② problem:-

Fit a straight line to the following data relating to the sales of a leading departmental stores assuming that same rate of change continous what would be the predicted Earnings for the year 2016

years	2007	2008	2009	2010	2011	2012	2013	2014
sales (cres)	76	80	130	144	138	120	174	190

Find the trend values & also draw the graph

Sl^n let us shift the origin to 2011 (even no of observations)

$x = t - 2011$

year	production y_t	$x = t - 2011$	$x * y_t$	x^2	$y =$
2007	76	-4	-304	16	80.1666
2008	80	-3	-240	9	94.8333
2009	130	-2	-260	4	109.5
2010	144	-1	-144	1	124.1667
2011	138	0	0	0	138.8334
2012	120	1	120	1	153.5001
2013	174	2	348	4	168.1668
2014	190	3	570	9	182.8335
	$\Sigma y_t = 1052$	$\Sigma x = -4$	$\Sigma x y_t = 90$	$\Sigma x^2 = 44$	$\Sigma y = 1052.0004$

$y_t = na + b \Sigma x$ $\quad \Sigma x y_t = a \Sigma x + b \Sigma x^2$

$1052 = 8 * a + b(-4)$ $\quad 90 = -4a + 44b$

$1052 = 8a - 4b$

$90 = -4a + 44b \Rightarrow 180 = -\cancel{8}a + 88b$

$1052 = 8\cancel{a} - 4b$

$1232 = 84b$

$b = 14.6667$

$\left\{ \begin{array}{l} \cancel{a} = \dfrac{\cancel{833}}{6} \\ \cancel{b} = \dfrac{\cancel{44}}{3} \end{array} \right\}$

$a = \dfrac{833}{6} = 138.8334$

$b = \dfrac{44}{3} = 14.6667$

st line eq^n $y_t = 138.8334 + 14.6667(t - 2011)$

Estimation for 2016

$y_t = 138.8334 + 14.6667(2016 - 2011)$

$y_t = 212.1669$

(2) fitting of a Second degree Trend:- Let a second degree parabolic trend curve be $y_t = a + bt + ct^2$, normal eqns for estimating a, b & c are

$$\Sigma y_t = na + b\Sigma t + c\Sigma t^2$$

$$\Sigma t y_t = a\Sigma t + b\Sigma t^2 + c\Sigma t^3$$

$$\Sigma t^2 y_t = a\Sigma t^2 + b\Sigma t^3 + c\Sigma t^4$$

440

Problem :-

The following figures are the production data of a certain factory manufacturing air-conditioners

year(t)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
productions (1000 units)	17	20	19	26	24	40	35	55	51	74	79

Fit the second degree parabolic trend curve to the above data & obtain trend values

year	production y_t	$x = t - 2005$	x^2	x^3	x^4	$y_t * x$	$y_t x^2$	y_c
2000	17	-5	25		625	-85	425	15.191
2001	20	-4	16		256	-80	320	19.0968
2002	19	-3	9		81	-57	171	23.5306
2003	26	-2	4		16	-52	104	28.4924
2004	24	-1	1		1	-24	24	33.9822
2005	40	0	0		0	0	0	40
2006	35	1	1		1	35	35	46.5458
2007	55	2	4		16	110	220	53.6196
2008	51	3	9		81	153	459	61.2214
2009	74	4	16		256	296	1184	69.3512
2010	79	5	25		625	395	1975	78.009
	$\Sigma y_t = 440$	$\Sigma x = 0$	$\Sigma x^2 = 110$		$\Sigma x^4 = 1958$	$\Sigma y_t x = 691$	$\Sigma y_t x^2 = 4917$	

Normal eqn

$y_t = a + bx + cx^2$ (is the parabolic Curve)

