GDAŃSK UNIVERSITY OF TECHNOLOGY
FACULTY OF MANAGEMENT AND ECONOMICS

TIME SERIES

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AGENDA

1. **Classical time series model**
2. **Mechanical Method**
3. **Analytical Method**
4. **Practice**

CLASSICAL TIME SERIES MODEL

Classical time series model (addictive):

$$Y_t = T_t + C_t + S_t + I_t$$

Y_t – time series;

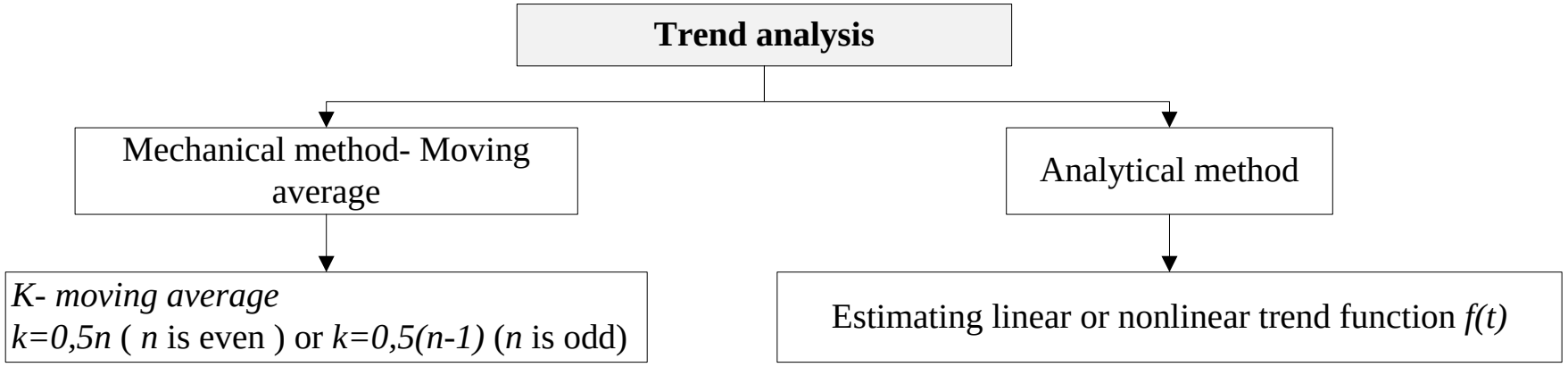
T_t –trend; a long term relatively smooth pattern or direction that the series exhibits;

C_t – cycle, wavelike or oscillatory pattern about a long term trend that is generally apparent over a number of years; it has duration of more than one year;

S_t – seasonal variations, are like cycles but they occur over short repetitive calendar periods and have durations of less than one year;

I_t – residual or irregular variation; the random movement that a series exhibits after the trend, cycle and seasonal variation are removed.

TREND ANALYSIS



MECHANICAL METHOD

The moving average (MA), takes away the short term seasonal and irregular variation, leaving a combined trend and cyclical movement.

Moving averages are widely used to to remove seasonal variation, irregular variation or both.

TASK 1. (1)

Monthly sales figures for gasoline were recorded at all the gas stations in a particular town, as shown in table. Calculate the three-month and five-month moving averages. Create a graph.

