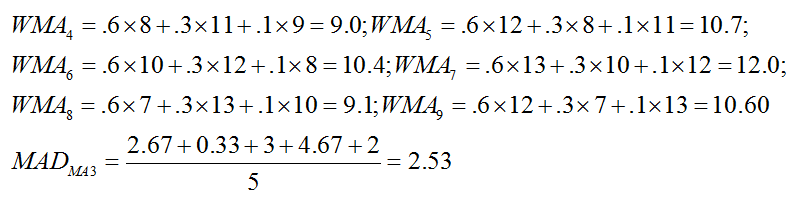
Solutions Manual

# Chapter 13: Demand Forecasting Methods

1abc.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Week* | *Auto Demand* | *MA3* | *ADMA3* | *WMA* | *ADWMA* |
| 1 | 9 |  |  |  |  |
| 2 | 11 |  |  |  |  |
| 3 | 8 |  |  |  |  |
| 4 | 12 | 9.333 | 2.67 | 9.00 | 3 |
| 5 | 10 | 10.333 | 0.33 | 10.70 | 0.7 |
| 6 | 13 | 10.000 | 3.00 | 10.40 | 2.6 |
| 7 | 7 | 11.667 | 4.67 | 12.00 | 5 |
| 8 | 12 | 10.000 | 2.00 | 9.10 | 2.9 |
| 9 |  | 10.667 |  | 10.60 |  |





MADwma = (3 + 0.7 + 2.6 + 5 +2.9)/5 = 2.84

The moving average of three periods is more accurate based on the MAD calculation.

1d. The naïve forecast for Week 9 is the actual demand for Week 8, which is 12.

Cognitive Domain: Knowledge Difficulty Level: Easy

2ac.

|  |  |  |  |
| --- | --- | --- | --- |
| *Month* | *Average Fund Price ($)* | *MA5* | *ADMA5* |
| 1 | 55.10 |  |  |
| 2 | 53.8 |  |  |
| 3 | 53.4 |  |  |
| 4 | 52.95 |  |  |
| 5 | 52.15 |  |  |
| 6 | 52.75 | $53.48 | 0.73 |
| 7 | 52.65 | $53.01 | 0.36 |
| 8 | 51.5 | $52.78 | 1.28 |
| 9 | 52.25 | $52.40 | 0.15 |
| 10 | 51.7 | $52.26 | 0.56 |
| 11 |  | $52.17 |  |

2bc.

|  |  |  |  |
| --- | --- | --- | --- |
| *Month* | *Average Fund Price ($)* | *Expon.3* | *ADExpon.3* |
| 1 | 55.10 |  |  |
| 2 | 53.8 |  |  |
| 3 | 53.4 |  |  |
| 4 | 52.95 |  |  |
| 5 | 52.15 |  |  |
| 6 | 52.75 | $52.15 | 0.6 |
| 7 | 52.65 | $52.33 | 0.32 |
| 8 | 51.5 | $52.43 | 0.926 |
| 9 | 52.25 | $52.15 | 0.1018 |
| 10 | 51.7 | $52.18 | 0.47874 |
| 11 |  | $52.04 |  |





Exponential smoothing has the lower MAD and is therefore more accurate.

Cognitive Domain: Knowledge

Difficulty Level: Easy

3abc.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Month* | *March* | *April* | *May* | *June* |
| Battery sales | 17 | 28 | 32 | 26 |
| Expon .2 | -.2(23)+0.8(18) = 19 | .2(17)+0.8(19) = 18.6 | -0.2(28)+0.8(18.6) = 20.48 | -0.2(32)+0.8(20.48) = 22.78 |
| AD Expon.2 | |17-19| = 2 | |28-18.6| = 9.4 | |32-20.48| = 11.52 | |26-22.78| = 3.22 |
| Expon .4 | 0.4(23)+0.6(18) = 20 | 0.4(17)+0.6(20) = 18.8 | 0.4(28)+0.6(18.8) = 22.48 | 0.4(32)+0.6(22.48) = 26.29 |
| AD Expon.4 | |17-20| = 3 | |28-18.8| = 9.2 | |32-22.48| = 9.52 | |26-26.29| = .29 |

MAD exp 0.2 = (2 + 9.4 + 11.52 + 3.22)/4 = 6.53

MAD exp 0.4 = (3 + 9.2 + 9.52 + 0.29)/4 = 5.50

The α=.4 is more accurate.

Cognitive Domain: Knowledge

Difficulty Level: Easy

4abc.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Week* | *Patient Admissions* | *WMA* | *Expon.2* | *SEWMA* | *SEExpon* |
| 1 | 120 |  |  |  |  |
| 2 | 145 |  |  |  |  |
| 3 | 95 |  |  |  |  |
| 4 | 112 | 115 | 95 | 9 | 289 |
| 5 | 130 | 113.5 | 98.4 | 272.25 | 998.56 |
| 6 | 110 | 117.6 | 104.72 | 57.76 | 27.88 |
| 7 | 200 | 116.4 | 105.776 | 268.96 | 33.36 |
| 8 | 140 | 109 | 104.6208 | 961 | 1251.69 |
| 9 |  | 122 | 111.6966 |  |  |



The weighted moving average approach is more accurate.

Cognitive Domain: Knowledge

Difficulty Level: Easy

5ab.

|  |  |  |
| --- | --- | --- |
| *Month* | *Rate* | *Expon.4* |
| 1 | 65 |  |
| 2 | 68 | 65 |
| 3 | 72 | 66.2 |
| 4 | 75 | 68.5 |
| 5 | 78 | 71.1 |
| 6 | 83 | 73.9 |
| 7 | 92 | 77.5 |
| 8 | 88 | 83.3 |
| 9 | 76 | 85.2 |
| 10 | 65 | 81.5 |
| 11 | 64 | 74.9 |
| 12 | 69 | 70.5 |
| 1 |  | 69.9 |

