B|A)

P(A∩B) = 20/30 × 19/29 = 38/87**bili**y

Addition Rules for Probability

Addition Rule 1: When two events, A and B, are mutually exclusive, the probability that A or B will occur is the sum of the probability of each event.

P(A or B) = P(A) + P(B)

Let's use this addition rule to find the probability for Experiment 1.

Experiment 1: A single 6-sided die is rolled. What is the probability of rolling a 2 or a 5?

Probabilities:

$$P(2) = \frac{1}{6}$$

$$P(5) = \frac{1}{6}$$

$$P(2 \text{ or } 5) = P(2) + P(5)$$

$$= \frac{1}{6} + \frac{1}{6}$$

$$= \frac{2}{6}$$

$$= \frac{1}{3}$$

Experiment 3: A glass jar contains 1 red, 3 green, 2 blue, and 4 yellow marbles. If a single marble is chosen at random from the jar, what is the probability that it is yellow or green?

Probabilities:

$$P(\text{yellow}) = \frac{4}{10}$$

$$P(\text{green}) = \frac{3}{10}$$

$$P(\text{yellow or green}) = P(\text{yellow}) + P(\text{green})$$

$$= \frac{4}{10} + \frac{3}{10}$$

$$= \frac{7}{10}$$

Additional Rule 2: When two events, A and B, are non-mutually exclusive, the probability that A or B will occur is:

P(A or B) = P(A) + P(B) - P(A and B)

In the rule above, P(A and B) refers to the overlap of the two events. Let's apply this rule to some other experiments.

Experiment 1: In a math class of 30 students, 17 are boys and 13 are girls. On a unit test, 4 boys and 5 girls made an A grade. If a student is chosen at random from the class, what is the probability of choosing a girl or an A student?

Probabilities: P(girl or A) = P(girl) + P(A) - P(girl and A)

$$= \frac{13}{30} + \frac{9}{30} - \frac{5}{30}$$

$$= \frac{17}{30}$$

Summary: To find the probability of event A or B, we must first determine whether the events are mutually exclusive or non-mutually exclusive. Then we can apply the appropriate Addition Rule:
Addition Rule 1: When two events, A and B, are mutually exclusive, the probability that A or B will occur is the sum of the probability of each event.
P(A or B) = P(A) + P(B)
Addition Rule 2: When two events, A and B, are non-mutually exclusive, there is some overlap between these events. The probability that A or B will occur is the sum of the probability of each event, minus the probability of the overlap.

P(A or B) = P(A) + P(B) - P(A and B)