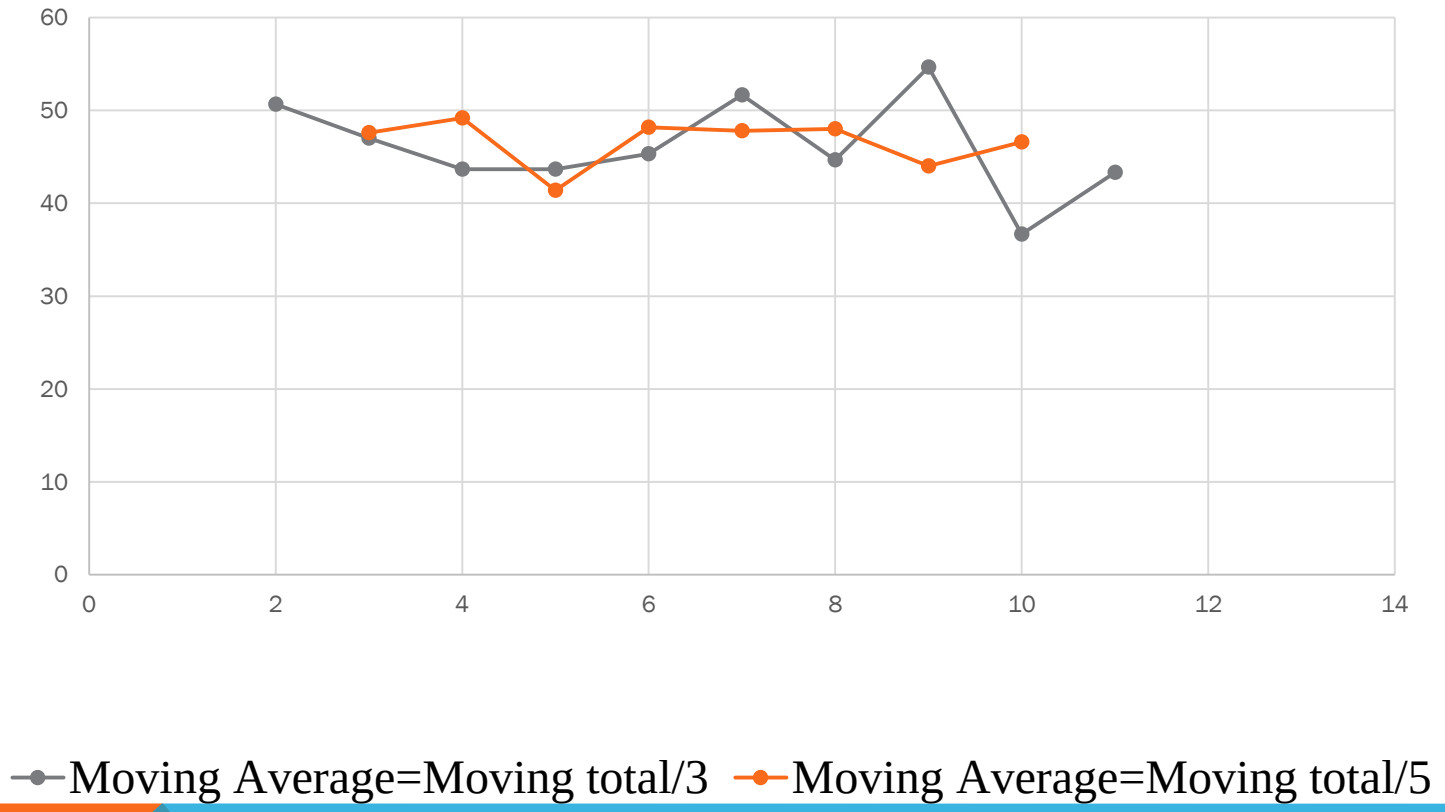
HINT

(A moving average is a simple arithmetic average computed over any numer of time periods. For a three period moving average we would take the first three months (1,2 and 3) and average them. Then we would move to the next three month grouping (2,3 and 4) and average them; and so on.)

TASK 1. (2)

		3 – Month MA		5- Month MA	
Month	Gasoline sales	Moving Total	Moving Average= Moving total/3	Moving Total	Moving Average= Moving total/5
1	37	-	-	-	-
2	70	37+70+45=152	152/3=50,67	-	-
3	45	141	47,00	37+70+45+26+60=238	238/5=47,6
4	26	131	43,67	246	49,2
5	60	131	43,67	207	41,4
6	45	136	45,33	241	48,2
7	31	155	51,67	239	47,8
8	79	134	44,67	240	48
9	24	164	54,67	220	44
10	61	110	36,67	233	46,6
11	25	130	43,33	-	-
12	44	-	-	-	-

