Inventory Management

Summer 2025

- Assignment 2 -

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Exercise 1:

A retail company has collected the following demand information for umbrellas during the last 5 years.

Year	2007	2008	2009	2010	2011
Demand	1200	1100	1000	960	850

Given this information, you are asked to determine the ex-post single-period forecasts using the following methods:

a) Moving average over 2 years.

b) Exponential smoothing with α=0.2 and starting value=1300.

c) Trend model with α=0.2, β=0.1 and starting values a=1300, b=20.

Evaluate the performance of your forecasts in a), b) and c):

d) Calculate the MAD with exponential smoothing (γ=0.1 and starting value=0).

e) Monitor the forecast accuracy by calculating the error signal SIG (γ=0.1, σ=0.1) and interpret your result in terms of demand over- or underestimation.

Exercise 1.a) Moving average over 2 years.

Year	Demand
2007	1200
2008	1100
2009	1000
2010	960
2011	850

$$\underbrace{\begin{aligned}
\hat{a}_t &= \frac{1}{n}\sum_{k=t-n+1}^{t} y_k \\
\hat{a}_{2008} &= \frac{1}{2}\sum_{2007}^{2008} y_t = \frac{1200+1100}{2} = 1150 \\
\hat{a}_{2009} &= \frac{1100+1000}{2} = 1050 \\
\hat{a}_{2010} &= \frac{1000+960}{2} = 980 \\
\hat{a}_{2011} &= \frac{960+850}{2} = 905
\end{aligned}}_{\text{Parameter}}$$

$$\underbrace{\begin{aligned}
p_{t+i} &= \hat{a}_t \quad i = 1,2,\ldots \\
p_{2009} &= \hat{a}_{2008} = 1150 \\
p_{2010} &= \hat{a}_{2009} = 1050 \\
p_{2011} &= \hat{a}_{2010} = 980
\end{aligned}}_{\text{Forecast}}$$

Exercise 1.b) **Exponential smoothing** with **α=0.2** and **starting value=1300**.

$$\hat{a}_t = \alpha \cdot y_t + (1-\alpha) \cdot \hat{a}_{t-1}$$

$$p_{t+i} = \hat{a}_t \quad i = 1,2,\ldots$$

***Starting value ($\hat{a}_{2006}$) = 1300**

Year	Demand
2007	1200
2008	1100
2009	1000
2010	960
2011	850

$$\hat{a}_{2007} = 0.2 \cdot y_{2007} + (1-0.2) \cdot \hat{a}_{2006}$$

$$= 0.2 \cdot 1200 + 0.8 \cdot 1300 = 1280$$

$$\hat{a}_{2008} = 0.2 \cdot 1100 + 0.8 \cdot 1280 = 1244$$

$$\hat{a}_{2009} = 0.2 \cdot 1000 + 0.8 \cdot 1244 = 1195.2$$

$$\hat{a}_{2010} = 0.2 \cdot 960 + 0.8 \cdot 1195.2 = 1148.16$$

$$\hat{a}_{2011} = 0.2 \cdot 850 + 0.8 \cdot 1148.16 = 1088.528$$

Parameter

$$p_{2007} = \hat{a}_{2006} = 1300$$

$$p_{2008} = \hat{a}_{2007} = 1280$$

$$p_{2009} = \hat{a}_{2008} = 1244$$

$$p_{2010} = \hat{a}_{2009} = 1195.2$$

$$p_{2011} = \hat{a}_{2010} = 1148.16$$

Forecast

Exercise 1.c) Trend model with α=0.2, β=0.1 and starting values a=1300, b=20.

***Starting value**
$\hat{a}_{2006}$ **= 1300**
$\hat{b}_{2006}$ **= 20**

Year	2007	2008	2009	2010	2011
Demand	1200	1100	1000	960	850

$$\hat{a}_t = \alpha \cdot y_t + (1-\alpha)(\hat{a}_{t-1} + \hat{b}_{t-1})$$

$$\hat{b}_t = \beta(\hat{a}_t - \hat{a}_{t-1}) + (1-\beta)(\hat{b}_{t-1})$$

$\hat{a}_{2007} = 0.2 \cdot y_{2007} + (1-0.2) \cdot (\hat{a}_{2006} + \hat{b}_{2006})$
$= 0.2 \cdot 1200 + 0.8 \cdot (1300 + 20) = 1296$
$\hat{a}_{2008} = 0.2 \cdot 1100 + 0.8 \cdot (1296 + 17.6) = 1270.88$
$\hat{a}_{2009} = 0.2 \cdot 1000 + 0.8 \cdot (1270.88 + 13.33) = 1227.37$
$\hat{a}_{2010} = 0.2 \cdot 960 + 0.8 \cdot (1227.37 + 7.65) = 1180.02$
$\hat{a}_{2011} = 0.2 \cdot 850 + 0.8 \cdot (1180.02 + 2.15) = 1115.74$

