

## Custom tests and contrasts in factorial ANOVA: Potato data

```
/* potato.sas */
options linesize=79 noovp formdlim='_';
title 'Rotten potatoes: STA442/1008 F 2005';
title2 'Custom tests with proc reg and proc glm';

data spud;
  infile 'potato2.dat' firstobs=2; /* Skip the first line that R uses */
  input id bact temp rot;
  if temp=1 and bact=1 then mu11=1; else mu11=0;
  if temp=1 and bact=2 then mu12=1; else mu12=0;
  if temp=1 and bact=3 then mu13=1; else mu13=0;
  if temp=2 and bact=1 then mu21=1; else mu21=0;
  if temp=2 and bact=2 then mu22=1; else mu22=0;
  if temp=2 and bact=3 then mu23=1; else mu23=0;
  combo = 10*temp+bact;

proc means;
  class bact temp;
  var rot;
/* Better looking output from proc tabulate */

proc tabulate;
  class bact temp;
  var rot;
  table (temp all),(bact all) * (mean*rot);

proc glm;
  title3 'Standard 2-way ANOVA with proc glm';
  class bact temp;
  model rot=temp|bact;
  means temp*bact;

/* Now generate the tests for main effects and interaction, and also 2 tests
for bacteria type, once just for low temp and once just for high. Do this
first with test statements in proc reg, and then with contrasts in proc glm.

      BACTERIA TYPE
TEMP    1         2         3
  1     mu11      mu12      mu13
  2     mu21      mu22      mu23
*/

proc reg;
  title3 'Using the proc reg test statement';
  model rot = mu11--mu23 / noint;
  overall: test mu11=mu12=mu13=mu21=mu22=mu23;
  temper:  test mu11+mu12+mu13=mu21+mu22+mu23;
  bacter:  test mu11+mu21=mu12+mu22,
              mu12+mu22=mu13+mu23;
  B_by_T:  test mu11-mu21=mu12-mu22=mu13-mu23;
  BjustLO: test mu11=mu12=mu13;
  BjustHI: test mu21=mu22=mu23;
```

```

/* Definition: A contrast is a linear combination whose coefficients
add to zero. We can test whether collections of contrasts
of cell means are all to equal zero.*/

```

```

proc glm;
title3 'Test contrasts with proc glm';
class combo;
model rot=combo;
contrast 'Main Effect for Temperature'
  combo 1 1 1 -1 -1 -1;
contrast 'Main Effect for Bacteria'
  combo 1 -1 0 1 -1 0,
  combo 0 1 -1 0 1 -1;
contrast 'Temperature by Bacteria Interaction'
  combo 1 -1 0 -1 1 0,
  combo 0 1 -1 0 -1 1;
contrast 'Bacteria Just for Low Temp'
  combo 1 -1 0 0 0 0,
  combo 0 1 -1 0 0 0;
contrast 'Bacteria Just for High Temp'
  combo 0 0 0 1 -1 0,
  combo 0 0 0 0 1 -1;

```

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Custom tests with proc reg and proc glm  
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The MEANS Procedure

Analysis Variable : rot

bact	temp	N		Mean	Std Dev	Minimum
		Obs	N			
1	1	9	9	3.5555556	4.2752518	0
	2	9	9	7.0000000	3.5355339	0
2	1	9	9	4.7777778	3.1135903	0
	2	9	9	13.5555556	6.3267510	3.0000000
3	1	9	9	8.0000000	4.5552168	2.0000000
	2	9	9	19.5555556	5.5251948	8.0000000

Analysis Variable : rot

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	bact			All
	1	2	3	
	Mean	Mean	Mean	
	rot	rot	rot	
temp				
1	3.56	4.78	8.00	5.44
2	7.00	13.56	19.56	13.37
All	5.28	9.17	13.78	9.41

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 Custom tests with proc reg and proc glm  
 Standard 2-way ANOVA with proc glm  
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The GLM Procedure

Class Level Information

Class	Levels	Values
bact	3	1 2 3
temp	2	1 2

Number of observations      54

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 Custom tests with proc reg and proc glm  
 Standard 2-way ANOVA with proc glm  
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The GLM Procedure

Dependent Variable: rot

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	1652.814815	330.562963	15.05	<.0001
Error	48	1054.222222	21.962963		
Corrected Total	53	2707.037037			

R-Square      Coeff Var      Root MSE      rot Mean  
 0.610562      49.81676      4.686466      9.407407