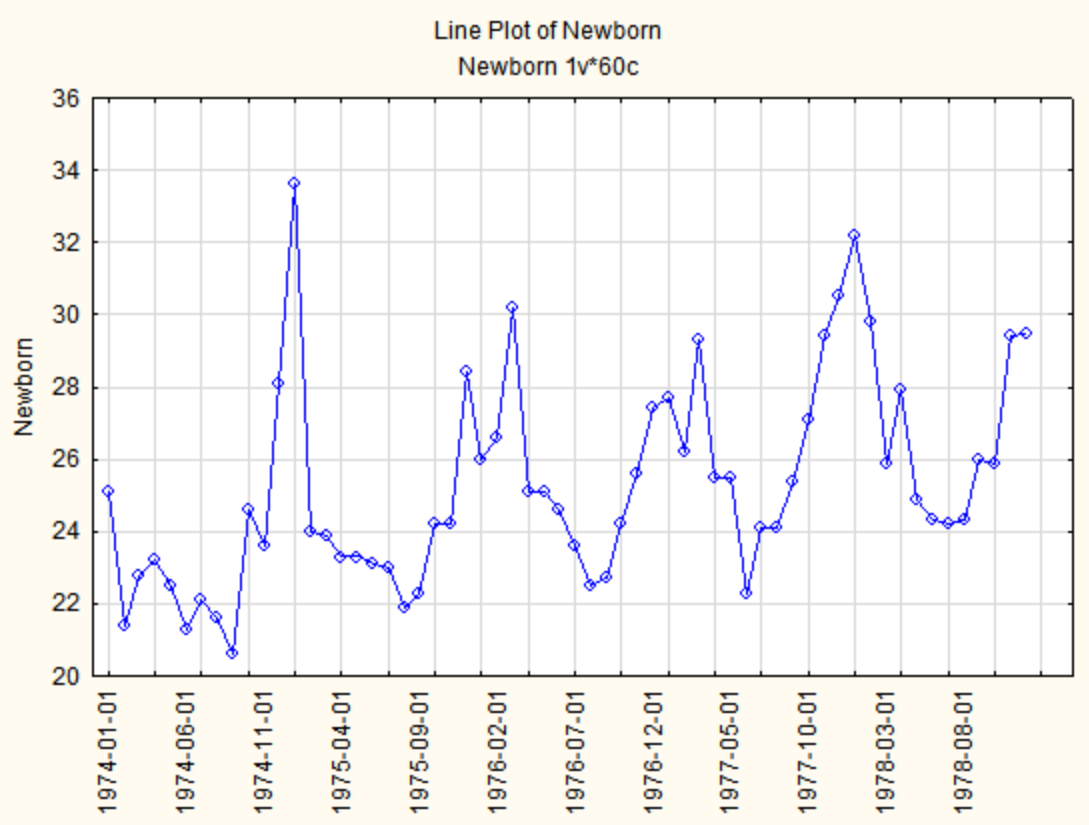
TASK 1. (3)


60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
Moving Average=Moving total/3
Moving Average=Moving total/5

STATISTICA

TASK 2. (1)

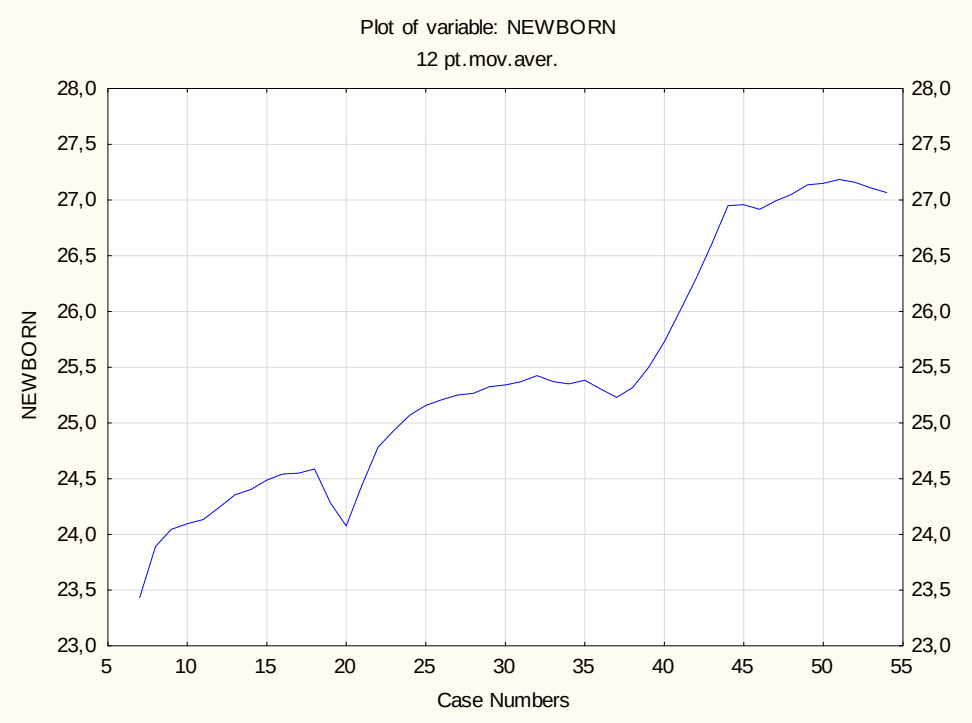
The data concerned the newborn in Poland in the years 1974-1978 is available in the file Newborn.sta. Create a time series plot.