$\hat{b}_{2007} = 0.1(\hat{a}_{2007} - \hat{a}_{2006}) + (1-0.1) \cdot \hat{b}_{2006}$
$= 0.1(1296 - 1300) + (1-0.1) \cdot 20 = 17.6$
$\hat{b}_{2008} = 0.1(1270.88 - 1296) + (1-0.1) \cdot 17.6 = 13.33$
$\hat{b}_{2009} = 0.1(1227.38 - 1270.88) + (1-0.1) \cdot 13.33 = 7.65$
$\hat{b}_{2010} = 0.1(1180.02 - 1227.37) + (1-0.1) \cdot 7.65 = 2.15$
$\hat{b}_{2011} = 0.1(1115.75 - 1180.02) + (1-0.1) \cdot 2.15 = -4.5$

$p_{2007} = \hat{a}_{2006} + \hat{b}_{2006} = 1300 + 20 = 1320$
$p_{2008} = \hat{a}_{2007} + \hat{b}_{2007} = 1296 + 17.6 = 1313.6$
$p_{2009} = \hat{a}_{2008} + \hat{b}_{2008} = 1270.88 + 13.33 = 1284.21$
$p_{2010} = \hat{a}_{2009} + \hat{b}_{2009} = 1227.37 + 7.65 = 1235.02$
$p_{2011} = \hat{a}_{2010} + \hat{b}_{2010} = 1180.02 + 2.15 = 1182.17$

Parameter

Forecast

Exercise 1.d) Calculate the MAD with exponential smoothing (**γ=0.1 and starting value=0**).

Year	Moving Average	Exponential Smoothing	Trend Model
2007		1300	1320
2008		1280	1313.6
2009	1150	1244	1284.21
2010	1050	1195.2	1235.02
2011	980	1148.16	1182.17

$$MAD_t = \gamma \cdot |e_i| + (1-\gamma) \cdot MAD_{t-1}$$

$$e_t = y_t - p_t$$

Year	Actual Demand (y_t)	Moving Average (p_t)	Deviation ($e_t = y_t - p_t$)	MAD_t $\gamma \cdot \lvert e_t \rvert + (1-\gamma) \cdot MAD_{t-1}$
2007	1200			
2008	1100			
2009	1000	1150	-150	0.1·150 + 0.9·0 = 15
2010	960	1050	-90	0.1·90 + 0.9·15 = 22.5
2011	850	980	-130	0.1·130 + 0.9·22.5 = 33.25

Year	Actual Demand (y_t)	Exponential Smoothing (p_t)	Deviation ($e_t = y_t - p_t$)	MAD_t $\gamma \cdot \lvert e_t \rvert + (1-\gamma) \cdot MAD_{t-1}$
2007	1200	1300	-100	0.1·100 + 0.9·0 = 10
2008	1100	1280	-180	0.1·180 + 0.9·10 = 27
2009	1000	1244	-244	0.1·244 + 0.9·27 = 48.7
2010	960	1195.2	-235.2	0.1·235.2 + 0.9·48.7 = 67.35
2011	850	1148.16	-298.16	0.1·298.16 + 0.9·67.35 = 90.43

Year	Actual Demand (y_t)	Trend Model (p_t)	Deviation ($e_t = y_t - p_t$)	MAD_t $\gamma \cdot \lvert e_t \rvert + (1-\gamma) \cdot MAD_{t-1}$
2007	1200	1320	-120	0.1·120 + 0.9·0 = 12
2008	1100	1313.6	-213.6	0.1·213.6 + 0.9·12 = 32.16
2009	1000	1284.21	-284.21	0.1·284.21 + 0.9·32.16 = 57.36
2010	960	1235.02	-275.02	0.1·275.02 + 0.9·57.36 = 79.12
2011	850	1182.17	-332,17	0.1·332.17 + 0.9·79.12 = 104.42

Exercise 1.e) Monitor the forecast accuracy by calculating the error signal SIG (**γ=0.1, σ=0.1**) and interpret your result in terms of demand over- or underestimation.