5c.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Month* | *Rate* | *Expon* | *Bias* | *SE* |
| 3 | 72 | 66.2 | 72-66.2=5.8 | (72-66.2)2 |
| 4 | 75 | 68.5 | 75-68.5=6.5 | (75-68.5) 2 |
| 5 | 78 | 71.1 | 78-71.1=6.9 | (78-71.1) 2 |
| 6 | 83 | 73.9 | 83-73.9=9.1 | (83-73.9) 2 |
| 7 | 92 | 77.5 | 92-77.5=14.5 | (92-77.5) 2 |
| 8 | 88 | 83.3 | 88-83.3=4.7 | (88-83.3) 2 |
| 9 | 76 | 85.2 | 76-85.2=-9.2 | (76-85.2) 2 |
| 10 | 65 | 81.5 | 65-81.5=-16.5 | (65-81.5) 2 |
| 11 | 64 | 74.9 | 64-74.9=-10.9 | (64-74.9) 2 |
| 12 | 69 | 70.5 | 69-70.5=-1.5 | (69-70.5) 2 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Month* | *Rate* | *Unadj* | *Trend* | *Trend-Adj* | *SE* | *Bias* |
| 3 | 72 | 68.00 | 0.00 | 68.00 | 16.00 | 4.00 |
| 4 | 75 | 69.60 | 0.32 | 69.92 | 25.81 | 5.08 |
| 5 | 78 | 71.76 | 0.69 | 72.45 | 30.82 | 5.55 |
| 6 | 83 | 74.26 | 1.05 | 75.31 | 59.20 | 7.69 |
| 7 | 92 | 77.75 | 1.54 | 79.29 | 161.47 | 12.71 |
| 8 | 88 | 83.45 | 2.37 | 85.82 | 4.74 | 2.18 |
| 9 | 76 | 85.27 | 2.26 | 87.53 | 132.99 | -11.53 |
| 10 | 65 | 81.56 | 1.07 | 82.63 | 310.80 | -17.63 |
| 11 | 64 | 74.94 | -0.47 | 74.47 | 109.54 | -10.47 |
| 12 | 69 | 70.56 | -1.25 | 69.31 | 0.10 | -0.31 |

The MSE for the exponential smoothing approach is 91.65, and for the trend adjusted, exponential smoothing is 85.15. The bias for the exponential smoothing approach is .93, and for the trend adjusted, exponential smoothing is -0.27. The trend adjusted exponential smoothing method is more accurate.

Cognitive Domain: Knowledge

Difficulty Level: Easy

6.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Week* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| Number of guests | 194 | 220 | 232 | 248 | 256 | 270 | 274 | 290 |  |
| Ft+1 |  | 220 | 220 | 226 | 237 | 246.5 | 258.25 | 266.125 | 278.06 |
| Tt+1 |  | 0 | 0 | 1.8 | 4.56 | 6.042 | 7.7544 | 7.79058 | 9.03 |
| Trend adjusted |  | 220 | 220 | 227.8 | 241.56 | 252.542 | 266.004 | 273.916 | 287.10 |

The number of guests for January 2015 is 287.

Cognitive Domain: Knowledge

Difficulty Level: Easy

7a. The slope of the line provides the monthly change in the sales level—in this case, 27.

7b. F9 = 220 + 27 x 9 = 463

Cognitive Domain: Knowledge

Difficulty Level: Easy

8a.

The data appear to have a linear trend.

8b.



F11 = 871.93 + 33.83 \* 11 = 1,244.07

F12 = 871.93 + 33.83 \* 12 = 1,277.9

F13 = 871.93 + 33.83 \* 13 = 1,311.73

F14 = 871.93 + 33.83 \* 14 = 1,345.56

Cognitive Domain: Knowledge

Difficulty Level: Easy

9a.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Mon* | *New Checking Accounts* | α=0.4 | β=0.5 | *Trend Adj Smoothing* |
| 1 | 120 | ***F***t | ***T***t |
| 2 | 144 | 120 | 0 | 120 |
| 3 | 178 | 0.4(144)+0.6(120)=129.6 | 0.5(129.6-120)+0.5(0)=4.8 | 134.40 |
| 4 | 228 | 0.4(178)+0.6(129.6)=148.9 | 0.5(148.9-129.6)+0.5(4.8)=12.08 | 161.04 |
| 5 | 245 | 180.58 | 21.85 | 202.42 |
| 6 | 252 | 206.35 | 23.81 | 230.15 |
| 7 | 255 | 224.61 | 21.04 | 245.64 |
| 8 | 262 | 236.76 | 16.60 | 253.36 |
| 9 | 277 | 246.86 | 13.35 | 260.20 |
| 10 | 282 | 258.92 | 12.70 | 271.62 |
| 11 | 290 | 268.15 | 10.97 | 279.12 |
| 12 | 295 | 276.89 | 9.85 | 286.74 |
| 13 |  | 284.13 | 8.55 | 292.68 |

9b.



|  |  |  |
| --- | --- | --- |
| *Month* | *New Checking Accounts* | *Linear Trend* |
| 1 | 120 |
| 2 | 144 | 138.71+14.91(2)=168.54 |
| 3 | 178 | 138.71+14.91(3)=183.46 |
| 4 | 228 | 198.38 |
| 5 | 245 | 213.29 |
| 6 | 252 | 228.21 |
| 7 | 255 | 243.12 |
| 8 | 262 | 258.04 |
| 9 | 277 | 272.96 |
| 10 | 282 | 287.87 |
| 11 | 290 | 302.79 |
| 12 | 295 | 317.71 |
| 13 |  | 332.62 |

9c.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Month* | *New Cking Accts* | *Trend Adj Smoothing* | *APETAES* | *Linear Trend* | *APETrend* |
| 1 | 120 |
| 2 | 144 | 120 | |144-120|/120=0.17 | 168.54 | |144-168.5|/144=0.17 |
| 3 | 178 | 134.40 | |178-134.4|/178=0.24 | 183.46 | |178-183.5|/178=0.03 |
| 4 | 228 | 161.04 | 0.29 | 198.38 | 0.13 |
| 5 | 245 | 202.42 | 0.17 | 213.29 | 0.13 |
| 6 | 252 | 230.15 | 0.09 | 228.21 | 0.09 |
| 7 | 255 | 245.64 | 0.04 | 243.12 | 0.05 |
| 8 | 262 | 253.36 | 0.03 | 258.04 | 0.02 |
| 9 | 277 | 260.20 | 0.06 | 272.96 | 0.01 |
| 10 | 282 | 271.62 | 0.04 | 287.87 | 0.02 |
| 11 | 290 | 279.12 | 0.04 | 302.79 | 0.04 |
| 12 | 295 | 286.74 | 0.03 | 317.71 | 0.08 |
| 13 |  | 292.68 | MAPEAdjExpSmooth=11% | 332.62 | MAPETrend7% |

The trend line approach has the lower MAPE—7% versus 11%—and is therefore more accurate.

Cognitive Domain: Knowledge

Difficulty Level: Easy

10a.



10b. F15 = 128.71 + 36.8(15) = 680.72; F16 = 128.71 + 36.8(16) = 717.52

10c. 600 = 128.71 + 36.8(x) 🡪x = (600 – 128.71)/36.8 = 12.8. The port needs to place that order now because when the 13th month rolls around, they should exceed 600 containers.