Path: <Graphs> <2D Graphs> <Line plots (Variables)>

TASK 2. (2)

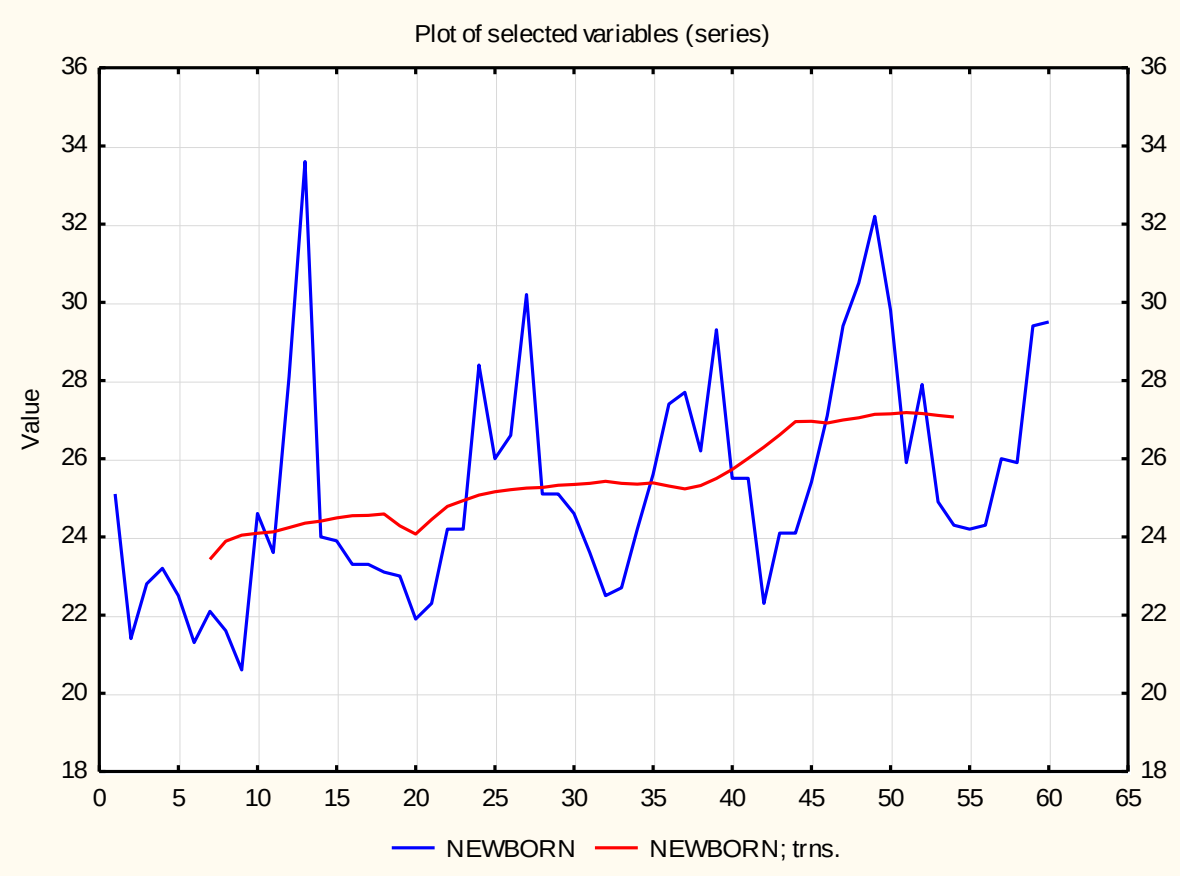
Use *k=12 month moving average* and find the trend.



