Smoothing or Filtering the Time Series

SESSION 16

Structure

16.1 INTRODUCTION

We have explained in Unit 13 of MSTE-002 (Industrial Statistics-II) that the time series data are usually a combination of four components, i.e., trend (T), cyclic (C), seasonal (S) and irregular (I) effects. Suppose the data have been recorded on a monthly basis and reflect an annual seasonal effect. This means that after every twelve months, the data behave in a similar way. This is called a **period** of the seasonal effect.

For estimation of trend, it is very important to filter the effects of seasonal and irregular fluctuations from the time series so that the trend and cyclic effects can be estimated easily. In Unit 13 of MSTE-002, we have explained the simple moving average, weighted moving average and exponential smoothing methods for the estimation of trend values by smoothing or filtering the effects of the seasonal and irregular fluctuations from the time series data.

In Lab Session 15, you have learnt how to estimate trend values using the curve fitting method. You have applied three types of curve fitting: linear, quadratic and exponential. In this lab session, you will learn about the techniques of smoothing, i.e., simple and weighted moving average methods. You will also learn the exponential smoothing technique.

Prerequisite

- Lab Session 15 of MSTL-002 (Industrial Statistics Lab).
- Unit 13 of MSTE-002 (Industrial Statistics-II).

Objectives

After performing the activities of this session, you should be able to:

- prepare the spreadsheet in MS Excel 2007;
- apply the simple moving average, weighted moving averages and exponential smoothing method for filtering the seasonal and irregular fluctuations; and
- plot and interpret the data along with the moving averages or exponentially smoothed values.

16.2 PROBLEM DESCRIPTION

Suppose the owner of an ice-cream parlour situated in a locality of a metro city wants to analyse its monthly sales. The data of the total quantity of ice-cream sold every month for 5 years from 2008 to 2012 are recorded in Table 1.

Table 1: Monthly sales of ice-cream

Month	Quantity (in litre)	Month	Quantity (in litre)	Month	Quantity (in litre)
1	288	21	767	41	1210
2	316	22	738	42	1237
3	414	23	689	43	1248
4	540	24	596	44	1217
5	558	25	540	45	1215
6	586	26	630	46	1134
7	558	27	879	47	1024
8	548	28	990	48	898
9	540	29	1032	49	834
10	565	30	1020	50	934
11	465	31	1005	51	1312
12	396	32	1017	52	1398
13	396	33	967	53	1475
14	450	34	924	54	1446
15	648	35	848	55	1456
16	764	36	774	56	1411
17	824	37	694	57	1379
18	802	38	765	58	1358
19	812	39	1134	59	1189
20	776	40	1224	60	1064

For the data given in Table 1,

- Compute the 3, 6, 9 and 12 monthly moving averages. Plot the results along with the quantity of ice-cream sold.
- Compute the weighted moving average for the period of 3 months for the weights 0.2, 0.3 and 0.5. Plot the results on the chart.
- Compute the weighted moving average for the period of 9 months for the weights 0.05, 0.06, 0.08, 0.1, 0.11. 0.13, 0.14, 0.16, and 0.17. Plot the results on the chart.
- Use the smoothing coefficients of 0.05, 0.1, 0.25 and 0.5 to compute the exponentially smoothed series. Plot the results on the chart.

16.3 SIMPLE MOVING AVERAGE

You have studied about the estimation of trend values using the moving averages method in Unit 13 of MSTE-002. Here we mention the main steps involved in the method for both odd and even periods.

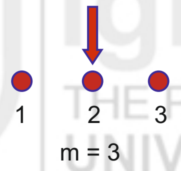
In this method, we find the simple moving averages of the time series data over m periods and these are called **m-period moving averages**. This method will also filter the effect of seasonal (S) and irregular (I) components. When the effects of S and I are removed, the data has only the trend (T) and cyclic (C) effects. The simple moving averages for odd and even periods can be computed as follows:

When m is odd

In some situations, the data may show seasonal effect over an **odd period** of time, e.g., 7 days, or 9 months, etc. It means that after every 7 days or 9 months, data behave in a similar manner. For odd periods, the method consists of the following steps:

Step 1: We calculate the average of the first m values of the time series and place it against the middle value, i.e., $\frac{(m+1)}{2}$.

For example, if m = 3, we compute the average of the first three values and place it against the second value.



Step 2: We discard the first value and include the next value. Then we take the average of m values again. For example, if m = 3, we discard the first value to determine the average of the second, third and fourth values and place it against the third value.

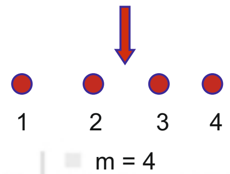
Step 3: We repeat this process until all data are exhausted. These steps provide us a new time series of m-period moving averages.