Cognitive Domain: Knowledge

Difficulty Level: Easy

11a. Simple average

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Day* | *WEEK* | | | |  |  |
| *1* | *2* | *3* | *4* | *Average* | *Indices* |
| Monday | 110 | 105 | 109 | 112 | (110 + 105 + 109 + 112)/4 = 109 | 0.79 |
| Tuesday | 95 | 100 | 92 | 88 | (95 + 100 + 92 + 88)/4 = 93.75 | 0.68 |
| Wednesday | 89 | 85 | 80 | 84 | 84.5 | 0.62 |
| Thursday | 93 | 96 | 78 | 90 | 89.25 | 0.65 |
| Friday | 150 | 155 | 152 | 148 | 151.25 | 1.10 |
| Saturday | 255 | 260 | 268 | 275 | 264.5 | 1.93 |
| Sunday | 160 | 166 | 170 | 175 | 167.75 | 1.22 |

Overall average of all entries in the table is 137.14.

11b. Centered moving average

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Day* | *Time* | *MA-7* | *Centered MA* | *Ratio* | *Unadj SI* | *Adj SI* | *Day* | *Unadj SI* | *Adj SI* |
| Mon | 110 |  |  |  | 0.80 | 0.80 | Mon | 0.80 | 0.80 |
| Tue | 95 |  |  |  | 0.69 | 0.69 | Tue | 0.69 | 0.69 |
| Wed | 89 |  |  |  | 0.61 | 0.61 | Wed | 0.61 | 0.61 |
| Thu | 93 |  | 136.0 | 0.68 | 0.65 | 0.65 | Thu | 0.65 | 0.65 |
| Fri | 150 |  | 135.3 | 1.11 | 1.11 | 1.12 | Fri | 1.11 | 1.12 |
| Sat | 255 |  | 136.0 | 1.88 | 1.91 | 1.92 | Sat | 1.91 | 1.92 |
| Sun | 160 |  | 135.4 | 1.18 | 1.21 | 1.22 | Sun | 1.21 | 1.22 |
| Mon | 105 | 136.0 | 135.9 | 0.77 | 0.80 | 0.80 | Σ | 6.99 | 7.00 |
| Tue | 100 | 135.3 | 136.6 | 0.73 | 0.69 | 0.69 |  |  |  |
| Wed | 85 | 136.0 | 137.3 | 0.62 | 0.61 | 0.61 |  |  |  |
| Thu | 96 | 135.4 | 138.1 | 0.69 | 0.65 | 0.65 |  |  |  |
| Fri | 155 | 135.9 | 138.7 | 1.12 | 1.11 | 1.12 |  |  |  |
| Sat | 260 | 136.6 | 137.6 | 1.89 | 1.91 | 1.92 |  |  |  |
| Sun | 166 | 137.3 | 136.9 | 1.21 | 1.21 | 1.22 |  |  |  |
| Mon | 109 | 138.1 | 134.3 | 0.81 | 0.80 | 0.80 |  |  |  |
| Tue | 92 | 138.7 | 133.9 | 0.69 | 0.69 | 0.69 |  |  |  |
| Wed | 80 | 137.6 | 135.0 | 0.59 | 0.61 | 0.61 |  |  |  |
| Thu | 78 | 136.9 | 135.6 | 0.58 | 0.65 | 0.65 |  |  |  |
| Fri | 152 | 134.3 | 136.0 | 1.12 | 1.11 | 1.12 |  |  |  |
| Sat | 268 | 133.9 | 135.4 | 1.98 | 1.91 | 1.92 |  |  |  |
| Sun | 170 | 135.0 | 136.0 | 1.25 | 1.21 | 1.22 |  |  |  |
| Mon | 112 | 135.6 | 137.7 | 0.81 | 0.80 | 0.80 |  |  |  |
| Tue | 88 | 136.0 | 137.1 | 0.64 | 0.69 | 0.69 |  |  |  |
| Wed | 84 | 135.4 | 138.1 | 0.61 | 0.61 | 0.61 |  |  |  |
| Thu | 90 | 136.0 |  |  | 0.65 | 0.65 |  |  |  |
| Fri | 148 | 137.7 |  |  | 1.11 | 1.12 |  |  |  |
| Sat | 275 | 137.1 |  |  | 1.91 | 1.92 |  |  |  |
| Sun | 175 | 138.1 |  |  | 1.21 | 1.22 |  |  |  |

Cognitive Domain: Knowledge

Difficulty Level: Easy

12a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | *Year* | | | |  |  |
| *Quarter* | *1* | *2* | *3* | *4* | *Average* | *Indices* |
| Jan–Mar | 370 | 380 | 470 | 530 | (370 + 380 + 470 + 530)/4 = 437.5 | 437.5/598.75 = 0.73 |
| April–June | 550 | 500 | 620 | 700 | (550 + 500 + 620 + 700)/4 = 592.5 | 592.5/598.75 = 0.99 |
| Jul–Sept | 770 | 820 | 980 | 990 | 890 | 1.49 |
| Oct–Dec | 420 | 440 | 510 | 530 | 475 | 0.79 |

Overall average is 598.75.

12b.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Quarter* | *Demand* | *MA-4* | *Centered MA* | *Ratio* | *Unadj SI* | *Adj SI* | *Q* | *Unadj SI* | *Adj SI* |
| Jan–Mar | 370 |  |  |  | 0.77 | 0.76 | Jan–Mar | 0.77 | 0.76 |
| Apr–Jun | 550 |  |  |  | 0.99 | 0.97 | Apr–Jun | 0.99 | 0.97 |
| Jul–Sep | 770 |  | 527.5 | 1.46 | 1.50 | 1.49 | Jul–Sep | 1.50 | 1.49 |
| Oct–Dec | 420 |  | 530 | 0.79 | 0.78 | 0.78 | Oct–Dec | 0.78 | 0.78 |
| Jan–Mar | 380 | 527.5 | 517.5 | 0.73 | 0.77 | 0.76 |  | 4.05 | 4.00 |
| Apr–Jun | 500 | 530 | 530 | 0.94 | 0.99 | 0.97 |  |  |  |
| Jul–Sep | 820 | 517.5 | 535 | 1.53 | 1.50 | 1.49 |  |  |  |
| Oct–Dec | 440 | 530 | 557.5 | 0.79 | 0.78 | 0.78 |  |  |  |
| Jan–Mar | 470 | 535 | 587.5 | 0.80 | 0.77 | 0.76 |  |  |  |
| Apr–Jun | 620 | 557.5 | 627.5 | 0.99 | 0.99 | 0.97 |  |  |  |
| Jul–Sep | 980 | 587.5 | 645 | 1.52 | 1.50 | 1.49 |  |  |  |
| Oct–Dec | 510 | 627.5 | 660 | 0.77 | 0.78 | 0.78 |  |  |  |
| Jan–Mar | 530 | 645 | 680 | 0.78 | 0.77 | 0.76 |  |  |  |
| Apr–Jun | 700 | 660 | 682.5 | 1.03 | 0.99 | 0.97 |  |  |  |
| Jul–Sep | 990 | 680 |  |  | 1.50 | 1.49 |  |  |  |
| Oct–Dec | 530 | 682.5 |  |  | 0.78 | 0.78 |  |  |  |

Seasonal indices are Jan to Mar = 0.76; Apr to Jun = 0.97; Jul to Sep = 1.49; Oct to Dec = 0.78.