$\Sigma y_t = na + b\Sigma x + c\Sigma x^2$

$\Sigma x y_t = a\Sigma x + b\Sigma x^2 + c\Sigma x^3$

$\Sigma x^2 y_t = a\Sigma x^2 + b\Sigma x^3 + c\Sigma x^4$

$440 = 11a + b(0) + c(0)$

$691 = a(0) + b(110) + c(0)$

$4917 = a(110) + b(0) + c(1958)$

$11a = 440$ $\quad$ $110b = 691$

$a = \frac{440}{11}$ $\quad$ $b = \frac{691}{110}$

$a = 40$ $\quad$ $b = 6.2818$

$4917 = 40(110) + c(1958)$

$4917 = 4400 + c(1958)$

$517 = 1958c$

$c = \frac{517}{1958}$

$c = 0.2640$

$y = 40 + 6.2818x + 0.2640x^2$

Trend values

$y_t = 40 + 6.2818(t-2005) + 0.2640\,(t-2005)^2$

fitting of exponential Curve:- let ~~$y_t = ab^t$~~

let $y_t = ab^t \rightarrow (1)$ be the Exponential curve

Taking logs on both sides

$\log y_t = \log a + t\log b$

put $Y = \log y_t$; $A = \log a$; $B = \log b$

$\therefore$ Eqn (1) changes to $Y = A + Bt \rightarrow (2)$

This is straight line eqn

Normal eqns are

$\Sigma Y = nA + B\Sigma t \rightarrow (3)$

$\Sigma tY = A\Sigma t + B\Sigma t^2 \rightarrow (4)$

solving (3) & (4) we get A & B

$a = \text{antilog}(A)$

$b = \text{antilog}(B)$

(4) Fit an Exponential curve $y = ab^x$ to the following data by the method of least Squares of population in India. Estimate the population of 1991, 2001 & 2011.

Census year (x):	1911	1921	1931	1941	1951	1961	1971
popln (crores) (y):	25.0	25.1	27.9	31.9	36.1	43.9	54.7

year (t)	production y_t	$x = \frac{t-1941}{10}$	$Y = \log(y_t)$	xY
1911	25.0	−30	3.2189	−9.6567
1921	25.1	−20	3.2229	−6.4458
1931	27.9	−10	3.3286	−3.3286
1941	31.9	0	3.4626	0
1951	36.1	10	3.5863	3.5863
1961	43.9	20	3.7819	7.5638
1971	54.7	30	4.0019	12.0057
	$\Sigma y_t = 244.6$	$\Sigma x = 0$	$\Sigma Y = 24.6031$	$\Sigma xy = 3.724$

$\Sigma Y = nA + B\Sigma x$

$\Sigma xY = A\Sigma x + B\Sigma x^2$

$a = \text{Anti}\log A$

$b = \text{Anti}\log B$

x^2

9

4

1

0

1

4

9

$\Sigma x^2 = 28$

ΣY =

$24.6031 = 7A + B(0)$

$3.7247 = A(0) + B(28)$

$A = \frac{24.6031}{7} = 3.51417$

$B = \frac{3.7247}{28} = 0.1330$

$a = \text{Antilog}(3.5147) = 33.6058$

$b = \text{Antilog}(0.1330) = 1.1422$

$\therefore y_t = (33.6058)(1.1422)^x$ is the exponential curve

estimation y_t =

$t = 1991 \Rightarrow x = \frac{t-1941}{10} = \frac{50}{10} = 5$ 60, 70

$y_t = (33.6058)(1.1422)^5 = 65.3319$

$x = \frac{t-1941}{10} = \frac{2001-1941}{10} = 6$

$\therefore y_t = (33.6058)(1.1422)^6$

$= 74.6220$

4 $t = 2011 \Rightarrow x = \frac{t - \cancel{1}941}{10} = \frac{2011 - 1941}{10} = 7$

$\therefore y_t = (33.6058)(1.1422)^7$

$= 85.2333$

$Y = nA + B\Sigma x$

$xY = A\Sigma x + B\Sigma x^2$

$a = \text{Anti}$

$b =$

Year	Tonage of goods carr	4 yearly moving total (non centered)	2 yearly moving total centered
2000	2204		
2001	2500		
		9744	
			19708
2002	2360		
		9964	
			20062
2003	2680		
		10098	
			20740
2004	2424		
		10642	
			21702
2005	2634		
		11060	
			22868
2006	2904		
		11808	
			23934
2007	3098		
		12126	
			24596
2008	3172		
		12470	
			~~24670~~ 25014
2009	2952		
		12544	
2010	3248		
2011	3172		

4 yearly moving average (trend values)