When m is even

If the period is even, we compute the centred simple moving averages. Sometimes, there may be a seasonal effect over an **even period** of time, e.g., 4 days or 12 months etc. This means that after every 4 days or 12 months, data behave in a similar way. The simple moving averages for even periods need to be centred. So it is also known as centred moving averages. If we take a centred moving average with m = 4 then it will filter (or eliminate) the effect of the season of a quarter. This method consists of the following steps:

Step 1: We calculate the average of the first m values of time series and place it against the middle value, i.e., $\frac{m}{2}$.

For example, if m = 4, we compute the average of the first four values and place it against the middle of the second and third values.



Step 2: We discard the first value and include the next value and then take the average of m values again. For example, if m = 4, we discard the first value, find the average of the second, third, fourth and fifth values and place it against the middle of third and fourth values.

Step 3: We repeat this process until all the data are exhausted. These steps provide us new time series of m-period moving averages.

Step 4: Since the period (m) is even, we determine the centred moving average. To determine the first centred moving average, we compute the average of the first two moving averages and place it against the middle value, i.e., $\left(\frac{m}{2}+1\right)$.

For example, if m = 4, we calculate the average of the first two moving averages and place it against the middle of the first and second moving averages, i.e., against the third period.

Step 5: We repeat this process until all data are exhausted. These steps give a new time series of m-period centred moving averages.

Steps in Excel

In this lab session, we compute 3, 6, 9 and 12 monthly moving averages in which 3 and 9 monthly moving averages are based on odd periods of time and the remaining two are based on even periods of time. The steps involved in the computation of 3, 6, 9 and 12 monthly moving averages are given below for each period:

3 Monthly Moving Averages

Step 1: We enter the given data in an Excel Sheet and name it "**Moving Averages**" as depicted in Fig. 16.1.

	A	B	C
1	Year	Month	Quantity (in litre)
2	2008	1	288
3		2	316
4		3	414
5		4	540
6		5	558
7		6	586
8		7	558
9		8	548
10		9	540
11		10	565
12		11	465
13		12	396
14	2009	13	396
15		14	450
16		15	648
17		16	764
18		17	824
19		18	802
20		19	812

Moving Averages

Fig. 16.1

Step 2: The first 3 monthly moving average is the average of first 3 values which will be placed at the middle, i.e., against the 2nd month. So we choose Cell D3 to calculate the first 3 monthly moving average. In Cell D3, we type "=Average(C2:C4)" as shown in Fig. 16.2.

D3 =AVERAGE(C2:C4)

	A	B	C	D	E
1	Year	Month	Quantity (in litre)	3 Monthly Moving Averages	
2	2008	1	288		
3		2	316	339.333	
4		3	414		
5		4	540		
6		5	558		

DRAG IT DOWN

Fig. 16.2

Step 3: We drag down Cell D3 up to Cell D60 as shown in Fig. 16.3, since the last moving average corresponds to the 59th month.

	A	B	C	D	E
1	Year	Month	Quantity (in litre)	3 Monthly Moving Averages	
2	2008	1	288		
3		2	316	339.333	
4		3	414	423.333	
5		4	540	504.000	
6		5	558	561.333	
7		6	586	567.333	
8		7	558	564.000	
9		8	548	548.667	
10		9	540	551.000	
11		10	565	523.333	
12		11	465	475.333	
13		12	396	419.000	
14	2009	13	396	414.000	
15		14	450	498.000	
16		15	648	620.667	
17		16	764	745.333	
18		17	824	796.667	
19		18	802	812.667	
20		19	812	796.667	

Moving Averages

Fig. 16.3

If we consider 3 monthly moving averages, we need to leave the first cell corresponding to the first month for calculating the first moving average and we should also leave the last cell corresponding to the last month for calculating the last moving average.

6 Monthly Moving Averages

Step 4: As discussed in Sec. 13.7 of Unit 13 in MSTE-002, we proceed as follows for finding the moving average for even period of 6 months:

i) We find the average of the first 6 months, which is placed at 3.5th month and then compute the average of the next 6 months after discarding the first month, i.e., 2nd to 7th months, which is placed at 4.5th month. The process continues until all data are used.

ii) In the end, we compute the average of the first two averages obtained in (i), which corresponds to (3.5 + 4.5)/2 = 4th month.

In Excel, we can type "=(Average (C2:C7)+Average (C3:C8))/2" in Cell E5 to find the first 6 monthly centred moving average which corresponds to the 4th month as shown in Fig. 16.4.