Year	Moving Average (MA)	Exponential Smoothing (ES)	Trend Model (TM)
2007		1300	1320
2008		1280	1313.6
2009	1150	1244	1284.21
2010	1050	1195.2	1235.02
2011	980	1148.16	1182.17

Year	MA Deviation	ERR_t $(\sigma \cdot e_t + (1-\sigma) ERR_{t-1})$	MAD_t	SIG_t $(\frac{ERR_t}{MAD_t})$
2007				
2008				
2009	-150	0.1·(-150)+0.9·0 = -15	15	(-15)/15=-1
2010	-90	0.1·(-90)+0.9·(-15) = -22.5	22.5	(-22.5)/25=-1
2011	-130	0.1·(-130)+0.9·(-22.5) = -33.25	33.25	(-33.25)/33.25=-1

$$SIG_t = \frac{ERR_t}{MAD_t} \quad where, \quad \begin{aligned} MAD_t &= \gamma \cdot |e_t| + (1-\gamma) \cdot MAD_{t-1} \\ ERR_t &= \delta \cdot e_t + (1-\delta) \cdot ERR_{t-1} \end{aligned}$$

Year	ES Deviation	ERR_t	MAD_t	SIG_t
2007	-100	0.1·(-100)+0.9·(0) = -10	10	(-10)/10=-1
2008	-180	0.1·(-180)+0.9·(-10) = -27	27	(-27)/27=-1
2009	-244	0.1·(-244)+0.9·(-27) = -48.7	48.7	(-48.7)/48.7=-1
2010	-235.2	0.1·(-235.2)+0.9·(-48.7) = -67.35	67.35	(-67.35)/67.35 = -1
2011	-298.16	0.1·(-298.16)+0.9·(-67.35) = -90.43	90.43	(-90.43)/90.43 = -1

Year	TM Deviation	ERR_t	MAD_t	SIG_t
2007	-120	0.1·(-120)+0.9·(0) = -12	12	(-12)/12=-1
2008	-213.6	0.1·(-213.6)+0.9·(-12) = -32.16	32.16	(-32.16)/32.16=-1
2009	-284.21	0.1·(-284.21)+0.9·(-32.16) = -57.36	57.36	(-57.36)/57.36=-1
2010	-275.02	0.1·(-275.02)+0.9·(-57.36) = -79.12	79.12	(-79.12)/79.12 = -1
2011	-332,17	0.1·(-332.17)+0.9·(-79.12) = -104.42	104.42	(-104.42)/104.42 = -1

Exercise 2:

Provigo sells a variety of excellent chocolate desserts. A major problem with these desserts is their short shelf-life. Therefore, the retail chain wants to improve its forecast accuracy. From the products' sales history, it can be observed that demand strongly increased during promotions and went down when prices were high. You are given the following demand observations and the corresponding prices of one of their best selling products French Mousse au Chocolat:

Week	1	2	3	4	5	6	7	8	9	10	11	12
Demand	1500	2000	500	600	550	3000	3100	1800	700	200	1600	800
Price ($)	2,49	1,99	3,49	3,59	3,59	1,49	1,49	2,49	3,29	3,59	2,49	3,19

a) Visualize the relationship between demand and price.

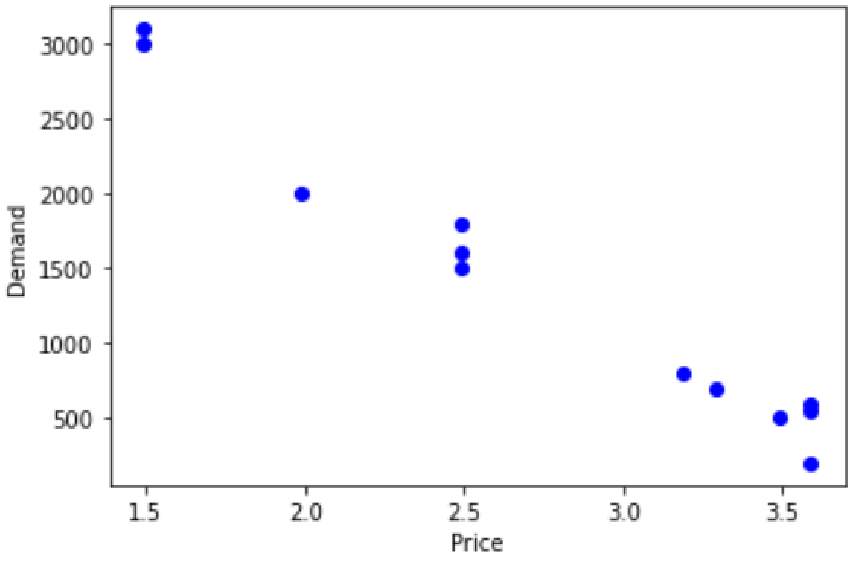
b) Calculate the regression function using least squares estimation.

