

Operations Research Chapter 7

Moving Average

The number of cans of soft drinks sold in a machine each week is recorded below. Develop forecasts using a three period moving average.

338, 219, 278, 265, 314, 323, 299, 259, 287, 302

Time Period	Actual Value	Forecast	Forecast Error	Error	(Error) ²
1	338				
2	219				
3	278				
4	265				
5	314				
6	323				
7	299				
8	259				
9	287				
10	302				

THE FORECAST FOR PERIOD 11

MEAN ABSOLUTE ERROR

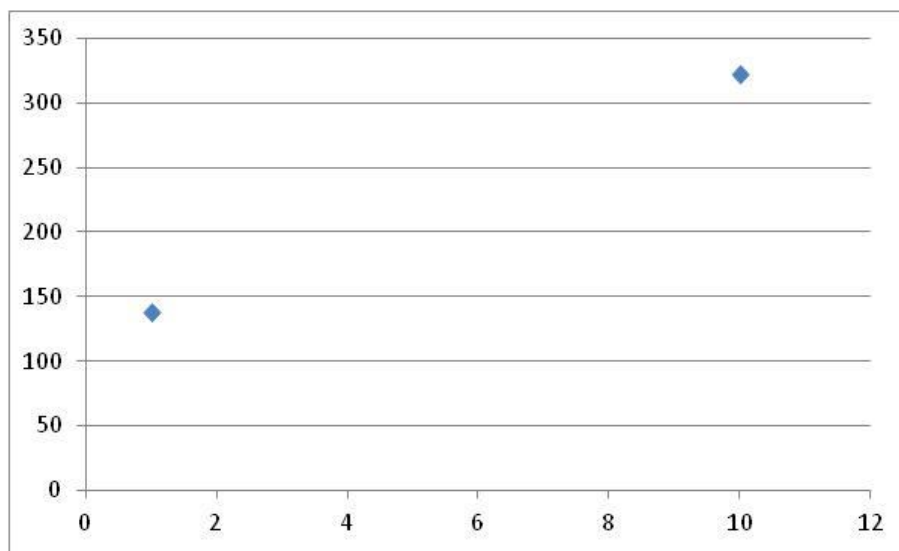
MEAN SQUARED ERROR

Trend Analysis

A company's annual sales are shown below in thousands of dollars for a period of 10 years.

Year (t)	1	2	3	4	5	6	7	8	9	10
Actual Sales (Tt)	138	150	142	151	161	188	191	224	254	322

Plot the time series; find the linear regression model, and also the forecast value and error for each of the years. Also discuss whether you think a linear model appears to be appropriate.



Linear regression can be used to develop a trend-based forecasting model. The model will take the following form:

$$\hat{y} = b_0 + b_1t.$$

The intercept and slope are calculated using the least squares equations:

$$b_1 = \frac{n \sum ty - \sum t \sum y}{n \sum t^2 - (\sum t)^2}$$

and

$$b_0 = \bar{y} - b_1\bar{t}.$$

Year (t)	Actual Sales (T _t)	t*T _t	t ²
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Sum			

$$b_1 = \frac{n \sum ty - \sum t \sum y}{n \sum t^2 - (\sum t)^2} =$$

and

$$b_0 = \bar{y} - b_1 \bar{t} =$$

The results of the calculations are: $\hat{y} = 94.07 + 17.82t$.

Trend and Seasonal Components

a) The number of properties newly listed with a real estate agency in each quarter over the last four years is given.

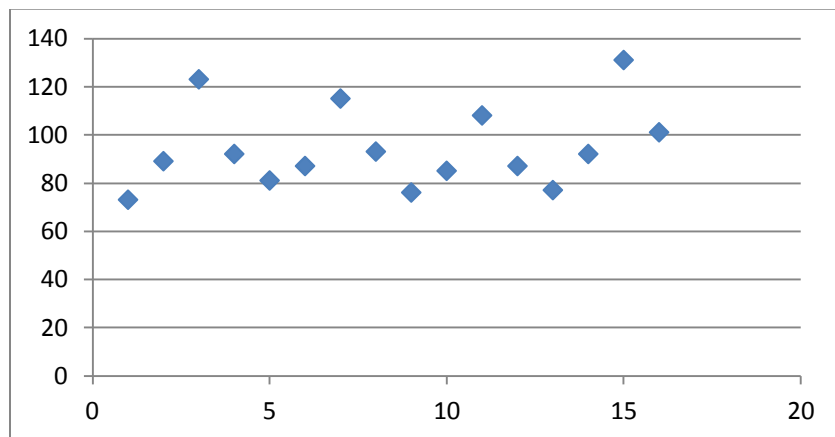
Quarter	Year			
	1	2	3	4
1	73	81	76	77
2	89	87	85	92
3	123	115	108	131
4	92	93	87	101

Quarter (t)	Actual Sales (Tt)		Centered Moving average	Seasonal-Irregular
1	73			
2	89			
3	123			
4	92			
1	81			
2	87			
3	115			
4	93			
1	76			
2	85			
3	108			
4	87			
1	77			
2	92			
3	131			
4	101			