E5   fx =(AVERAGE(C2:C7)+AVERAGE(C3:C8))/2

	B	C	D	E	F
1	Month	Quantity (in litre)	3 Monthly Moving Averages	6 Monthly Moving Averages (Centred)	
2	1	288			
3	2	316	339.333		
4	3	414	423.333		
5	4	540	504.000	472.833	
6	5	558	561.333		
7	6	586	567.333		
8	7	558	564.000		

DRAG IT DOWN

Fig. 16.4

Step 5: We now drag down Cell E5 up to Cell E58 (Fig. 16.5.), as the last moving average corresponds to the 57th month.

	B	C	D	E	F
1	Month	Quantity (in litre)	3 Monthly Moving Averages	6 Monthly Moving Averages (Centred)	
2	1	288			
3	2	316	339.333		
4	3	414	423.333		
5	4	540	504.000	472.833	
6	5	558	561.333	514.667	
7	6	586	567.333	544.500	
8	7	558	564.000	557.083	
9	8	548	548.667	551.417	
10	9	540	551.000	527.833	
11	10	565	523.333	498.500	
12	11	465	475.333	476.833	
13	12	396	419.000	477.667	
14	13	396	414.000	503.250	
15	14	450	498.000	549.750	
16	15	648	620.667	613.500	
17	16	764	745.333	682.000	
18	17	824	796.667	743.833	
19	18	802	812.667	780.917	
20	19	812	796.667	788.667	

Moving Averages

Fig. 16.5

9 Monthly Moving Averages

Step 6: Using the procedure explained in Steps 1-3, we compute the first 9 monthly moving average in Cell F6 by typing "=Average (C2:C10)" and dragging down Cell F6 up to Cell F57 as shown in Fig.16.6.

F6 =AVERAGE(C2:C10)

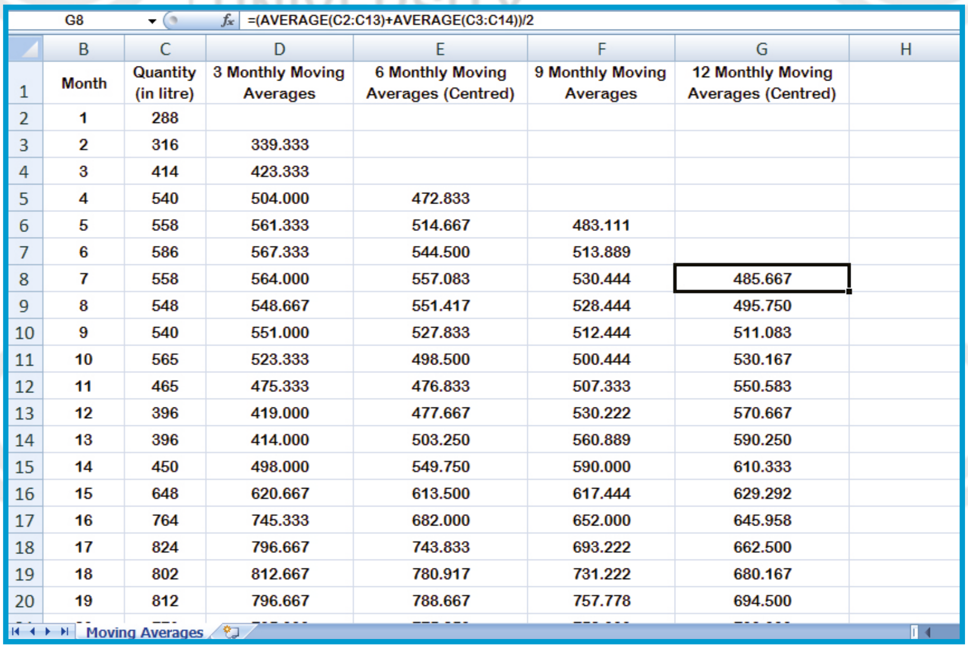
	B	C	D	E	F	G
1	Month	Quantity (in litre)	3 Monthly Moving Averages	6 Monthly Moving Averages (Centred)	9 Monthly Moving Averages	
2	1	288				
3	2	316	339.333			
4	3	414	423.333			
5	4	540	504.000	472.833		
6	5	558	561.333	514.667	483.111	
7	6	586	567.333	544.500	513.889	
8	7	558	564.000	557.083	530.444	
9	8	548	548.667	551.417	528.444	
10	9	540	551.000	527.833	512.444	
11	10	565	523.333	498.500	500.444	
12	11	465	475.333	476.833	507.333	
13	12	396	419.000	477.667	530.222	
14	13	396	414.000	503.250	560.889	
15	14	450	498.000	549.750	590.000	
16	15	648	620.667	613.500	617.444	
17	16	764	745.333	682.000	652.000	
18	17	824	796.667	743.833	693.222	
19	18	802	812.667	780.917	731.222	
20	19	812	796.667	788.667	757.778	

Moving Averages

Fig. 16.6

12 Monthly Moving Averages

Step 7: We compute the first 12 monthly average by typing "=(Average(C2:C13)+Average(C3:C14))/2" in Cell G8 and dragging it down up to Cell G55 as shown in Fig. 16.7.



