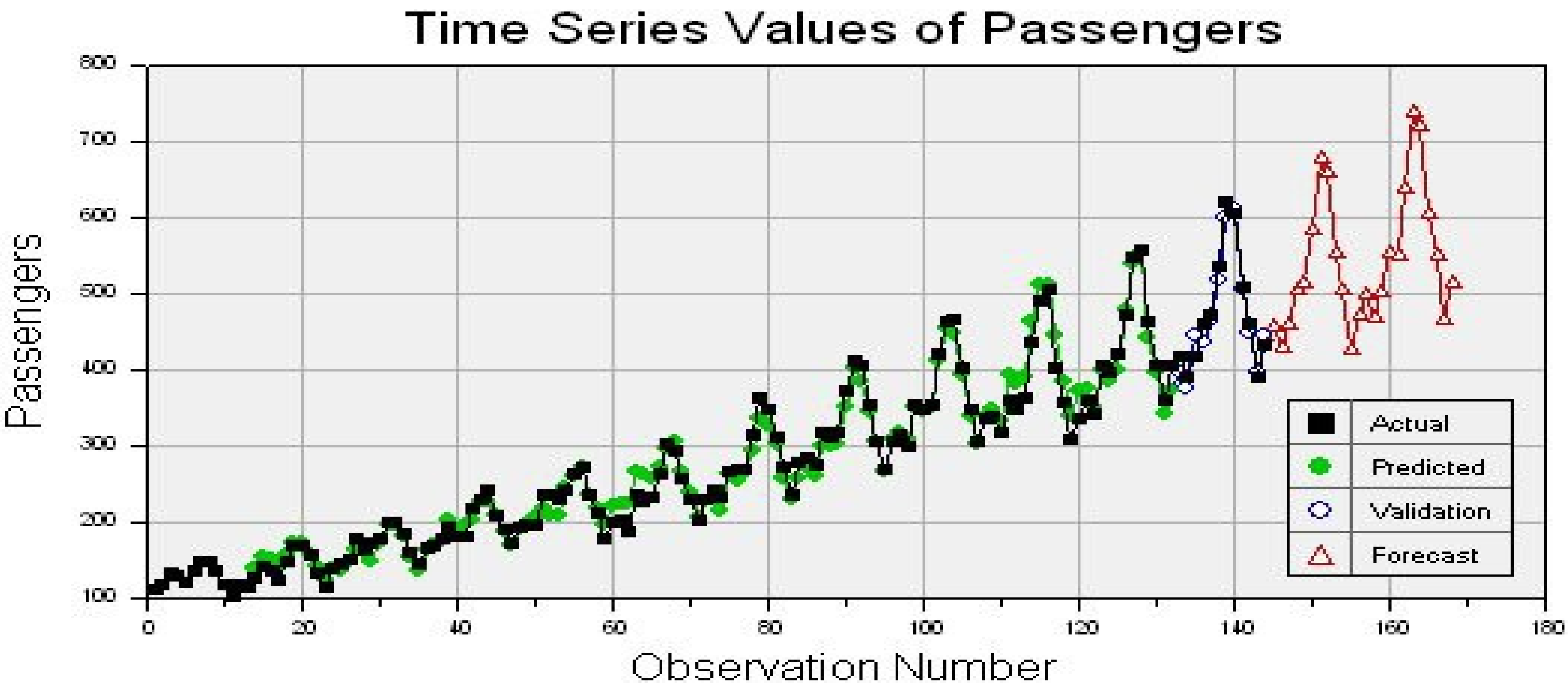
TIME SERIES ANALYSIS



Introduction:
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We know that planning about future is very necessary for the every business firm, every govt. institute, every individual and for every country. Every family is also doing planning for his income expenditure. As like every business is doing planning for possibilities of its financial resources & sales and for maximization its profit.

Definition: "A time series is a set of observation taken at specified times, usually at equal intervals".

"A time series may be defined as a collection of reading belonging to different time periods of some economic or composite variables".

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- Time series establish relation between **"cause" & "Effects".**
- One variable is "Time" which is independent variable & and the second is "Data" which is the dependent variable.