Path: <Statistics> <Advanced linear/nonlinear models> <Times series/Forecasting> <Exponential smoothing and forecasting>
Part <Advanced> <Other transfomations & plots>
Part <Smothing>
<OK>

TASK 2. (2)

Compare this two plots.



ANALYTICAL METHOD

$$\hat{y} = a + bt$$

Trend coefficient

$$a = \bar{y} - b\bar{t}$$

Trend line

$$b = \frac{SS_{ty}}{SS_{t}}$$

Time

$$SS_{ty} = \sum t_i y_i - \frac{(\sum t_i)(\sum y_i)}{n}$$

$$SS_{t} = \sum t_i^2 - \frac{(\sum t_i)^2}{n}$$

Note!

Remember to create a new independent variable *t* (time)

TASK 3. (1)

Annual sales figures for a pharmaceutical company have been recorded over the past 10 years; they are shown in the table. Calculate the linear trend line of the data. Predict the annual sales in 1985.

Year	Sales
1975	18
1976	19,4
1977	18
1978	19,9
1979	19,3
1980	21,1
1981	23,5
1982	23,2
1983	20,4
1984	24,4

TASK 3. (1)

Year	Sales;y	Time; t	t^2	ty
1975	18	1	1	18
1976	19,4	2	4	38,8
1977	18	3	9	54
1978	19,9	4	16	79,6
1979	19,3	5	25	96,5
1980	21,1	6	36	126,6
1981	23,5	7	49	164,5
1982	23,2	8	64	185,6
1983	20,4	9	81	183,6
1984	24,4	10	100	244
Sum	207,2	55	385	1191,2