Season	Average Seasonal Index	Adjusted Seasonal Index
Quarter 1		
Quarter 2		
Quarter 3		
Quarter 4		

b) Plot the time series

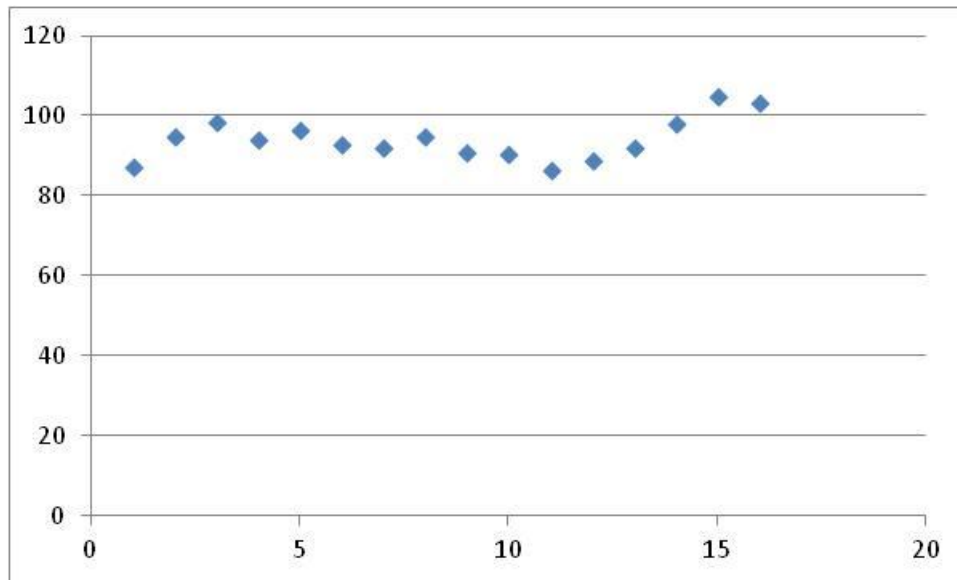
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
73	89	123	92	81	87	115	93	76	85	108	87	77	92	131	101



c) Plot the deseasonalized time series

Period	Actual Sales (T _t)	Adjusted Seasonal Index	Deseasonalized Sales
1	73	0.83712	87.20372
2	89	0.937631	94.92007
3	123	1.24714	98.62564
4	92	0.978109	94.05909
5	81	0.83712	96.76029
6	87	0.937631	92.78704
7	115	1.24714	92.21096
8	93	0.978109	95.08147

9	76	0.83712	90.78743
10	85	0.937631	90.654
11	108	1.24714	86.59812
12	87	0.978109	88.94719
13	77	0.83712	91.982
14	92	0.937631	98.11963
15	131	1.24714	105.0403
16	101	0.978109	103.2605



c) Calculate the seasonal index values and forecast for Year 5.

Trend Analysis on deseasonalized Sales: $\hat{y} = 91.02 + 0.3729 t$

Year 5	Deseasonalized Sales Forecast	Seasonal	Seasonalized Sales Forecast
Quarter 1 (17)	97.35927	0.83712	81.50142
Quarter 2 (18)	97.73214	0.937631	91.63668
Quarter 3 (19)	98.10502	1.24714	122.3507
Quarter 4 (20)	98.47789	0.978109	96.32206

Multiple Choices Questions:

1. Recently, a manager for a major retailer computed the following seasonal indexes:

Fall Qtr	Winter Qtr	Spring Qtr	Summer Qtr
1.21	0.85	0.91	

Note that the index for Summer Qtr is missing. However, it can be determined that the index for that period is approximately 1.03.

TRUE / FALSE

2. Recently, a manager for a major retailer computed the following seasonal indexes:

Fall Qtr	Winter Qtr	Spring Qtr	Summer Qtr
1.61	0.75	0.91	0.73

The manager then developed the following least squares trend model based on the past five years of quarterly data: $\hat{y} = 200 + 11.5t$. Based on this, the seasonally adjusted forecast for quarter 25, which is the winter quarter, is 489.11.

TRUE / FALSE

3. A company has developed a linear trend regression model based on 16 quarters of data. The independent variable is the measure of time ($t = 1$ thru 16 where quarter 1 is winter quarter, 2 is spring, etc.). The company has also developed seasonal indexes for each quarter as follows:

Winter	Spring	Summer	Fall
1.20	1.00	0.70	1.10

The linear trend forecast equation is: $\hat{y} = 120 + 56t$.

Given this information, what is the seasonally unadjusted forecast for period 19?

- A) 1,064
- B) 1,184
- C) 828.80
- D) 986.7

4. Given this information, what is the seasonally adjusted forecast for period 19?

- A) 1,064
- B) 1,184
- C) 828.80
- D) 986.7

5. Given this information, which of the four quarters beginning next winter (period $t = 17$) will have the highest seasonally adjusted forecast?

- A) Winter
- B) Spring
- C) Summer
- D) Fall