```
 performed by Inna Williams

Chapter 7
#################################################################
#
  Problem 7.1
#################################################################
#

data Problem_7_1;
do BRAND = 'A', 'N', 'T';
   do SUBJECT = 1 to 8;
      input TIME @;
      output;
   end;
end;
cards;
8  10  9 11 10 10 8 12
4   7  5  5  6  7 6  4
12  8 10 10 11  9 9 12
;

proc anova data=problem_7_1;
title "Problem_7_1";
class BRAND;
model TIME=BRAND;
means BRAND / tukey;
Run;
```

Problem_7_1

The ANOVA Procedure

Class Level Information		
Class	Levels	Values
BRAND	3	A N T

Number of Observations Read	24
Number of Observations Used	24

Problem_7_1

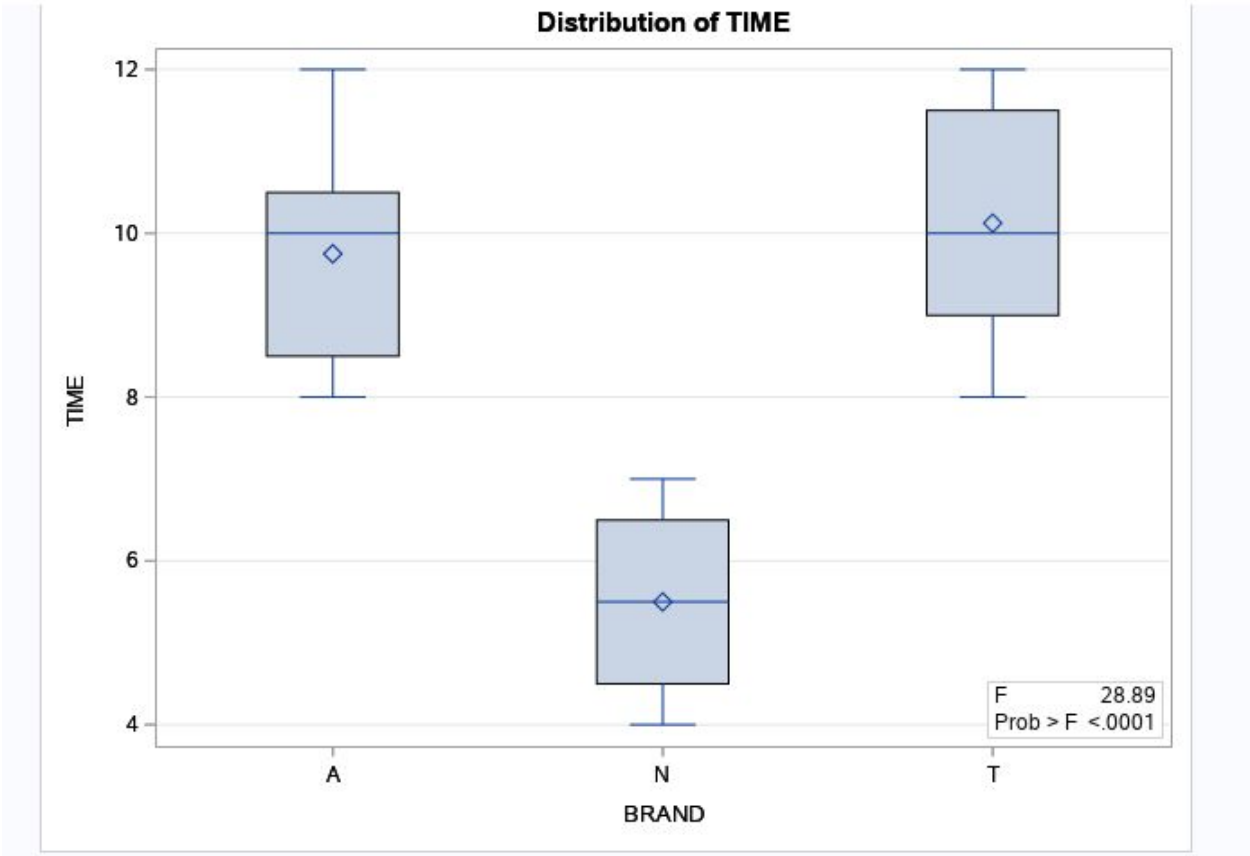
The ANOVA Procedure

Dependent Variable: TIME

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	105.5833333	52.7916667	28.89	<.0001
Error	21	38.3750000	1.8273810		
Corrected Total	23	143.9583333			

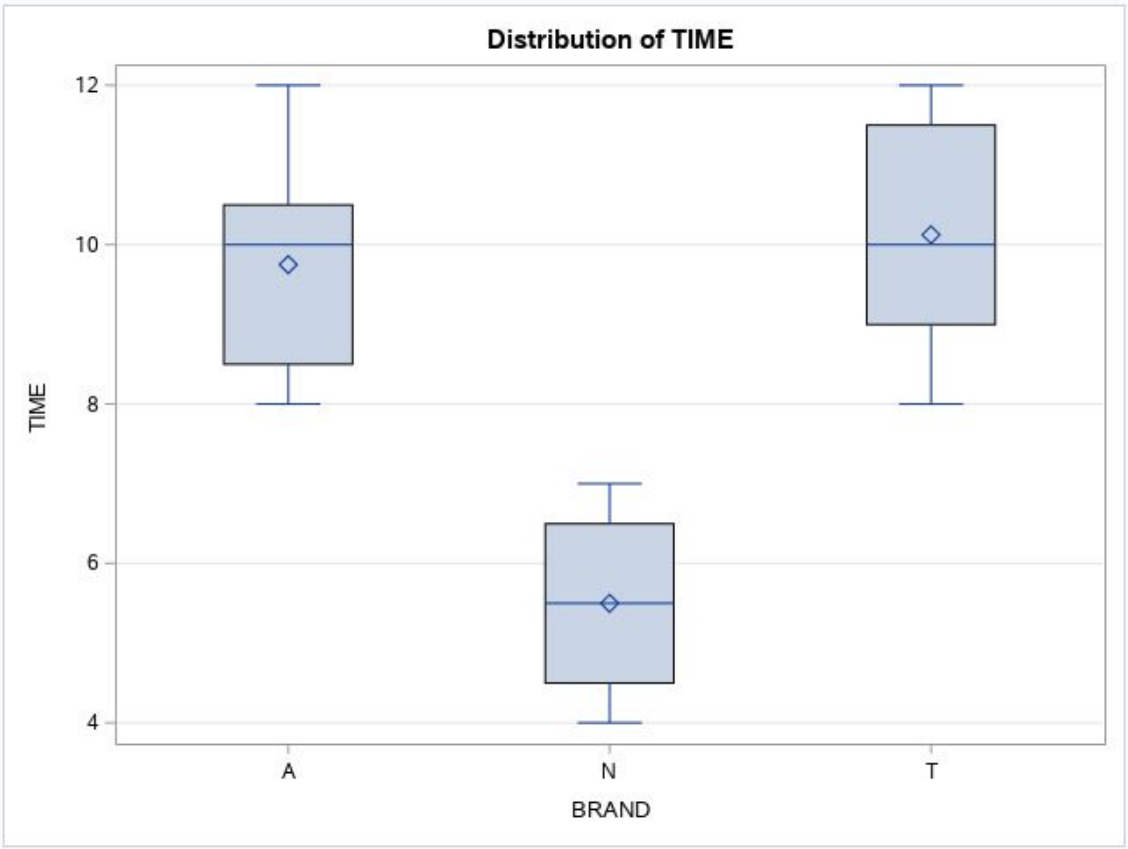
R-Square	Coeff Var	Root MSE	TIME Mean
0.733430	15.98195	1.351807	8.458333

Source	DF	Anova SS	Mean Square	F Value	Pr > F
BRAND	2	105.5833333	52.7916667	28.89	<.0001


Distribution of TIME
TIME
12
10
8
6
4
A
N
T
BRAND
F 28.89
Prob > F <.0001

Problem_7_1

The ANOVA Procedure



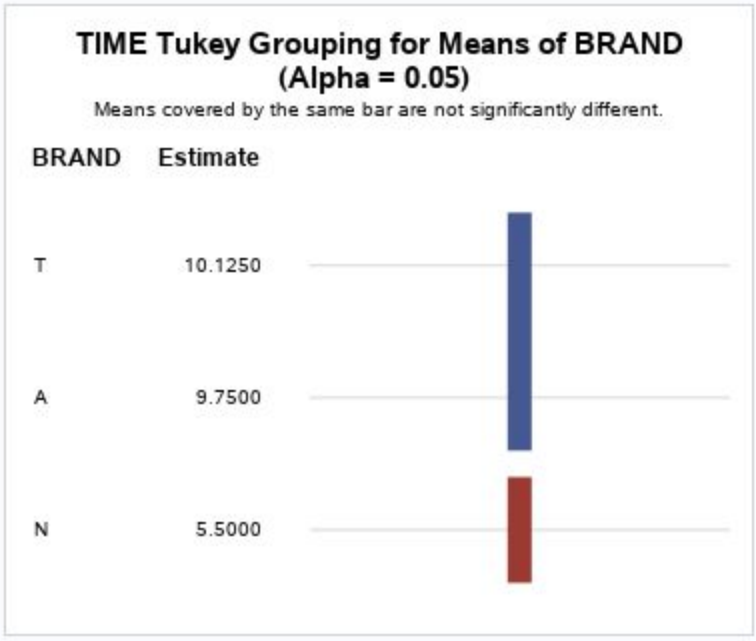
Problem_7_1

The ANOVA Procedure

Tukey's Studentized Range (HSD) Test for TIME

Note: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REG

Alpha	0.05
Error Degrees of Freedom	21
Error Mean Square	1.827381
Critical Value of Studentized Range	3.56462
Minimum Significant Difference	1.7037



Ho-> the brands are equal in wear quality
Ha-> the the brands are not equal in wear quality
F value = 28.89 p-value = 0.0001 <= alpha = 0.005

Reject Ho.