Cognitive Domain: Knowledge

Difficulty Level: Easy

13a. There appears to be a slight upward trend.

13bcde.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Period* | *New Car Sales* | *Seasonal Indexes* | *Deseasoned Data* | *Forecast* | *Reseasoned Forecast* |
| 1 | 720 | 0.85 | 847.1 | 960.3 | 816.3 |
| 2 | 742 | 0.85 | 872.9 | 932.6 | 792.7 |
| 3 | 695 | 0.65 | 1069.2 | 904.9 | 588.2 |
| 4 | 798 | 0.9 | 886.7 | 877.2 | 789.5 |
| 5 | 740 | 0.85 | 870.6 | 849.5 | 722.1 |
| 6 | 830 | 1 | 830.0 | 821.8 | 821.8 |
| 7 | 785 | 0.96 | 817.7 | 794.1 | 762.3 |
| 8 | 900 | 1.2 | 750.0 | 766.3 | 919.6 |
| 9 | 990 | 1.3 | 761.5 | 738.6 | 960.2 |
| 10 | 920 | 1.3 | 707.7 | 710.9 | 924.2 |
| 11 | 890 | 1.35 | 659.3 | 683.2 | 922.3 |
| 12 | 840 | 1.35 | 622.2 | 655.5 | 884.9 |
| 13 |  | 0.85 |  | 627.8 | 533.6 |
| 14 |  | 0.85 |  | 600.0 | 510.0 |

Trend line equation for deseasoned data: 

13e.



Cognitive Domain: Analysis

Difficulty Level: Medium

14abcd.

The seasonal indices are in the table, based on four occurrences of each day.

|  |  |  |
| --- | --- | --- |
| *Day* | *Average* | *Indices* |
| Monday | 109 | 0.79 |
| Tuesday | 93.75 | 0.68 |
| Wednesday | 84.5 | 0.62 |
| Thursday | 89.25 | 0.65 |
| Friday | 151.25 | 1.10 |
| Saturday | 264.5 | 1.93 |
| Sunday | 167.75 | 1.22 |

The deseasonalized data was regressed on the time variable. The equation  is the best-fitting line to the deseasonalized data.

The forecast values appear in the Forecast column and are reseasoned with the indices to develop the reseasoned forecast. The forecast for the 29th and 30th days are both 136.1 but are adjusted by the respective indices to the values 108.2 and 93.0.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Day* | *Time* | *Patients* | *Deseasoned Patients* | *Forecast* | *Reseasoned Forecast* |
| Monday | 1 | 110 | 138.4 | 138.1 | 109.8 |
| Tuesday | 2 | 95 | 139.0 | 138.0 | 94.3 |
| Wednesday | 3 | 89 | 144.4 | 137.9 | 85.0 |
| Thursday | 4 | 93 | 142.9 | 137.9 | 89.7 |
| Friday | 5 | 150 | 136.0 | 137.8 | 152.0 |
| Saturday | 6 | 255 | 132.2 | 137.7 | 265.7 |
| Sunday | 7 | 160 | 130.8 | 137.7 | 168.4 |
| Monday | 8 | 105 | 132.1 | 137.6 | 109.4 |
| Tuesday | 9 | 100 | 146.3 | 137.5 | 94.0 |
| Wednesday | 10 | 85 | 138.0 | 137.5 | 84.7 |
| Thursday | 11 | 96 | 147.5 | 137.4 | 89.4 |
| Friday | 12 | 155 | 140.5 | 137.3 | 151.4 |
| Saturday | 13 | 260 | 134.8 | 137.2 | 264.7 |
| Sunday | 14 | 166 | 135.7 | 137.2 | 167.8 |
| Monday | 15 | 109 | 137.1 | 137.1 | 109.0 |
| Tuesday | 16 | 92 | 134.6 | 137.0 | 93.7 |
| Wednesday | 17 | 80 | 129.8 | 137.0 | 84.4 |
| Thursday | 18 | 78 | 119.9 | 136.9 | 89.1 |
| Friday | 19 | 152 | 137.8 | 136.8 | 150.9 |
| Saturday | 20 | 268 | 139.0 | 136.8 | 263.8 |
| Sunday | 21 | 170 | 139.0 | 136.7 | 167.2 |
| Monday | 22 | 112 | 140.9 | 136.6 | 108.6 |
| Tuesday | 23 | 88 | 128.7 | 136.5 | 93.3 |
| Wednesday | 24 | 84 | 136.3 | 136.5 | 84.1 |
| Thursday | 25 | 90 | 138.3 | 136.4 | 88.8 |
| Friday | 26 | 148 | 134.2 | 136.3 | 150.4 |
| Saturday | 27 | 275 | 142.6 | 136.3 | 262.8 |
| Sunday | 28 | 175 | 143.1 | 136.2 | 166.6 |
| Monday | 29 |  |  | 136.1 | 108.2 |
| Tuesday | 30 |  |  | 136.1 | 93.0 |

A plot of the forecast versus actual values demonstrates a good fit.