We explain it from the following example:

Day	No. of Packets of milk sold
Monday	90
Tuesday	88
Wednesday	85
Thursday	75
Friday	72
Saturday	90
Sunday	102

Year	Population (in Million)
1921	251
1931	279
1941	319
1951	361
1961	439
1971	548
1981	685

- From example 1 it is clear that the sale of milk packets is decrease from Monday to Friday then again its start to increase.
- Same thing in example 2 the population is continuously increase.

Importance of Time Series Analysis:-

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As the basis of Time series Analysis businessman can predict about the changes in economy. There are following points which clear about the its importance:

1. Profit of experience.
2. Safety from future
3. Utility Studies
4. Sales Forecasting
5. Budgetary Analysis
6. Stock Market Analysis
7. Yield Projections
8. Process and Quality Control
9. Inventory Studies
10. Economic Forecasting
11. Risk Analysis & Evaluation of changes.
12. Census Analysis

Components of Time Series:-

The change which are being in time series, They are effected by Economic, Social, Natural, Industrial & Political Reasons. These reasons are called components of Time Series.

- SECULAR TREND :-
- SEASONAL VARIATION :-
- CYCLICAL VARIATION :-
- IRREGULAR VARIATION :-

❑ Secular trend:

The increase or decrease in the movements of a time series is called Secular trend.

A time series data may show upward trend or downward trend for a period of years and this may be due to factors like:

- ❑ increase in population,
- ❑ change in technological progress ,
- ❑ large scale shift in consumers demands,

For example,

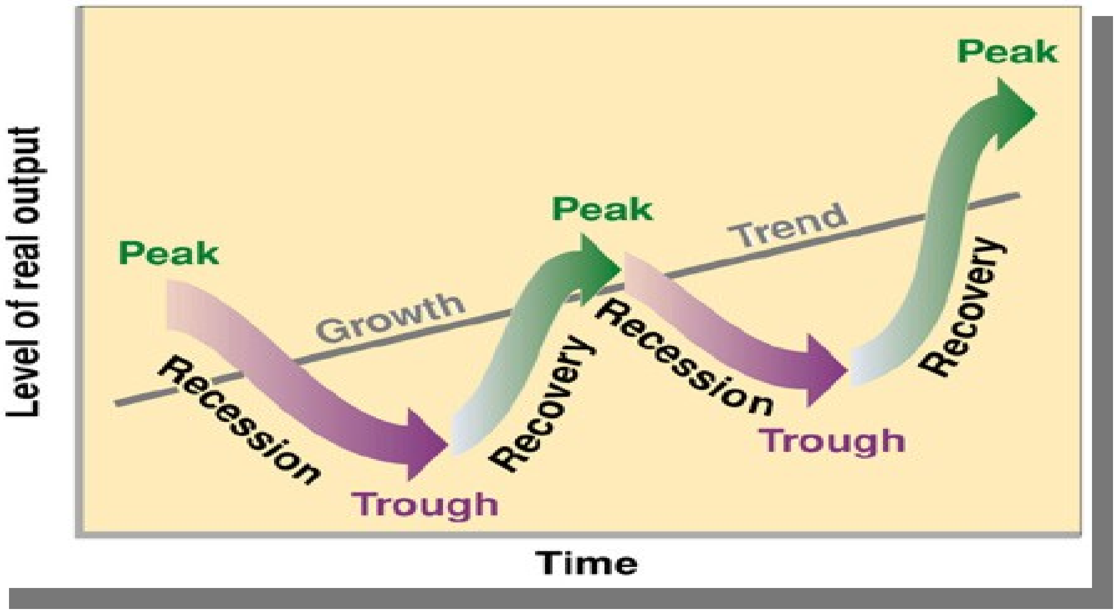
- population increases over a period of time,price increases over a period of years,production of goods on the capital market of the country increases over a period of years.These are the examples of upward trend.
- The sales of a commodity may decrease over a period of time because of better products coming to the market.This is an example of declining trend or downward.

- **Seasonal variation:**

- Seasonal variation are short-term fluctuation in a time series which occur periodically in a year. This continues to repeat year after year.
  - The major factors that are weather conditions and customs of people.
  - More woolen clothes are sold in winter than in the season of summer .
  - each year more ice creams are sold in summer and very little in Winter season.
  - The sales in the departmental stores are more during festive seasons that in the normal days.