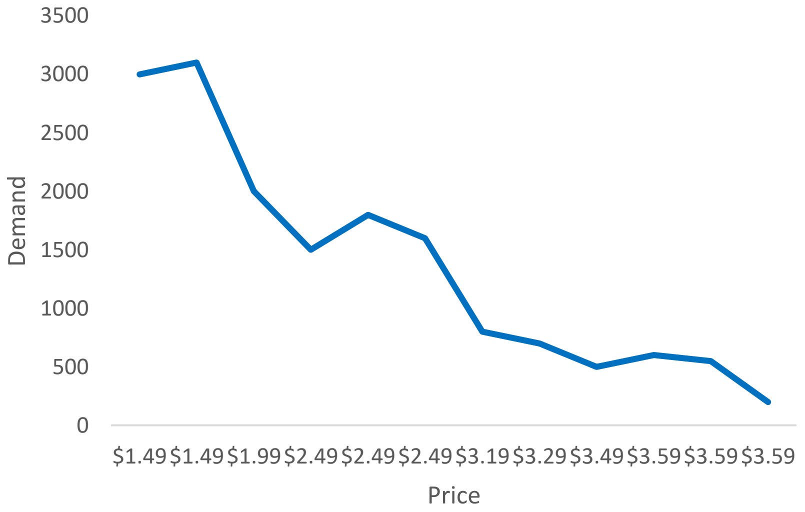
c) How well does the function fit past observations?

d) Which demand can be predicted for the following week when price is 1.49?

Exercise 2.a) Visualize the relationship between **demand and price.**

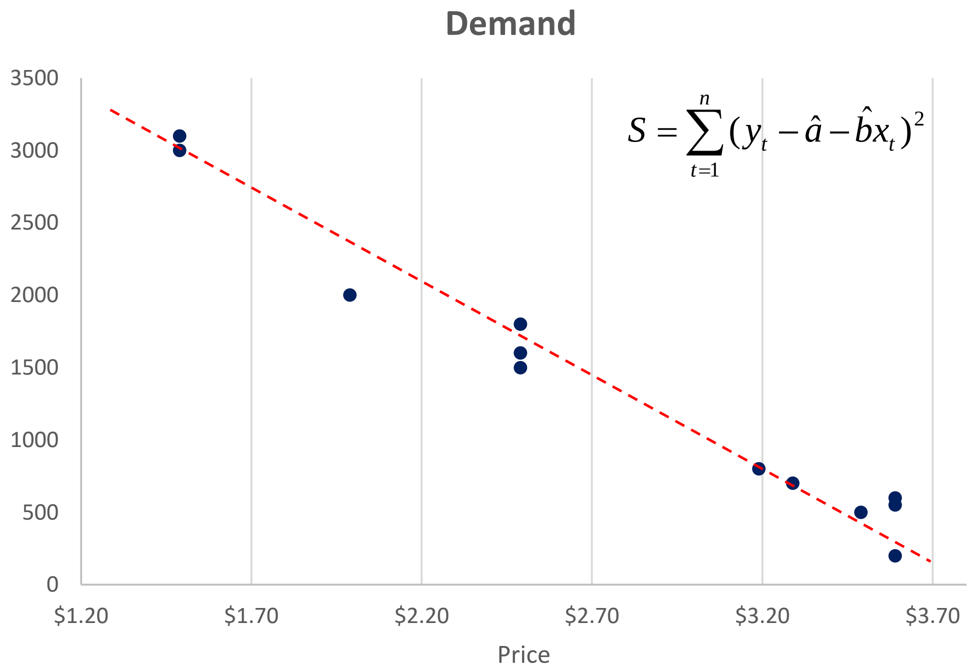
Week	Demand	Price ($)
6	3000	1,49
7	3100	1,49
2	2000	1,99
1	1500	2,49
8	1800	2,49
11	1600	2,49
12	800	3,19
9	700	3,29
3	500	3,49
4	600	3,59
5	550	3,59
10	200	3,59





Exercise 2.b) Calculate the regression function using **least squares estimation**.