Cognitive Domain: Knowledge

Difficulty Level: Easy

15a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Quarter* | *Demand* | *Adjusted Seas Ind* | *Adj Demand* | *Quarter* | *Forecast* | *Reseasoned* |
| Jan–Mar | 370 | 0.76 | 486.84 | 1 | 488.46 | 371.23 |
| Apr–Jun | 550 | 0.97 | 567.01 | 2 | 503.09 | 488.00 |
| Jul–Sep | 770 | 1.49 | 516.78 | 3 | 517.72 | 771.41 |
| Oct–Dec | 420 | 0.78 | 538.46 | 4 | 532.35 | 415.24 |
| Jan–Mar | 380 | 0.76 | 500.00 | 5 | 546.99 | 415.71 |
| Apr–Jun | 500 | 0.97 | 515.46 | 6 | 561.62 | 544.77 |
| Jul–Sep | 820 | 1.49 | 550.34 | 7 | 576.25 | 858.61 |
| Oct–Dec | 440 | 0.78 | 564.10 | 8 | 590.88 | 460.88 |
| Jan–Mar | 470 | 0.76 | 618.42 | 9 | 605.51 | 460.19 |
| Apr–Jun | 620 | 0.97 | 639.18 | 10 | 620.14 | 601.54 |
| Jul–Sep | 980 | 1.49 | 657.72 | 11 | 634.77 | 945.81 |
| Oct–Dec | 510 | 0.78 | 653.85 | 12 | 649.40 | 506.53 |
| Jan–Mar | 530 | 0.76 | 697.37 | 13 | 664.03 | 504.66 |
| Apr–Jun | 700 | 0.97 | 721.65 | 14 | 678.66 | 658.30 |
| Jul–Sep | 990 | 1.49 | 664.43 | 15 | 693.29 | 1033.01 |
| Oct–Dec | 530 | 0.78 | 679.49 | 16 | 707.92 | 552.18 |
|  |  | 0.78 |  | 17 | 722.55 | 563.59 |

Adjusted demand is obtained by dividing Demand by the Adjusted Seasonal Index column. A linear trend forecast of Adjusted Demand regressed on Quarter number resulted in the equation . Results in the Forecast column were reseasoned by multiplying by the Adjusted Seasonal Indices; the actual forecast appears in the Reseasoned column. The forecast for the first quarter of Year 5 is 

Cognitive Domain: Knowledge

Difficulty Level: Easy

16.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Year* | *Time* | *Sales* | *Indices* | *Deseasoned Sales* | *Forecast* | *Forecast Reseasoned* |
| Q-1 | 1 | 98 | 1 | 98/1=98.0 | 106.0 | 106x1=106.0 |
| Q-2 | 2 | 140 | 1.2 | 140/1.2=116.7 | 106.3 | 106.3x1.2=127.5 |
| Q-3 | 3 | 112 | 0.96 | 112/.96=116.7 | 106.6 | 106.6x.96=102.3 |
| Q-4 | 4 | 80 | 0.85 | 80/.85=94.1 | 106.8 | 106.8x.85=90.8 |
| Q-1 | 5 | 92 | 1 | 92.0 | 107.1 | 107.1 |
| Q-2 | 6 | 152 | 1.2 | 126.7 | 107.4 | 128.9 |
| Q-3 | 7 | 104 | 0.96 | 108.3 | 107.7 | 103.4 |
| Q-4 | 8 | 88 | 0.85 | 103.5 | 108.0 | 91.8 |
| Q-1 | 9 |  | 1 |  | 108.3 | 108.3 |
| Q-2 | 10 |  | 1.2 |  | 108.6 | 130.4 |

Regression of Deseasoned Sales on Time yields Deseasoned Sales = 105.66 +. 296Time.

For the second quarter of 2016, Deseasoned Sales = 105.66 + .296 x 10 = 108.6. Reseasoning yields 108.6 x 1.2 = 130.4.

Cognitive Domain: Comprehension

Difficulty Level: Medium

17a.



17b.  The value of the independent variable is well outside the range of data used to build the model.

17c. 

The model explains almost 83% of the variation and demonstrates a strong positive linear relationship. The standard error of the estimate is about 7% of the average of the dependent variable.

Cognitive Domain: Comprehension

Difficulty Level: Medium

18a.



18b. 

18c.



The model explains almost 80% of the variation and demonstrates a strong positive linear relationship, correlation = .893. The standard error of the estimate is about 10% of the average of the dependent variable.

Cognitive Domain: Comprehension

Difficulty Level: Medium

19a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.993 |  |  |  |  |  |
| R square | 0.987 |  |  |  |  |  |
| Adjusted R square | 0.984 |  |  |  |  |  |
| Standard error | 1.696 |  |  |  |  |  |
| Observations | 12 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 2 | 1903.04 | 951.52 | 330.98 | 3.75E-09 |  |
| Residual | 9 | 25.87 | 2.87 |  |  |  |
| Total | 11 | 1928.92 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Std Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | -5.21 | 1.80 | -2.89 | 0.02 | -9.28 | -1.13 |
| Personal income (in $000) | 0.52 | 0.07 | 7.28 | 0.00 | 0.36 | 0.69 |
| Advertising | -0.06 | 0.07 | -0.84 | 0.42 | -0.22 | 0.10 |

19b. b0 is the level of sales in the absence of advertising and personal income. It is difficult to purchase a car without personal income, and the data set does not contain any observations with a value of personal income near 0, so the b0 value is not very meaningful. The coefficient b1 is the incremental change in sales attributable to one more unit—in this case, $1,000, of personal income. The coefficient b2 is the incremental change in sales derived from one additional unit of advertising, in this case $1,000.

19c. Multiple R is the multiple correlation coefficient, which provides some sense of how strong the linear relationship is between the model and the actual data. R Squared is the percentage of the variation in sales predicted by the level of income and advertising expenditures. We explain 98.7% of sales variation using these two variables, and the correlation is very strong.

19d. 

Cognitive Domain: Comprehension

Difficulty Level: Medium

20a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.923 |  |  |  |  |  |
| R square | 0.852 |  |  |  |  |  |
| Adjusted R square | 0.838 |  |  |  |  |  |
| Standard error | 42.085 |  |  |  |  |  |
| Observations | 24 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 2 | 214569.2 | 107284.6 | 60.6 | 1.9E-09 |  |
| Residual | 21 | 37193.3 | 1771.1 |  |  |  |
| Total | 23 | 251762.5 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Std Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | 639.37 | 45.91 | 13.93 | 0.00 | 543.89 | 734.85 |
| Price ($) | -5.51 | 0.55 | -10.01 | 0.00 | -6.65 | -4.36 |
| In-store promotion ($) | 0.02 | 0.00 | 4.57 | 0.00 | 0.01 | 0.03 |

20b. b0 is the level of sales in the absence of price and promotion. The data set does not contain any observations with a value of price 0, so the b0 value is not very meaningful. Common sense suggests that a price of zero could make the shoes very popular indeed. The coefficient b1 is the incremental change in sales attributable to one more unit—in this case, $1, of price. The coefficient b2 is the incremental change in sales derived from one additional unit of in-store promotion.

20c. Multiple R is the multiple correlation coefficient, which provides some sense of how strong the linear relationship is between the model and the actual data. R Squared is the percentage of the variation in sales predicted by the level of income and advertising expenditures. We explain 85% of sales variation using these two variables, and the correlation is very strong.

20d. 

