# Chapter # 02   Graphs and Charts/Diagrams

Diagrammatic and Graphic Representation of Data
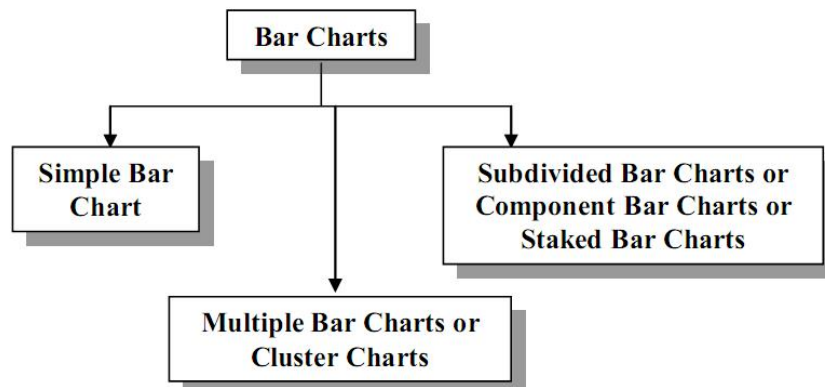
Diagrams

Charts or diagrams give visual representations of the data. Diagrams also show comparisons between two or more sets of data. Diagrams should be clear and easy to read and understand. Too much information should not be shown in the same diagram otherwise it might become confusing.

- Bar Charts
- Rectangle and Sub-divided Rectangle
- Pie Chart or Circle Diagram
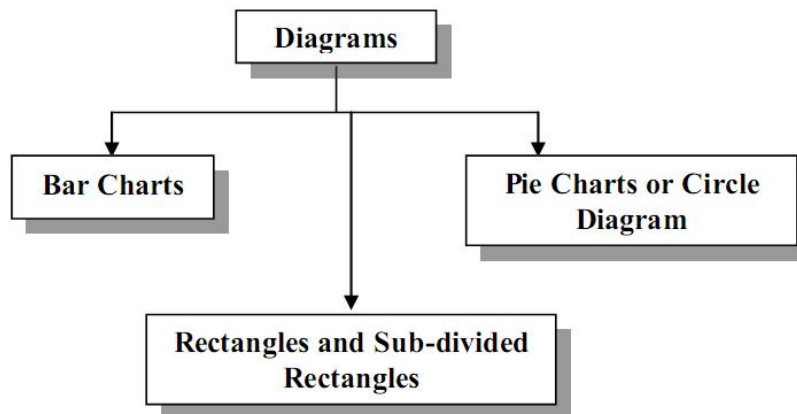
Bar Charts

- Simple bar chart
- Multiple bar charts or cluster chart
- Subdivided bar charts or component bar charts or staked bar charts

# Diagrammatic and Graphic Representation of Data

- ## *Simple Bar Chart*

This chart consists of vertical or horizontal bars of equal width. The length of the bars represents the magnitude of the values of the variable i.e. the lengths of the bars vary depending on the size of data values.

The following table gives the population of Punjab. Draw a simple bar chart.

Years	1998	1999	2000	2001	2002
Population	40	45	60	64	68

The following is the required Simple Bar Chart:

Simple Bar Chart of Population
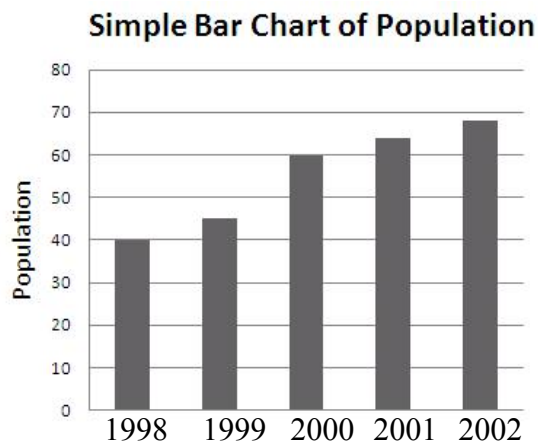
- ## *Multiple Bar Charts or Cluster Chart*

By multiple bar charts two or more sets of inter-related data are represented. The technique of simple bar chart is used to draw this chart but the difference is that we use different shades, colours or dots to distinguish between different phenomena. Multiple bar charts facilities comparison between more than one phenomenon.
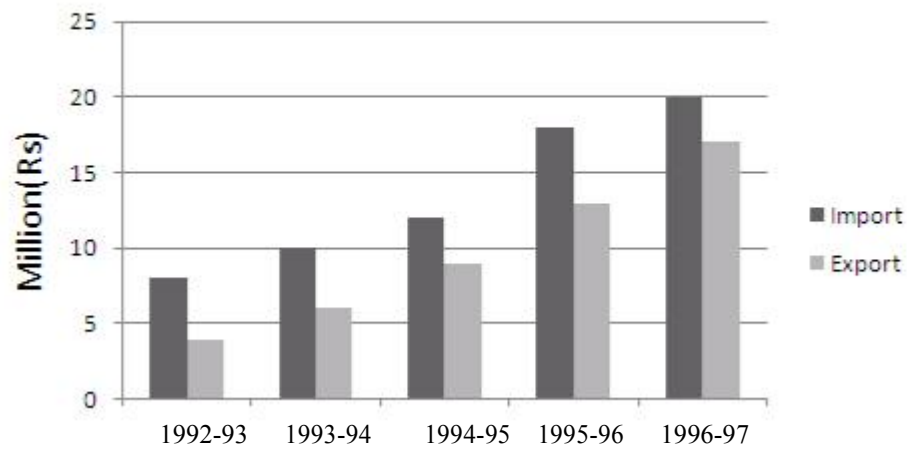
The following table gives the imports and exports of Pakistan for year 1992-93 to 1996-97. Draw a multiple bar chart.