Demand	Price ($)
3000	1,49
3100	1,49
2000	1,99
1500	2,49
1800	2,49
1600	2,49
800	3,19
700	3,29
500	3,49
600	3,59
550	3,59
200	3,59



Forecast: $p_{t+i}=\hat{a}+\hat{b}\cdot x_{t+i}$

where, $\hat{a}=\bar{y}-\hat{b}\bar{x}$

$$\hat{b}=\frac{\sum_{t=1}^{n}(x_t-\bar{x})(y_t-\bar{y})}{\sum_{t=1}^{n}(x_t-\bar{x})^2}$$

with $\bar{x}=\frac{1}{n}\sum_{t=1}^{n}x_t \quad \bar{y}=\frac{1}{n}\sum_{t=1}^{n}y_t$

Exercise 2.b) Calculate the regression function using **least squares estimation**.

Price x_t(IV)	Demand y_t (DV)
1,49	3000
1,49	3100
1,99	2000
2,49	1500
2,49	1800
2,49	1600
3,19	800
3,29	700
3,49	500
3,59	600
3,59	550
3,59	200

$$\bar{x} = \frac{1}{n}\sum_{t=1}^{n} x_t = \frac{1{,}49+1{,}49+1{,}99+2{,}49+2{,}49+2{,}49+3{,}19+3{,}29+3{,}49+3{,}59+3{,}59+3{,}59}{12} = 2{,}765$$

$$\bar{y} = \frac{1}{n}\sum_{t=1}^{n} y_t = \frac{3000+3100+2000+1500+1800+1600+800+700+500+600+550+200}{12} = 1362{,}5$$

$x_t - \bar{x}$	$(x_t - \bar{x})^2$	$y_t - \bar{y}$	$(x_t - \bar{x})(y_t - \bar{y})$
(1,49-2,765) = -1,275	(-1,275)^2 = 1,625625	(3000-1362,5) = 1637,5	(-1,275)*(1637,5) = -2087,8125
-1,275	1,625625	1737,5	-2215,3125
-0,775	0,600625	637,5	-494,0625
-0,275	0,075625	137,5	-37,8125
-0,275	0,075625	437,5	-120,3125
-0,275	0,075625	237,5	-65,3125
0,425	0,180625	-562,5	-239,0625
0,525	0,275625	-662,5	-347,8125
0,725	0,525625	-862,5	-625,3125
0,825	0,680625	-762,5	-629,0625
0,825	0,680625	-812,5	-670,3125
0,825	0,680625	-1162,5	-959,0625
	7,1025		-8491,25

$$\hat{a} = \bar{y} - \hat{b}\bar{x}$$
$$= 1362{,}5 - (-1195{,}53) * 2{,}765 = 4668{,}14$$

$$\hat{b} = \frac{\sum_{t=1}^{n}(x_t - \bar{x})(y_t - \bar{y})}{\sum_{t=1}^{n}(x_t - \bar{x})^2} = \frac{-8491{,}25}{7{,}1025} = -1195{,}53$$

Therefore,

$$p_{t+i} = \hat{a} + \hat{b} \cdot x_{t+i} = 4668{,}14 - 1195{,}53 \cdot x_{t+1}$$

Exercise 2.c) How well does the function fit past observations?

$$p_t = 4668{,}14 - 1195{,}53 \cdot x_t$$

$y_t - \bar{y}$	$(y_t - \bar{y})^2$	p_t	$p_t - \bar{y}$	$(p_t - \bar{y})^2$
(3000-1362,5) = 1637,5	(1637,5)^2 = 2681406,25	4668,14-1195,53*1,49 = 2886,80	2886,80-1362,5 = 1524,30	(1524,3)^2 = 2323490,49
1737,5	3018906,25	2886,80	1524,30	2323490,49
637,5	406406,25	2289,04	926,54	858467,11
137,5	18906,25	1691,27	328,77	108089,71
437,5	191406,25	1691,27	328,77	108089,71
237,5	56406,25	1691,27	328,77	108089,71
-562,5	316406,25	854,40	508,10	258165,61
-662,5	438906,25	734,85	627,65	393948,29
-862,5	743906,25	495,74	866,76	751271,16
-762,5	581406,25	376,19	986,31	972811,36
-812,5	660156,25	376,19	986,31	972811,36
-1162,5	1351406,25	376,19	986,31	972811,36
	10465625			10151536,37

$$R^2 = \frac{\sum_{t=1}^{n}(p_t - \bar{y})^2}{\sum_{t=1}^{n}(y_t - \bar{y})^2}$$

$$= \frac{10151536{,}37}{10465625} = 0{,}96998 \ (\approx 97\%)$$

$\therefore$ *The linear model explains approx. 97% of the dependent variable variation.*