❑Cyclical Variations:

Cyclical variations are recurrent upward or downward movements in a time series but the period of cycle is greater than a year. Also these variations are not regular as seasonal variation.



A business cycle showing these oscillatory movements has to pass through four phases-prosperity, recession, depression and recovery. In a business, these four phases are completed by passing one to another in this order.

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Irregular variation:

Irregular variations are fluctuations in time series that are short in duration, erratic in nature and follow no regularity in the occurrence pattern. These variations are also referred to as residual variations since by definition they represent what is left out in a time series after trend ,cyclical and seasonal variations. Irregular fluctuations results due to the occurrence of unforeseen events like :

- FLOODS,
- EARTHQUAKES,
- WARS,
- FAMINES

Time Series Model

Time Series Model

- **Addition Model:**

$$Y = T + S + C + I$$

Where:- Y = Original Data

T = Trend Value

S = Seasonal Fluctuation

C = Cyclical Fluctuation

I = Irregular value

- **Multiplication Model:**

$$Y = T \times S \times C \times I$$

or

$$Y = TSCI$$

Measurement of Secular trend:-

- The following methods are used for calculation of trend:

  - FREE HAND CURVE METHOD:
  - SEMI – AVERAGE METHOD:
  - MOVING AVERAGE METHOD:
  - LEAST SQUARE METHOD:

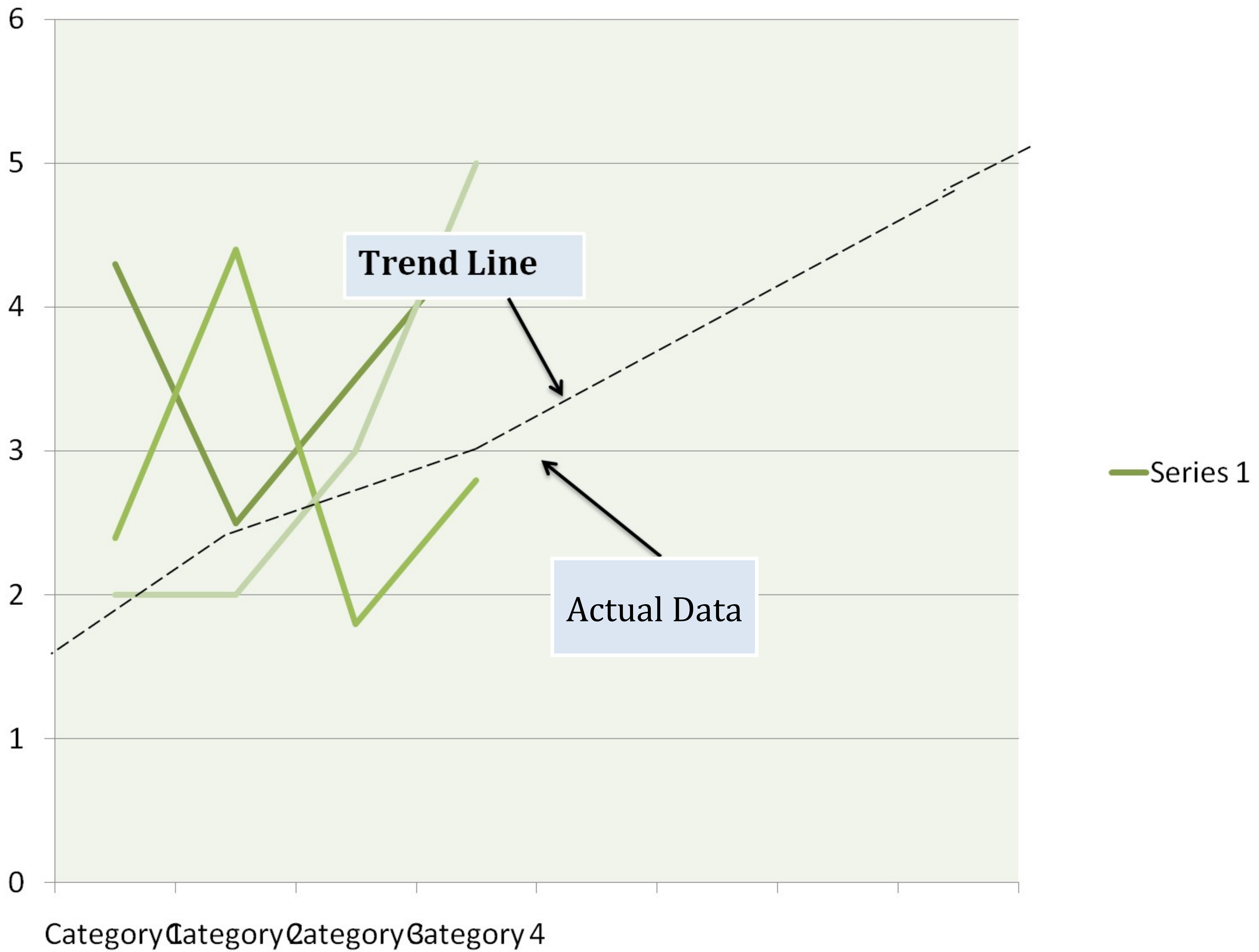
Free hand Curve Method:-

- In this method the data is denoted on graph paper. We take "Time" on 'x' axis and "Data" on the 'y' axis. On graph there will be a point for every point of time. We make a smooth hand curve with the help of this plotted points.

Example:

Draw a free hand curve on the basis of the following data:

Years	1989	1990	1991	1992	1993	1994	1995	1996
Profit	148	149	149.5	149	150.5	152.2	153.7	153


Trend Line
Actual Data
Series 1
6
5
4
3
2
1
0
Category 1
Category 2
Category 3
Category 4

Semi – Average Method:-

- In this method the given data are divided in two parts, preferable with the equal number of years.

- For example, if we are given data from 1991 to 2008, i.e., over a period of 18 years, the two equal parts will be first nine years, i.e.,1991 to 1999 and from 2000 to 2008. In case of odd number of years like, 9, 13, 17, etc.., two equal parts can be made simply by ignoring the middle year. For example, if data are given for 19 years from 1990 to 2007 the two equal parts would be from 1990 to 1998 and from 2000 to 2008 - the middle year 1999 will be ignored.