Years	Imports	Exports
1992-93	8	4
1993-94	10	6
1994-95	12	9
1995-96	18	13
1996-97	20	17

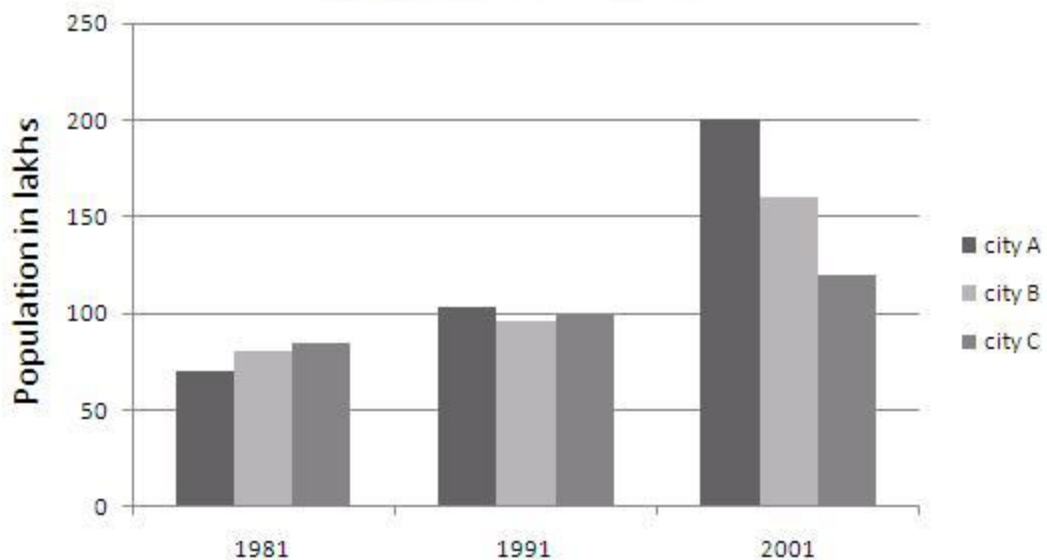The following is the required Multiple Bar Chart:

Multiple Bar Chart

EXAMPLE

Construct a Multiple Bar Chart to show the population of the cities given in the following table:

City	Population in Lakes		
	1981	1991	2001
A	70	103	200
B	80	96	160
C	85	99	120

Multiple Bar Chart

- *Sub-divided Bar Charts or Component Bar Charts or Staked Bar Charts*

A component bar chart is an effective technique in which each bar is sub-divided into two or more parts. The component parts are shaded or coloured differently to increase the overall effectiveness of the diagram.

EXAMPLE

The following table represents the yearly development in the filed of industry, transport and agriculture of Pakistan. Construct a Sub-divided Bar Chart:

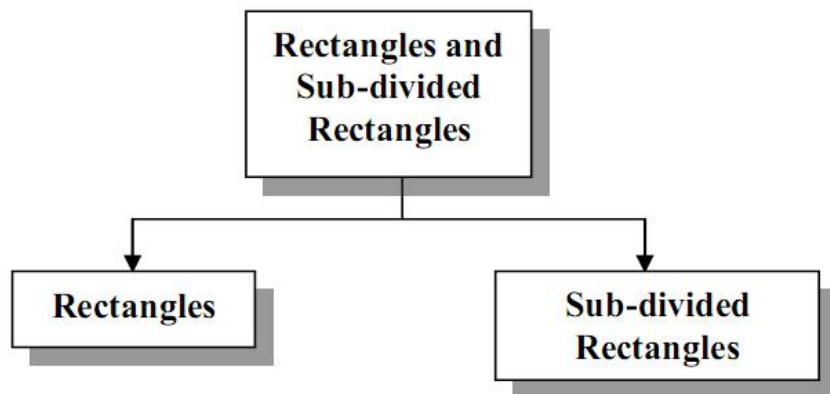| Years	Industry	Transport	Agriculture	Total
1998	100	80	40	220
1999	120	100	50	270
2000	130	120	55	305