$$SS_{ty} = \sum t_i y_i - \frac{(\sum t_i)(\sum y_i)}{n} =$$

$$= 1191.2 - \frac{55 * 207.2}{10} = 51.6$$

$$SS_t = \sum t_i^2 - \frac{(\sum t_i)^2}{n} =$$

$$= 385 - \frac{55 * 55}{10} = 82.5$$

$$b = \frac{SS_{ty}}{SS_t} = \frac{51.6}{82.5} = 0.63$$

Correlation coefficient

$$\bar{y} = \frac{207.2}{10} = 20.72$$

$$\bar{t} = \frac{55}{10} = 5.5$$

Intercept coefficient

$$a = \bar{y} - b\bar{t} = 20.72 - 0.63 * 5.5 = 17.26$$

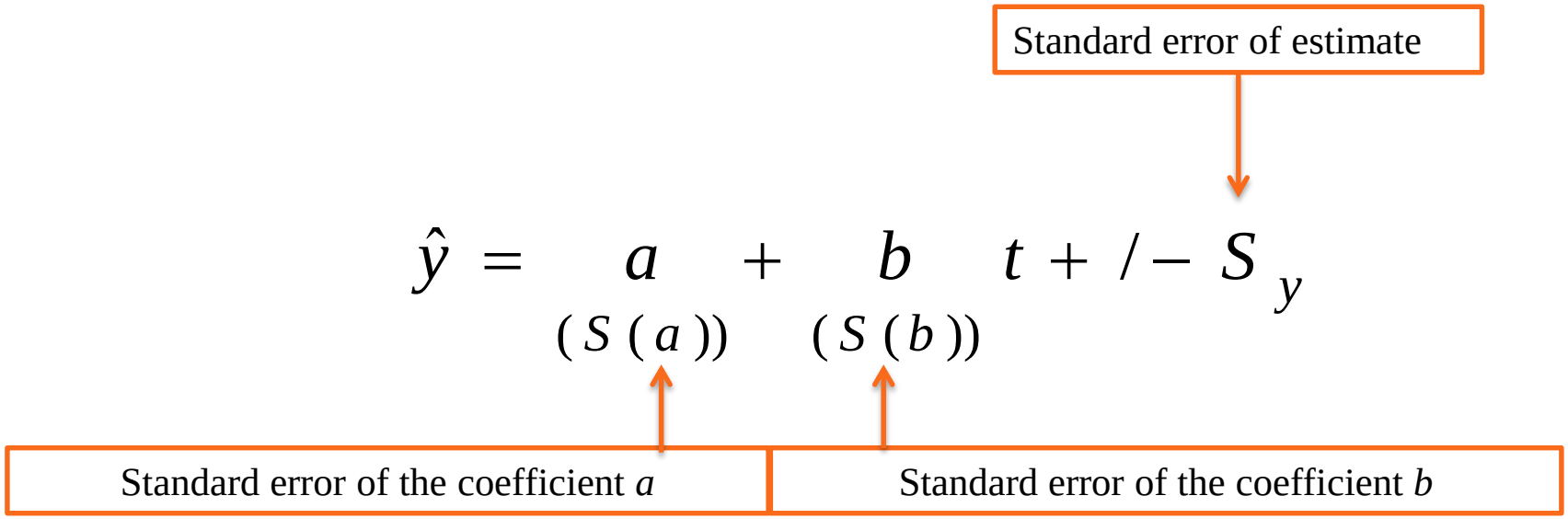
$$\hat{y} = a + bt$$

Predicted sales (1985)

$$\hat{y} = 17.26 + 0.63 * 11 = 24.19$$

STATISTICA

ANALYSIS OF THE ERRORS



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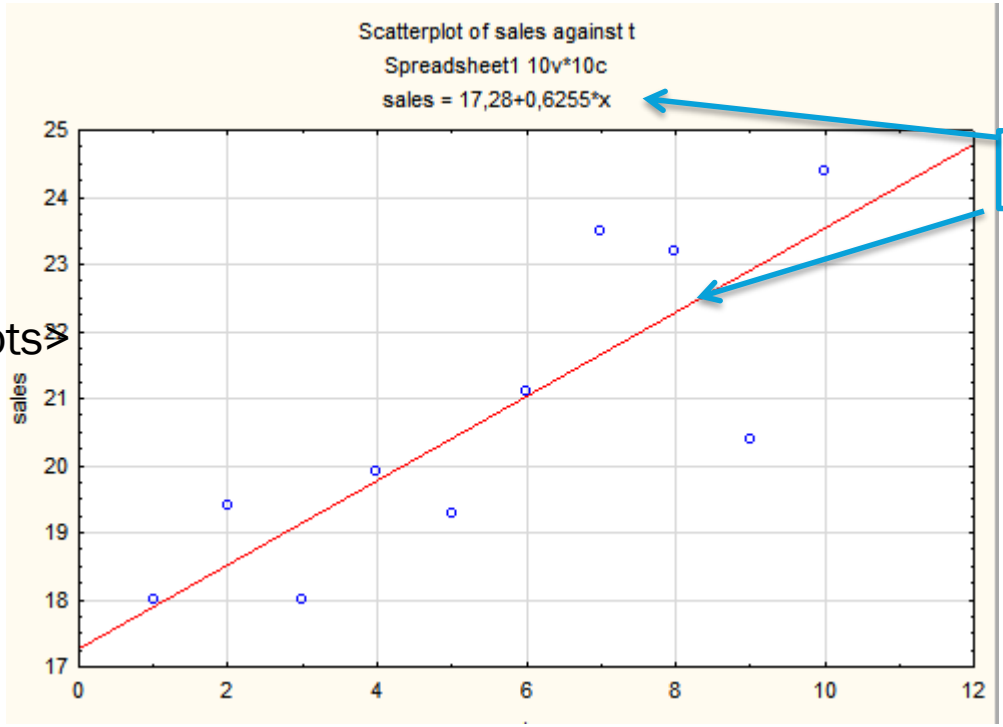
	1 year	2 sales	3 t	4 Var4	5 Var5
1	1975	18	1		
2	1976	19,4	2		
3	1977	18	3	New variable	
4	1978	19,9	4		
5	1979	19,3	5		
6	1980	21,1	6		
7	1981	23,5	7		
8	1982	23,2	8		
9	1983	20,4	9		
10	1984	24,4	10		

