

TI-83 Labs For Statistics 514

Design of Experiments

by

Jonathan Kuhn, Ph.D.
Associate Professor of Statistics,
Mathematics and Physics Section,
Purdue University North Central

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TI-83 Lab 1 For Statistics 514

Topics:

Part V. Statistical Methods Useful in Quality Improvement

Chapter 16. Single-Factor ANOVA Model and Tests

Chapter 17. Analysis of Factor Level Effects

Critical Contrast Values (CCV),

pairwise comparisons from data/stats (PAIRWISE, PAIRSTAT),

CIs for contrasts (CSTCI, CSTCISTA)

Dataset(s): “mice.dat”, a dataset on effect of air temperature on the rate of oxygen consumption ROC of 16 deer mice,

temp →	0°C	10°C	20°	30°
	10.3	9.7	3.6	7.8
	14.0	11.2	5.3	10.0
	12.6	10.5	4.6	6.3
	11.4	7.9	5.3	7.6

One-Factor Analysis of Variance Test. Given the “mice.dat”, test whether the average rate of oxygen consumption is the same or different for the four different temperatures.

- First store the ROCs at the four different temperatures in the lists (L_1, L_2, L_3, L_4).
- Under the null that the average ROCs are the same, the p-value is given by:

– STAT TESTS F:ANOVA(L_1 , L_2 , L_3 , L_4) ENTER

The p-value 0.000049 is returned.

Critical Contrast Values. Given the “cotton.dat”, calculate Fisher’s CCV, Bonferroni’s CCV and Scheffe’s CCV to be used in testing if the contrast $\theta = -\frac{1}{4}(\mu_1 + \mu_2 + \mu_3 + \mu_4) + \mu_5$ is significant at $\alpha = 0.05$ if we assume this is one of $k = 4$ contrasts.

- Type the five sets of data into L_1, \dots, L_5 .
- Type PRGM CCV ENTER
- Type 5 ENTER for the number of treatments (T).

- Type 0.05 for the value of α .
- Type 4 ENTER for the number of contrasts (K).
- Type $\{-.25, -.25, -.25, -.25, 1\}$ ENTER for the coefficients of the contrast θ considered ({CONTRAST}?)
- The program returns:

FISHER	2.49
BONFERRONI	3.25
SCHEFFE	4.01

PAIRWISE: Pairwise Comparisons From Data. For “cotton.dat”, use Fisher’s LSD test, Bonferroni’s LSD test, Scheffe’s LSD test and Tukey’s LSD test, to decide if there are any significant differences in the i -th mean tensile strength of fiber and the j -th mean tensile strength of fiber, for all i and j , at $\alpha = 0.05$.

- Type the five sets of data into L_1, \dots, L_5 .
- Type PRGM PAIRWISE ENTER
- Type 5 ENTER for the number of treatments (T).
- Type 4.17 ENTER for the value of the studentized range (Q).
- Type 0.05 for α .
- Type $\{1,1,1,1\}$ for $\{F,B,S,T\}$? to choose all four the LSD tests.
- The output for the Fisher LSD gives (by pressing ENTER appropriately):

I	J	MI-MJ	LSD	S?
(2)	(1)	1.5	3.1	N
(3)	(1)	5.7	3.1	S
(4)	(1)	7.7	3.1	S
(5)	(1)	12.2	3.1	S
(3)	(2)	4.2	3.1	S
(4)	(2)	6.2	3.1	S
(5)	(2)	10.7	3.1	S
(4)	(3)	2	3.1	N
(5)	(3)	6.5	3.1	S
(5)	(4)	4.5	3.1	S

and

UNOR	ORD	
9.8	9.8	I
15.5	11.3	I
17.5	15.5	I
22	17.5	I
11.3	22	

where, in the first table, I is the i -th treatment and J is the j -th observation, and $MI - MJ$ is the difference in the means and S? means "significant?". In the second table, UNOR is the unordered set of treatment means, and ORD is the ordered set of treatment means and where the "I"s indicate which treatments are not significant.

- For the Bonferroni LSD, the program returns the following information:

I	J	MI - MJ	LSD	S?
(2)	(1)	1.5	4.7	N
(3)	(1)	5.7	4.7	S
(4)	(1)	7.7	4.7	S
(5)	(1)	12.2	4.7	S
(3)	(2)	4.2	4.7	N
(4)	(2)	6.2	4.7	S
(5)	(2)	10.7	4.7	S
(4)	(3)	2	4.7	N
(5)	(3)	6.5	4.7	S
(5)	(4)	4.5	4.7	S

and

UNOR	ORD		
9.8	9.8	I	
15.5	11.3	I	I
17.5	15.5	I	I
22	17.5		I I
11.3	22		I

- For the Scheffe LSD, the program returns the following information:

I	J	MI-MJ	LSD	S?
(2)	(1)	1.5	5.1	N
(3)	(1)	5.7	5.1	S
(4)	(1)	7.7	5.1	S
(5)	(1)	12.2	5.1	S
(3)	(2)	4.2	5.1	N
(4)	(2)	6.2	5.1	S
(5)	(2)	10.7	5.1	S
(4)	(3)	2	5.1	N
(5)	(3)	6.5	5.1	S
(5)	(4)	4.5	5.1	S

and

UNOR	ORD			
9.8	9.8	I		
15.5	11.3	I	I	
17.5	15.5		I	I
22	17.5			I
11.3	22			I

- For the Tukey LSD, the program returns the following information:

I	J	MI-MJ	LSD	S?
(2)	(1)	1.5	4.5	N
(3)	(1)	5.7	4.5	S
(4)	(1)	7.7	4.5	S
(5)	(1)	12.2	4.5	S
(3)	(2)	4.2	4.5	N
(4)	(2)	6.2	4.5	S
(5)	(2)	10.7	4.5	S
(4)	(3)	2	4.5	N
(5)	(3)	6.5	4.5	S
(5)	(4)	4.5	4.5	S

and

UNOR	ORD			
9.8	9.8	I		
15.5	11.3	I	I	
17.5	15.5		I	I
22	17.5			I
11.3	22			I

PAIRSTAT: Pairwise Comparisons From Summary Statistics. For $t = 4$ treatment means, $\{4.2, 5.1, 7.5, 2.5\}$ of sample sizes $\{4, 5, 4, 6\}$ and standard deviation of $s = 0.25$ use Fisher's LSD test to decide if there are any significant differences in the i -th mean tensile strength of fiber and the j -th mean tensile strength of fiber, for all i and j , at $\alpha = 0.05$.

- Type the five sets of data into L_1, \dots, L_5 .
- Type PRGM PAIRSTAT ENTER
- Type 4 ENTER for the number of treatments (T).
- Type $\{4,5,4,6\}$ ENTER for the sample sizes of the data sets.
- Type $\{4.2, 5.1, 7.5, 2.5\}$ ENTER for the treatment means.
- Type 0.25 ENTER for the standard deviation.
- Type 4.17 ENTER for the value of the studentized range (Q).
- Type 0.05 for α .
- Type $\{1,0,0,0\}$ for $\{F,B,S,T\}$? to choose the Fisher LSD test.
- The output for the Fisher LSD gives (by pressing ENTER appropriately):

I	J	MI-MJ	LSD	S?
(2)	(1)	1.7	0.4	S
(3)	(1)	2.6	0.4	S
(4)	(1)	5	0.3	S
(3)	(2)	0.9	0.4	S
(4)	(2)	3.3	0.3	S
(4)	(3)	2.4	0.3	S

and

UNOR	ORD
4.2	2.5
5.1	4.2
7.5	5.1
2.5	7.5

where, in the first table, I is the i -th treatment and J is the j -th observation, and MI-MI is the difference in the means and S? means "significant"? and, in the second table, UNOR is the unordered set of treatment means, and ORD is the ordered set of treatment means.

CSTCI: Confidence Intervals For Contrasts From Data. Given the “cotton.dat”, calculate four confidence intervals (Fisher, Bonferroni Scheffe and Tukey) for the contrast $\theta = \frac{1}{2}(-\mu_1 + \mu_2 + \mu_3 - \mu_4) + (0)\mu_5$ (one of $k = 4$ CIs) where the studentized range statistic is $q = 4.17$ and where $\alpha = 0.05$.

- Type the five sets of data into L_1, \dots, L_5 .
- Type PRGM CSTCI ENTER
- Type 5 ENTER for the number of treatments (T).
- Type 4 ENTER for the number of contrasts (K).
- Type 4.17 ENTER for the value of the studentized range (Q).
- Type 0.05 for the value of α .
- Type $\{-.5, .5, .5, -.5, 0\}$ ENTER for the coefficients of the contrast θ considered ({CONTRAST}?)
- The program returns the following 95% CIs:

FI	-1.65	2.81
BF	-2.33	3.49
SH	-3.01	4.17
TK	-2.61	3.77

where FI is Fisher, BF is Bonferroni, SH is Scheffe and TK is Tukey.

CSTCISTA: Confidence Intervals For Contrasts From Summary Statistics. Given $t = 5$ treatments, where the means are $\{2.5, 3.1, 4.5, 1.2, 6.5\}$ and the sample sizes are $\{5, 5, 5, 5, 5\}$ and the standard deviation is $s = 0.45$, calculate four confidence intervals (Fisher, Bonferroni Scheffe and Tukey) for the contrast $\theta = \frac{1}{2}(-\mu_1 + \mu_2 + \mu_3 - \mu_4) + (0)\mu_5$ (one of $k = 4$ CIs) where the studentized range statistic is $q = 4.17$ and where $\alpha = 0.05$.

- Type the five sets of data into L_1, \dots, L_5 .
- Type PRGM CSTCISTA ENTER
- Type 5 ENTER for the number of treatments (T).
- Type 4 ENTER for the number of contrasts (K).
- Type 4.17 ENTER for the value of the studentized range (Q).

- Type .45 ENTER for the value of the standard deviation (S).
- Type 0.05 for the value of α .
- Type $\{-.5, .5, .5, -.5, 0\}$ ENTER for the coefficients of the contrast θ considered ({CONTRAST}?)
- Type $\{5, 5, 5, 5, 5\}$ ENTER for the treatment sample sizes, ({SAMPLES SIZES}?)
- Type $\{2.5, 3.1, 4.5, 1.2, 6.5\}$ ENTER for the treatment means, ({MEANS}?)
- The program returns the following 95% CIs:

FI	1.53	2.37
BF	1.4	2.5
SH	1.27	2.63
TK	1.36	2.54

where FI is Fisher, BF is Bonferroni, SH is Scheffe and TK is Tukey.