G8 =(AVERAGE(C2:C13)+AVERAGE(C3:C14))/2

	B	C	D	E	F	G	H
1	Month	Quantity (in litre)	3 Monthly Moving Averages	6 Monthly Moving Averages (Centred)	9 Monthly Moving Averages	12 Monthly Moving Averages (Centred)	
2	1	288					
3	2	316	339.333				
4	3	414	423.333				
5	4	540	504.000	472.833			
6	5	558	561.333	514.667	483.111		
7	6	586	567.333	544.500	513.889		
8	7	558	564.000	557.083	530.444	485.667	
9	8	548	548.667	551.417	528.444	495.750	
10	9	540	551.000	527.833	512.444	511.083	
11	10	565	523.333	498.500	500.444	530.167	
12	11	465	475.333	476.833	507.333	550.583	
13	12	396	419.000	477.667	530.222	570.667	
14	13	396	414.000	503.250	560.889	590.250	
15	14	450	498.000	549.750	590.000	610.333	
16	15	648	620.667	613.500	617.444	629.292	
17	16	764	745.333	682.000	652.000	645.958	
18	17	824	796.667	743.833	693.222	662.500	
19	18	802	812.667	780.917	731.222	680.167	
20	19	812	796.667	788.667	757.778	694.500	

Moving Averages

Fig. 16.7

Step 8: We plot and format the graph of the 3, 6, 9 and 12 monthly moving averages computed in Columns D, E, F and G, respectively, and the data given in Column C against the corresponding months as explained in Sec. 15.3 of Lab Session 15. The resulting chart is shown in Fig. 16.8.

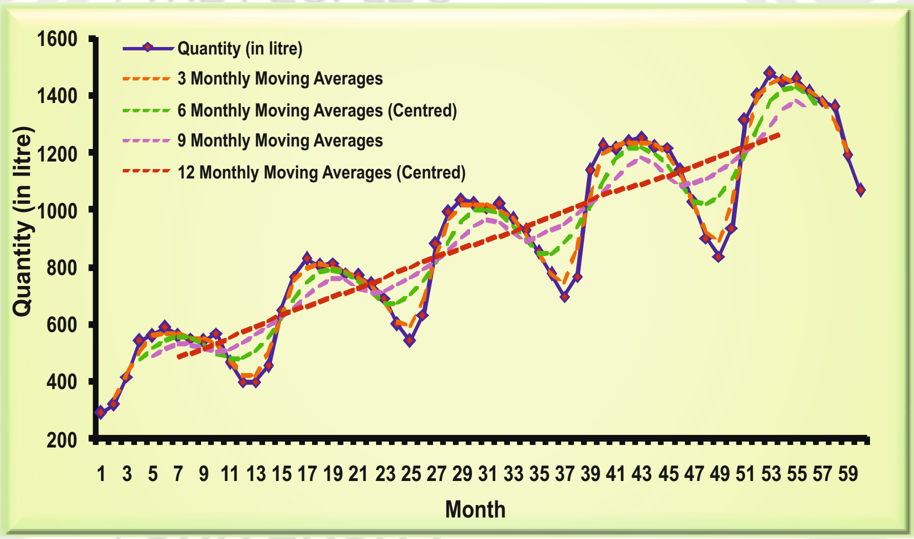


Fig. 16.8

From Fig. 16.8, we can notice the difference among the moving averages of the different periods along with the given data. Note that the fluctuations (crest and trough) are minimum when we consider 12 monthly moving average. The given data contained seasonal or irregular variation and we have eliminated these variations using the moving average method. Fig. 16.8 reveals that the smoothest curve is obtained for the 12 monthly moving average. So we can say that the period of the season is 12 months in the data given here. We can also study the long term trend after smoothing the data.

16.4 WEIGHTED (UNEQUAL) MOVING AVERAGE

As you have learnt in Sec. 13.5 of Unit 13 of MSTE-002, the simple moving average method described in Sec. 16.3 does not lie close to the latest values in the data. So we use weighted (unequal) moving averages method. In this method, we assign unequal weights to all values. The formulae and procedure involved in this method are given below:

Step 1: If w_i denotes the weight of the i^{th} observation, the moving average value y_t is given by

$$y_t = \sum_{i=-q}^{q} w_i x_{t+i} \qquad \ldots(1)$$

such that $w_i \geq 0, \ \sum_{i=-q}^{q} w_i = 1$

where x_t is the original series.