$\frac{19708}{8} = 2463.5$

$\frac{20062}{8} = 2507.75$

$\frac{20740}{8} = 2592.5$

$\frac{21702}{8} = 2712.75$

$\frac{2858.5}{8} = 2858.5$

2991.75

3074.5

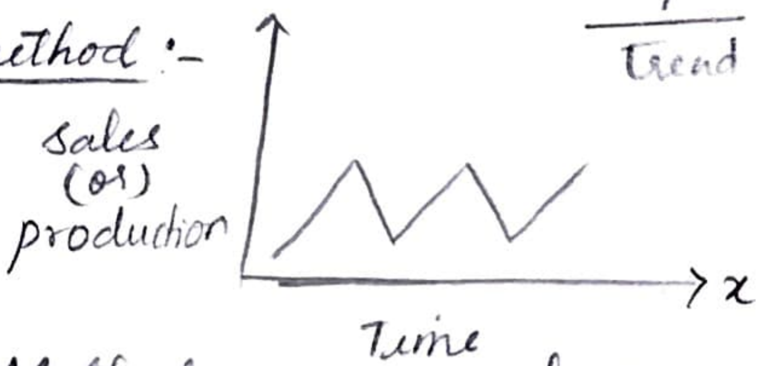
3126.75

1/3/2021

Ratio to trend

$$\frac{\text{original}}{\text{Trend}} \times 100$$

graphical method :-



link relative Method :- This is also known as Pearson's method and is based on averaging the link relatives

$$\text{link relative for any month} = \frac{\text{Current month's figure}}{\text{previous month's figure}} \times 100$$

$$\text{chain relative for feb} = \frac{\text{link relative of Feb} \times \text{Chain relative for Jan}}{100}$$

$$\text{chain relative of March} = \frac{\text{Link relative of March} \times \text{chain relative for feb}}{100}$$

$$\text{chain relative of Dec} = \frac{\text{LR of Dec} \times \text{CR of Nov}}{100}$$

now by taking this Dec. value as base, a new chain relative for Jan can be obtains as =

new chain relative for Jan = LR [illegible] of Dec / 100

Usually this will not be 100 due to trend & we have to adjust the chain relatives for trend. This adjustment is done by subtracting a correction factor from each chain relative.

If we write $d = \frac{1}{12}$ [second (new) CR for Jan $- 100$]

correction factor

Then assuming linear trend the correction factor for Feb, Mar, ... Dec is $d, 2d, \dots 11d$ respectively.

Problem:-

The data below gives the average quarterly prices of a commodity for 5 year. Calculate the seasonal variation indices by the method of link relatives.

Quarter \ Year	1979	1980	1981	1982	1983
I	30	35	31	31	34
II	26	28	29	31	36
III	22	22	28	25	26
IV	31	36	32	35	33

link relatives

year	I quarter	II quarter	III quarter	IV quarter
1979	—	$\frac{26}{30} \times 100 = 86.7$	$\frac{22}{26} \times 100 = 84.6$	$\frac{31}{22} \times 100 = 140.9$
1980	$\frac{35}{31} \times 100 = 112.9$	$\frac{28}{35} \times 100 = 80$	$\frac{22}{28} \times 100 = 78.6$	$\frac{36}{22} \times 100 = 163.6$
1981	86.1	93.5	96.6	114.3
1982	96.9	100	80.7	140
1983	97.1	105.9	72.2	$\frac{33}{26} \times 100 = 126.9$
link relative Arithmetic Average	98.25	93.22	82.54	137.14
chain Relative	100	$\frac{93.22 \times 100}{100}$ 93.22	$\frac{82.54 \times 93.22}{100}$ 76.94	$\frac{137.14 \times 76.94}{100}$ 105.52
adjusted CR	100	93.22 - 0.92 = 92.3	76.94 - (2 × 0.92) = 75.1	105.22 - 3 × 0.92) = 102.46
subtracting seasonal index	$\frac{100}{92.47} \times 100 = 108.14$	99.82	$\frac{75.1}{92.47} \times 100 = 81.22$	$\frac{102.46}{92.47} \times 100 = 110.80$

Average of adjusted chain relative

$$= \frac{100 + 92.3 + 75.1 + 102.46}{4}$$

$$= 92.47$$

sesonal index for any = $\frac{\text{Adjusted CR} \times 100}{92.47}$

Second chain relative for I Qtr

$$= \frac{\text{LR of 1st Qtr} \times \text{CR of IV Qtr}}{100}$$

$$= \frac{98.25 \times 105.52}{100}$$

$$= 103.67$$

Correction factor $d = \frac{1}{4}(103.67 - 100)$

$$d = 0.92$$

Adjusted chain relative are obtained by subtracting 0.92, 2×0.92, 3×0.92 from chain relatives of IInd, IIIrd & IVth quarters respectively

principal of least square
moving average
Ratio to trend method
link relative method

Corrections :- module-2
χ^2 (chi-square) for independent attributes

pg :- 13, 14, 15 (we have to see that)

pg :- 17 (density for to not to go deeply)

pg :- 18-25 (we have to read) (pg 21-25*)

star mark problems

module-3
Pg no:- 31 (link relative)

* mark $\left(\frac{30}{27.5} \times 100\right) = 109.1$

$\frac{40}{30.5} \times 100 = 131.$