**Probability**

**Recap**

* *What is probability*
* *Types of probability*
* *What is sample space*
* *What is the addition rule?*
* *How do you use the Venn diagram for non-independent events?*

**Today**

* **Exercises in addition rule (non-independent events)**
* **Multiplicative Rule**
* **Conditional Probability**

**Exercises**

**Exercise –1**

A computer is programmed to compute various chances. Match the numerical answers with the verbal descriptions.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Number |  | Description |
| A | -50% | 1 | This is as likely to happen as not |
| B | 0% | 2 | This is very likely to happen, but it’s not certain |
| C | 10% | 3 | This won’t happen |
| D | 50% | 4 | This may happen, but it’s not likely |
| E | 90% | 5 | This will happen, for sure |
| F | 100% | 6 | There is a bug in the program |
| G | 200% |  |  |

**Example - 2**

Suppose a survey of 100 persons revealed that 50 persons read India Today and 30 persons read Time Magazine and 10 of these 100 persons read both India Today and Time.

What is the probability that a randomly selected person is reader of India Today or the Time magazine?

Event(A) = 50

Event(B) = 30

Event(AB) = 10

P(A or B) = P(A) + P(B) – P(A and B)

= 50/100 + 30/100 – 10/100

= 70/100 = 0.7

**Example – 3**

Suppose a sample of 50 students is taken and a survey is made of this sample regarding their reading habits. The survey results are shown below;

|  |  |  |
| --- | --- | --- |
| **Event** | **Number of Students** | **Magazines they read** |
| A | 20 | Time |
| B | 15 | Newsweek |
| C | 10 | Filmfare |
| AB | 8 | Time and Newsweek |
| AC | 6 | Time and Filmfare |
| BC | 4 | Newsweek and Filmfare |
| ABC | 2 | Time and Newsweek and Filmfare |

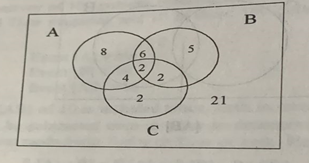
The question is to find out the probability that a student picked up at random from this sample of 50 students does not ready any of these 3 magazines.

P(A or B or C) = P(A) + P(B) + P(C) – P(AB) – P(AC) – P(BC) – P(ABC)

= 20/50 + 15/50 + 10/50 – 8/50 – 6/50 - 4/50 - 2/50

= 29/50

This is the probability that a student picked up at random reads at least one of the magazines. The probability that a randomly picked student does not read any of these three magazines is 21/50 which is 1- 29/50.



**Multiplicative Rule**

**Theory**

Multiplication rule is applied when it is necessary to compute the probability of both events A and B will occur at the same time.

The multiplication rule is different if the two events are independent as against the two events being not independent.

**Independent events**

If events A and B are independent events, then the probability that they both will occur is the product of their separate probabilities.

P(A and B) = P(A) x P(B)

*Example:*

If we toss a coin twice, then the probability that the first toss results in a head and the second toss results in a tail is given by:

P(HT) = P(H) x P(T) = ½ x ½ = ¼

**Non-independent events**

If events A and B are not independent, meaning that the probability of occurrence of an event is dependent or conditional upon the occurrence or non-occurrence of the other event, then the probability that they both will occur is given by;

P(A and B) = P(A) X P(B given the outcome of A)

P(AB) = P(A) x P(B|A)

*Example:*

A bowl has 6 black balls and 4 white balls. A ball is drawn at random from the ball. Then a second ball is draw *without replacement* of the first ball back in the bowl.

The probability of the second ball being black or white would depend upon the result of the first draw as to whether the first ball was black or white.

What is the probability that both these balls are black is given by

P(two black balls) = P(black on 1st draw) x P(black on 2nd draw | black on 1st draw)

= 6/10 x 5/9 = 30/90 = 1/3

**Exercises – 1**

Two cards will be dealt off the top of a well-shuffled deck. What is the chance that the first card will be seven of clubs and second card will be the queen of hearts.

1/52 x 1/51 = 1/2652

**Exercises - 2**

A deck of cards is shuffled and two cards are dealt. What is the chance that both are aces?

4/52 x 3/51 = 12/2652

**Conditional Probability**

In many situations, a manager may know the outcome of an event that has already occurred and may want to know the chances of a second even occurring based on the knowledge of the outcome of the earlier event.

We are interested in finding out as to how the additional information obtained as result of the knowledge about the outcome of an event affects the probability of the occurrence of the second event.

**Exercises – 1**

A deck of cards is shuffled and the top two cards are put on the table, face down. You win $100, if the second card is the queen of hearts.

1. What is the chance of winning the dollar?
2. You turn over the first card. It is the seven of clubs. Now what is your chance of winning.

Ans:

1. 1/52
2. 1/51

In the first part, there is no condition on the first. Hence the prob is 1/52. In the second part, it’s a conditional probability. The second card is a queen of hearts *given* the first is the seven of clubs.

**Exercise – 2**

Some one works that in part a) of previous question as follows

‘For me to win, the queen can’t be the first card dealt – so basically probability of 51 out 52 chances. And queen must be the second card (1 chance in 51), so one must apply the multiplication rule. ‘

Evaluate this statement

Ans: 51/52 x 1/51

**Exercise – 3**

Five cards are dealt off the top of a well-shuffled deck.

1. Find the chance that the 5th card is the queen of spades
2. Find the chance that the 5th card is the queen of spades, given that the first 4 cards are hearts.

Ans. 1/52; 1/48