Simple moving average becomes a particular case of weighted moving average which is obtained by taking $m = 2q+1$ and

$$w_i = \frac{1}{(2q+1)}.$$

In Sec. 16.3, we have considered m =3.

$\Rightarrow m = 2q+1 = 3$

$\Rightarrow q = 1$

$\Rightarrow w_i = 1/(2q+1) = 1/3.$

Step 2: The procedure for getting the smooth trend values by the weighted moving average method is the same as that for the simple moving average in spite of weights. We calculate here the weighted average of the first m values given in time series as per equation (1).

Step 3: We now discard the first value and include the next one and take the average of the m values.

Step 4: We repeat this process until all values are exhausted. These steps produce a new time series of m period weighted moving averages.

Steps in Excel

In this lab session, we continue with the data given in Sec. 16.2 to help you learn how to compute the weighted moving averages of 3 and 9 months periods in Excel 2007. The steps are given below:

3 Monthly Weighted Moving Averages

Step 1: We enter the data given in Table 1 in Excel sheet and name it "**Weighted Moving Averages**" as shown in Fig. 16.9.

	A	B	C
1			
2	Year	Month	Quantity (in litre)
3	2008	1	288
4		2	316
5		3	414
6		4	540
7		5	558
8		6	586
9		7	558
10		8	548
11		9	540
12		10	565
13		11	465
14		12	396
15	2009	13	396
16		14	450
17		15	648
18		16	764
19		17	824
20		18	802

Exponential Smoothing

Fig. 16.9

Step 2: Since it is given that $w_1 = 0.2$, $w_2 = 0.3$ and $w_3 = 0.5$, we calculate the first weighted moving average of the first 3 values by typing "=0.2*C2+0.3*C3+0.5*C4" in Cell D3 as shown in Fig. 16.10.

D3 fx =0.2*C2+0.3*C3+0.5*C4

	A	B	C	D	E
1	Year	Month	Quantity (in litre)	3 Monthly Weighted Moving Averages	
2	2008	1	288		
3		2	316	359.400	
4		3	414		
5		4	540		
6		5	558	DRAG IT DOWN	

Fig. 16.10

Step 3: We drag down Cell D3 up to Cell D60 to get the remaining values of 3 monthly weighted moving averages as shown in Fig. 16.11.

	A	B	C	D	E
1	Year	Month	Quantity (in litre)	3 Monthly Weighted Moving Averages	
2	2008	1	288		
3		2	316	359.400	
4		3	414	457.400	
5		4	540	523.800	
6		5	558	568.400	
7		6	586	566.400	
8		7	558	558.600	
9		8	548	546.000	
10		9	540	554.100	
11		10	565	510.000	
12		11	465	450.500	
13		12	396	409.800	
14	2009	13	396	423.000	
15		14	450	538.200	
16		15	648	666.400	
17		16	764	770.800	
18		17	824	801.000	
19		18	802	811.400	
20		19	812	792.000	

Weighted Moving Averages

Fig. 16.11

Step 4: For 9 monthly moving averages, we are given $w_1 = 0.05$, $w_2 = 0.06$, $w_3 = 0.08$, $w_4 = 0.1$, $w_5 = 0.11$, $w_6 = 0.13$ $w_7 = 0.14$, $w_8 = 0.16$ and $w_9 = 0.17$. We now type "=0.05*C2+0.06*C3+0.08*C4+0.1*C5+0.11*C6+0.13* C7+0.14*C8+0.16*C9 +0.17*C10" in Cell E6 to get the first 9 monthly weighted moving average and drag it down up to Cell E57 to get the remaining moving averages as shown in Fig. 16.12.

E6 | f_x =0.05*C2+0.06*C3+0.08*C4+0.1*C5+0.11*C6+0.13*C7+0.14*C8+0.16*C9+0.17*C10

	C	D	E	F	G
1	Quantity (in litre)	3 Monthly Weighted Moving Averages	9 Monthly Weighted Moving Averages		
2	288				
3	316	359.400			
4	414	457.400			
5	540	523.800			
6	558	568.400	515.64		
7	586	566.400			
8	558	558.600			
9	548	546.000			

DRAG IT DOWN

	C	D	E	F	G
1	Quantity (in litre)	3 Monthly Weighted Moving Averages	9 Monthly Weighted Moving Averages		
2	288				
3	316	359.400			
4	414	457.400			
5	540	523.800			
6	558	568.400	515.64		
7	586	566.400	535.81		
8	558	558.600	534.01		
9	548	546.000	514.46		
10	540	554.100	491.13		
11	565	510.000	478.52		
12	465	450.500	500.71		
13	396	409.800	543.1		
14	396	423.000	592.8		
15	450	538.200	636.31		
16	648	666.400	676.01		
17	764	770.800	709.64		
18	824	801.000	738.17		
19	802	811.400	755.5		
20	812	792.000	757.15		

Weighted Moving Averages

Fig. 16.12

Step 5: In Columns F and G, we compute the 3 and 9 monthly simple moving averages shown in Fig. 16.13 following Steps 2, 3 and 6 under the heading 'Steps in Excel' of Sec.16.3.