Cognitive Domain: Comprehension

Difficulty Level: Medium

21.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Month* | *Demand* | *Forecast* | *At-Ft* | *CSE* | *AD* | *MAD* | *Signal* |
| 1 | 1772 | 1774 | 1772-1774=-2 | -2 | 2 | 2/1=2.00 | -2/2=-1.00 |
| 2 | 1790 | 1780 | 1790-1780=10 | -2+10=8 | 10 | (2+10)/2=6.00 | 8/6=1.33 |
| 3 | 1796 | 1792 | 1796-1792=4 | 8+4=12 | 4 | (2+10+4)/3=5.33 | 12/5.33=2.25 |
| 4 | 1783 | 1794 | 1783-1794=-11 | 12-11=1 | 11 | (2+10+4+11)/4=6.75 | 1/6.75=0.15 |
| 5 | 1775 | 1772 | 3 | 4 | 3 | 6.00 | 0.67 |
| 6 | 1770 | 1764 | 6 | 10 | 6 | 6.00 | 1.67 |
| 7 | 1765 | 1758 | 7 | 17 | 7 | 6.14 | 2.77 |
| 8 | 1777 | 1779 | -2 | 15 | 2 | 5.63 | 2.67 |
| 9 | 1782 | 1765 | 17 | 32 | 17 | 6.89 | 4.65 |
| 10 | 1794 | 1782 | 12 | 44 | 12 | 7.40 | 5.95 |
| 11 | 1755 | 1768 | -13 | 31 | 13 | 7.91 | 3.92 |
| 12 | 1779 | 1795 | -16 | 15 | 16 | 8.58 | 1.75 |

The approach shows two out of the 12 forecasts exceed the +4 MAD limit.

Cognitive Domain: Comprehension

Difficulty Level: Medium

22a. 

22b. For every unit increase of the X1 variable, the value of Y drops by 3.29 units. For every unit increase of the X2 variable, the value of Y increases by 1.17 units.

22c. 

Cognitive Domain: Comprehension

Difficulty Level: Medium

23a. 

23b. For every unit increase of the Price variable, the value of Sales drops by 47.326 units. For every unit increase of the Promotion variable, the value of Sales increases by 5.3581 units.

23c. 

Cognitive Domain: Comprehension

Difficulty Level: Medium

24a.



24b.

24c.



The predictor variable explains 83.6% of the variability in the dependent variable. There is a strong positive linear correlation between the two variables of 0.914. Finally, the *s****yx*** value indicates that actual ridership values (Y) deviate from the predicted (yc) values by about 0.37 millions of riders.

Cognitive Domain: Comprehension

Difficulty Level: Medium

25a.



25b. 

25c.



The number of homework problems explains 78.8% of the variation of the course score. The two variables exhibit a strong positive correlation, so most values fall along a straight line with a positive slope. The difference between the predicted and actual course score is 5.4.

Cognitive Domain: Application

Difficulty Level: Hard

26a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.9509 |  |  |  |  |  |
| R square | 0.9043 |  |  |  |  |  |
| Adjusted R square | 0.8769 |  |  |  |  |  |
| Standard error | 607.7259 |  |  |  |  |  |
| Observations | 10 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 2 | 24415376.29 | 1.2E+07 | 33.0535 | 0.0003 |  |
| Residual | 7 | 2585315.31 | 369331 |  |  |  |
| Total | 9 | 27000691.6 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Std Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | -1014.36 | 452.62 | -2.24 | 0.06 | -2084.63 | 55.91 |
| Age of the truck | 380.11 | 92.99 | 4.09 | 0.00 | 160.22 | 600.00 |
| Number of miles driven | 0.06 | 0.02 | 2.80 | 0.03 | 0.01 | 0.11 |

Maintenance cost = -1014.36 + 380.11Age + .06Miles

26b. For every additional year of age of a truck, the maintenance cost rises $380.11. For every additional mile driven, the maintenance cost of the truck rises six cents.

26c.  Cognitive Domain: Application

Difficulty Level: Hard

27a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.893 |  |  |  |  |  |
| R square | 0.797 |  |  |  |  |  |
| Adjusted R Square | 0.772 |  |  |  |  |  |
| Standard error | 827.671 |  |  |  |  |  |
| Observations | 10 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 21520380 | 21520379.6 | 31.41482 | 0.0005073 |  |
| Residual | 8 | 5480312 | 685039.001 |  |  |  |
| Total | 9 | 27000692 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Std Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | -905.90 | 614.17 | -1.48 | 0.18 | -2322.17 | 510.37 |
| Age of the truck (in years) | 546.33 | 97.47 | 5.60 | 0.00 | 321.56 | 771.11 |

If the truck is 7 years old, the maintenance cost is -905.9 + 546.33(7) = $2,918.43.

27b.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.822 |  |  |  |  |  |
| R square | 0.676 |  |  |  |  |  |
| Adjusted R square | 0.635 |  |  |  |  |  |
| Standard error | 1046.204 |  |  |  |  |  |
| Observations | 10 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 18244342.95 | 1.8E+07 | 16.6684 | 0.00352 |  |
| Residual | 8 | 8756348.646 | 1094544 |  |  |  |
| Total | 9 | 27000691.6 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Std Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | 168.003 | 599.310 | 0.280 | 0.786 | -1214.008 | 1550.013 |
| Number of miles driven | 0.120 | 0.029 | 4.083 | 0.004 | 0.052 | 0.188 |

A truck driven 32,300 miles will have maintenance costs of 168 + 0.12(32,300) = $4,055.18.

27c. All measures in the table demonstrate that Age is a better predictor of maintenance cost than Miles. The correlation and variance explained are higher, and the standard error of the estimate is lower.

|  |  |  |
| --- | --- | --- |
| *Statistic* | *Age* | *Miles* |
| R2 | .797 | .676 |
| r | .893 | .822 |
| Sxy | 827.67 | 1046.2 |

27d. The forecasts in 27a and 27b are statistically significant, but the multiple regression forecast performs better in terms of explained variance, correlation, and standard error.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Model* | *Prediction* | *R2* | *r* | *Sxy* |
| Age | $2,918 | .797 | .893 | 827.67 |
| Miles | $4,055 | .676 | .822 | 1046.2 |
| Age & miles | $3,658 | .836 | .914 | 607.73 |

Cognitive Domain: Application

Difficulty Level: Hard

28a. The data are consistent from month to month except for the seventh observation. If the company believes that this month is anomalous and unlikely to reoccur, then it is best to omit this observation when building a model.