- **Example:**

Find the trend line from the following data by Semi – Average Method:-

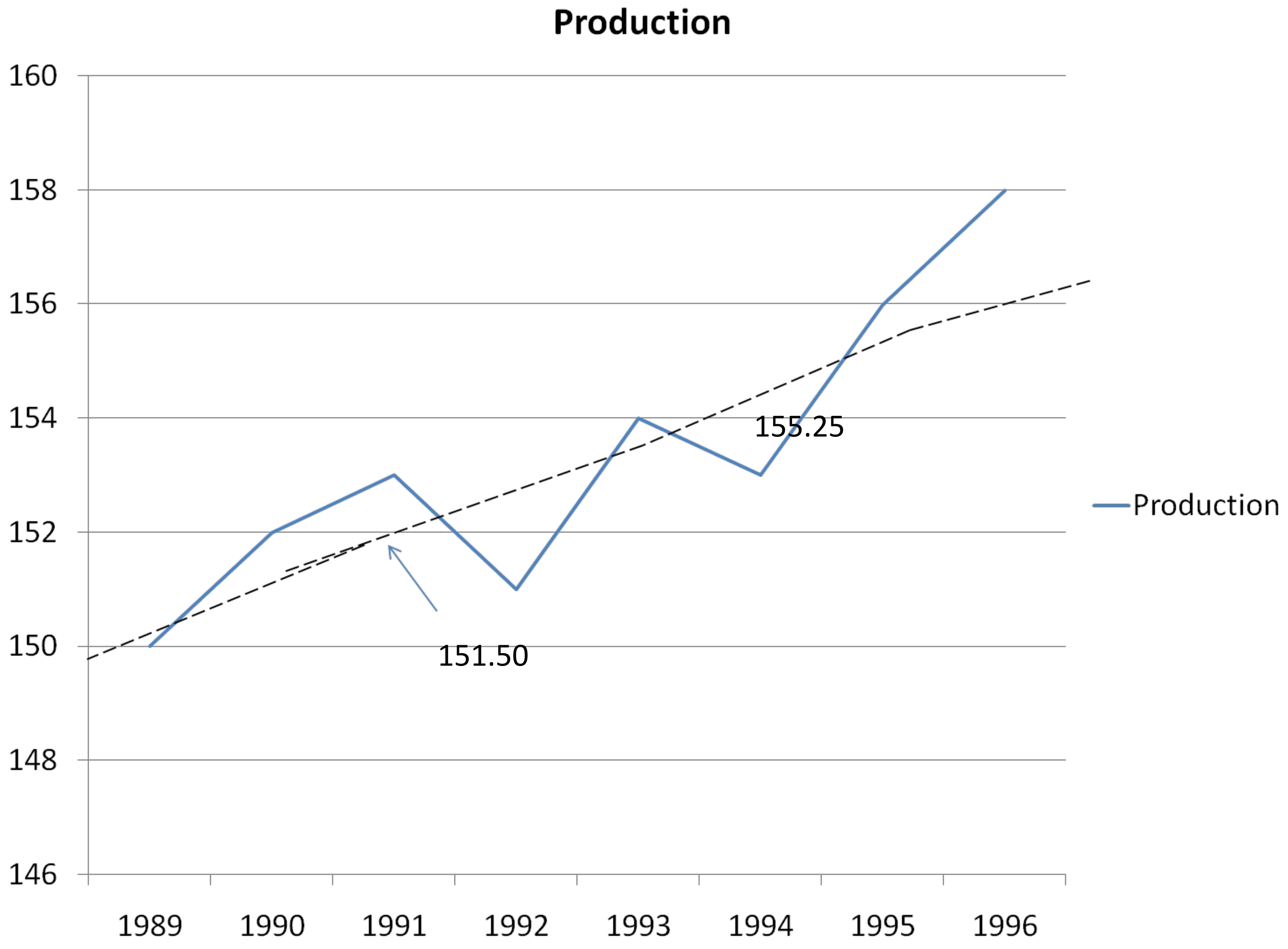
Year	1989	1990	1991	1992	1993	1994	1995	1996
Production (M.Ton.)	150	152	153	151	154	153	156	158

- There are total 8 trends. Now we distributed it in equal part. Now we calculated Average mean for every part.

$$\text{First Part} = \frac{150 + 152 + 153 + 151}{4} = 151.50$$

$$\text{Second Part} = \frac{154 + 153 + 156 + 158}{4} = 155.25$$

Year (1)	Production (2)	Arithmetic Mean (3)
1989	150	
1990	152	
1991	153	151.50
1992	151	
1993	154	
1994	153	
1995	156	155.25
1996	158	



Production
160
158
156
154
152
150
148
146
1989
1990
1991
1992
1993
1994
1995
1996
155.25
151.50
Production

Moving Average Method:-

Moving Average Method:-

- It is one of the most popular method for calculating Long Term Trend. This method is also used for 'Seasonal fluctuation', 'cyclical fluctuation' & 'irregular fluctuation'. In this method we calculate the 'Moving Average for certain years.
- For example: If we calculating 'Three year's Moving Average' then according to this method:

$$= \frac{(1)+(2)+(3)}{3}, \quad \frac{(2)+(3)+(4)}{3}, \quad \frac{(3)+(4)+(5)}{3}, \quad \ldots\ldots\ldots\ldots\ldots$$

Where (1),(2),(3),………. are the various years of time series.

Example: Find out the five year's moving Average:

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Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Price	20	25	33	33	27	35	40	43	35	32	37	48	50	37	45

Year	Price of	Five year's moving	Five year's moving
1982	20	-	-
	sugar (Rs.)	Total	Average (Col 3/5)
1983	25	-	-
(1)	(2)	(3)	(4)
1984	33	135	27

Exponential Smoothing

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

where: F_t = new forecast

F_{t-1} = previous period forecast

A_{t-1} = previous period *actual* demand

α = smoothing (weighting) constant

❖ Least Square Method:-

- This method is most widely in practice. When this method is applied, a trend line is fitted to data in such a manner that the following two conditions are satisfied:-

❑ The sum of deviations of the actual values of y and computed values of y is zero.

$$\sum \left(Y - Y_c\right) = 0$$

❑ i.e., the sum of the squares of the deviation of the actual and computed values is least from this line. That is why method is called the method of least squares. The line obtained by this method is known as the line of `best fit`.

is least

$$\sum \left(Y - Y_c\right)^2$$

The Method of least square can be used either to fit a straight line trend or a parabolic trend.