Conclusion:
At least one of the brands are not equal to one of others in wear quality.

At significance level alpha=0.05
From tukey test we can see that groups T and A are not significantly different and covered by blue bar.

```
but the Group N covered in the different color (red) than
other 2 brands (blue) and therefore group
N is significantly different from A and T at significance level
alpha = 0.05.

#####################################################################
#
  Problem 7.2
#####################################################################
#

data Problem_7_2;
do TREAT = 'A', 'B', 'Placebo';
   do SUBJECT = 1 to 10;
      input READINGS @;
      output;
   end;
end;
cards;
200 190 180 185 210 170 178 200 177 189
160 168 178 200 172 155 159 167 185 199
240 220 246 244 198 238 277 255 190 188
;

proc anova data=problem_7_2;
title "Problem_7_2";
class TREAT;
model READINGS=TREAT;
means TREAT / tukey;
run;
```

Problem_7_2

The ANOVA Procedure

Class Level Information		
Class	Levels	Values
TREAT	3	A B P

Number of Observations Read	30
Number of Observations Used	30

Problem_7_2

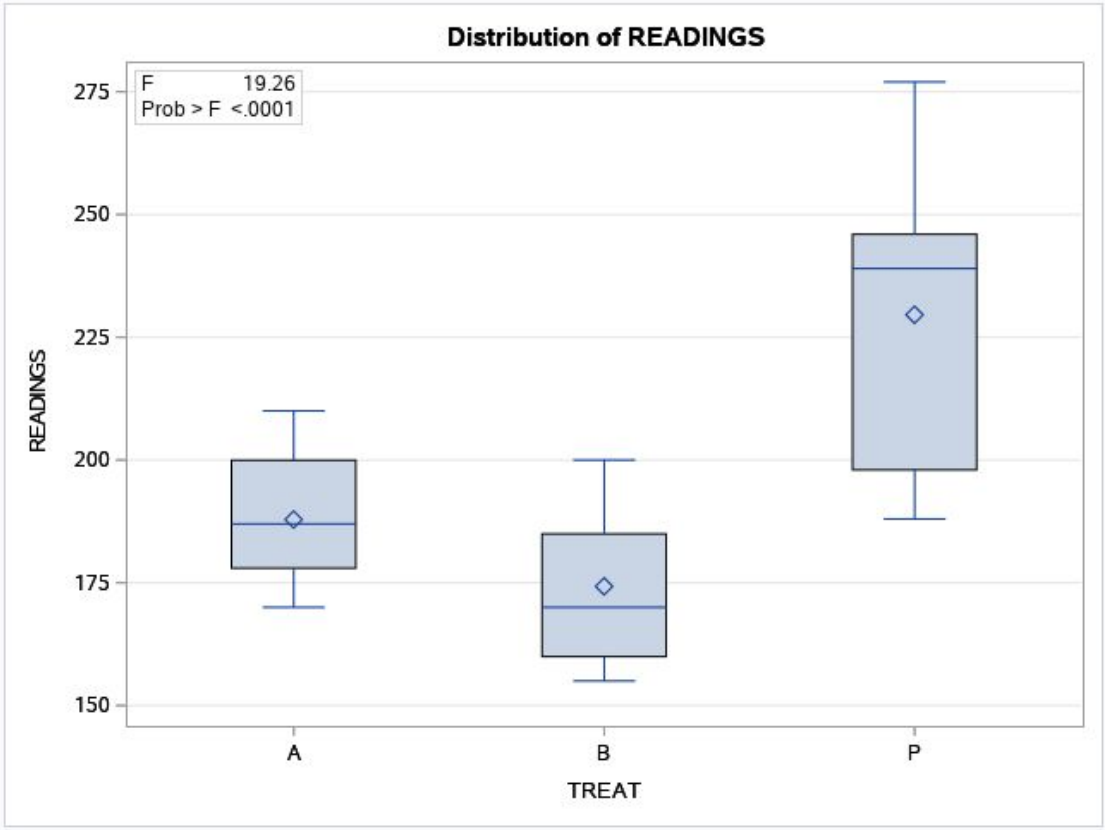
The ANOVA Procedure

Dependent Variable: READINGS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	16606.46667	8303.23333	19.26	<.0001
Error	27	11639.40000	431.08889		
Corrected Total	29	28245.86667			

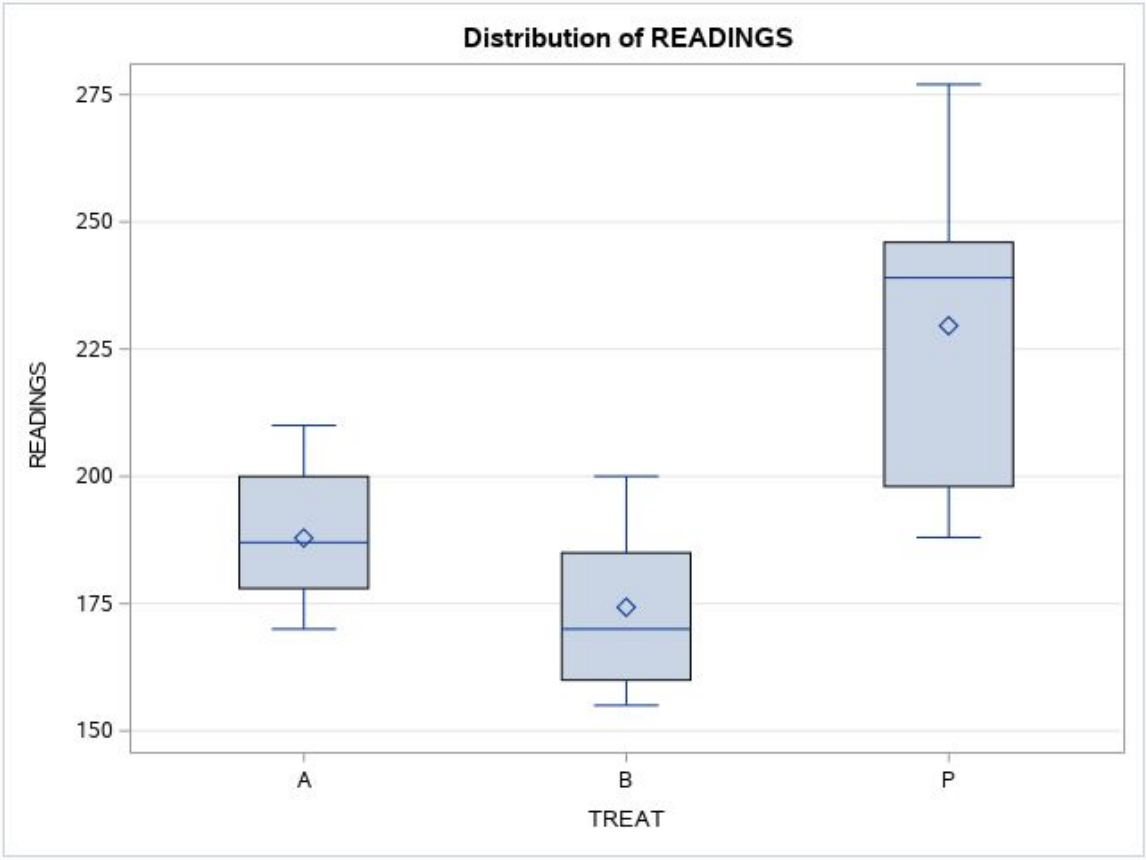
R-Square	Coeff Var	Root MSE	READINGS Mean
0.587926	10.52518	20.76268	197.2667

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TREAT	2	16606.46667	8303.23333	19.26	<.0001


Distribution of READINGS
F 19.26
Prob > F <.0001
275
250
225
200
175
150
READINGS
A
B
P
TREAT

Problem_7_2

The ANOVA Procedure



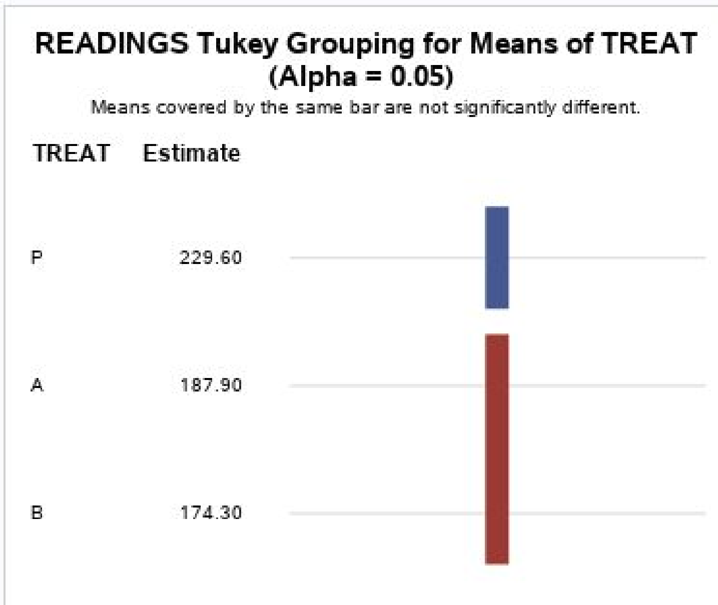
Problem_7_2

The ANOVA Procedure

Tukey's Studentized Range (HSD) Test for READINGS

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	27
Error Mean Square	431.0889
Critical Value of Studentized Range	3.50633
Minimum Significant Difference	23.022



Ho-> the treats are equal in cholesterol lowering
Ha-> the treats are not equal in cholesterol lowering
F value = 19.26   p-value = 0.0001 <= alpha = 0.005

Reject Ho.