Sub-divided Bar Chart
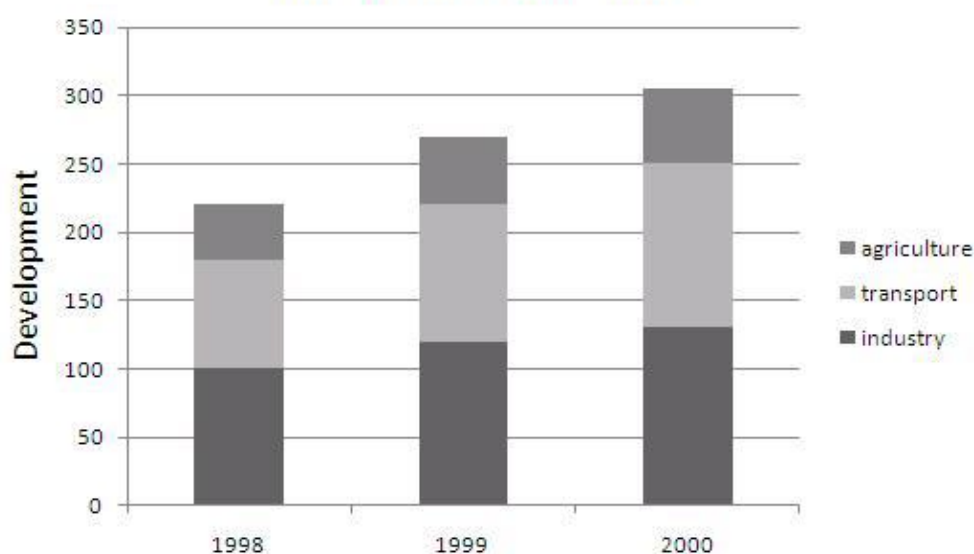
Rectangles and Sub-divided Rectangles

- Rectangles
- Sub-divided Rectangles or Percentage Subdivided Bar Charts

- *Rectangle*

We know that, the area of a rectangle is equal to the product of its length and breadth. Therefore, to represent a quantity by a rectangle, both length and breadth of the rectangle are used. There are two methods of drawing rectangles.

- When their widths are kept equal and their lengths are proportional to the size of the total figures.
- When their lengths are kept equal and their widths are proportional to the size of the total figures.

Generally, lengths of the rectangles are kept equal and their widths are proportional to the size of the total figures.

Rectangle diagrams are a modified form of bar diagrams and give more detailed information than bar diagrams.

Represent the following data by a Rectangle:

Items	Family
Food	1500
Misc	3050
Saving	450

To construct a Rectangle; first we find percentages and cumulative percentages as given below:

Items	Family	Percentages	Cumulative %
Food	1500	30%	30%
Misc	3050	61%	91%
Saving	450	9%	100%
Total	5000	100	--
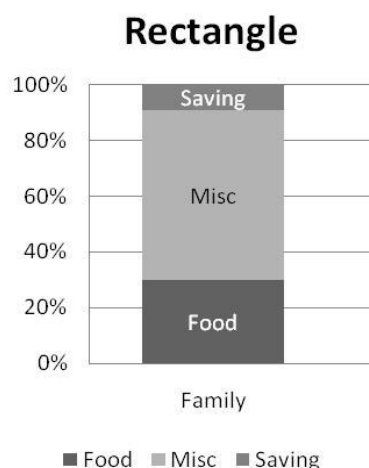
• *Sub-divided Rectangles or Percentage Sub-divided Bar Charts*

Like component bar chart, sub-divided rectangles may be used to compare the total magnitude and its components. Sub-divided rectangles are constructed with length equal to 100 and widths proportional to the size of the values. The components are expressed as percentages of their respective totals and are shown by different shades in the rectangles.

EXAMPLE

The following table gives the details of monthly budgets of two families:

| Items of Expenditure	Family A	Family B
Food	300	600
Clothing	200	100
Rent	200	400
Fuel	150	100
Misc	150	300
Total	1000	1500

Construct Sub-divided Rectangles.
To construct Sub-divided rectangles; first we find percentages and cumulative percentages as given below:

Items of Expenditure	Family A	%	Cum %	Family B	%	Cum %
Food	300	30	30	600	40.0	40.0
Clothing	200	20	50	100	6.7	46.7
Rent	200	20	70	400	26.6	73.3
Fuel	150	15	85	100	6.7	80.0
Misc	150	15	100	300	20.0	100
Total	1000	100	--	1500	100	--

Now we draw two rectangles with length equal to 100 but breadth proportional to 1000: 1500 i.e. 2: 3 and divided each rectangle in components by using the percentages.