The straight line trend is represented by the equation:-

$$= Y_c = a + bx$$

Where, **Y = Trend value to be computed**

X = Unit of time (Independent Variable)

a = Constant to be Calculated

b = Constant to be calculated

- **Example:-**

Draw a straight line trend and estimate trend value for 1996:

Year	**1991**	**1992**	**1993**	**1994**	**1995**

Solution:-

	Deviation From				Trend
Year	1990	Y	XY	X^2	$Y_c = a + bx$
1991	1	8	8	1	$5.2 + 1.6(1) = 6.8$
(1)	X	(3)	(4)	(5)	(6)
,	$\sum X$	$\sum Y$	$\sum XY$	$\sum X^2$	

N= 5

Now we calculate the value of two constant 'a' and 'b' with the help of two equation.

1992	(2)	9	18	4	$5.2 + 1.6(2) = 8.4$

$$\sum Y = Na + b\sum X$$

$$\sum XY = a\sum X + b\sum X^2$$

Now we put the value of $\sum X, \sum Y, \sum XY, \sum X^2, \& N$:-

50 = 5a + 15(b) .... (i)

166 = 15a + 55(b) .... (ii)

Or 5a + 15b = 50 .... (iii)

15a + 55b = 166 .... (iv)

Equation (iii) Multiply by 3 and subtracted by (iv)

-10b = -16

b = 1.6

Now we put the value of "b" in the equation (iii)

$$= \quad 5a + 15(1.6) = 50$$

$$5a = 26$$

$$a = \frac{26}{5} = 5.2$$

As according the value of ‘a’ and ‘b’ the trend line:-

$$Yc = a + bx$$

$$Y = 5.2 + 1.6X$$

Now we calculate the trend line for 1996:-

$$Y_{1996} = 5.2 + 1.6\ (6) = 14.8$$

Shifting The Trend Origin:-

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- In above Example the trend equation is:

$$Y = 5.2 + 1.6x$$

Here the base year is 1993 that means actual base of these year will 1st July 1993. Now we change the base year in 1991. Now the base year is back 2 years unit than previous base year.

Now we will reduce the twice of the value of the ‘b’ from the value of ‘a’.

Then the new value of ‘a’ = 5.2 – 2(1.6)

Now the trend equation on the basis of year 1991:

$$Y = 2.0 + 1.6x$$

Y = 2.0 + 1.6x

Parabolic Curve:-

Parabolic Curve:-

[redacted]ch draw by “Least Square Method” is not prove ‘Line of best fit’ because it is not present actual long term trend So we distributed Time Series in sub-part and make following equation:-

$$Y_c = a + bx + cx^2$$

- If this equation is increase up to second degree then it is “Parabola of second degree” and if it is increase up to third degree then it “Parabola of third degree”. There are three constant ‘a’, ‘b’ and ‘c’.

Its are calculated by following three equation:-

Parabola of second degree:-

$$\sum Y = Na + b\sum X + c\sum X^2$$

$$\sum XY = a\sum X + b\sum X^2 + c\sum X^3$$

$$\sum X^2Y = a\sum X^2 + b\sum X^3 + c\sum X^4$$

If we take the deviation from 'Mean year' then the all three equation are presented like this:

$$\sum Y = Na + C\sum X^2$$

$$\sum XY = b\sum X^2$$

$$\sum X^2Y = a\sum X^2 + c\sum X^4 +$$

❑ Example:

➢ Draw a parabola of second degree from the following data:-

Year	1992	1993	1994	1995	1996
Production (000)	5	7	4	9	10

Year	Production	Dev. From Middle Year (x)	xY	x^2	x^2Y	x^3	x^4	Trend Value $Y = a + bx + cx^2$
1992	5	-2	-10	4	20	-8	16	5.7
1993	7	-1	-7	1	7	-1	1	5.6
1994	4	0	0	0	0	0	0	6.3
1995	9	1	9	1	9	1	1	8.0
1996	10	2	20	4	40	8	16	10.5
	$\sum Y = 35$	$\sum X = 0$	$\sum XY = 12$	$\sum X^2 = 10$	$\sum X^2Y = 76$	$\sum X^3 = 0$	$\sum X^4 = 34$	

We take deviation from middle year so the equations are as below:

$$\sum Y = Na + \sum X^2$$

$$\sum XY = b\sum X^2$$

$$\sum X^2Y = a\sum X^2 + c\sum X^4 +$$

Now we put the value of $\sum X, \sum Y, \sum XY, \sum X^2, \sum X^3, \sum X^4, \& N$

$35 = 5a + 10c$ .... (i)

$12 = 10b$ .... (ii)

$76 = 10a + 34c$ .... (iii)

From equation (ii) we get $b = \frac{12}{10} = 1.2$

Equation (ii) is multiply by 2 and subtracted from (iii):

$$10a + 34c = 76 \quad \ldots\ldots\ldots\ldots\ldots \quad \text{(iv)}$$

$$10a + 20c = 70 \quad \ldots\ldots\ldots\ldots\ldots \quad \text{(v)}$$

$$14c = 6 \ \text{ or } c = \frac{6}{14} = 0.43$$

Now we put the value of c in equation (i)

$$5a + 10\,(0.43) = 35$$

$$5a = 35\text{-}4.3 \quad = 5a = 30.7$$

$$a = 6.14$$

Now after putting the value of 'a', 'b' and 'c', Parabola of second degree is made that is:

$$Y = 6.34 + 1.2x + 0.43x^2$$

$$Y = 6.34 + 1.2x + 0.43x^2$$

Methods Of Seasonal Variation:-

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- Seasonal Average Method
- Link Relative Method
- Ratio To Trend Method
- Ratio To Moving Average Method

Seasonal Average Method

- Seasonal Averages = $\frac{\text{Total of Seasonal Values}}{\text{No. Of Years}}$
- General Averages = $\frac{\text{Total of Seasonal Averages}}{\text{No. Of Seasons}}$
- Seasonal Index = $\frac{\text{Seasonal Average}}{\text{General Average}}$

EXAMPLE:-

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- [redacted]owing data calculate quarterly seasonal indices assuming the absence of any type of trend:

Year	I	II	III	IV
1989	-	-	127	134

Solution:-

Calculation of quarterly seasonal indices

Year	I	II	III	IV	Total
1989	-	-	127	134	
1990	[illegible]	[illegible]	[illegible]	[illegible]	
Total	503	476	488	524	
Average Quarterly	125.75	119	122	131	497.75

- General Average = $\frac{497.75}{4} = 124.44$

Quarterly Seasonal variation index = $\frac{125.75}{124.44} \times 100$

So as on we calculate the other seasonal indices

Link Relative Method:

- In this Method the following steps are taken for calculating the seasonal variation indices
- We calculate the link relatives of seasonal figures.

$$\text{Link Relative: } \frac{\text{Current Season's Figure} \times 100}{\text{Previous Season's Figure}}$$

Ratio To Moving Average Method:

Ratio To Moving Average Method:

- In this method seasonal variation indices are calculated in following steps:
- We calculate the 12 monthly or 4 quarterly moving average.
- We use following formula for calculating the moving average Ratio:

$$\textbf{Moving Average Ratio} = \frac{\text{Original Data}}{\text{Moving Average}} \times 100$$

Ratio To Trend Method:-

Ratio To Trend Method:-

- This method based on Multiple model of Time Series. In it we use the following Steps:
- We calculate the trend value for various time duration (Monthly or Quarterly) with the help of Least Square method
- Then we express the all original data as the percentage of trend on the basis of the following formula.

$$= \frac{\text{Original Data}}{\text{Trend Value}} \times 100$$

Rest of Process are as same as moving Average Method