	F	G
1	3 Monthly Moving Averages	9 Monthly Moving Averages
2		
3	339.333	
4	423.333	
5	504.000	
6	561.333	483.111
7	567.333	513.889
8	564.000	530.444
9	548.667	528.444
10	551.000	512.444
11	523.333	500.444
12	475.333	507.333
13	419.000	530.222
14	414.000	560.889
15	498.000	590.000
16	620.667	617.444
17	745.333	652.000
18	796.667	693.222
19	812.667	731.222
20	796.667	757.778

Weighted Moving Averages

Fig. 16.13

Step 6: We now plot the simple and weighted moving averages along with the original data as explained in Step 8 of Sec. 16.3. The resulting graphical representation is shown in Fig. 16.14.

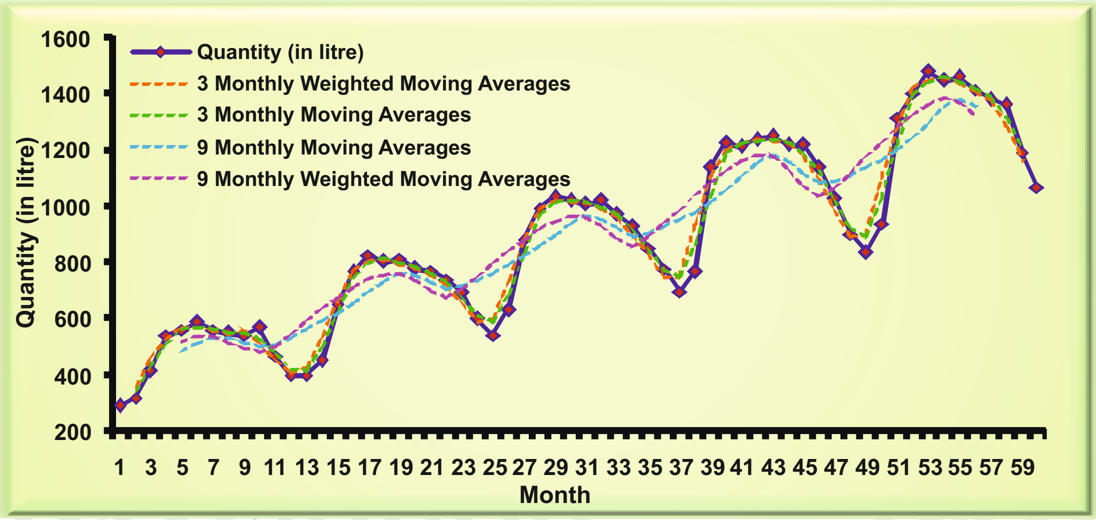


Fig. 16.14

Note from Fig. 16.14 that weighted moving averages (3 and 9 monthly) show the upward trend faster than the simple moving averages.

16.5 EXPONENTIAL SMOOTHING METHOD

This smoothing method is very popular. You have already learnt all formulae and procedure in Unit 13 of MSTE-002. We explain the main steps involved in this method to compute the exponentially smoothed time series as follows:

In this method, we assign weights in such a way that the latest observation gets the maximum weight and then the weights decrease exponentially. We select a single weight w, which is called the exponential smoothing constant.

Step 1: If $y_1, y_2, \ldots, y_t$ is a given time series, the smoothed value at time t is given by

$$y'_t = \sum_{j=0}^{t-2} w(1-w)^j y_{t-j} + (1-w)^{t-1} y_1 \qquad \ldots(2)$$

where $0<w<1$ and $\sum w_i = 1$. We choose the value of 'w' according to the requirement.