****

Conclusion:
At least one of the treats are not equal to one of others in cholesterol lowering

At significance level alpha=0.05
From tukey test we can see that groups A and B are not significantly different and both covered by the same red bar.

```
but the Group P (placebo) covered in the different color(blue) from
other groups color (red).
Therefore group P is significantly different from
A and B at significance level alpha=0.05

#################################################################
#
Problem_7_3
#################################################################
#
data Problem_7_3;
do AGE = 'New', 'Old';
   do BRAND = 'W', 'P';
      do SUBJECT = 1 to 5;
         input BOUNCES @;
         output;
       end;
   end;
end;
cards;
67 72 74 82 81
75 76 80 72 73
46 44 45 51 43
63 62 66 62 60
;
proc anova data=problem_7_3;
title "Problem_7_3";
class BRAND AGE;
model BOUNCES=BRAND | AGE;
means BRAND | AGE;
run;
```

Problem_7_3

The ANOVA Procedure

Class Level Information		
Class	Levels	Values
BRAND	2	P W
AGE	2	New Old

Number of Observations Read	20
Number of Observations Used	20

Problem_7_3

The ANOVA Procedure

Dependent Variable: BOUNCES

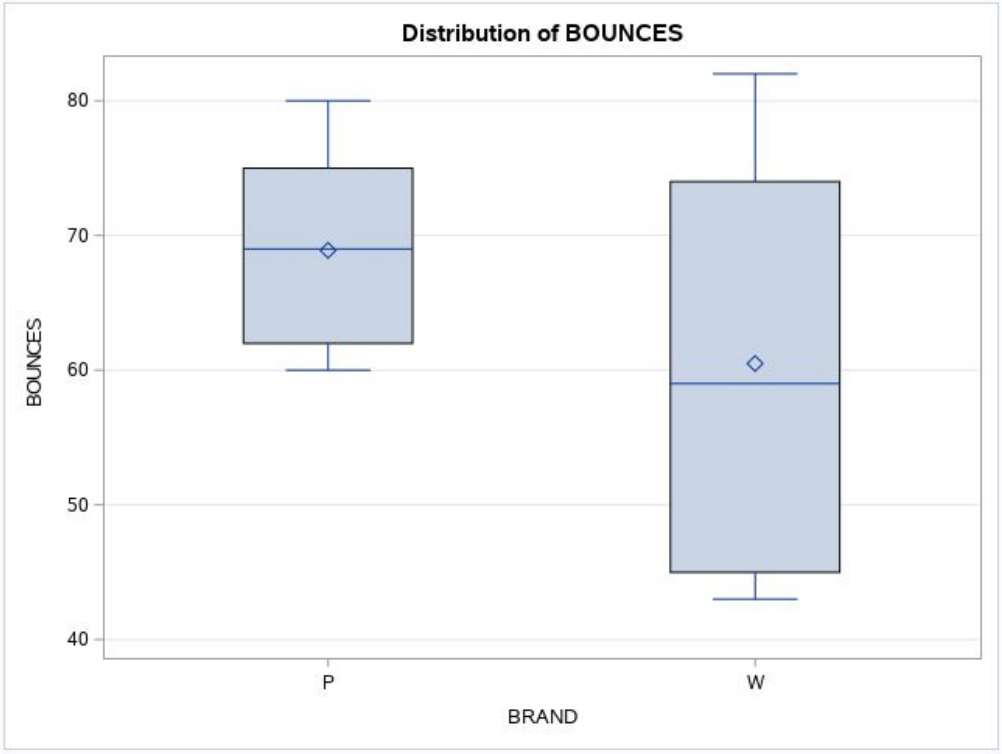
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	2910.600000	970.200000	60.73	<.0001
Error	16	255.600000	15.975000		
Corrected Total	19	3166.200000			

R-Square	Coeff Var	Root MSE	BOUNCES Mean
0.919272	6.177548	3.996874	64.70000

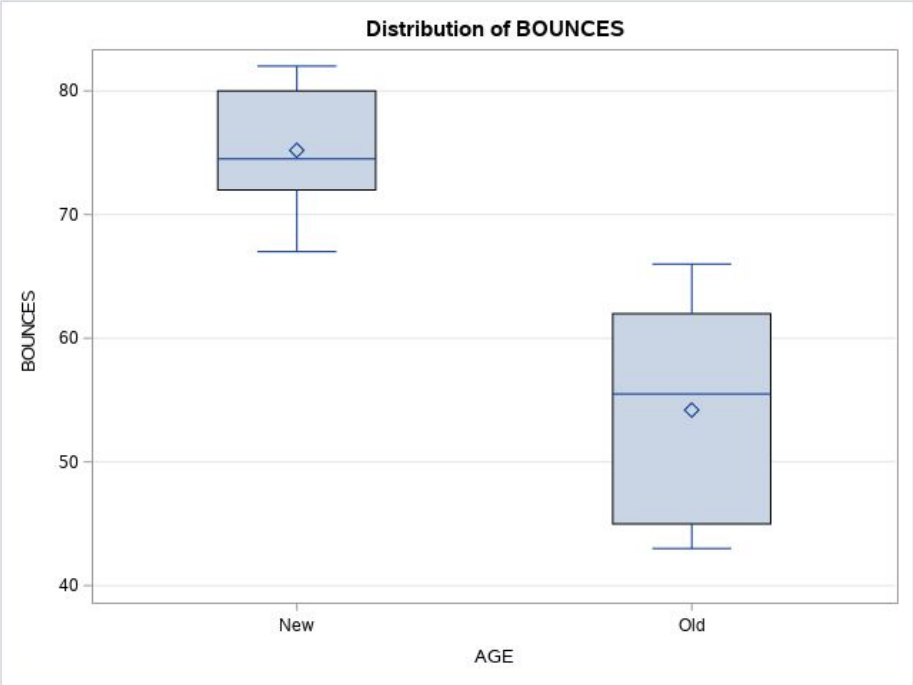
Source	DF	Anova SS	Mean Square	F Value	Pr > F
BRAND	1	352.800000	352.800000	22.08	0.0002
AGE	1	2205.000000	2205.000000	138.03	<.0001
BRAND*AGE	1	352.800000	352.800000	22.08	0.0002

Problem_7_3

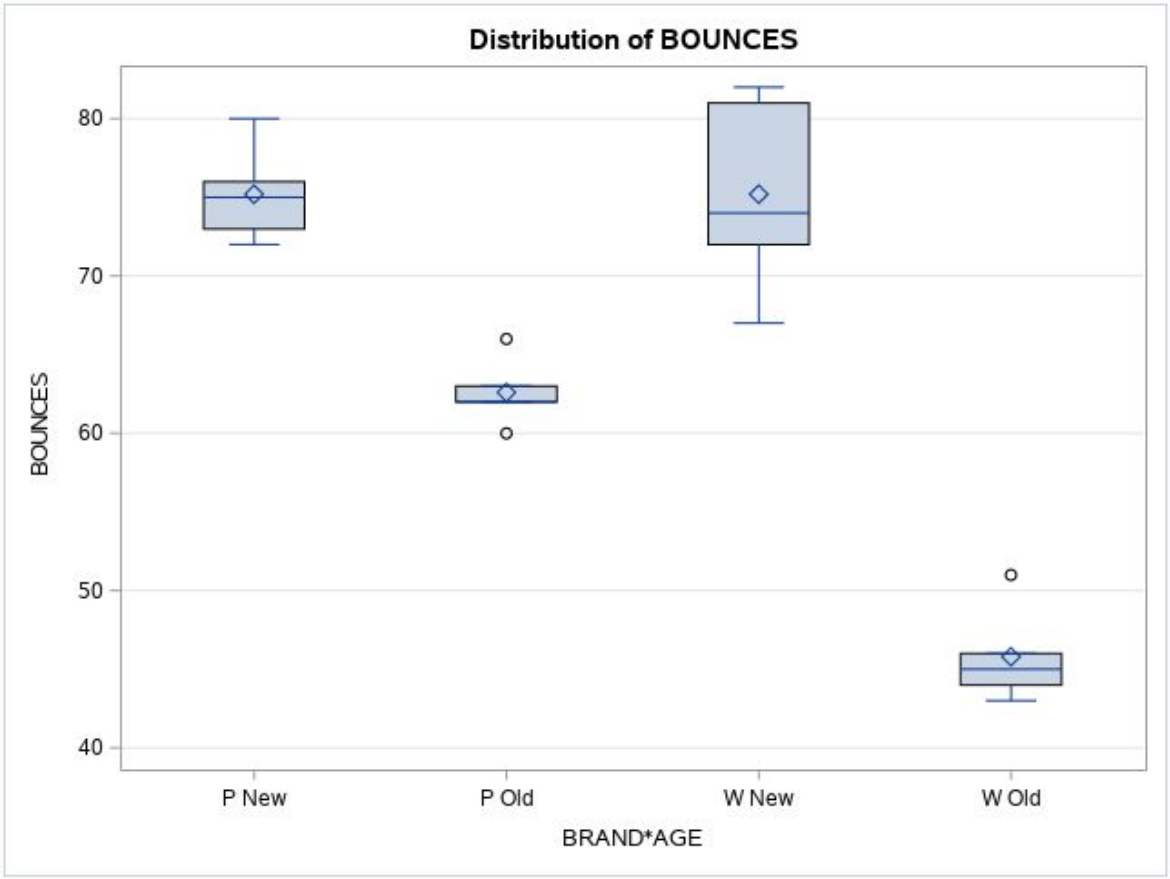
The ANOVA Procedure



Level of BRAND	N	BOUNCES	
		Mean	Std Dev
P	10	68.9000000	7.1094616
W	10	60.5000000	16.1881301



Level of AGE	N	BOUNCES	
		Mean	Std Dev
New	10	75.2000000	4.68567557
Old	10	54.2000000	9.21110441



Level of BRAND	Level of AGE	N	BOUNCES	
			Mean	Std Dev
P	New	5	75.2000000	3.11448230
P	Old	5	62.6000000	2.19089023
W	New	5	75.2000000	6.30079360
W	Old	5	45.8000000	3.11448230

****

Effects Of Age:

****

Ho-> The effects of AGE on number of bounces = zero

Ha-> The effects of AGE on number of bounces are not = zero

F-value = 138.03 p-value=0.0001 < alpha=0.05

Reject Ho.