Exercise 2.d) Which demand can be predicted for the following week when **price is 1.49?**

- Independent Variable (Price): x_t
- Dependent Variable (Demand): $\mathrm{y}_t(\mathrm{p}_t)$

$$p_t = 4668{,}14 - 1195{,}53 \cdot x_t$$

$$p_t = 4668{,}14 - 1195{,}53(1{,}49)$$

$$= 2886{,}80$$

Exercise 3:

During your internship with the service parts division of a TV manufacturer, you are asked to forecast the parts demand for an after series part. A previous intern has already prepared the data, however failed to come up with a reasonable forecast as he was only aware of simple exponential smoothing techniques.

Day	12	18	35	47	61
Demand	7	8	5	3	5

At the days not shown in the table, there was no demand for the part. Explain the problem that the previous intern faced and apply an appropriate method to overcome the problem. Any required smoothing constant should have the value 0.2. Your supervisor tells you that her experience suggests that there will be a demand of 5 units every 14 days.

Exercise 3.a) At the days not shown in the table, there was no demand for the part. **Explain the problem that the previous intern faced** and **apply an appropriate method to overcome the problem**. Any required smoothing constant should have the value **0.2**. Your supervisor tells you that her experience suggests that there will be a demand of **5 units every 14 days.**

Problem?

Some periods with demand, the other without demand (Intermittent Demand)

Appropriate Method?

Croston Method

- Parameter estimation (Croston method)
  - Case 1: $y_t=0$
    $\hat{a}_t = \hat{a}_{t-1}$ Demand Size
    $\hat{x}_t = \hat{x}_{t-1}$ Demand Interval
  - Case 2: $y_t>0$
    $\hat{a}_t = \alpha y_t + (1-\alpha)\hat{a}_{t-1}$
    $\hat{x}_t = \beta(t-\tau) + (1-\beta)\hat{x}_{t-1}$
- Forecast
  $$p_{t+i} = \begin{cases} \hat{a}_t & i = k \cdot \lfloor \hat{x}_t \rfloor, k = 1,2,\ldots \\ 0 & otherwise \end{cases}$$

Exercise 3.a) At the days not shown in the table, there was no demand for the part. **Explain the problem that the previous intern faced** and **apply an appropriate method to overcome the problem**. Any required smoothing constant should have the value **0.2**. Your supervisor tells you that her experience suggests that there will be a demand of **5 units every 14 days.**

	Day t	Demand y_t	$\hat{a}_t$	$\hat{x}_t$	Quantity p_{t+1}	Day $Timing$
Case 1: y_t=0	0	0	$= \hat{a}_{t-1} = 5$	$= \hat{x}_{t-1} = 14$	$\hat{a}_t = 5$	$\hat{x}_t = 14$
Case 2: y_t>0	12	7	$= \alpha \cdot y_t + (1-\alpha) \cdot \hat{a}_{t-1}$ $0.2 \cdot 7 + (1-0.2) \cdot 5 = 5.4$	$= \beta \cdot (t-\tau) + (1-\beta) \cdot \hat{x}_{t-1}$ $0.2 \cdot (12-0) + (1-0.2) \cdot 14 = 13.6$	$\lceil \hat{a}_t \rceil$ $\lceil 5.4 \rceil = 6$	$t + \lfloor \hat{x}_t \rfloor$ $12 + \lfloor 13.6 \rfloor = 25$
	18	8	$0.2 \cdot 8 + (1-0.2) \cdot 5.4 = 5.92$	$0.2 \cdot (18-12) + (1-0.2) \cdot 13.6 = 12.08$	$\lceil 5.92 \rceil = 6$	$18 + \lfloor 12.08 \rfloor = 30$
	35	5	$0.2 \cdot 5 + (1-0.2) \cdot 5.92 = 5.74$	$0.2 \cdot (35-18) + (1-0.2) \cdot 12.08 = 13.06$	$\lceil 5.74 \rceil = 6$	$35 + \lfloor 13.06 \rfloor = 48$
	47	3	$0.2 \cdot 3 + (1-0.2) \cdot 5.74 = 5.20$	$0.2 \cdot (47-35) + (1-0.2) \cdot 13.06 = 12.85$	$\lceil 5.20 \rceil = 6$	$47 + \lfloor 12.85 \rfloor = 59$
	61	5	$0.2 \cdot 5 + (1-0.2) \cdot 5.2 = 5.16$	$0.2 \cdot (61-47) + (1-0.2) \cdot 12.85 = 13.08$	$\lceil 5.16 \rceil = 6$	$61 + \lfloor 13.08 \rfloor = 74$

Exercise 4:

CampingPlus sells waterproof tents for which parts are first produced in its Austrian factory, then parts are assembled to tents and the complete tents are finally sold to the end-customers in stores for outdoor equipment in Austria, Germany and Switzerland. Stores in the three countries usually review their inventory once a week (RS=1) and CampingPlus then immediately supplies the stores with the amount of tents ordered (LS=0).