Step 2: We assume the first given value as the first smoothed value, i.e.,

$$y'_1 = y_1 \qquad \ldots(3)$$

Step 3: The second smoothed value is computed using the first smoothed value and the second value of the given time series from the following equation:

$$y'_2 = w\, y_2 + (1-w)\, y'_1 \qquad \ldots(4)$$

Step 4: The third smoothed value is computed using the second smoothed value and the third value of the given time series as follows:

$$y'_3 = w\, y_3 + (1-w)\, y'_2 \qquad \ldots(5)$$

Step 5: In the same way, the tth smoothed value can be computed as follows:

$$y'_t = w\,y_t + (1-w)\,y'_{t-1} \qquad \ldots(6)$$

Step 6: If the forecast for y_t is y'_t, we calculate the forecast error as

$$e_t = y_t - y'_t \qquad \ldots(7)$$

Steps in Excel

We consider the data given in Sec. 16.2 to filter the seasonal and irregular fluctuations using the exponential smoothing method. The following steps will make you familiar with the exponential smoothing method for different values of the weight (w):

Step 1: We enter the data given in Table 1 in an Excel sheet and name it "**Exponential Smoothing**" as shown in Fig. 16.15.

	A	B	C
1			
2	Year	Month	Quantity (in litre)
3	2008	1	288
4		2	316
5		3	414
6		4	540
7		5	558
8		6	586
9		7	558
10		8	548
11		9	540
12		10	565
13		11	465
14		12	396
15	2009	13	396
16		14	450
17		15	648
18		16	764
19		17	824
20		18	802

Exponential Smoothing

Fig. 16.15

Step 2: We calculate the exponentially smoothed values for w = 0.05. The first exponentially smoothed value will be the same as the original first value, i.e., $y'_1 = y_1$. So in Cell D3, we type "=C3" as shown in Fig. 16.16.

D3 f_x =C3

	A	B	C	D	E
1				Exponentially Smoothed Values (y_t')	
2	Year	Month	Quantity (in litre)	w = 0.05	
3	2008	1	288	288	
4		2	316		
5		3	414		
6		4	540		
7		5	558		

Fig. 16.16

Step 3: In Cell D4, we type "= (0.05 * C4) + ((1 – 0.05) * D3)" to get the second smoothed value as shown in Fig. 16.17.

D4 | f_x | =(0.05*$C4)+((1-0.05)*D3)

	A	B	C	D	E
1				Exponentially Smoothed Values (y_t')	
2	Year	Month	Quantity (in litre)	w = 0.05	
3	2008	1	288	288	
4		2	316	289.400	
5		3	414		
6		4	540		
7		5	558	DRAG IT DOWN	
8		6	586		
9		7	558		
10		8	548		
11		9	540		

Fig. 16.17

Step 4: We drag down Cell D4 up to Cell D62 to determine the remaining exponentially smoothed values for w = 0.05 as shown in Fig. 16.18.

	A	B	C	D	E
1				Exponentially Smoothed Values (y_t')	
2	Year	Month	Quantity (in litre)	w = 0.05	
3	2008	1	288	288	
4		2	316	289.400	
5		3	414	295.630	
6		4	540	307.849	
7		5	558	320.356	
8		6	586	333.638	
9		7	558	344.856	
10		8	548	355.014	
11		9	540	364.263	
12		10	565	374.300	
13		11	465	378.835	
14		12	396	379.693	
15	2009	13	396	380.508	
16		14	450	383.983	
17		15	648	397.184	
18		16	764	415.525	
19		17	824	435.948	
20		18	802	454.251	
21		19	812	472.138	
22		20	776	487.331	
23		21	767	501.315	
24		22	738	513.149	
25		23	689	521.942	

Exponential Smoothing

Fig. 16.18

The choice of w is very important. If we want to eliminate seasonal and irregular fluctuations, we choose a small value (close to zero) of w.

But if our aim is to forecast, we choose a large value of w (close to 1).

Step 5: We follow the procedure explained in Steps 2 to 4 and compute the exponentially smoothed values for other values of weight (w), i.e., 0.1, 0.25 and 0.5 as shown in Fig. 16.19.

The difference between original data given in Column C and exponentially smoothed values given in column D, E, F and G give the forecast errors for the weights 0.05, 0.1, 0.25 and 0.5, respectively.

	B	C	D	E	F	G
1			Exponentially Smoothed Values (y_t')			
2	Month	Quantity (in litre)	w = 0.05	w = 0.1	w = 0.25	w = 0.5
3	1	288	288	288	288	288
4	2	316	289.400	290.800	295.000	302.000
5	3	414	295.630	303.120	324.750	358.000
6	4	540	307.849	326.808	378.563	449.000
7	5	558	320.356	349.927	423.422	503.500
8	6	586	333.638	373.534	464.066	544.750
9	7	558	344.856	391.981	487.550	551.375
10	8	548	355.014	407.583	502.662	549.688
11	9	540	364.263	420.825	511.997	544.844
12	10	565	374.300	435.242	525.248	554.922
13	11	465	378.835	438.218	510.186	509.961
14	12	396	379.693	433.996	481.639	452.980
15	13	396	380.508	430.197	460.229	424.490
16	14	450	383.983	432.177	457.672	437.245
17	15	648	397.184	453.759	505.254	542.623
18	16	764	415.525	484.783	569.941	653.311
19	17	824	435.948	518.705	633.455	738.656
20	18	802	454.251	547.034	675.592	770.328

Exponential Smoothing

Fig. 16.19

Step 6: To compare the original series and the exponentially smoothed values obtained for different values of w given in Cells C3:G62, we plot them as shown in Fig. 16.20.

