

## 8. Bivariate Frequency Distribution

The set of observations on two variables  $X$  and  $Y$  that are expressed as ordered pairs  $x_1, y_1, x_2, y_2, x_3, y_3, \dots$  is called **bivariate data**.

### Tabulation of Bivariate Data

If we have bivariate data for a large number of observations, then we require to classify this data and prepare a frequency table. Such a table is called bivariate frequency table.

Correlation is a statistical measure that indicates the extent to which two or more variables fluctuate together. It can vary from  $+1$  to  $-1$ .

### Types of Correlation

The correlation can be of two types:

- 1) Positive Correlation
- 2) Negative Correlation

### Methods of Studying Correlation:

- i) Scatter Diagram (graphical method)
- ii) Karl Pearson's coefficient of correlation (algebraic method)

### Scatter Diagram

It is a graphical tool showing relationship between two variables.

The values of the two variables are plotted on a graph paper. The manner in which these points are scattered, suggest the degree and the direction of correlation. The degree of correlation is denoted by ' $r$ ' and its direction is given by the signs positive (+) and negative (-).

- 1) If all points lie on a rising straight line the correlation is perfectly positive and  $r = +1$ .
- 2) If all points lie on a falling straight line the correlation is perfectly negative and  $r = -1$ .
- 3) If the points lie in a narrow strip, rising upwards, the correlation is high degree of positive.
- 4) If the points lie in a narrow strip, rising downwards, the correlation is high degree of negative.
- 5) If the points are spread widely over a broad strip, rising upwards, the correlation is low degree of positive.
- 6) If the points are spread widely over a broad strip, falling downwards, the correlation is low degree of negative.
- 7) If the points are spread without any specific pattern, then there is no correlation between the two variables, i.e.  $r = 0$ .

### Covariance:

Covariance is a measure of joint variation between two variables  $X$  and  $Y$ .

$$\text{Cov } X, Y = \frac{1}{n} \sum_i x_i y_i - \bar{x} \bar{y}$$

### Karl Pearson's Coefficient of Correlation

It gives the numerical expression for the measure of correlation. It is denoted by  $r$  or  $\text{corr}(X, Y)$ . The value of  $r$

gives the magnitude of correlation and the sign denotes whether the direction is positive or negative.

It is defined as the ratio of covariance between X and Y to the product of standard deviations of X and Y,  
i.e.  $r = \text{corr } X, Y = \frac{\text{Cov } X, Y}{\sigma_X \cdot \sigma_Y}$

This coefficient measures only the linear relationship between the two variables.

**Interpretation of value of  $r$ , correlation coefficient :**

- i) If  $r = 1$ , there is perfect positive correlation between the two variables.
- ii) If  $r = -1$ , there is perfect negative correlation between the two variables.
- iii) If  $r = 0$ , there is no linear relation between the two variables.
- iv) If  $r > 0$ , there is positive correlation between the two variables.
- v) If  $r < 0$ , there is negative correlation between the two variables.
- vi) If  $r > 0.8$ , there is high correlation.
- vii) If  $0.3 < r < 0.8$ , there is moderate correlation.
- viii) If  $r < 0.3$ , the correlation is marginal.