****

Conclusion about Age:

****

At significance level alpha=0.05
effects of Age on number of bounces are significantly different
from zero.(effect of age is significant)

****

Effects Of BRAND:

****

Ho-> The effects of BRAND on number of bounces = zero
Ha-> The effects of BRAND on number of bounces are not = zero
F-value = 22.08 p-value=0.0002 < alpha=0.05

Reject Ho.

****

Conclusion about BRAND:

****

At significance level alpha=0.05
effects of BRAND on number of bounces are significantly different
from zero. (effect of BRAND is significant)

****

Effects Of BRAND and Age Interaction:

****

Ho-> The effects of Interaction of Brand and Age on the number
of bounces = zero
Ha-> The effects of Interaction of Brand and Age on the number
of bounces are not = zero
F-value = 22.08   p-value=0.0002 < alpha=0.05

Reject Ho.

****

Conclusion about BRAND and AGE interaction:

****

At significance level alpha=0.05
effects of BRAND and AGE on number of bounces are
significantly different from zero.
(effect of Age and Brand interaction is significant)

```
#########################################################################
Problem_7_4
#########################################################################
Design is unbalanced so we use GLM
data Problem_7_4;
input GROUP $ SCORE @@;
cards;
A 560 A 520 A 530 A 525 A 575 A 527 A 580 A 620
B 565 B 522 B 520 B 530 B 510 B 522 B 600 B 590
C 512 C 518 C 555 C 502 C 510 C 520 C 516
D 505 D 508 D 513 D 520 D 543 D 523 D 517
;
proc anova data=problem_7_4;
title "Problem_7_4";
class GROUP;
model SCORE=GROUP;
means GROUP / snk;
Run;
```

Problem_7_4

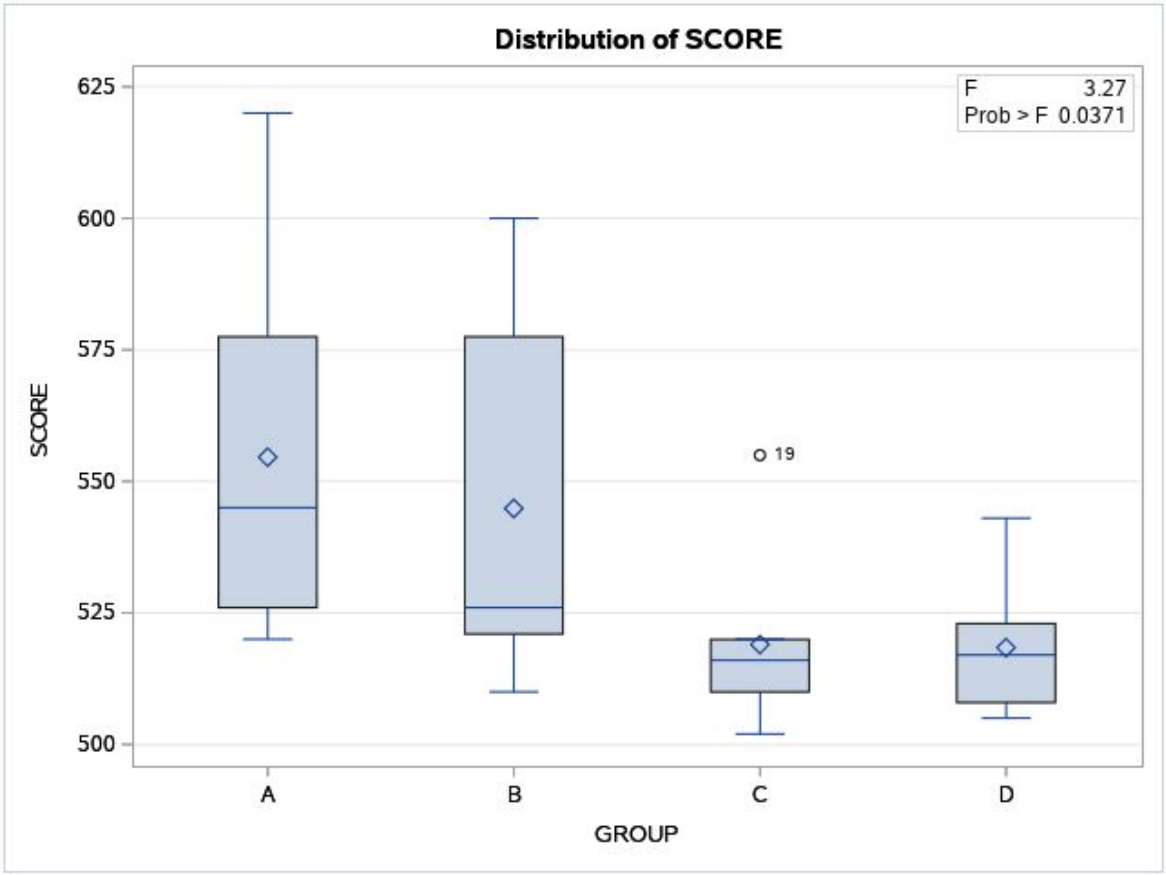
The ANOVA Procedure

Dependent Variable: SCORE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	7573.40238	2524.46746	3.27	0.0371
Error	26	20064.46429	771.71016		
Corrected Total	29	27637.86667			

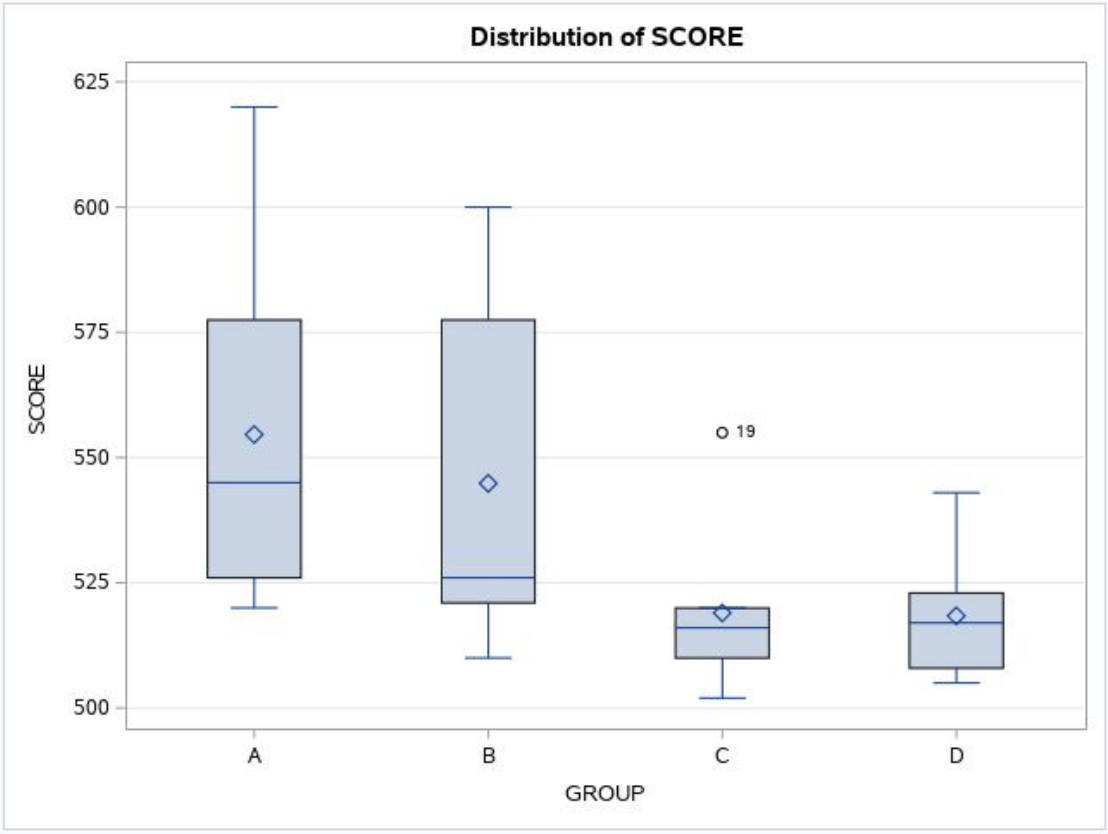
R-Square	Coeff Var	Root MSE	SCORE Mean
0.274023	5.189875	27.77967	535.2667

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	3	7573.402381	2524.467460	3.27	0.0371


Distribution of SCORE
F 3.27
Prob > F 0.0371
625
600
575
550
525
500
SCORE
19
A
B
C
D
GROUP