28b. Excel output for the 24 observation model follows:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.971 |  |  |  |  |  |
| R square | 0.942 |  |  |  |  |  |
| Adj R square | 0.940 |  |  |  |  |  |
| Standard error | 0.795 |  |  |  |  |  |
| Observations | 24 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 227.96 | 227.96 | 360.27 | 3.964E-15 |  |
| Residual | 22 | 13.92 | 0.633 |  |  |  |
| Total | 23 | 241.88 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Std Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | -0.278 | 0.483 | -0.576 | 0.571 | -1.281 | 0.724 |
| Number hits | 0.228 | 0.012 | 18.981 | 0.000 | 0.203 | 0.253 |

28c. Excel output for the 23 observation model follows:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.960 |  |  |  |  |  |
| R square | 0.922 |  |  |  |  |  |
| Adj R square | 0.918 |  |  |  |  |  |
| Std error | 0.814 |  |  |  |  |  |
| Observations | 23 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 163.47 | 163.47 | 246.93 | 4.374E-13 |  |
| Residual | 21 | 13.90 | 0.66 |  |  |  |
| Total | 22 | 177.37 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Std Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | -0.224 | 0.593 | -0.377 | 0.710 | -1.457 | 1.009 |
| Number hits | 0.227 | 0.014 | 15.714 | 0.000 | 0.197 | 0.257 |

28d. The correlation and percentage of explained variance are both higher for the model that uses all observations. The standard error of the estimate is also lower for the *n* = 24 model.

|  |  |  |
| --- | --- | --- |
| *Statistic* | *n = 23* | *n = 24* |
| R2 | .92 | .94 |
| r | .96 | .97 |
| Sxy | .81 | .79 |

Cognitive Domain: Application

Difficulty Level: Hard

29a.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Month* | *F1* | *F2* | *Actual Demand* | *ADF1* | *ADF2* |
| 1 | 97 | 95 | 99 | |99-97|=2 | |99-95|=4 |
| 2 | 80 | 77 | 86 | |86-80|=6 | |86-77|=9 |
| 3 | 82 | 89 | 90 | |90-82|=8 | |90-89|=1 |
| 4 | 54 | 62 | 68 | 14 | 6 |
| 5 | 81 | 84 | 79 | 2 | 5 |
| 6 | 88 | 93 | 82 | 6 | 11 |
| 7 | 89 | 89 | 96 | 7 | 7 |
| 8 | 86 | 84 | 88 | 2 | 4 |
| 9 | 80 | 74 | 76 | 4 | 2 |



29b.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Month* | *F1* | *F2* | *Actual Demand* | *SEF1* | *SEF2* |
| 1 | 97 | 95 | 99 | (99-97) 2=4 | (99-95) 2=16 |
| 2 | 80 | 77 | 86 | (86-80) 2=36 | (86-77) 2=81 |
| 3 | 82 | 89 | 90 | (90-82) 2=64 | (90-89)2=1 |
| 4 | 54 | 62 | 68 | 196 | 36 |
| 5 | 81 | 84 | 79 | 4 | 25 |
| 6 | 88 | 93 | 82 | 36 | 121 |
| 7 | 89 | 89 | 96 | 49 | 49 |
| 8 | 86 | 84 | 88 | 4 | 16 |
| 9 | 80 | 74 | 76 | 16 | 4 |



29c.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Month* | *F1* | *F2* | *Actual Demand* | *APEF1* | *APEF2* |
| 1 | 97 | 95 | 99 | 100x|99-97|/99=2.020 | 100x|99-95|/99=4.040 |
| 2 | 80 | 77 | 86 | 100x|86-80|/80=6.977 | 100x|86-77|/86=10.465 |
| 3 | 82 | 89 | 90 | 100x|90-82|/90=8.889 | 100x|90-89|/90=1.111 |
| 4 | 54 | 62 | 68 | 20.588 | 8.824 |
| 5 | 81 | 84 | 79 | 2.532 | 6.329 |
| 6 | 88 | 93 | 82 | 7.317 | 13.415 |
| 7 | 89 | 89 | 96 | 7.292 | 7.292 |
| 8 | 86 | 84 | 88 | 2.273 | 4.545 |
| 9 | 80 | 74 | 76 | 5.263 | 2.632 |



29d. Convenience and ease of computation are important, but ultimately the ability to help the forecaster distinguish the best forecast from among the possibilities is the most important criterion.

Cognitive Domain: Application

Difficulty Level: Hard

30a.

|  |  |  |  |
| --- | --- | --- | --- |
| ***Week*** | ***Demand in Cases*** | ***Forecast α=.2*** | ***Forecast α=.4*** |
| 1 | 48 |  |  |
| 2 | 52 | 48 | 48 |
| 3 | 49 | .2(52)+.8(48)=48.8 | .4(52)+.6(48)=49.6 |
| 4 | 35 | .2(49)+.8(48.8)=48.8 | .4(49)+.6(49.6)=49.4 |
| 5 | 47 | .2(35)+.8(48.8)=46.1 | .4(35)+.6(49.4)=43.6 |
| 6 | 53 | 46.3 | 45.0 |
| 7 | 48 | 47.6 | 48.2 |
| 8 | 46 | 47.7 | 48.1 |
| 9 | 55 | 47.3 | 47.3 |
| 10 | 54 | 48.9 | 50.4 |
| 11 | 58 | 49.9 | 51.8 |
| 12 | 57 | 51.5 | 54.3 |
| 13 |  | 52.6 | 55.4 |

Actual demand is available for Week 12, so a forecast can be developed for Week 13.

30b.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Week*** | ***Demand in Cases*** | ***ADα=.2*** | ***ADα=.4*** | ***SEα=.2*** | ***SEα=.4*** |
| 1 | 48 |  |  |  |  |
| 2 | 52 | |52-48| = 4.0 | |52+48| = 4.0 | (52-48)2 = 16.0 | (52-48) 2 = 16.0 |
| 3 | 49 | |49-48.8| = 0.2 | |49-49.6| = 0.6 | (49-48.8) 2 = 0.0 | (49-49.6) 2 = 0.4 |
| 4 | 35 | 13.8 | 14.4 | 191.5 | 206.2 |
| 5 | 47 | 0.9 | 3.4 | 0.9 | 11.5 |
| 6 | 53 | 6.7 | 8.0 | 45.5 | 64.5 |
| 7 | 48 | 0.4 | 0.2 | 0.2 | 0.0 |
| 8 | 46 | 1.7 | 2.1 | 2.8 | 4.4 |
| 9 | 55 | 7.7 | 7.7 | 58.6 | 59.8 |
| 10 | 54 | 5.1 | 3.6 | 26.2 | 13.3 |
| 11 | 58 | 8.1 | 6.2 | 65.6 | 38.2 |
| 12 | 57 | 5.5 | 2.7 | 30.0 | 7.3 |
| 13 |  | 4.9 | 4.8 | 39.8 | 38.3 |



The α = 0.4 smoothing constant produces forecasts that are more accurate.

