Practice

TUTORIAL 1: DEMAND FORECASTING

1) An electrical contractor's records during the last five weeks indicate the following number of job requests:

Week:	**1**	**2**	**3**	**4**	**5**
Requests:	20	22	18	21	22

Predict the number of requests for week 6 using each of these methods:

a) Naïve
b) Four-week moving average
c) Exponential smoothing with $\alpha = 0.3$.

a) 22

b) $\frac{22+18+21+22}{4} = 20.75$

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

$F_1 = 20$

$F_2 = 20 + 0.3(20 - 20) = 20$

$F_3 = 20 + 0.3(22 - 20) = 20.6$

$F_4 = 20.6 + 0.3(18 - 20.6) = 19.82$

$F_5 = 19.82 + 0.3(21 - 19.82) = 20.17$

$F_6 = 20.17 + 0.3(22 - 20.17) = 20.72$

Practice

2. A manager has just received an evaluation from an analyst on two potential forecasting methods. The analyst is indifferent between the two methods, saying that they should be equally accurate and in control. The demand and the forecasts using the two methods for nine periods follow:

Period:	1	2	3	4	5	6	7	8	9
Demand:	37	39	37	39	45	49	47	49	51
Method 1:	36	38	40	42	46	46	46	48	52
Method 2:	36	37	38	38	41	52	47	48	52

i. Calculate the MSE, MAD, and MAPE for each method. Does one method seem superior? Explain.
ii. Do all three measures of method errors provide the same conclusion (i.e. are they consistent) in this scenario? Do you expect consistent results in every case? Explain.
iii. In practice, either MAD, MSE, or MAPE would be employed to compute a measure of forecast errors. What factors might lead a manager to favour one?
iv. Calculate 2s control limits and construct a 2s control chart for each method and interpret them. Do you agree with the analyst?

i. $MSE = \frac{\sum(A_i - F_i)^2}{n}, MAD = \frac{\sum|e|}{n}, MAPE = \frac{\sum\left[\frac{|A_i - F_i|}{A_i} \times 100\right]}{n}$

Method	MSE	MAD	MAPE
1	3.7	1.7	4.0
2	3.8	16	3.6

Both methods have similar $MSE, MAD, MAPE$, so neither is superior.

ii. In this case, all calculations are similar, but may not be the same in other cases.

iii. MSE is more sensitive to large forecast errors, MAD is easy to calculate, $MAPE$ is easy to understand.

iv. $s_1 = \sqrt{MSE_1} = \sqrt{3.7} = 1.92, s_2 = \sqrt{MSE_2} = \sqrt{3.78} = 1.95$

Method 1: $2s$ control limits: $0 \pm 2s_1 = 0 \pm 2(1.92) \Rightarrow 0 \pm 3.8$

Method 1: $2s$ control limits: $0 \pm 2s_2 = 0 \pm 2(1.95) \Rightarrow 0 \pm 3.9$

Similar $2s$ control limits, however some errors outside limits.

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Practice

3) Develop a linear trend equation for the following data on demand for white bread loaves at a bakery (using Excel is recommended).

a) Use the linear trend equation to forecast demand on days 16.

Day	Loafs
1	200
2	214
3	211
4	228
5	235
6	232
7	248
8	250
9	253
10	267
11	281
12	275
13	280
14	288
15	310

b) **The variations around the linear trend line seem to have above and below the line runs.** Therefore, use trend-adjusted exponential smoothing with and to model the bread demand. Use the first four days to estimate the initial smoothed series (use the average of the first four days) and smoothed trend (use the increase from day 1 to day 4 divided by 3). Start forecasting day 5. What is the forecast for day 16?

$\alpha = 0.3, \beta = 0.2$

a) Equation of the trend: $y = 7x + 195.47$

$D_{16} = 7(16) + 195.47 \Rightarrow D_{16} = 307.47$

b) $S_t = TAF_t + \alpha(A_t - TAF_t)$

$T_t = T_{t-1} + \beta(S_t - S_{t-1} - T_{t-1})$

$TAF_{t+1} = S_t + T_t$

$$T_4 = \frac{228 - 200}{3} = 9.33, S_4 = \frac{200 + 214 + 211 + 228}{4} = 213.25$$

Use above equations each time to get $TAF_{16} = S_{15} + T_{15} = 303.53 + 7.64 = 311.17$.