Problem_7_4

The ANOVA Procedure



Problem_7_4

The ANOVA Procedure

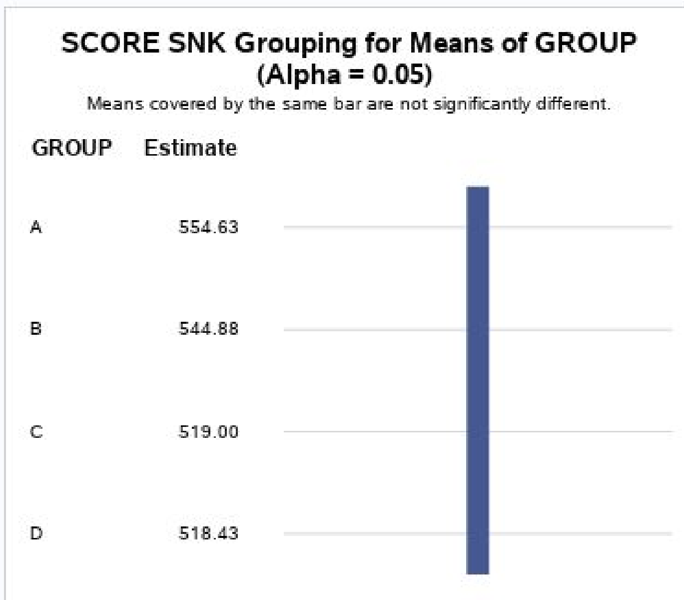
Student-Newman-Keuls Test for SCORE

Note: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha	0.05
Error Degrees of Freedom	26
Error Mean Square	771.7102
Harmonic Mean of Cell Sizes	7.466667

Note: Cell sizes are not equal.

Number of Means	2	3	4
Critical Range	29.552957	35.724921	39.441661



Multi Comparison

****

Ho-> the methods are equal in preparing for college entrance exam
Ha-> the methods are not equal in preparing for college entrance exam entry
F value = 3.27   p-value=0.0371 < alpha = 0.005

Reject Ho.

****
Conclusion:
At significance level alpha=0.005
at least one of the methods are not equal to one of

others in preparing for college entrance exam.

****

snk test :

From snk test we can see that groups at significance level alpha=0.05 the groups A, B, C and D are not significantly different from each other and covered in the same color bar(blue).

****

Contrasts:

****

```
proc glm  data=problem_7_4;
title "Problem_7_4 Contrasts";
class GROUP;
model SCORE=GROUP;
contrast 'A VS B AND C AND D' GROUP -3 1 1 1;
contrast 'D VS A AND B AND C' GROUP  1 1 1 -3;
run;
```

Problem_7_4 Contrasts

The GLM Procedure

Class Level Information		
Class	Levels	Values
GROUP	4	A B C D

Number of Observations Read	30
Number of Observations Used	30

Problem_7_4 Contrasts

The GLM Procedure

Dependent Variable: SCORE

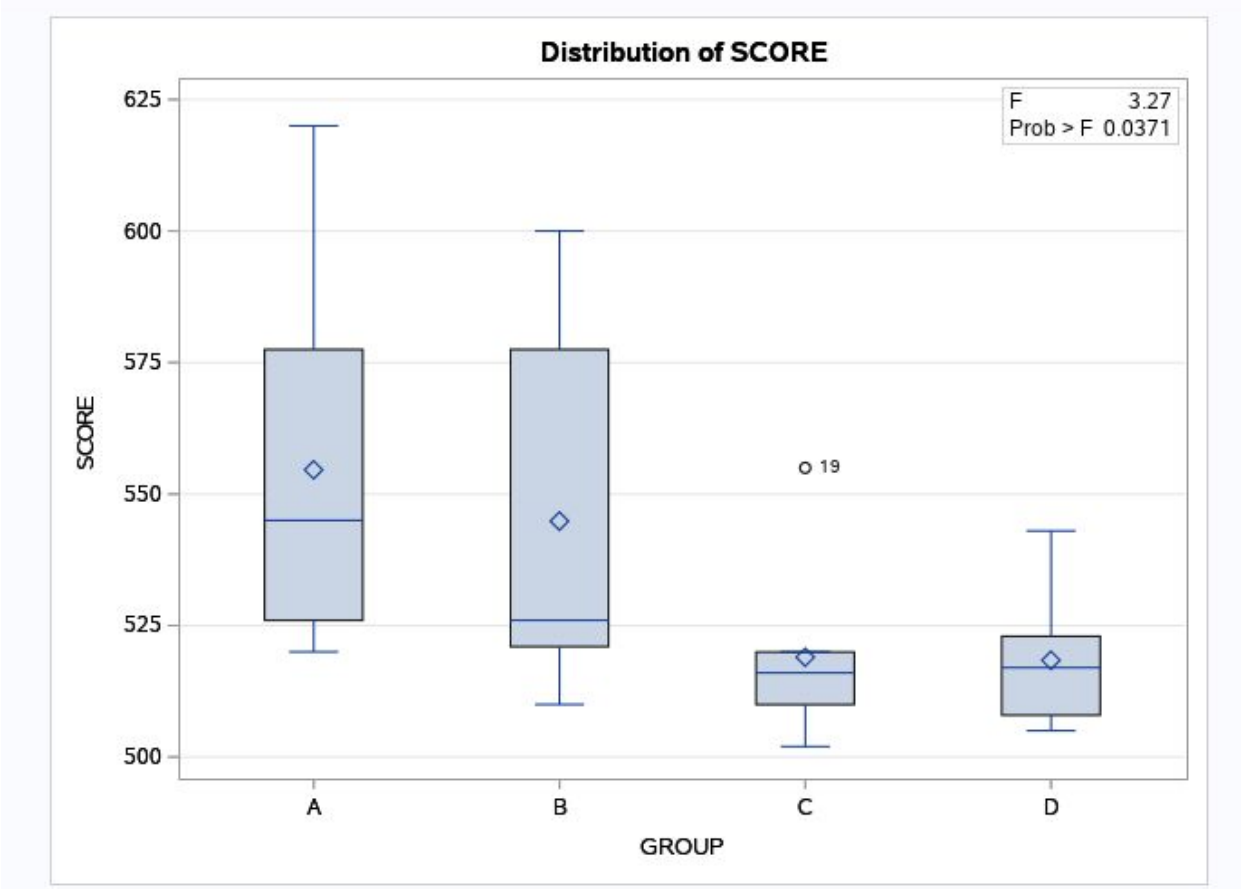
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	7573.40238	2524.46746	3.27	0.0371
Error	26	20064.46429	771.71016		
Corrected Total	29	27637.86667			

R-Square	Coeff Var	Root MSE	SCORE Mean
0.274023	5.189875	27.77967	535.2667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
GROUP	3	7573.402381	2524.467460	3.27	0.0371

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GROUP	3	7573.402381	2524.467460	3.27	0.0371

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
A VS B AND C AND D	1	4332.770764	4332.770764	5.61	0.0255
D VS A AND B AND C	1	2380.623100	2380.623100	3.08	0.0908



For contract A VS B and C and D:

****

Ho->method A have no difference from methods B, C and D.

Ha->method A different from methods B, C and D.

F=5.61 p-value=0.0255 < alpha=0.05

Reject Ho.

****

Conclusion:

At significance level alpha=0.05

Method A is significantly different from methods B, C and D

****

For contrast D vs A and B and C:

Ho->method D have no difference from methods A, B and C.

Ha->method D different from methods A,B and C.

F=3.08p-value=0.0908 > alpha=0.05

Fail to reject Ho

```
**********************************************************************
Conclusion:
At significance level alpha=0.05
Method D is not significantly different from methods B, C and D
```

##
Problem_7_5
##
Design is unbalanced so we use GLM

```
data Problem_7_5;
input BRAND $ AGE SCORE @@;
cards;
C 1 7 C 1 6 C 1 6 C 1 5 C 1 6 P 1 9 P 1 8
P 1 9 P 1 9 P 1 9 P 1 8 C 2 9 C 2 8 C 2 8
C 2 9 C 2 7 C 2 8 C 2 8 P 2 6 P 2 7 P 2 6
P 2 6 P 2 5
;
proc glm  data=problem_7_5;
title "Problem_7_5";
class BRAND AGE;
model SCORE=BRAND | AGE;
means BRAND | AGE;
run;
```