Sub-divided Rectangles
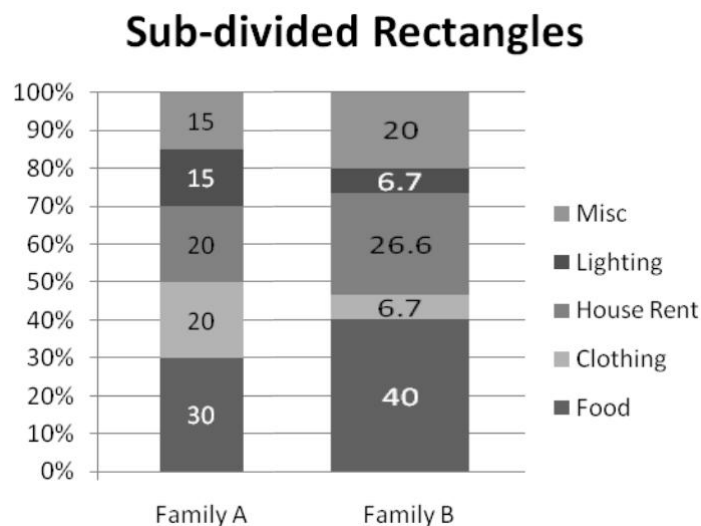
Pie Chart or Circle Diagram

A pie-diagram, also known as sector or circle diagram, is a device consisting of a circle divided into sectors or pie-shaped pieces whose areas are proportional to the various parts into which the whole quantity is divided. The sectors are shaded or coloured differently. The procedure of constructing a pie chart is very simple; draw a circle of some suitable radius. As a circle consists of 360^0, the whole quantity to be displayed is equated to 360. Then divide the circle into different sectors by constructing angles at the centre by means of a protractor and draw the corresponding radii.

The angles are calculated by the following formula:

$$Angle = \frac{Component\ Part}{Whole\ Quantity} \times 360^0$$

Diagrammatic and Graphic Representation of Data

Draw a Pie-diagram for the following data:

Items	Expenditure in Rs.
Food	190
Clothing	64
Rent	100
Medical	46
Other	80

To construct Pie-diagram; first we find Angles and cumulative Angles as given below:

Items	Expenditure in Rs.	Angles	Cum: Angles
Food	190	142.5	142.5
Clothing	64	48	190.5
Rent	100	75	265.5
Medical	46	34.5	300
Other	80	60	360
Total	480	360	--

Pie-Chart

■ Food ■ Clothing ■ Rent ■ Medical ■ Other
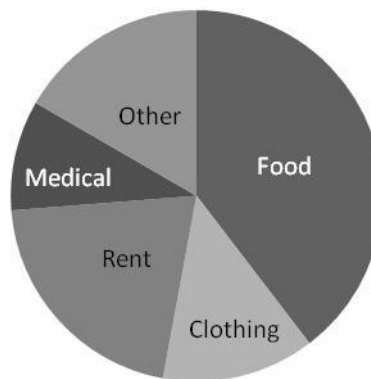
Graphs

Data can also be effectively presented by means of graphs. A graph consists of curves or straight lines. Graphs provide a very good method of showing fluctuations and trends in statistical data. Graphs can also be used to make predictions and forecasts.

- Histogram
- Frequency Polygon
- Frequency Curve
- Cumulative Frequency Polygon (Ogive)
- Graph of Time Series (Historigram)

Diagrammatic and Graphic representation of Data
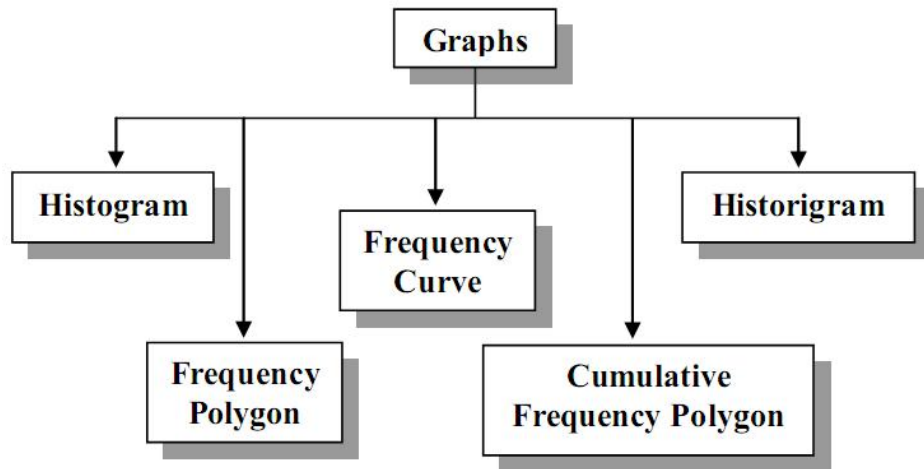
• *Histogram*

A histogram consists of a set of rectangles having bases on a horizontal axis i.e. X-axis (note that these bases are marked off by class boundaries not class limits) with centers at the class marks and areas proportional to the class frequencies.

If the class intervals sizes are equal then the heights of the rectangles are also proportional to the class frequencies and are taken numerically equal to class frequencies.

If the class intervals sizes are not equal then the heights of the rectangles have to be adjusted.

1st Method (Equal Class Interval)

- Draw X-axis and Y-axis.
- Take class boundaries on X-axis and frequencies on Y-axis.
- Construct joint rectangles. The resulting figure is the required histogram.

Construct Histogram from the following frequency distribution:

Class Limits	40-49	50-59	60-69	70-79	80-89	90-99	100-109
Frequency	1	3	4	5	4	2	1

To draw a Histogram we proceed with the following steps:

- Find class-boundaries.