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Practice

4) A gift shop in a tourist centre is open only on weekends (Friday, Saturday, and Sunday). The owner-manager hopes to improve scheduling of part-time employees by determining seasonal relatives for each of these days. Data on recent activity at the store (sales transactions per day) are shown in the following table:

	Week					
	1	2	3	4	5	6
Friday	149	154	152	150	159	163
Saturday	250	255	260	268	273	276
Sunday	166	162	171	173	176	183

a) Develop seasonal relatives for each day using the centered moving average method.

b) Deseasonalize the data, fit an appropriate model to the deseasonalized data, project three days ahead, and reseasonalize the projections to forecast the sales transactions for each day, Friday to Sunday, of next week.

a) Seasonal relatives are shown as the values in the *adjusted* row:

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a

Week	Day	Sales	CMA_3	$Sales/CMA_3$
1	Fri	149		
	Sat	250	188.3	1.327
	Sun	166	190.0	0.874
2	Fri	154	191.7	0.803
	Sat	255	190.3	1.340
	Sun	162	189.7	0.854
3	Fri	152	191.3	0.794
	Sat	260	194.3	1.338
	Sun	171	193.7	0.883
4	Fri	150	196.3	0.764
	Sat	268	197.0	1.360
	Sun	173	200.0	0.865
5	Fri	159	201.7	0.788
	Sat	273	202.7	1.347
	Sun	176	204.0	0.863
6	Fri	163	205.0	0.795
	Sat	276	207.3	1.331
	Sun	183		

	Fri	Sat	Sun	
Week 1		1.327	0.874	
Week 2	0.803	1.340	0.854	
Week 3	0.794	1.338	0.883	
Week 4	0.764	1.360	0.865	
Week 5	0.788	1.347	0.863	
Week 6	0.795	1.331		sum ΣAvg_s
avg	0.789	1.341	0.868	2.997
adjusted	0.790	1.342	0.868	3.000

$CMA_3 \rightarrow$ no. of seasons Fri, Sat, Sun

$250/188.3 = 1.327$

$276/207.3 = 1.331$

Next step: calculate avg. of Sales/CMA_3 for each season

$$\text{Adjusted SR} = Avg_s \times \frac{\text{No. of seasons}}{\Sigma Avg} = .789 \times \frac{3}{2.997} = 0.790$$

Adjusted SRs

SR

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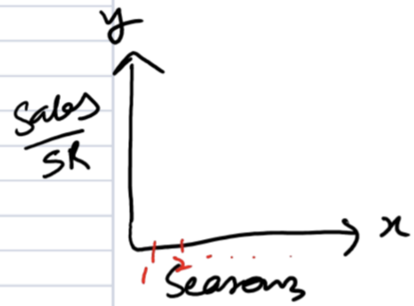
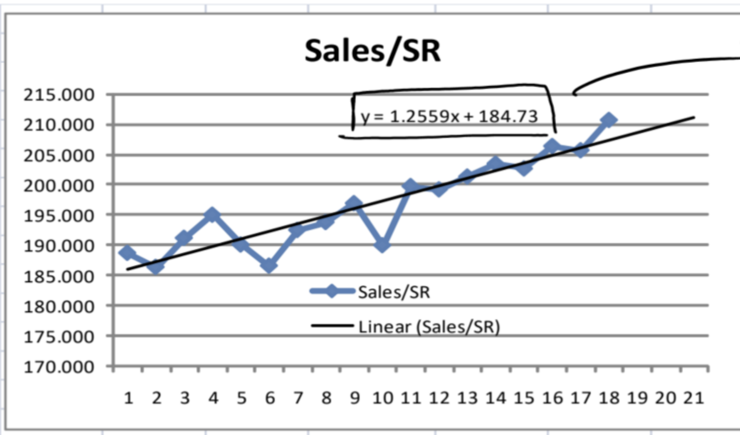
b) Deseasonalized data is shown as the values in the $Sales/SR$ column:

Deseasonalizing = $\frac{\text{Sales}}{\text{SR}}$

b						
Week	Day		Sales	SR	Sales/SR
1	Fri	1	149	0.790	188.662
	Sat	2	250	1.342	186.320
	Sun	3	166	0.868	191.145
2	Fri	4	154	0.790	194.993
	Sat	5	255	1.342	190.047
	Sun		162	0.868	186.539
3	Fri		152	0.790	192.461
	Sat		260	1.342	193.773
	Sun		171	0.868	196.902
4	Fri		150	0.790	189.928
	Sat		268	1.342	199.735
	Sun		173	0.868	199.205
5	Fri		159	0.790	201.324
	Sat		273	1.342	203.462
	Sun		176	0.868	202.660
6	Fri		163	0.790	206.389
	Sat		276	1.342	205.697
	Sun		183	0.868	210.720



The model, projection, and reseasonalized data is shown below:



$x = 19$

$y = 1.2559(19) + 184.73$

$= 208.592$

Final Step:

* Reseasonalize the trend forecasted values from model.

* Reseasonalizing = TF value × SR

$= 208.592 \times 0.790$

$= 164.740$

			Trend fcst	forecast
7	Fri	19	208.592	164.740
	Sat	20	209.848	281.569
	Sun	21	211.104	183.333

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Practice

TUTORIAL 2: CAPACITY PLANNING AND FACILITY LAYOUT

1. Determine the utilization and the efficiency for each of these situations:

   a. A loan processing operation that processes an average of 7 loans per day. The operation has a design capacity of 10 loans per day and an effective capacity of 8 loans per day.

   b. A furnace repair team that services an average of four furnaces a day if the design capacity is six furnaces a day and the effective capacity is five furnaces a day.

   c. Would you say that systems that have higher efficiency ratios than other systems will always have higher utilization ratios than those other systems? Explain.

a. $actual\ output = 7, design\ capacity = 10, effective\ capacity = 8$

$$utilization = \frac{actual\ output}{design\ capacity} = \frac{7}{10} = 70\%$$

$$efficiency = \frac{actual\ output}{effective\ capacity} = \frac{7}{8} = 87.5\%$$

b. $actual\ output = 4, design\ capacity = 6, effective\ capacity = 5$

$$utilization = \frac{actual\ output}{design\ capacity} = \frac{4}{6} = 66\%$$

$$efficiency = \frac{actual\ output}{effective\ capacity} = \frac{4}{5} = 80\%$$

c. No because utilization depends on design capacity while efficiency depends on effective capacity.

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Practice

2. Corner Tavern is a small-town bar that sells only bottled beer. The average price of a bottle of beer at the tavern is $3.00 and the average cost of bottle of beer to the tavern is $1.00. The tavern is open every night. One bartender and two to three waitresses are on duty each night. The fixed costs (salaries, rent, tax, utilities, etc.) total $260,000 per year.

   a. The owner wishes to know how many bottles of beer the tavern must sell during the year to start making profit.
   b. What is the revenue at the break-even quantity found in part a.
   c. The owner thinks $50,000 is a reasonable annual profit. How many bottles of beer should the tavern sell to make $50,000 profit?
   d. An available option is to open the tavern earlier on the weekends. The attraction would be discount of $0.50 off the regular price. The extra salaries of waitresses and bartender for the whole year are estimated to be $30,000. How many extra bottles of beer must the tavern sell in order to break-even in this option?