Problem_7_5

The GLM Procedure

Class Level Information		
Class	Levels	Values
BRAND	2	C P
AGE	2	1 2

Number of Observations Read	23
Number of Observations Used	23

Problem_7_5

The GLM Procedure

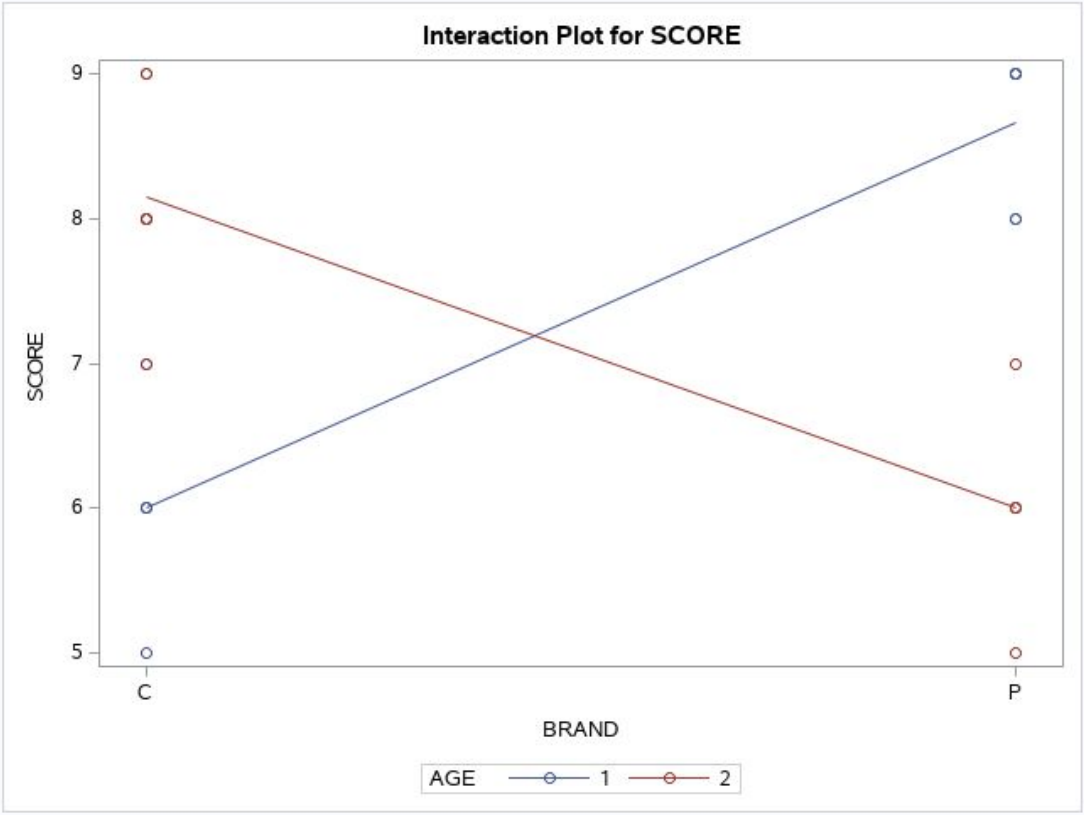
Dependent Variable: SCORE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	33.02691511	11.00897170	25.54	<.0001
Error	19	8.19047619	0.43107769		
Corrected Total	22	41.21739130			

R-Square	Coeff Var	Root MSE	SCORE Mean
0.801286	8.935501	0.656565	7.347826

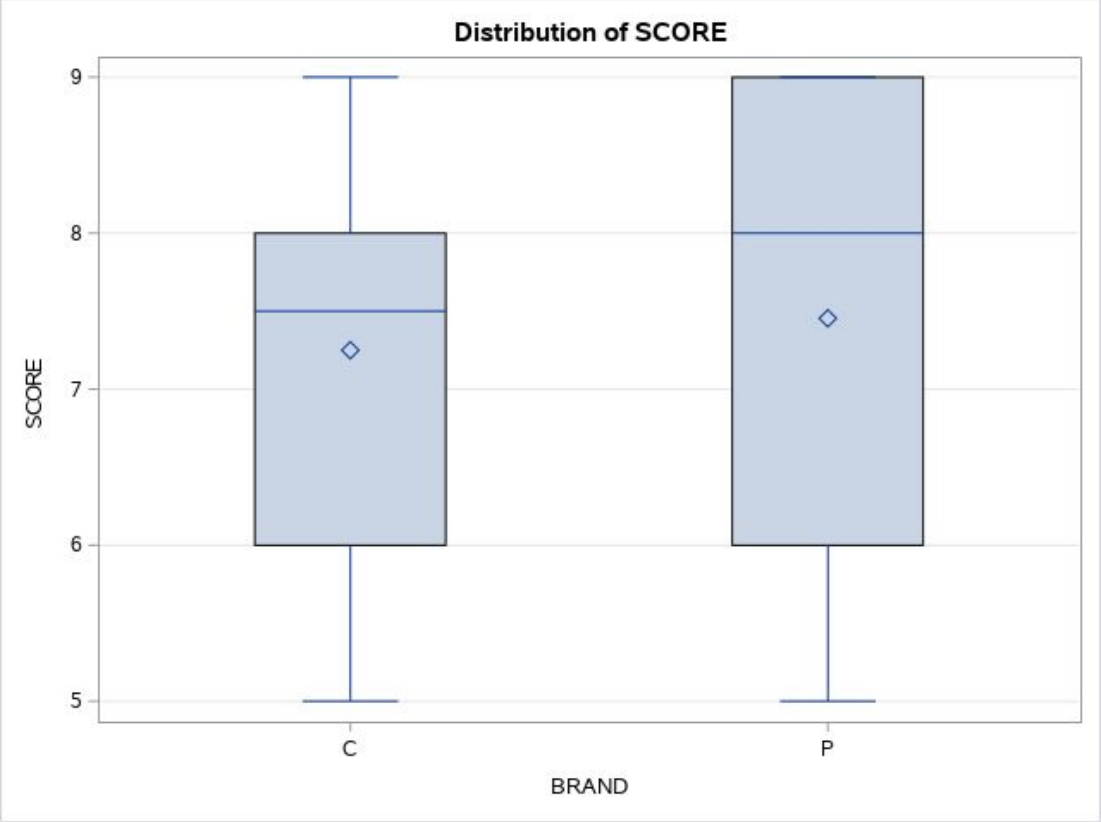
Source	DF	Type I SS	Mean Square	F Value	Pr > F
BRAND	1	0.24011858	0.24011858	0.56	0.4646
AGE	1	0.18532642	0.18532642	0.43	0.5199
BRAND*AGE	1	32.60147012	32.60147012	75.63	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
BRAND	1	0.38670502	0.38670502	0.90	0.3555
AGE	1	0.38670502	0.38670502	0.90	0.3555
BRAND*AGE	1	32.60147012	32.60147012	75.63	<.0001