CampingPlus itself **continuously reviews** its inventory, but it takes **one week** until the tents ordered arrive at the assembly center. All parties in the supply chain are supposed to satisfy **a non-stockout probability target of 80 %** in the off-season (September – February). Demand at the stores is aggregated so that you are given the following information that has been observed by all local stores during the last four weeks. Demand is assumed to be **normally distributed** with unknown level (**initial guess 50**) and known **standard deviation 15**.

Week Number	40	41	42	43
Demand	55	48	57	58

Exercise 4:

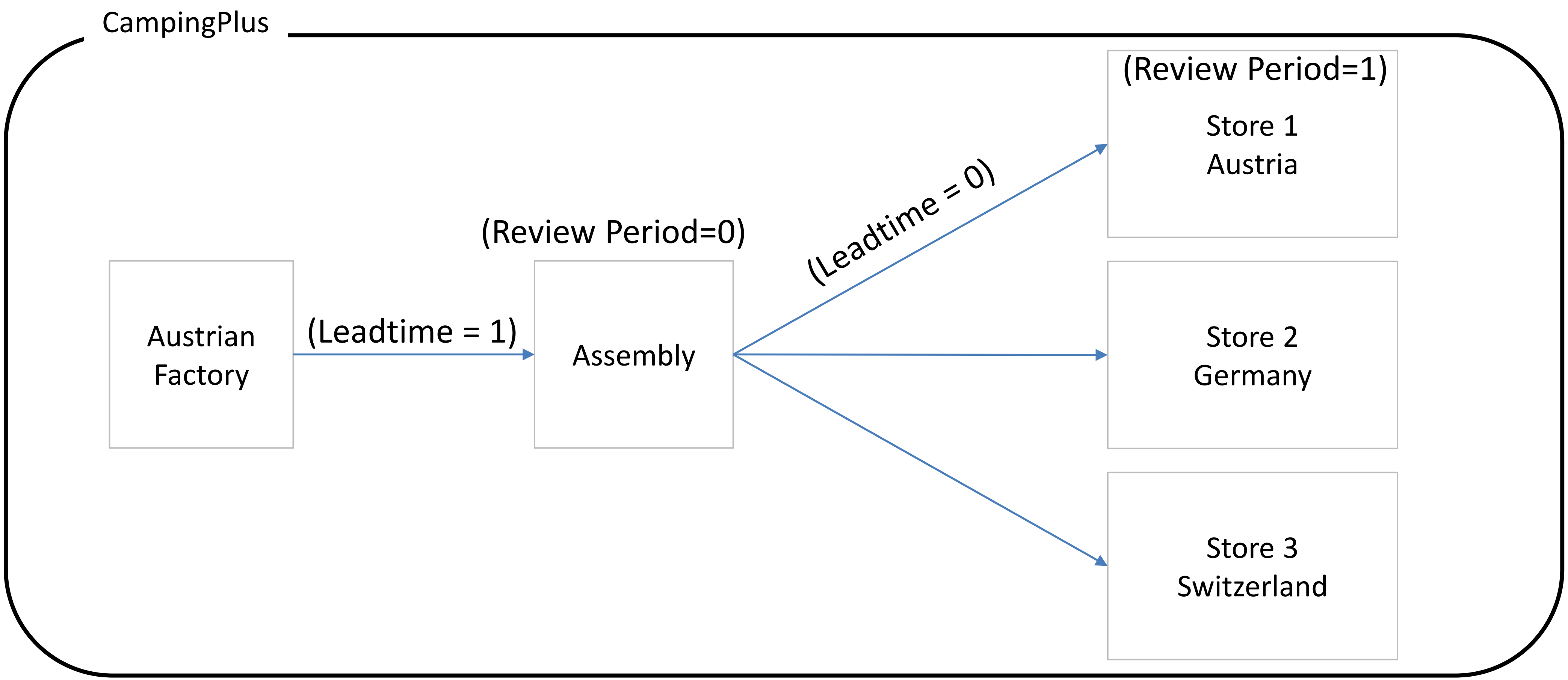
Week Number	40	41	42	43
Demand	55	48	57	58

a) Depict the supply chain described in the exercise graphically.

b) Perform an ex-post forecast for the local stores using exponential smoothing with alpha=0.1 and determine the order-up-to level that would have been optimal given the forecast. Calculate the aggregate order quantity to be placed by the local stores.

c) Perform an ex-post forecast for CampingPlus using exponential smoothing with alpha=0.3 and determine the order-up-to level that would have been optimal given the forecast. Calculate CampingPlus' order quantity.