a. $average\ price = \$3.00, average\ cost = \$1.00, fixed\ cost = \$260{,}000$

$$Q_{BEP} = \frac{FC}{R - v} = \frac{260{,}000}{3 - 1} = 130{,}000\ bottles$$

b. $TR_{BEP} = Q_{BEP} \cdot R = 130{,}000 \cdot 3 = \$390{,}000$

c. $Q = \frac{P+FC}{R-v} = \frac{50{,}000+260{,}000}{3-1} = 155{,}000\ bottles$

d. $Q'_{BEP} = \frac{FC'}{R'-v} = \frac{30{,}000}{2.5-1} = 20{,}000\ bottles$

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Practice

3. A producer of pottery is considering the addition of a new plant to absorb the backlog of demand that now exists. The primary location being considered will have fixed costs of $9,200 per month and variable costs of 70 cents per unit produced. Each item is sold to retailers at a price that averages 90 cents.
    a. What volume per month is required in order to break even?
    b. What profit would be realized on a monthly volume of 61,000 units? 87,000 units?
    c. What volume is needed to obtain a profit of $16,000 per month?
    d. What volume is needed to provide a revenue of $23,000 per month?
        e. Plot the total cost and total revenue lines.

a. $FC = \$9{,}200, v = 70\ cents \rightarrow \$0.7, R = 90\ cents = \$0.9$

$$Q_{BEP} = \frac{FC}{R - v} = \frac{9{,}200}{0.9 - 0.7} = 46{,}000\ units$$

b. $P = Q(R - v) - FC$

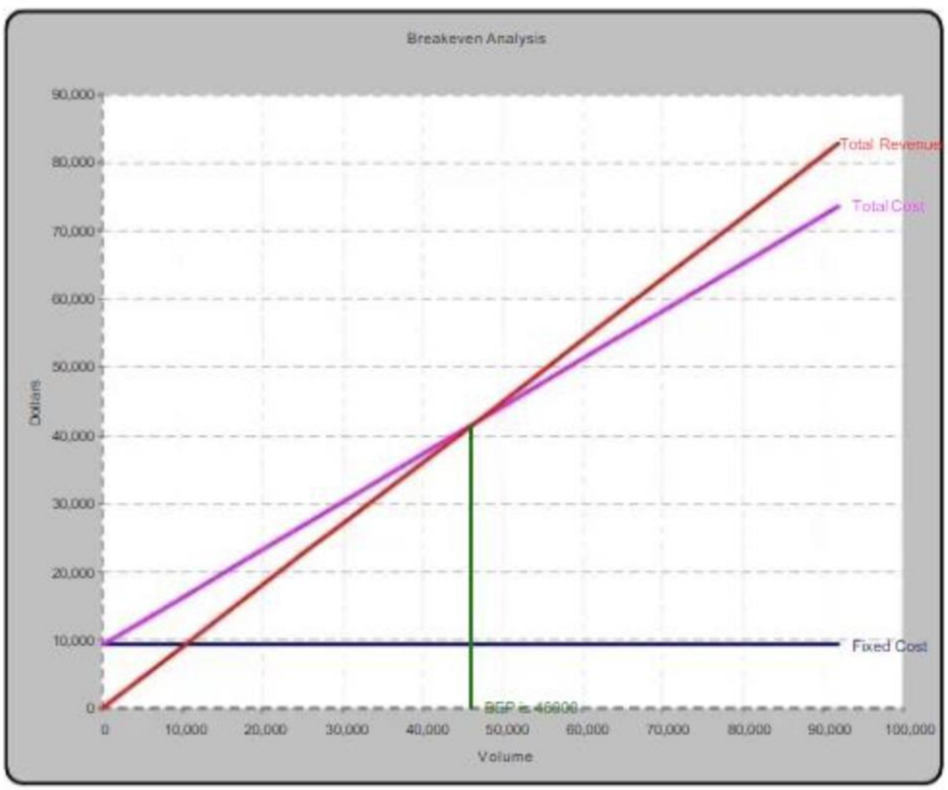
$$P_1 = 61{,}000(0.9 - 0.7) - 9{,}200 = \$3{,}000$$

$$P_2 = 87{,}000(0.9 - 0.7) - 9{,}200 = \$8{,}200$$

c. $Q = \frac{P+FC}{R-v} = \frac{16{,}000+9{,}200}{0.9-0.7} = 126{,}000\ units$

d. $Q = \frac{P+FC}{R-v} = \frac{23{,}000+9{,}200}{0.9-0.7} = 161{,}000\ units$

e. Plot of $total\ cost\ (TC) = 0.7Q + 10{,}000$ and $total\ revenue\ (TR) = 0.9Q$ lines:



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