Interaction Plot for SCORE
9
8
7
6
5
SCORE
C
P
BRAND
AGE
1
2

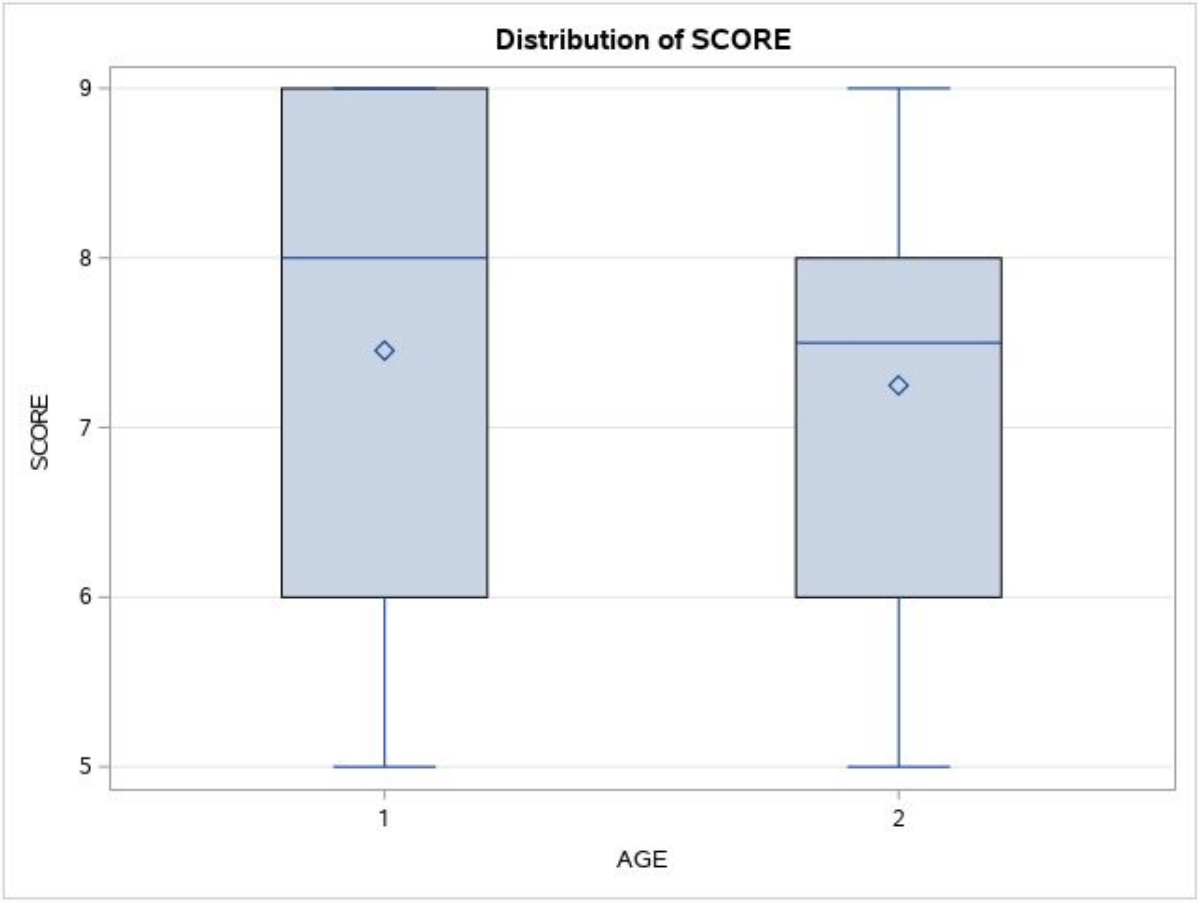
Problem_7_5

The GLM Procedure

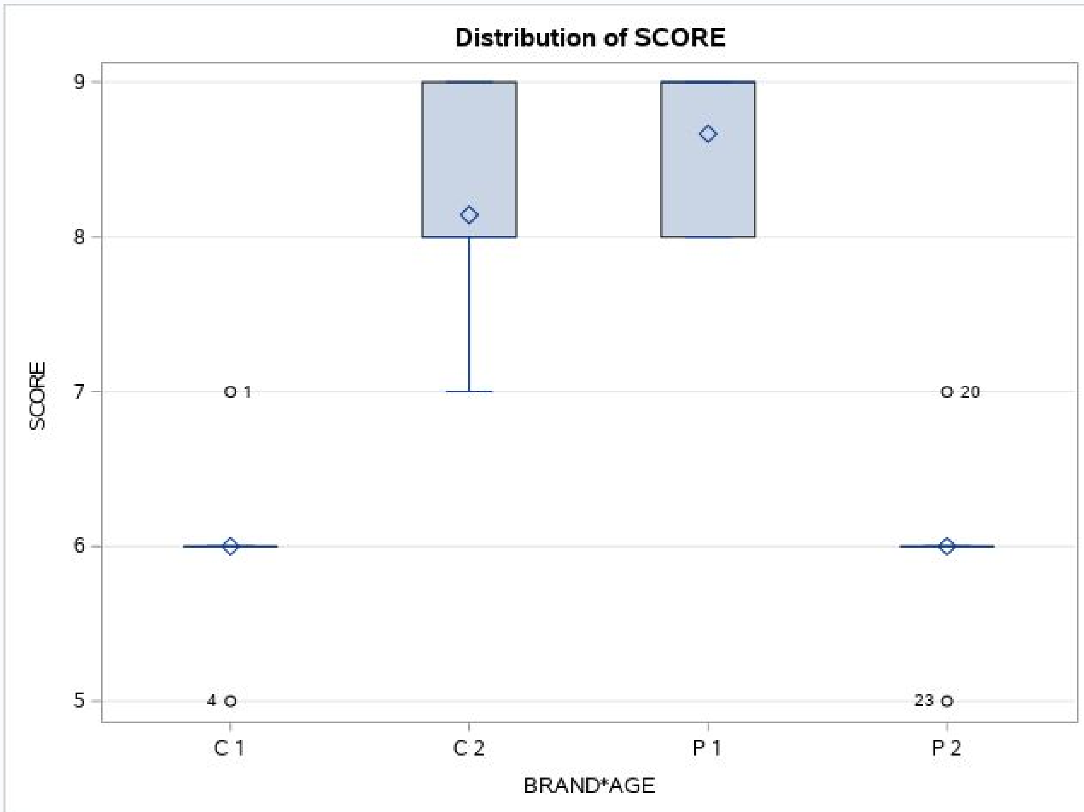


Level of BRAND	N	SCORE	
		Mean	Std Dev
C	12	7.25000000	1.28805703
P	11	7.45454545	1.50755672

Level of BRAND	N	SCORE	
		Mean	Std Dev
C	12	7.25000000	1.28805703
P	11	7.45454545	1.50755672



Level of AGE	N	SCORE	
		Mean	Std Dev
1	11	7.45454545	1.50755672
2	12	7.25000000	1.28805703



Level of BRAND	Level of AGE	N	SCORE Mean	SCORE Std Dev
C	1	5	6.00000000	0.70710678
C	2	7	8.14285714	0.69006556
P	1	6	8.66666667	0.51639778
P	2	5	6.00000000	0.70710678

Effects Of Age on consumer Preferences: (Type 1)

****

Ho-> The effects of AGE on consumer preferences = zero

Ha-> The effects of AGE on consumer preferences are not = zero

F-value = 0.43 p-value=0.5199 < alpha=0.05

Fail to Reject Ho.

****

Conclusion about the effects of AGE on consumer preferences:

At significance level alpha=0.05

effects of Age on consumer preferences are not significantly different from zero.(effect of age is not significant)

****

```
Effects Of Brand on consumer Preferences:  (Type 1)
************************************************************
Ho-> Consumer Differences in choosing the brand = zero
Ha-> Consumer Differences in choosing the brand in not = zero
F-value = 0.56    p-value=0.4646 > alpha=0.05
```

Fail to Reject Ho.

```
*****************************************************************
Conclusion about the effects of BRAND on consumer preferences:
At significance level alpha=0.05
Consumer Differences in choosing the brand = zero.
(preference in choosing the BRAND  is not significant)
*****************************************************************
Effects Of Brand and Age Interaction on consumer Preferences:  (Type 1)
*****************************************************************
Ho-> Interaction of Brand and Age   on consumer preferences = zero
Ha-> Interaction of Brand and Age   on consumer preferences is not = zero
F-value = 75.63   p-value=0.0001 < alpha=0.05

Reject Ho.

Conclusion about BRAND and AGE interaction on consumer preferences:
At significance level alpha=0.05
effects of BRAND and AGE on number of bounces are
significantly different from zero.
(effect of Age and Brand interaction  is significant)
```

##
Problem_7_6
##
Design is balanced so we use ANOVA

```
proc anova data=problem_7_6;

data Problem_7_6;
do GROUP = 'GeneticDeficiency', 'Normal';
   do DRUG = 'A', 'P';
      do SUBJECT = 1 to 4;
         input SCORE @;
         output;
       end;
```

```
   end;
end;
cards;
9 11 10 10
9  6  6  7
5  4  7  7
12 11 10 11
;
title "Problem_7_6";
class GROUP DRUG;
model SCORE=GROUP | DRUG;
means GROUP | DRUG /tukey;
run;
```

Problem_7_6

The ANOVA Procedure

Class Level Information		
Class	Levels	Values
GROUP	2	GeneticDeficiency Normal
DRUG	2	A P

Number of Observations Read	16
Number of Observations Used	16

Problem_7_6

The ANOVA Procedure

Dependent Variable: SCORE

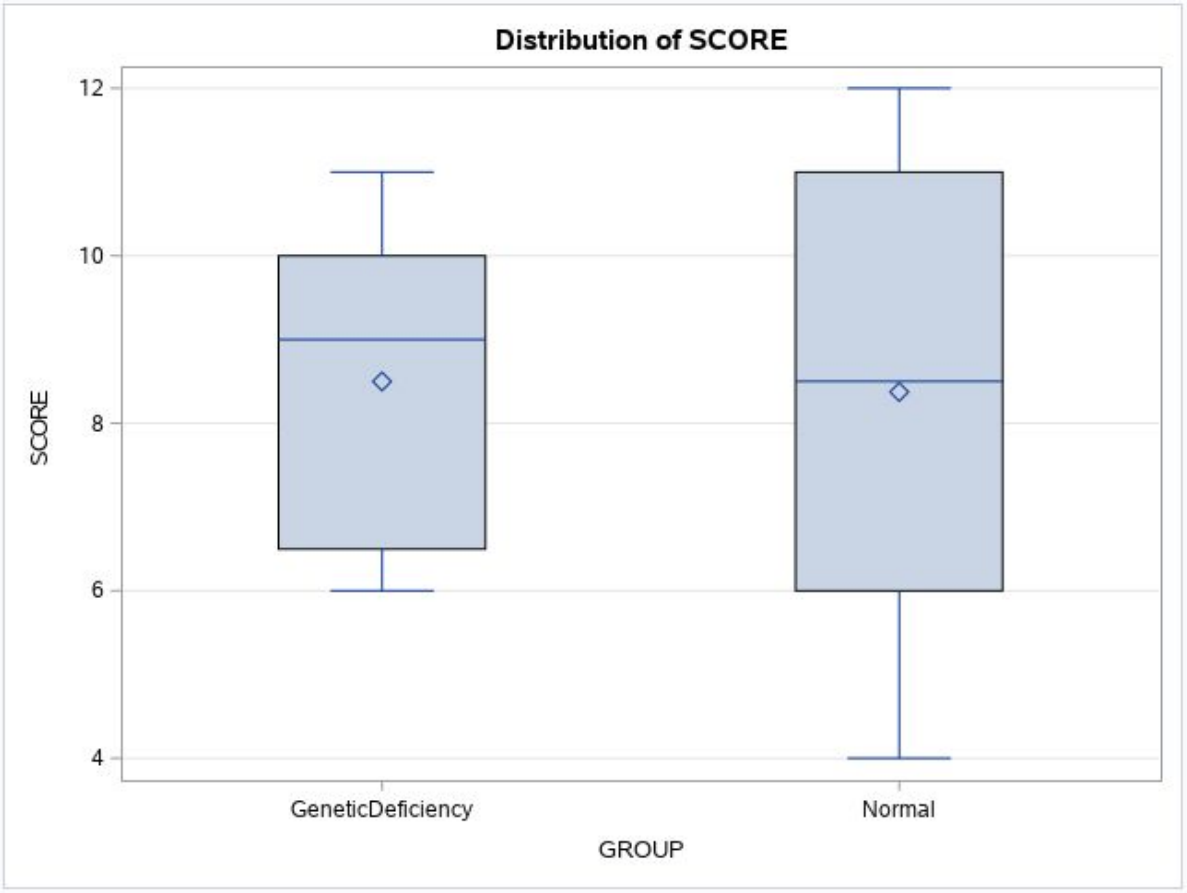
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	73.18750000	24.39583333	17.48	0.0001
Error	12	16.75000000	1.39583333		
Corrected Total	15	89.93750000			

R-Square	Coeff Var	Root MSE	SCORE Mean
0.813760	14.00242	1.181454	8.437500

Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	1	0.06250000	0.06250000	0.04	0.8360
DRUG	1	5.06250000	5.06250000	3.63	0.0811
GROUP*DRUG	1	68.06250000	68.06250000	48.76	<.0001