Exercise 4.a) Depict the supply chain described in the exercise graphically.



Exercise 4.b) Perform an ex-post forecast for **the local stores using exponential smoothing with alpha=0.1** and **determine the order-up-to level** that would have been optimal given the forecast. Calculate the aggregate order quantity to be placed **by the local stores**.

$$S = (R+L)\mu + k\sigma\sqrt{R+L}$$

$$\hat{\mu}_t = (1-\alpha)\hat{\mu}_{t-1} + \alpha d_t$$

t	t-1	40	41	42	43
d_t		55	48	57	58
$\hat{\mu}_t$	$\mu_{initial}$ =50,0	$(1-\alpha)\hat{\mu}_{t-1} + \alpha d_t$ (1-0,1)50+0,1(55)=50,5	0,9(50,5)+0,1(48) =50,25	0,9(50,25)+0,1(57) =50,92	0,9(50,92)+0,1(58) 51,62
σ	$\sigma = 15$				
S	$(R+L)\mu + k\sigma\sqrt{R+L}$ 50+0,84*15*$\sqrt{1}$ = 62,6 (63)	50,5+0,84*15*$\sqrt{1}$ =63,1 (64)	50,25+0,84*15*$\sqrt{1}$ =62,85 (63)	50,92+0,84*15*$\sqrt{1}$ =63,52 (64)	51,62+0,84*15*$\sqrt{1}$ =64,22 (65)
Q		$d_t - S_{t-1} + S_t$ $55 - 63 + 64 = 56$	48-64+63 = 47	57-63+64 = 58	58-64+65 = 59

R	1
L	0
alpha	0,1
k (SL: 80%)	0,8416 (≈0,84)

k	ϕ(k)	Φ(k)	G(k)
0.8200	0.28504	0.79389	0.11603
0.8300	0.28269	0.79673	0.11398
0.8400	0.28034	0.79955	0.11196
0.8500	0.27798	0.80234	0.10997
0.8600	0.27562	0.80511	0.10801
0.8700	0.27324	0.80785	0.10607

Exercise 4.c) Perform an ex-post forecast **for CampingPlus using exponential smoothing with alpha=0.3** and **determine the order-up-to level** that would have been optimal given the forecast. Calculate **CampingPlus' order quantity.**

t	t-1	40	41	42	43
$d_t(Store)$		**56**	**47**	**58**	**59**
$\hat{\mu}_t$	$\mu_{initial}$ =50,0	$(1-\alpha)\hat{\mu}_{t-1} + \alpha d_t$ (1-0,3)50+0,3(56)=51,8	0,7(51,8)+0,3(47) =50,36	0,7(50,36)+0,3(58) =52,65	0,7(52,65)+0,3(59) 54,55
σ	$\sigma = 15$				
S	$(R+L)\mu + k\sigma\sqrt{R+L}$ 50+0,84*15*$\sqrt{1}$ = 62,6 (63)	51,8+0,84*15*$\sqrt{1}$ =64,4 (65)	50,36+0,84*15*$\sqrt{1}$ =62,96 (63)	52,65+0,84*15*$\sqrt{1}$ =65,25 (66)	54,55+0,84*15*$\sqrt{1}$ =67,15 (68)
Q		$d_t - S_{t-1} + S_t$ 56-63+65 = 58	47-65+63 = 45	58-63+66 = 61	59-66+68 = 61

R	0
L	1
alpha	0,3
k (SL: 80%)	0,8416 (≈0,84)

k	ϕ(k)	Φ(k)	G(k)
0.8200	0.28504	0.79389	0.11603
0.8300	0.28269	0.79673	0.11398
$\boxed{0.8400}$	0.28034	0.79955	0.11196
$\boxed{0.8500}$	0.27798	0.80234	0.10997
0.8600	0.27562	0.80511	0.10801
0.8700	0.27324	0.80785	0.10607

Thank you!