ljgormezano 2005

PROC ANOVA and PROC GLM

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OPTIONS NOCENTER NODATE NONUMBER LS=80 PS=40 MISSING='.';

*****************************************************************
*PROGRAM TO ILLUSTRATE USE OF PROC ANOVA, PROC GLM - ANALYSIS OF
*VARIANCE IS USED TO TEST THE DIFFERENCE BETWEEN MEAN TEST GRADES
*OF STUDENTS ON A MATH EXAM TAUGHT BY ONE OF 3 DIFFERENT PROFESSORS
* AND HAVING EITHER 1 OR 2 YEARS OF CALCULUS UNDER THEIR BELTS.
*LJ GORMEZANO --CREATED 3/6/05
*****************************************************************;

DATA MATH;
      INPUT CALC 1 PROF $3 GRADE 5-7;
      CARDS;
1 A 65
1 B 70
1 C 90
1 B 85
1 B 95
1 C 100
1 A 75
1 C 89
2 B 87
2 A 73
2 C 75
2 A 55
2 B 79
2 C 98
2 A 82
;

PROC SORT DATA=MATH;
      BY CALC PROF;
RUN;

*ONE-WAY ANOVA TO TEST THE EFFECT OF HAVING A DIFFERENT PROFESSOR ON MEAN
TEST GRADES;
PROC ANOVA DATA=MATH;
      CLASS PROF;
      MODEL GRADE=PROF;
RUN;
```

The ANOVA Procedure
Class Level Information

```
Class         Levels    Values
PROF               3    A B C
Number of observations    15
```

```
The ANOVA Procedure
Dependent Variable: GRADE
```

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1070.400000	535.200000	5.51	0.0201
Error	12	1166.000000	97.166667		
Corrected Total	14	2236.400000			

R-Square	Coeff Var	Root MSE	GRADE Mean
0.478626	12.13955	9.857315	81.20000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
PROF	2	1070.400000	535.200000	5.51	0.0201

```
*ONE-WAY ANOVA TO TEST THE EFFECT OF PROFESSOR ON MEAN TEST GRADES;
PROC ANOVA DATA=MATH;
      CLASS PROF;
      MODEL GRADE=PROF;
      MEANS PROF/LSD BON;
RUN;
```

The ANOVA Procedure
t Tests (LSD) for GRADE

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NOTE: This test controls the Type I comparisonwise error rate, not the
experimentwise error rate.

Alpha                           0.05
Error Degrees of Freedom          12
Error Mean Square            97.16667
Critical Value of t           2.17881
Least Significant Difference   13.583

Means with the same letter are not significantly different.

  tGrouping     Mean      N    PROF
     A        90.400      5    C
     A
B    A        83.200      5    B
B
B             70.000      5    A
```

The ANOVA Procedure
Bonferroni (Dunn) t Tests for GRADE

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	12
Error Mean Square	97.16667
Critical Value of t	2.77947
Minimum Significant Difference	17.328

Means with the same letter are not significantly different.

Bon Grouping	Mean	N	PROF
A	90.400	5	C
A			
B A	83.200	5	B
B			
B	70.000	5	A

```
*TWO-WAY ANOVA USING PROC GLM TO TEST THE EFFECT OF PROFESSOR ON
MEAN TEST GRADES;
PROC GLM DATA=MATH;
      CLASS CALC PROF;
      MODEL GRADE=CALC PROF CALC*PROF;
      LSMEANS CALC PROF CALC*PROF/ADJUST=BON TDIFF PDIFF;
      CONTRAST 'A VS. C' PROF 1 0 -1;
      CONTRAST 'A VS. B' PROF 1 -1 0;
      CONTRAST 'B VS. C' PROF 0 1 -1;
RUN;
```

The GLM Procedure
Class Level Information

Class	Levels	Values
CALC	2	1 2
PROF	3	A B C
Number of observations	15	

The GLM Procedure
Dependent Variable: GRADE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	1121.233333	224.246667	1.81	0.2070
Error	9	1115.166667	123.907407		
Corrected Total	14	2236.400000			

R-Square	Coeff Var	Root MSE	GRADE Mean
0.501356	13.70858	11.13137	81.20000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
CALC	1	100.8107143	100.8107143	0.81	0.3906
PROF	2	988.2670635	494.1335317	3.99	0.0575
CALC*PROF	2	32.1555556	16.0777778	0.13	0.8799

Source	DF	Type III SS	Mean Square	F Value	Pr > F
CALC	1	18.6777778	18.6777778	0.15	0.7069
PROF	2	970.8222222	485.4111111	3.92	0.0597
CALC*PROF	2	32.1555556	16.0777778	0.13	0.8799

The GLM Procedure
Least Squares Means

CALC	GRADE LSMEAN
1	82.1111111
2	79.8333333

PROF	GRADE LSMEAN
A	70.0000000
B	83.1666667
C	89.7500000

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Bonferroni

PROF	GRADE LSMEAN	LSMEAN Number
A	70.0000000	1
B	83.1666667	2
C	89.7500000	3

Least Squares Means for Effect PROF
t for H0: LSMean(i)=LSMean(j) / Pr > |t|

Dependent Variable: GRADE

i/j	1	2	3
1		-1.83245	-2.74868
		0.3003	0.0676
2	1.832453		-0.91623
	0.3003		1.0000
3	2.748679	0.916226	
	0.0676	1.0000	

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Bonferroni

CALC	PROF	GRADE LSMEAN	LSMEAN Number
1	A	70.0000000	1
1	B	83.3333333	2
1	C	93.0000000	3
2	A	70.0000000	4
2	B	83.0000000	5
2	C	86.5000000	6

Least Squares Means for Effect CALC*PROF
t for H0: LSMean(i)=LSMean(j) / Pr > |t|

Dependent Variable: GRADE

i/j	1	2	3	4	5	6
1		-1.31214	-2.26344	0	-1.16787	-1.4823
		1.0000	0.7484	1.0000	1.0000	1.0000
2	1.312142		-1.06359	1.467019	0.032804	-0.31163
	1.0000		1.0000	1.0000	1.0000	1.0000
3	2.263444	1.063589		2.530608	0.984106	0.639669
	0.7484	1.0000		0.4830	1.0000	1.0000
4	0	-1.46702	-2.53061		-1.27934	-1.62378
	1.0000	1.0000	0.4830		1.0000	1.0000
5	1.167871	-0.0328	-0.98411	1.279338		-0.31443
	1.0000	1.0000	1.0000	1.0000		1.0000
6	1.482297	0.311634	-0.63967	1.623775	0.314427	
	1.0000	1.0000	1.0000	1.0000	1.0000	

The GLM Procedure
Dependent Variable: GRADE

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
A VS. C	1	936.1500000	936.1500000	7.56	0.0225
A VS. B	1	416.0666667	416.0666667	3.36	0.1001
B VS. C	1	104.0166667	104.0166667	0.84	0.3834