p69. exercise 3.1 Production Units vs. Overhead (Hand + SAS)

Production (in 10,000) units	5	6	7	8	9	10	11
Overhead costs (in \$1000)	12	11.5	14	15	15.4	15.3	17.5

$$\begin{split} y_i &= \beta_0 + \beta_1 x_i + \epsilon_i \,, \, i = 1, \dots, n \,, \, \epsilon_i \sim i.i.d \, N(0, \sigma^2) \\ -> & n = 7, \sum_{i=1}^n x_i = 56, \sum_{i=1}^n y_i = 100.7, \sum_{i=1}^n x_i y_i = 831.1, \sum_{i=1}^n x_i^2 = 476 \\ --> & \hat{y} = b_o + b_1 x, \, b_1 = \frac{\sum_{i=1}^n x_i y_i - \frac{1}{n} (\sum_{i=1}^n x_i) (\sum_{i=1}^n y_i)}{\sum_{i=1}^n x_i^2 - \frac{1}{n} (\sum_{i=1}^n x_i)^2} = 0.9107, \end{split}$$

$$b_0 = \overline{y} - b_1 \overline{x} = 7.1$$

 $\hat{y} = 7.1 + 0.9107x$ (Least Square Estimator)

Using SAS (proc reg)

```
/** p69. exercise 3-1 Production Units vs. Overhead **/
* Input data;
data budget ;
input production overhead @@;
5 12 6 11.5 7 14 8 15 9 15.4 10 15.3 11 17.5
run ;
proc print data=budget ;
* Simple linear regression (proc reg);
proc reg data=budget ;
model overhead=production ;
plot overhead*production / conf pred ;
run ; quit ;
  SAS 시스템
                                                      2015년 09월 14일 월요일 오후 07시02분39초
                                OBS
                                       product ion
                                                     overhead
                                            5
                                                       12.0
                                 1
                                 2
                                                       11.5
                                 3
                                                       14.0
                                 4
                                            8
                                                       15.0
                                 5
                                            9
                                                       15.4
```

		6	10	15.3			
		7	11	17.5			
SAS 시	스템			2			
				2015년 09월 1	4일 월요일	오후 07시02	분39초
			The REG Proced	lure			
			Model: MODEL				
		Depen	dent Variable:	overhead			
		Number of	Observations Re	ead 7			
			Observations Us				
		Trainsel 01	05001 (4010110 01				
			Analysis of Var	iance			
			Sum of	Mean			
	Source	DF	Squares	Square	F Value	Pr > F	
	Model	1	23.22321	23.22321	40.24	0.0014	
	Error	5	2.88536	0.57707			
	Corrected Total	6	26.10857				
	Poo	t MSE	0.75965	R-Square	0.8895		
		endent Mean	14.38571		0.8674		
		ff Var	5.28060	Adj K Sq	0.0074		
	COE	II vai	5.28000				
			Parameter Estim	ates			
		Dor	ameter St	andard			
	Variable		timate St	Error t Val	ue Pr >	1+1	
	varrabre	Dr ES	timate	EIIOI t Vai	ue II >		
	_	1 7	. 10000 1	. 18383 6.	00 0.0	0018	
	Intercent		.10000	10303 0.	0.0		
	Intercept		01071	14356 6	34 0.0	0014	
nverhead =	production		.91071 0	0.14356 6.	34 0.0	0014	
overhead =			.91071 0	0.14356 6.	34 0.0	0014	N 7
	production		.91071 0	0.14356 6.	34 0.0	0014	N 7 7 Rs 0,1
	production		.91071 0).14356 6.	34 0.0	0014	Rs 0,1 Ac
18-	production		.91071 0	0.14356 6.	34 0.0	0014	Rs 0,1 Ac
20 -	production		.91071 0	0.14356 6.	34 0.0	0014	Rs
18-	production		.91071 0	0.14356 6.	34 0.0	0014	Rs 0,1 Ac
18-	production		.91071	0.14356 6.	34 0.0	0014	Rs 0,1 Ac
18 - 16 - 14 14 15 - 14 16 - 14 16 - 14 16 - 14 16 - 16	production		.91071 0	0.14356 6.	34 0,0	0014	Rs 0,1 Ac
18-	production		.91071	0.14356 6.	34 0.0	0014	Rs 0,1 Ac
18-	production		.91071	0.14356 6.	34 0.0	0014 ±	Rs 0,1 Ac
18 - 16 - 14 14 15 - 14 16 - 14 16 - 14 16 - 14 16 - 16	production		.91071	1.14356 6.	34 0.0	1	Rs 0,1 Ac
18-16-12-+	production		.91071	0.14356 6.	34 0.0	1	Rs 0,1 Ac
18-	production		.91071	0.14356 6.	34 0.0	10	Rs 0,1 Ac