Diagrammatic and Graphic Representation of Data

Class Limits	Frequency	Class-boundaries
40-49	1	39.5-49.5
50-59	3	49.5-59.5
60-69	4	59.5-69.5
70-79	5	69.5-79.5
80-89	4	79.5-89.5
90-99	2	89.5-99.5
100-109	1	99.5-109.5

- Mark class-boundaries along the x-axis and the frequencies along y-axis.
- Construct rectangles having width proportional to class-interval size and heights proportional to class frequencies.
- The resulting graph will be the Histogram as given below.

Histogram with Equal class interval
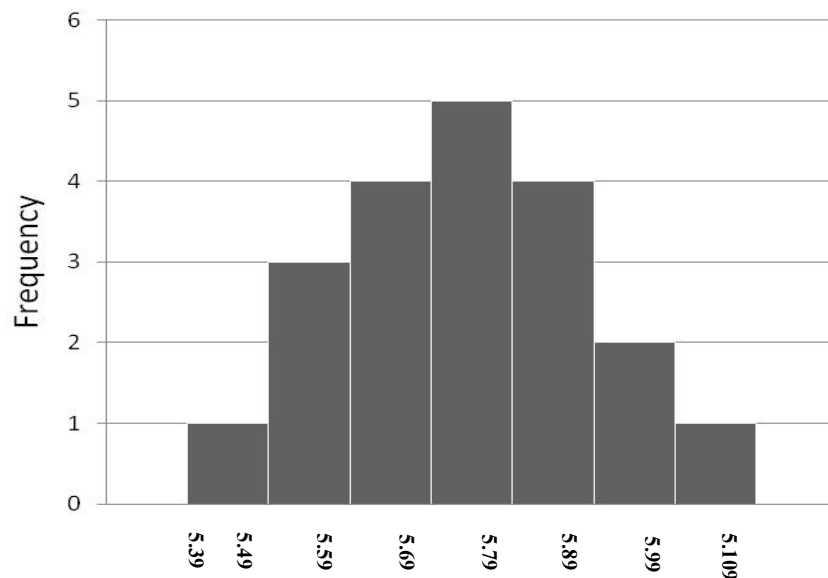
2nd Method (Unequal Class Interval)

- Draw X-axis and Y-axis.
- Take class boundaries on X -axis and adjusted frequencies on Y-axis. (Frequencies are adjusted by dividing them by their respective class interval size)
- Construct joint rectangles. The resulting figure is the required histogram.

EXAMPLE

Construct Histogram from the following frequency distribution:

Class Limits	40-49	50-53	54-64	65-79	80-89	90-99	100-109
Frequency	10	12	44	75	40	20	10

To draw a Histogram we proceed with the following steps:
- Find class-boundaries and adjusted frequencies.

Class Limits	f	Class-boundaries	Class interval (h)	$Adj : frequency = \dfrac{f}{h}$
40-49	10	39.5-49.5	10	1
50-53	12	49.5-53.5	4	3
54-64	44	53.5-64.5	11	4
65-79	75	64.5-79.5	15	5
80-89	40	79.5-89.5	10	4
90-99	20	89.5-99.5	10	2
100-109	10	99.5-109.5	10	1

- Mark class-boundaries along the x-axis and the adjusted frequencies along y-axis.
- Construct rectangles having width proportional to class-interval size and heights proportional to class adjusted frequencies.
- The resulting graph will be the Histogram as given below.
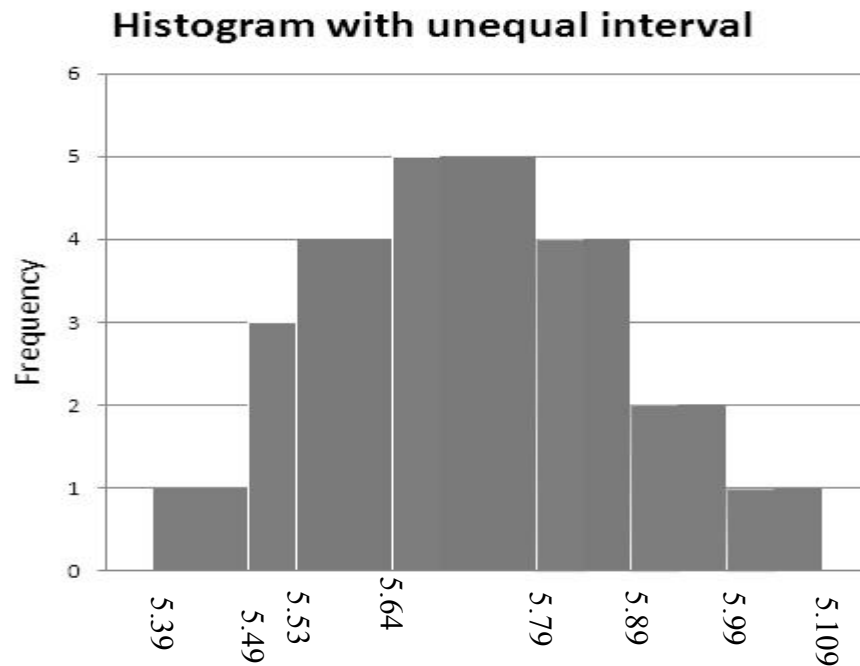
- *Frequency Polygon*

A frequency polygon is a many sided closed figure. It is constructed by plotting the class frequencies against their corresponding class marks (mid-points) and then joining the resulting points by means of straight lines. It can also be obtained by joining the mid-points of the tops of rectangles in the histograms.