Source	DF	Type I SS	Mean Square	F Value	Pr > F
temp	1	848.0740741	848.0740741	38.61	<.0001
bact	2	651.8148148	325.9074074	14.84	<.0001
bact*temp	2	152.9259259	76.4629630	3.48	0.0387

Source	DF	Type III SS	Mean Square	F Value	Pr > F
temp	1	848.0740741	848.0740741	38.61	<.0001
bact	2	651.8148148	325.9074074	14.84	<.0001
bact*temp	2	152.9259259	76.4629630	3.48	0.0387

The GLM Procedure

Level of bact	Level of temp	N	-----rot-----	
			Mean	Std Dev
1	1	9	3.5555556	4.27525178
1	2	9	7.0000000	3.53553391
2	1	9	4.7777778	3.11359028
2	2	9	13.5555556	6.32675097
3	1	9	8.0000000	4.55521679
3	2	9	19.5555556	5.52519482

The REG Procedure  
 Model: MODEL1  
 Dependent Variable: rot

NOTE: No intercept in model. R-Square is redefined.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	6431.77778	1071.96296	48.81	<.0001
Error	48	1054.22222	21.96296		
Uncorrected Total	54	7486.00000			

Root MSE	4.68647	R-Square	0.8592
Dependent Mean	9.40741	Adj R-Sq	0.8416
Coeff Var	49.81676		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
mu11	1	3.55556	1.56216	2.28	0.0273
mu12	1	4.77778	1.56216	3.06	0.0036
mu13	1	8.00000	1.56216	5.12	<.0001
mu21	1	7.00000	1.56216	4.48	<.0001
mu22	1	13.55556	1.56216	8.68	<.0001
mu23	1	19.55556	1.56216	12.52	<.0001

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The REG Procedure  
Model: MODEL1

Test overall Results for Dependent Variable rot

Source	DF	Mean Square	F Value	Pr > F
Numerator	5	330.56296	15.05	<.0001
Denominator	48	21.96296		

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The REG Procedure  
Model: MODEL1

Test temper Results for Dependent Variable rot

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	848.07407	38.61	<.0001
Denominator	48	21.96296		

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The REG Procedure  
Model: MODEL1

Test bacter Results for Dependent Variable rot

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	325.90741	14.84	<.0001
Denominator	48	21.96296		

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The REG Procedure  
Model: MODEL1

Test B\_by\_T Results for Dependent Variable rot

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	76.46296	3.48	0.0387
Denominator	48	21.96296		

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The REG Procedure  
 Model: MODEL1

Test BjustLO Results for Dependent Variable rot

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	47.44444	2.16	0.1264
Denominator	48	21.96296		

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 Using the proc reg test statement  
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The REG Procedure  
 Model: MODEL1

Test BjustHI Results for Dependent Variable rot

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	354.92593	16.16	<.0001
Denominator	48	21.96296		

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 Custom tests with proc reg and proc glm  
 Test contrasts with proc glm  
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The GLM Procedure

Class Level Information

Class	Levels	Values
combo	6	11 12 13 21 22 23

Number of observations 54

Rotten potatos: STA442/1008 F 2005 14  
 Custom tests with proc reg and proc glm  
 Test contrasts with proc glm  
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The GLM Procedure

Dependent Variable: rot

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	1652.814815	330.562963	15.05	<.0001
Error	48	1054.222222	21.962963		
Corrected Total	53	2707.037037			

R-Square	Coeff Var	Root MSE	rot Mean
0.610562	49.81676	4.686466	9.407407

Source	DF	Type I SS	Mean Square	F Value	Pr > F
combo	5	1652.814815	330.562963	15.05	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
combo	5	1652.814815	330.562963	15.05	<.0001

Contrast	DF	Contrast SS	Mean Square
Main Effect for Temperature	1	848.0740741	848.0740741
Main Effect for Bacteria	2	651.8148148	325.9074074
Temperature by Bacteria Interaction	2	152.9259259	76.4629630
Bacteria Just for Low Temp	2	94.8888889	47.4444444
Bacteria Just for High Temp	2	709.8518519	354.9259259

Contrast	F Value	Pr > F
Main Effect for Temperature	38.61	<.0001
Main Effect for Bacteria	14.84	<.0001
Temperature by Bacteria Interaction	3.48	0.0387
Bacteria Just for Low Temp	2.16	0.1264
Bacteria Just for High Temp	16.16	<.0001