Cognitive Domain: Comprehension

Difficulty Level: Medium

31a. 

31b. 

31c. 

Cognitive Domain: Comprehension

Difficulty Level: Medium

32a.There appears to be a cycle of 3 months.

32b.

|  |  |  |
| --- | --- | --- |
| *Month* | *Demand* | *MA3* |
| 1 | 60 |  |
| 2 | 80 |  |
| 3 | 40 |  |
| 4 | 80 | (60+80+40)/3 = 60.00 |
| 5 | 120 | (80+40+80)/3 = 66.67 |
| 6 | 70 | (40+80+120)/3 = 80.00 |
| 7 | 110 | (80+120+70)/3 = 90.00 |
| 8 | 120 | (120+70+110)/3 = 100.00 |
| 9 | 80 | (70+110+120)/3 = 100.00 |
| 10 | 100 | (110+120+80)/3 = 103.33 |

32c.

|  |  |  |
| --- | --- | --- |
| *Month* | *Demand* | *Exponα=.4* |
| 1 | 60 |  |
| 2 | 80 |  |
| 3 | 40 |  |
| 4 | 80 | 80.00 |
| 5 | 120 | .4(80)+.6(80) = 80.00 |
| 6 | 70 | .4(120)+.6(80) = 96.00 |
| 7 | 110 | .4(70)+.6(96) = 85.60 |
| 8 | 120 | .4(110)+.6(85.6) = 95.36 |
| 9 | 80 | .4(120)+.6(95.36) = 105.22 |
| 10 | 100 | .4(80)+.6(105.22) = 95.13 |
| 11 |  | .4(100)+.6(95.13) = 97.08 |

32d. It appears the moving average is doing a better job matching the actual demand data.

Cognitive Domain: Application

Difficulty Level: Hard

33a.

|  |  |  |
| --- | --- | --- |
| *Year* | *Kidney Transplants* | *MA3* |
| 1 | 38 |  |
| 2 | 42 |  |
| 3 | 47 |  |
| 4 | 51 | (38+42+47)/3 = 42.33 |
| 5 | 58 | (42+47+51)/3 = 46.67 |
| 6 | 60 | (47+51+58)/3 = 52.00 |
| 7 | 63 | (51+58+60)/3 = 56.33 |
| 8 |  | (58+60+63)/3 = 60.33 |

33b.

|  |  |  |  |
| --- | --- | --- | --- |
| *Year* | *Kidney Transplants* | *Exponα=.5* | *Exponα=.7* |
| 1 | 38 |  |  |
| 2 | 42 |  |  |
| 3 | 47 |  |  |
| 4 | 51 | 51 | 51 |
| 5 | 58 | .5(51)+.5(51) = 51 | .7(51)+.3(51) = 51 |
| 6 | 60 | .5(58)+.5(51) = 54.5 | .7(51)+.3(51) = 55.9 |
| 7 | 63 | .5(60)+.5(54.5) = 57.3 | .7(51)+.3(51) = 58.8 |
| 8 |  | .5(63)+.5(57.3) = 60.1 | .7(51)+.3(51) = 61.7 |

33c.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Year* | *Kidney Transplants* | *Exponα=.5* | *Trendβ=.2* | *Trend Adj Smoothing* |
| 1 | 38 |  |  |  |
| 2 | 42 |  |  |  |
| 3 | 47 |  |  |  |
| 4 | 51 | 51 | 0 | 51 + 0 = 51 |
| 5 | 58 | 51 | .2(51–51) + .8(0) = 0 | 51 + 0 = 51 |
| 6 | 60 | 54.5 | .2(54.5–51) + .8(0) = 0.7 | 54.5 + .7 = 55.2 |
| 7 | 63 | 57.3 | .2(57.3–54.5) + .8(0) = 1.11 | 57.3 + 1.11 = 58.36 |
| 8 |  | 60.1 | .2(60.1–57.3) + .8(0) = 1.46 | 60.1 + 1.46 = 61.59 |

33d.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Year* | *Kidney Transplants* | *SEExponα=.5* | *SEExponα=.7* | *SEMA3* | *SETAES* |
| 1 | 38 |  |  |  |  |
| 2 | 42 |  |  |  |  |
| 3 | 47 |  |  |  |  |
| 4 | 51 |  |  |  |  |
| 5 | 58 | (58–51)2 = 49.00 | (58–51)2 = 49.00 | (58–46.67)2 = 128.44 | (58–51)2 = 49.00 |
| 6 | 60 | (60–54.5)2 = 30.25 | (60–55.9)2 = 16.81 | (60–52)2 = 36.00 | (60–55.2)2 = 7.84 |
| 7 | 63 | (63–57.3)2 = 33.06 | (63–58.8)2 = 17.89 | (63–56.33)2 = 2.78 | (63–58.36)2 = 0.13 |
| 8 |  | 12.83 | 21.10 | 30.83 | 17.95 |

The mean squared error of 12.83 for Periods 5, 6, and 7 is lowest for the exponential smoothing α = .5 model, with trend adjusted exponential smoothing the second-best model at 17.95. The worst performer is the moving average of three periods at 30.83.

Cognitive Domain: Application

Difficulty Level: Hard

34a. 

34b. Other factors might include the number of retail outlets per square mile, the number of direct competitors per square mile, the month of the year, and the educational attainment of the population.

Cognitive Domain: Application

Difficulty Level: Hard

35a.

|  |  |  |  |
| --- | --- | --- | --- |
| *Quarter* | *Sales* | *Yt* | *Trended* |
| 1 | 18 | 15+6(1) = 21 | 0.85(21) = 17.85 |
| 2 | 33 | 15+6(2) = 27 | 0.9(27) = 24.3 |
| 3 | 40 | 15+6(3) = 33 | 1.1(33) = 36.3 |
| 4 | 36 | 15+6(4) = 39 | 1(39) = 39 |
| 5 | 24 | 15+6(5) = 45 | 0.85(45) = 38.25 |
| 6 | 38 | 15+6(6) = 51 | 0.9(51) = 45.9 |
| 7 | 45 | 15+6(7) = 57 | 1.1(57) = 62.7 |
| 8 | 42 | 15+6(8) = 63 | 1(63) = 63 |
| 9 | 32 | 15+6(9) = 69 | 0.85(69) = 58.65 |

A plot of the actual and forecasted sales indicates this model works well.

Cognitive Domain: Application

Difficulty Level: Hard