Diagrammatic and Graphic Representation of Data

Method

- Draw X-axis and Y-axis.
- Take class marks on X-axis and frequencies on Y-axis.
- Join the points by means of straight lines. The resulting figure is the required frequency polygon.

EXAMPLE

Construct Frequency Polygon from the following frequency distribution:

| Class Limits	10-19	20-29	30-39	40-49	50-59
Frequency	5	15	40	20	10

To draw a Frequency Polygon we proceed with the following steps:

- Find class-marks (mid-points).

Class Limits	Frequency	Mid-points
10-19	5	14.5
20-29	15	24.5
30-39	40	34.5
40-49	20	44.5
50-59	10	54.5

- Mark mid-points along the x-axis and the frequencies along y-axis.
- Place a dot against each mid-point with respect to its class frequency.
- Join the dots by straight lines to get Frequency Polygon as given below.

Frequency Polygon
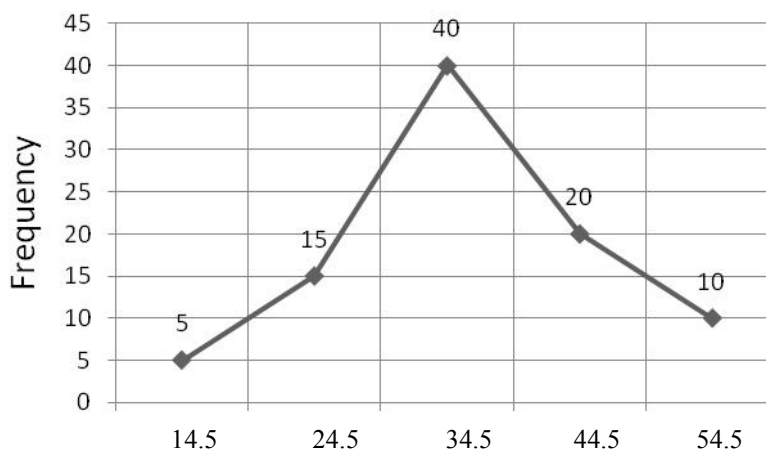
Diagrammatic and Graphic Representation of Data

In the above methods the ends of the graph do not meet the X-axis
and we know that a polygon is a many-sided closed figure. We may
therefore add extra classes at both ends of frequency distribution
with zero frequencies. By doing so the polygon forms a closed figure.

We can also draw a frequency polygon by the following method:
Draw a histogram.
- *The mid-points at the top of each rectangle; are joined by straight*
  lines. The figure is the required frequency polygon.

• *Frequency Curve*

When the frequency polygon is smoothed out as a curve then it becomes frequency curve. OR when the mid-points are potted against the frequencies then a smooth curve passes through these points is called a frequency curve.

The top of the smoothed curve should pass above the highest points of
the polygon.

Method

- Draw X-axis and Y-axis.
- Take class marks on X-axis and frequencies on Y-axis.
- Plot the frequencies against the class marks.
  The plotted points are then joined by a smooth curve, which gives frequency curves.

Construct Frequency Curve from the following frequency distribution:

Class Limits	10-19	20-29	30-39	40-49	50-59
Frequency	5	15	40	20	10

To draw a Frequency Curve we proceed with the following steps:
Find class-marks (mid-points).

Class Limits	Frequency	Mid-points
10-19	5	14.5
20-29	15	24.5
30-39	40	34.5
40-49	20	44.5
50-59	10	54.5

- Mark mid-points along the x-axis and the frequencies along y-axis.
- Place a dot against each mid-point with respect to its class frequency.
- Join the dots by smooth line to get Frequency Curve as given below.

Frequency Curve
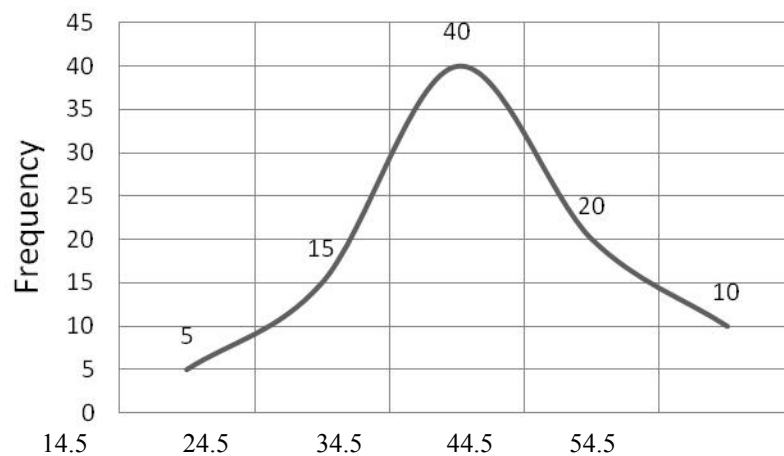
We can also draw a frequency curve by the following method:

- *Draw X-axis and Y-axis.*
- *Draw a histogram.*
- *Draw a smooth curve through the top of the rectangles. The resulting figure is the required frequency curve.*

- ## *Cumulative Frequency Polygon (Ogive)*

When a curve is based on cumulative frequencies then it is called a cumulative frequency polygon or ogive.

- Less Than Type
- More Than Type

Diagrammatic and Graphic Representation of Data

Cumulative Frequency Polygon (Ogive)

Less than Type ← → More than Type
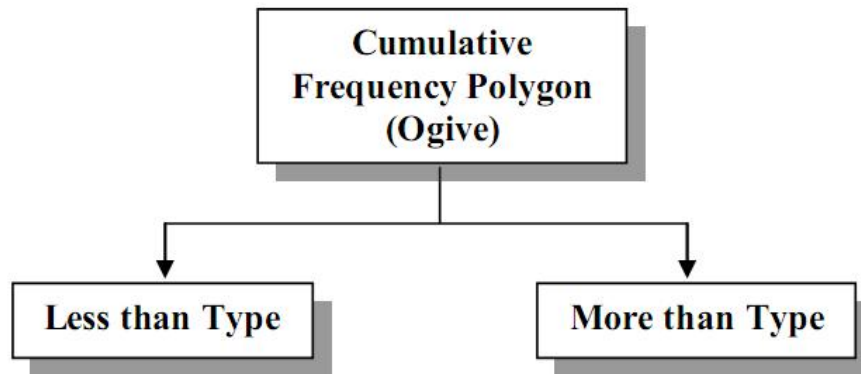
- ● *Less Than Type*

Method
- First calculate the cumulative frequencies.
- Take upper class boundaries on X-axis and the cumulative frequencies on Y-axis.
- Plot the cumulative frequency against the upper class boundaries.
- Join the potted points by straight lines. The resulting figure is the required less than cumulative frequency polygon or less than ogive.

EXAMPLE

Construct Cumulative Frequency Polygon (Ogive) from the following frequency distribution:

Class Limits	10-19	20-29	30-39	40-49	50-59
Frequency	5	25	45	15	1

To draw a Cumulative Frequency Polygon (Ogive) we proceed with the following steps:
- Find class-boundaries and cumulative frequencies.

Class Limits	Frequency	Cumulative Frequency	Class-boundaries
10-19	5	5	9.5-19.5
20-29	25	30	19.5-29.5
30-39	45	75	29.5-39.5
40-49	15	90	39.5-49.5
50-59	1	100	49.5-59.5

- Mark upper class-boundaries along the x-axis and cumulative frequencies along y-axis.
- Place a dot against each upper class-boundary with respect to its class cumulative frequency.

    Join the dots by straight line to get Cumulative Frequency Polygon (Ogive) as given below.