Problem_7_6

The ANOVA Procedure



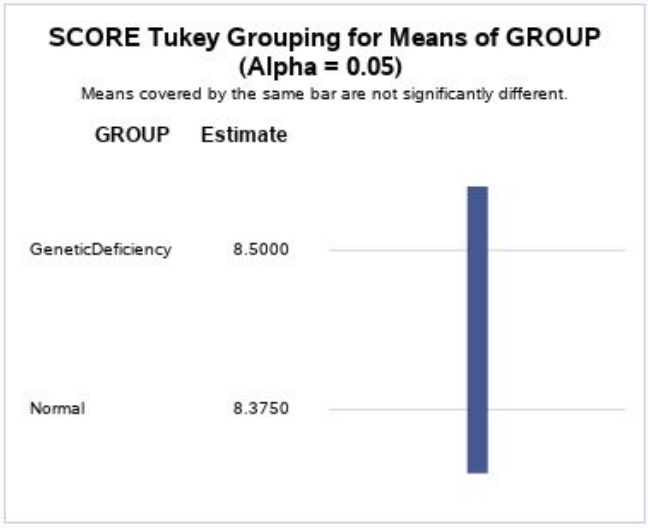
Problem_7_6

The ANOVA Procedure

Tukey's Studentized Range (HSD) Test for SCORE

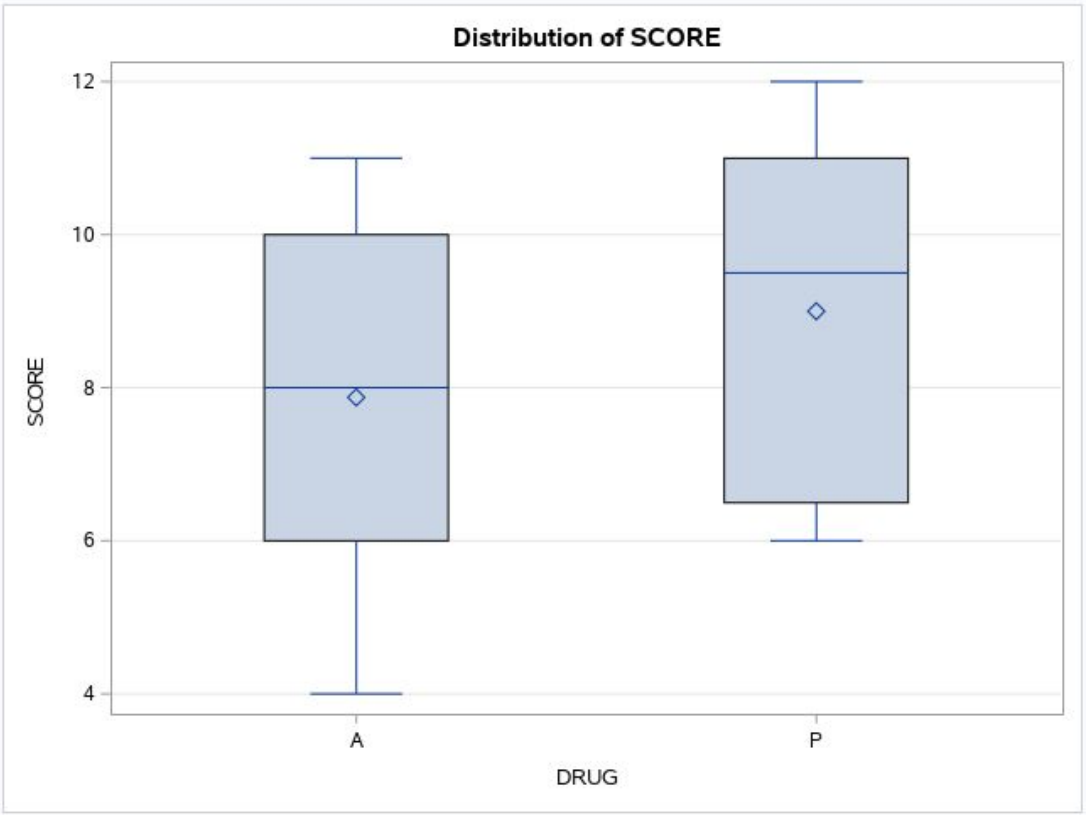
Note: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	12
Error Mean Square	1.395833
Critical Value of Studentized Range	3.08118
Minimum Significant Difference	1.287



Problem_7_6

The ANOVA Procedure



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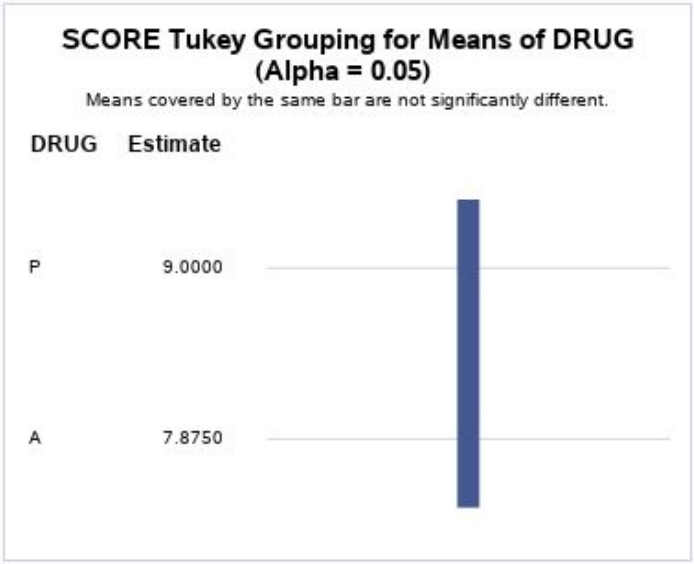
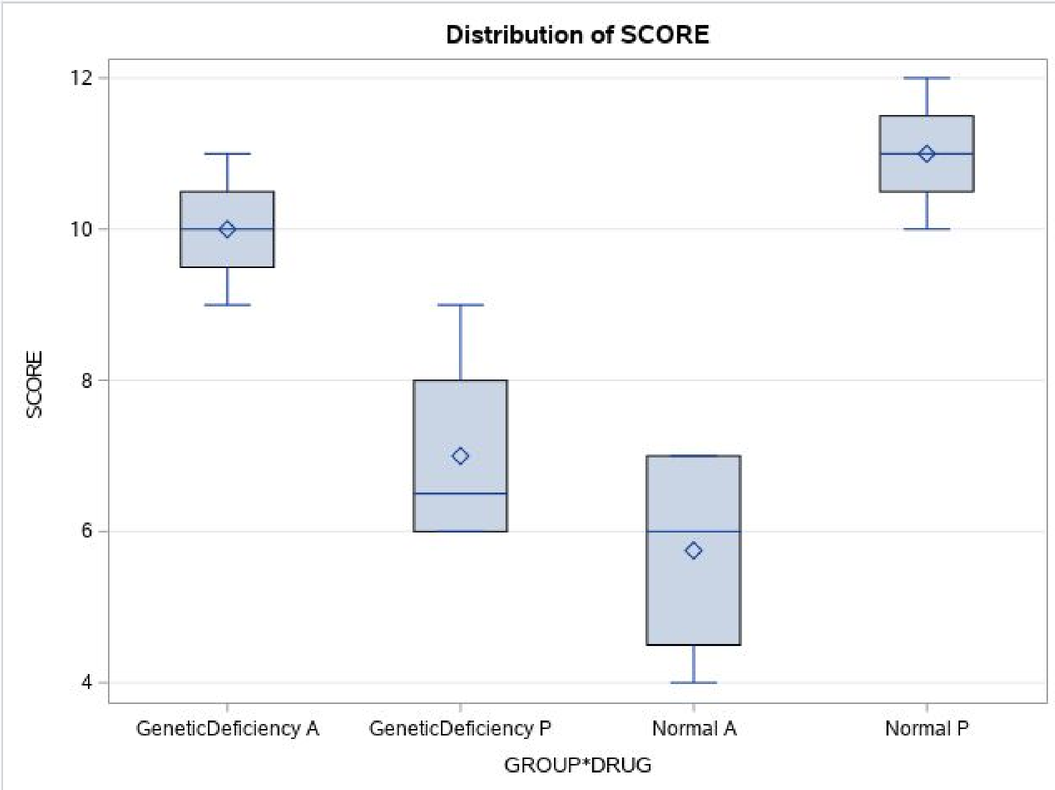


Problem_7_6

The ANOVA Procedure



Level of GROUP	Level of DRUG	N	SCORE Mean	SCORE Std Dev
GeneticDeficiency	A	4	10.0000000	0.81649658
GeneticDeficiency	P	4	7.0000000	1.41421356
Normal	A	4	5.7500000	1.50000000
Normal	P	4	11.0000000	0.81649658

Ho-> The effects of Genetic differences to cure depression = zero
Ha-> The effects of Genetic differences to cure depression is not = zero
F-value = 0.04   p-value=0.8360 > alpha=0.05

Fail to Reject Ho.

****
Conclusion for the effects of Genetic differences to cure depression:
At significance level alpha=0.05
the effects of Genetic differences to cure depression = zero
(effect of Genetic differences is not significant)
****

Ho-> The effects of DRUG to cure depression = zero
Ha-> The effects of DRUG to cure depression are not = zero
F-value = 3.63 p-value=0.0811 > alpha=0.05
Fail to reject Ho.

Conclusion for the effects of DRUG to cure depression:
At significance level alpha=0.05
effects of DRUG to cure depression = zero
(effect of DRUG is significant but much more significant
compare to the effects of Genetic differences)
****
Ho-> The effects of Interaction of Genetic Differences and Drug
to cure depression are zero.
Ha-> The effects of Interaction of Genetic Differences and Drug
to cure depression are not zero.
F-value = 48.76 p-value= 0.0001 < alpha=0.05

Reject Ho.

****
Conclusion for Genetic DIfferences and Drug interaction:
At significance level alpha=0.05
effects of Genetic DIfferences and Drug interactions are
significantly different from zero.
(effect of Genetic DIfferences and Drug interactions are significant)
****
Multi Comparison:

tukey test shows no difference between
    group with genetic deficiencies and normal group.
tukey test shows no difference between
    Anti-depression drug and placebo.
****