Time Series and Forecasting

Introduction:- We have studied various methods of statistics for analysing the data relating to a variable at a particular point of time. But a large part of the data, used in economics and business research, is of a type known as time series.

A time series is a collection of observations of well-defined data items obtained through repeated measurements over time. For example, measuring the values of retail sales each month of the year would comprise a time series.

Meaning The set of orderly arranged observations in terms of quantitative measured variable constitutes the time series. The variables may be related to years, months or days. In simple words, statistical data arranged with respect to time is called a time series.

$$y = f(t)$$

$t: t_1, t_2, t_3, t_4 \;--\; t_n$

$y: y_1, y_2, y_3, y_4 \;--\; y_n$

According to Werner Z. Hirsch, "A time series is a sequence of values of some variate corresponding to successive points in time."

According to Y.L. Croxton and Cowden," A time series consists of data arranged chronologically.

Importance of the time series Analysis

(i) Helpful in Studying Past Behaviour.
(ii) Helpful in Forecasting
(iii) Helpful in Evaluating Achievements.
(IV) Helpful in Comparison

Essentials of a time Series :-

(i) Homogeneity of data.
(ii) Sufficient Data.
(iii) Uniform Time Gap.
(IV) Completeness of Data.

Editing Time Series Data or Preparation of Data for Analysis

(i) Calender Adjustments.
(ii) Price Changes.
(iii) Population Adjustments.
(IV) Other Adjustments.

Time Series Components

- Series with Trends
  Observations increase or decrease regularly through time.

- Series with seasonality — observations stay high, then drop off, and pattern repeats from one period to next.
- Series with cyclic component — Business cycles (e.g. recessions)

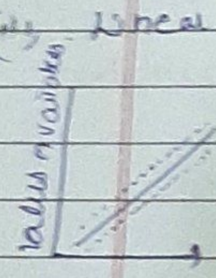
Components of Time series

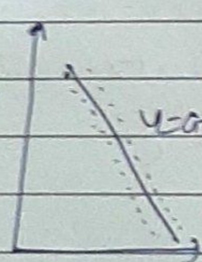
Secular trend

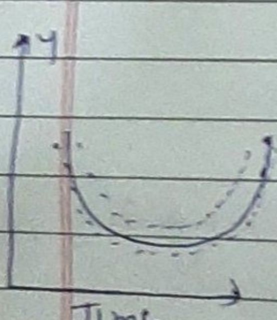
(i) Smooth long term direction

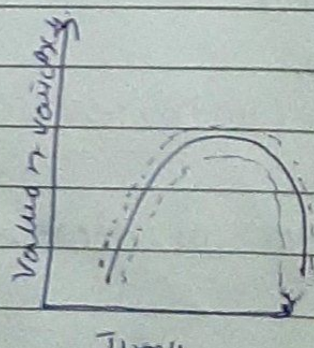
(ii) overall, persistent, long-term movement

(iii) Linear









Seasonal variations

(i) Patterns of change in a time series within a year which tends to repeat each year,

(ii) Regular periodic fluctuations, usually within a 12 month period

(iii) Climatic conditions

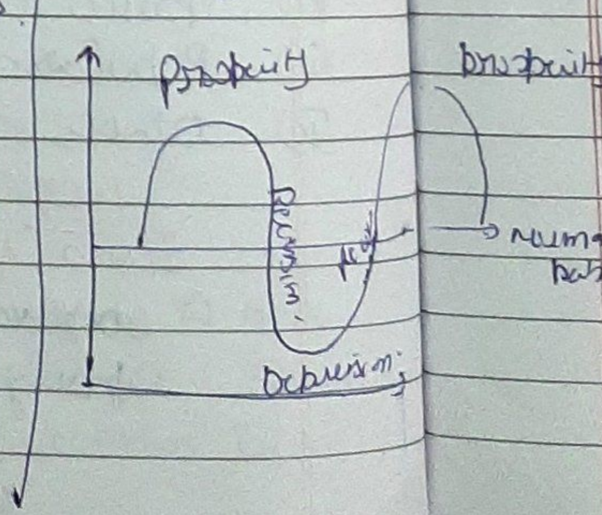
(iv) Rituals, customs and traditions

Cyclical variations

(i) The rise, fall of a time series over periods longer than one year

(ii) Repeating up & down movements over more than one year

(iii)



Methods of Least Squares

Let the linear trend b/w the given time-series values represented by y the time represented by x be given by equation

$$y = a + bx$$

which after simplification reduce to

$$\Sigma y = na + b\Sigma x$$

$$\Sigma xy = a\Sigma x + b\Sigma x^2$$

Steps 1 :- Take first year of the given time series as 0, next year as 1, subsequent years as 2, 3, and so on.