Less than Ogive
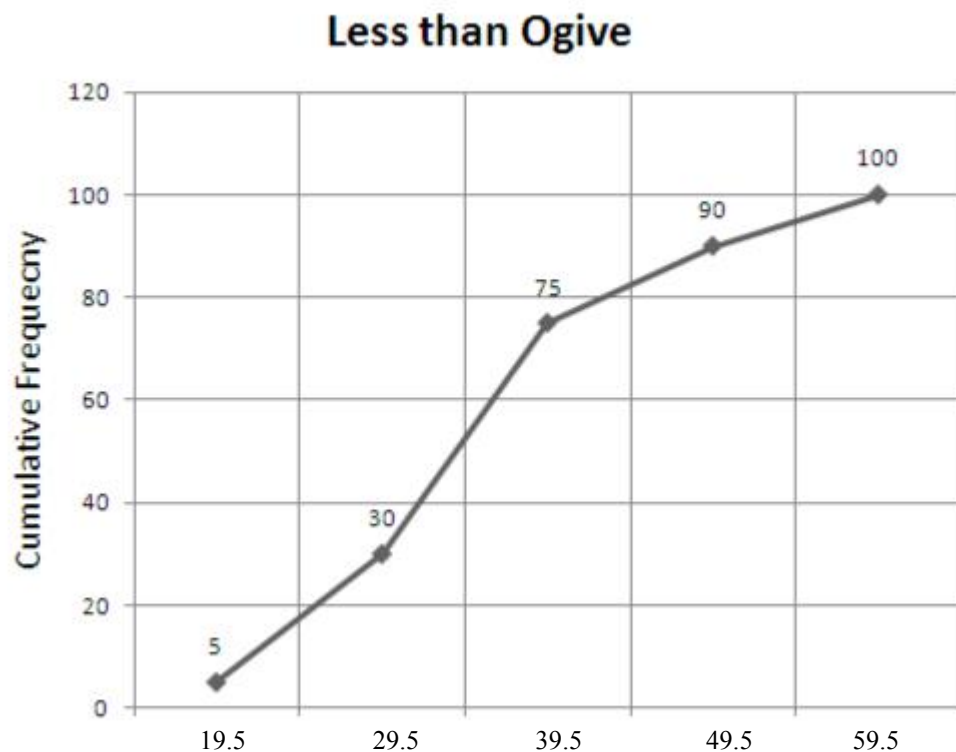
- *More Than Type*

Method

- First calculate the cumulative frequencies.
- Take lower class boundaries on X-axis and the cumulative frequencies on Y-axis.
- Plot the cumulative frequency against the lower class boundaries.
- Join the potted points by straight lines. The resulting figure is the required more than cumulative frequency polygon or more than ogive.

EXAMPLE

Construct Cumulative Frequency Polygon (Ogive) from the following frequency distribution:

Class Limits	10-19	20-29	30-39	40-49	50-59
Frequency	5	25	45	15	1

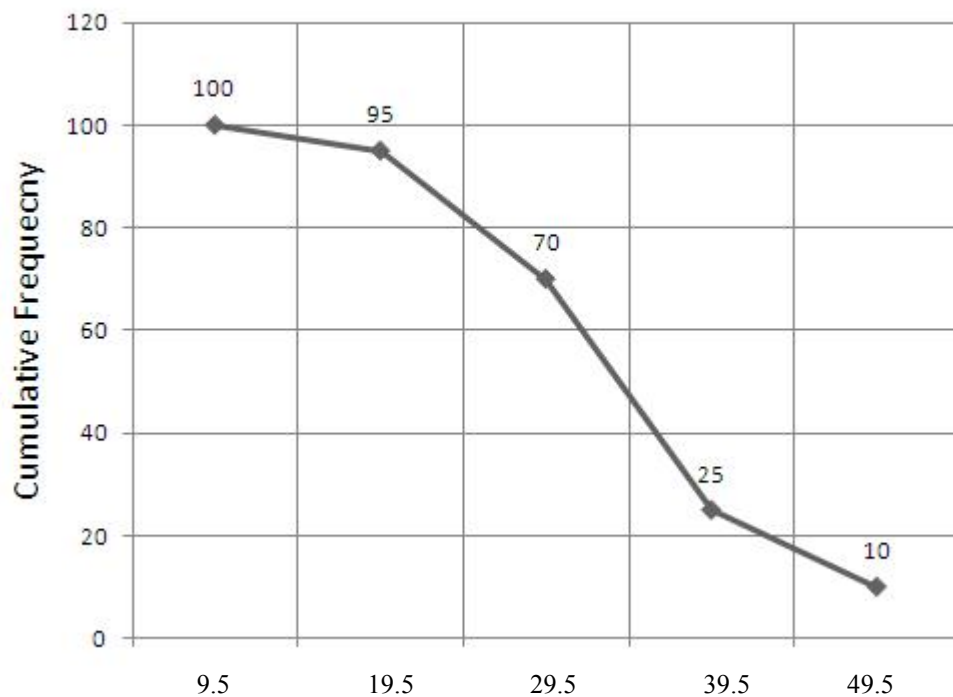To draw a Cumulative Frequency Polygon (Ogive) we proceed with the following steps:

Find class-boundaries and cumulative frequencies.

Diagrammatic and Graphic Representation of Data

Class Limits	Frequency	Cumulative Frequency	Class-boundaries
10-19	5	100	9.5-19.5
20-29	25	95	19.5-29.5
30-39	45	70	29.5-39.5
40-49	15	25	39.5-49.5
50-59	1	10	49.5-59.5

- Mark lower class-boundaries along the x-axis and cumulative frequencies along y-axis.
- Place a dot against each lower class-boundary with respect to its class cumulative frequency.
- Join the dots by straight line to get Cumulative Frequency Polygon (Ogive) as given below.

More than Ogive

If we join the points in cumulative frequency polygon by smoothed line then we get a smoothed ogive.

- ## *Graph of Time Series (Historigram)*

A curve showing changes in the value of one or more items from one period of time to the next is known as the graph of time series. This curve is also called historigram. Thus a historigram displays the variations in time series dealing with prices, production, imports, population etc.

Method

- Draw X-axis and Y-axis.
- Take time (years, months, weeks, etc) along X-axis and the corresponding values along Y-axis. Plot the various points.
- Join the plotted points either by a smooth curve or by straight lines. The resulting figure is the required Historigram.

EXAMPLE

Construct Historigram from the following Time Series:

Year	1995	1996	1997	1998	1999	2000	2001	2002
Values	5	7	10	8	6	11	12	10

- Draw X-axis and Y-axis.
- Take time along X-axis and the corresponding values along Y-axis. Plot the various points.
- Join the plotted points either by a smooth curve or by straight lines. The resulting figure is the required Historigram.

Time Series