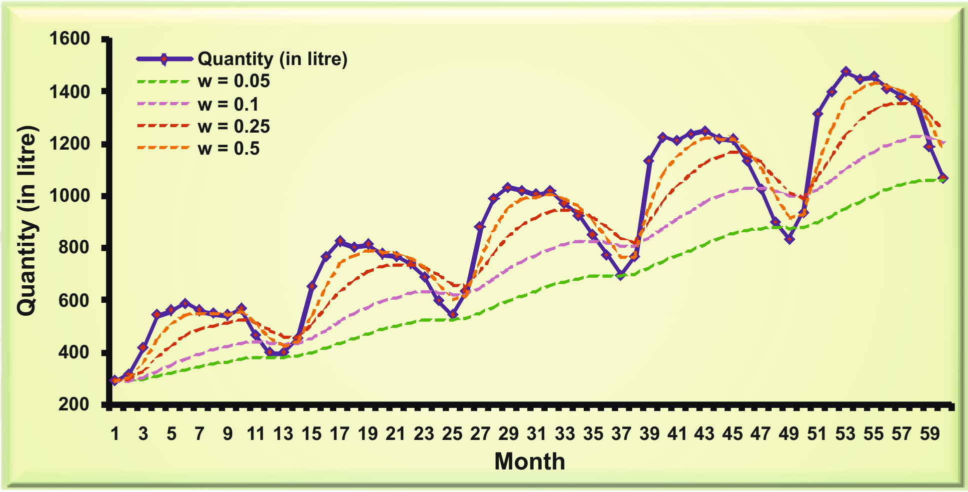


Fig. 16.20

Note that we get a smooth curve which changes slowly for small values of w and as we increase the value of w, the exponentially smoothed values come closer to the original values (Fig. 16.20).

You can now solve the following exercises to check whether you have learnt how to filter the seasonal and irregular fluctuations from the given data.

Activity

Filter the seasonal and irregular fluctuation with the help of MS Excel 2007 and interpret the results for

A1) Examples 1, 2 and 3 given in Unit 13 of MSTE-002.

A2) Exercises E1, E2 and E3 given in Unit 13 of MSTE-002.

Match the results with the calculation done in Unit 13 of MSTE-002.

Continuous Assessment 16

Suppose a company wants to start a sugar manufacturing unit. We know that the production of sugar depends on the yield of sugarcane. Hypothetical data for annual sugarcane yield for a state for 50 years from 1963 to 2012 are given in Table 2.

Table 2: Annual yield of sugarcane

Year	Yield (in hectares)	Year	Yield (in hectares)	Year	Yield (in hectares)
1	224	18	1060	35	1357
2	252	19	1046	36	1332
3	350	20	1073	37	1386
4	514	21	1084	38	1584
5	505	22	870	39	1763
6	533	23	823	40	1684
7	357	24	1123	41	1782
8	332	25	1234	42	1748
9	386	26	1311	43	1663
10	584	27	1243	44	1701
11	763	28	1292	45	1970
12	684	29	1170	46	2044
13	738	30	1134	47	1983
14	748	31	1350	48	2015
15	663	32	1514	49	1924
16	701	33	1505	50	1873

For the data given in Table 2,

- Compute the 3, 4 and 7 yearly moving averages. Plot the results along with the yield of sugarcane given in Table 2.
- Compute the weighted moving averages for a period of 3 years for the weights 0.2, 0.3 and 0.5. Plot the results on the chart.
- Compute the weighted moving averages for a period of 7 years for the weights 0.07, 0.09, 0.12. 0.14, 0.17, 0.19, and 0.22. Plot the results on the chart.
- Use the smoothing coefficients of 0.25, 0.1, 0.5 and 0.6 to compute the exponentially smoothed series. Plot the results on the chart.

Home Work: Do It Yourself

1) Follow the steps explained in Sec. 16.3 to 16.5 to filter the time series data given in Table 1. Use a different format for plotting the given data along with the smoothed time series values. Take the screenshots and keep them in your record book.
2) Develop the spreadsheets for the exercise given in "Continuous Assessment 16" as explained in this lab session. Take screenshots of the final spreadsheets and the charts.
3) **Do not forget** to keep the screenshots in your record book as these will contribute to your continuous assessment in the Laboratory.