Step 2 Calculate Σx, Σx^2, and Σxy from the given values.

Step 3 Put these values in normal equations and solve them simultaneously for 'a' and 'b'

Step 4 Put these values of 'a' and 'b' in trend equation $y = a + bx$

Step 5 By putting different values of x in above equation, calculate trends values.

Ex Fit a straight line trend by Method of Least Squares

Year	y	x	x^2	xy	Trend value
2000	20	0	0	0	
2001	17	1	1	17	
2002	26	2	4	52	
2003	23	3	9	69	
2004	24	4	16	96	
	$\Sigma y = 100$	$\Sigma x = 10$	$\Sigma x^2 = 30$	$\Sigma xy = 234$	

$$y = a + bx$$

Two normal equations are

$$\Sigma y = na + b\Sigma x$$

$$\Sigma xy = a\Sigma x + b\Sigma x^2$$

Substituting the values, we get

$$5a + 10b = 110 \quad \text{—(i)}$$

$$10a + 30b = 234 \quad \text{—(ii)}$$

$$10a + 20b = 220$$

$$-10a + 30b = 234$$

$$-10b = -14$$

$$b = \frac{14}{10} = 1.4$$

put value of b in (i)

$$5a + 10(1.4) = 110$$

$$5a = 110 - 14$$

$$5a = 96$$

$$a = \frac{96}{5} = 19.2$$

The estimated trend line :
$y = 19.2 + 1.4x$

We can calculate then trend values
$x = 0$, $y = 19.2 + 1.4(0) = 19.2$
$x = 1$, $y = 19.2 + 1.4(1) = 20.4$
$x = 2$, $y = 19.2 + 1.4(2) = 22.0$
$x = 3$, $y = 19.2 + 1.4(3) = 23.4$
$x = 4$, $y = 19.2 + 1.4(4) = 24.8$

You are given data on annual sales of Sarees (lac Rs.) for the year 1998-2004

Year :	1998	1999	2000	2001	2002	2003	2004
Sales :	83	92	71	90	169	191	203

Find the least squares, linear trend values, Estimate sales for the year 2006. Find monthy increment in sales

Year	y	x	x^2	xy	Trend values
1998	83	-3	9	-249	
1999	92	-2	4	-184	
2000	71	-1	1	-71	
2001	90	0	0	0	
2002	169	1	1	169	
2003	191	2	4	382	
2004	203	3	9	609	
	$\Sigma y = 849$	$\Sigma x = 0$	$\Sigma x^2 = 28$	$\Sigma xy = 636$	

Let the st line $y = a + bx$

$\Sigma y = na + b\Sigma x$

$\Sigma xy = a\Sigma x + b\Sigma x^2$

Substituting the values we have

$849 = 7a$

$a = \frac{849}{7} = 121.28$

$656 = 28b$

$b = \frac{656}{28} = 23.42$

$y = 121.28 \cancel{x} + 23.42$

origin = 2001, x unit = 1 year

$x = -3 \rightarrow y = 121.28 + 23.42(-3) = 57.02$

$x = -2, y = 121.28 + 23.42(-2) = 74.44$

$x = -1, y = 121.28 + 23.42(-1) = 97.86$

$x = 0, y = 121.28 + 23.42(0) = 121.28$

$x = 1, y = 121.28 + 23.42(1) = 144.7$

$x = 2, y = 121.28 + 23.42(2) = 168.12$

$x = 3, y = 121.28 + 23.42(3) = 191.54$

(ii) For sales in year 2006 put $x = 5$

$y_{2006} = 121.28 + 23.42(5)$

$= 238.38$ Ans