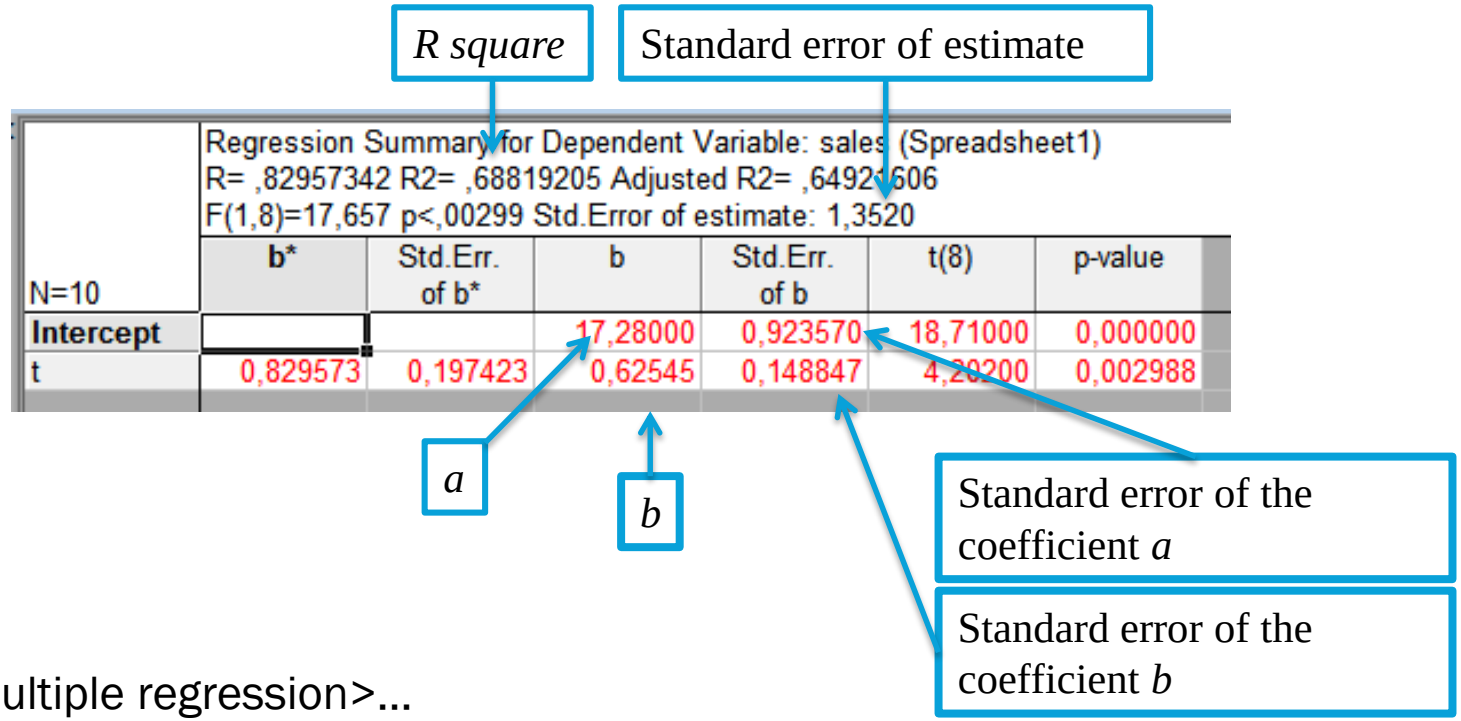
TASK 3. (3)

Graphs>Scatterplots>



Regression line/model

TASK. 3.(4)



Statistics>Multiple regression>...

$$\hat{y} = \underset{(0.92)}{17.28} + \underset{(0.15)}{0.63}\ t +/- 1.35$$

$$R^2 = 0.69$$

TASK 3. (5)

Variable	Predicting Values for (Spreadsheet1) variable: sales **b-Weight**	Value	b-Weight * Value
t	0,625455	11,00000	6,88000
Intercept			17,28000
Predicted			24,16000
-95,0%CL			22,03024
+95,0%CL			26,28976

Predicted sales (1985)

PREPARATION FOR THE NEXT CLASSES

McClave, J. T., Benson, P. G., Sincich, T. (2008) , *Statistics for Business & Economics*, Pearson Education Inc., New Jersey.

Thank you for your attention

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