/\*First data set is paired data\*/

data one;

input pair before after;

cards;

1    2.37   2.51

2    3.17   2.65

3    3.07   2.60

4    2.73   2.40

5    3.49   2.31

6    4.35   2.28

7    3.65   0.94

8    3.97   2.21

9    3.21   3.29

10    4.46  1.92

11    3.81  3.38

12    4.55  2.43

13    4.51  1.83

14    3.03  2.63

15    4.47  2.31

16    3.44  1.85

17    3.52  2.92

18    3.05  2.26

19    3.66  3.11

20    3.81  1.90

21    3.13  2.50

22    3.43  3.18

23    3.26  3.24

24    2.85  2.16

run;

proc print data=one;

run;

/\*changing from unstacked to stacked\*/

data two;set one;

length treatment $10;

treatment="before"; outcome=before;output;

treatment="after"; outcome=after;output;

keep pair treatment outcome;

run;

/\*model fitting CRBD, pair is the block\*/

proc glm data=two;

class treatment pair;

model outcome=treatment pair;

run;

proc ttest data=one;

paired before\*after;

run;

data one; set one;

difference=before-after;

run;

proc ttest data=one;

var difference; /\* paired t-test, with an assumption being

that the difference is normally distributed\*/

run;

proc univariate normal plot data=one;

var difference;

run;

/\* checking just for fun \*/

proc glm data=two;

class treatment pair;

model outcome=treatment pair;

output out=resid r=res;

run;

proc univariate normal plot data=resid;

var res;

run;

proc sort data=two;by pair;

proc rank data=two out=tworanks;

by pair; var outcome;

run;

proc print data=tworanks;

run;

proc freq data=two;

tables pair\*treatment\*outcome /\* <== order matters!!\*/ /cmh2 scores=rank noprint;

run;

data mpg;

input driver model blend miles;

cards;

1    1 1    15.5

2    1 2    16.3

3    1 3    10.5

4    1 4    14

1    2 2    33.8

2    2 3    26.4

3    2 4    31.5

4    2 1    34.5

1    3 3    13.7

2    3 4    19.1

3    3 1    17.5

4    3 2    19.7

1    4 4    29.2

2    4 1    22.5

3    4 2    30.1

4    4 3    21.6

run;

/\*

proc print data=mpg;

run;

\*/

proc glm data=mpg;

class blend driver model;

model miles = driver model blend;

output out=resids r=res;

run;

proc glm data=mpg;

class blend;

model miles = blend;

means blend /hovtest=levene;

proc glm data=mpg;

class model;

model miles = model;

means model /hovtest=levene;

run;

**Data nineseven;**

**Input distance oxygen;**

**cards;**

**1     1.173**

**1     2.318**

**1     1.541**

**1     1.173**

**1     1.541**

**1     1.541**

**1     2.092**

**1     1.837**

**1     0.612**

**1     1.541**

**5     2.092**

**5     2.894**

**5     1.541**

**5     1.837**

**5     2.894**

**5     2.318**

**5     2.525**

**5     2.092**

**5     1.837**

**5     1.837**

**10    4.514**

**10    5.136**

**10    4.937**

**10    3.373**

**10    5.327**

**10    4.514**

**10    4.402**

**10    4.402**

**10    4.623**

**10    4.937**

**20    6.114**

**20    5.511**

**20    5.136**

**20    4.937**

**20    6.432**

**20    5.037**

**20    6.031**

**20    5.601**

**20    5.601**

**20    5.777**

**run;**

**proc glm data=nineseven;**

**class distance;**

**model oxygen=distance;**

**output out=resids r=res;**

**run;**

**proc univariate normal plot data=resids;**

**var res;**

**run;**

**proc glm data=nineseven;**

**class distance;**

**model oxygen=distance;**

**means distance / hovtest=Levene;**

**run;**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tests for Normality** | | | | |
| **Test** | **Statistic** | | **p Value** | |
| **Shapiro-Wilk** | **W** | 0.97317 | **Pr < W** | 0.4508 |
| **Kolmogorov-Smirnov** | **D** | 0.119557 | **Pr > D** | >0.1500 |
| **Cramer-von Mises** | **W-Sq** | 0.05562 | **Pr > W-Sq** | >0.2500 |
| **Anderson-Darling** | **A-Sq** | 0.339228 | **Pr > A-Sq** | >0.2500 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Levene's Test for Homogeneity of oxygen Variance**  **ANOVA of Squared Deviations from Group Means** | | | | | |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **distance** | 3 | 0.0271 | 0.00903 | 0.09 | 0.9655 |
| **Error** | 36 | 3.6456 | 0.1013 |  |  |

data ninetwelve;

Input environment$ weight;

Cards;

Wild  114.7

Wild  128.9

Wild  111.5

Wild  116.4

Wild  134.5

Wild  126.7

Wild  120.6

Wild  129.59

Ranch 120.4

Ranch 91

Ranch 119.6

Ranch 119.4

Ranch 150

Ranch 169.7

Ranch 100.9

Ranch 76.1

Zoo   103.1

Zoo   90.7

Zoo   129.5

Zoo   75.8

Zoo   182.5

Zoo   76.8

Zoo   87.3

Zoo   77.3

run;

proc glm data=ninetwelve;

Class environment;

Model weight=environment;

output out=resids r=res;

run;

proc univariate normal plot data=resids;

var res;

run;

Data ninetwelvelogs; /\* transformation on x = ln(ln(x)+3) \*/

Input environment$ weight;

Cards;

wild 2.046701387

wild 2.061664068

wild 2.043040048

wild 2.048599856

wild 2.06706074

wild 2.059471216

wild 2.053159074

wild 2.062343146

ranch 2.052946058

ranch 2.016349907

ranch 2.05208998

ranch 2.051874951

ranch 2.080770071

ranch 2.096056763

ranch 2.030005722

ranch 1.992254913

zoo 2.032834538

zoo 2.015910161

zoo 2.062254802

zoo 1.991716041

zoo 2.104957007

zoo 1.993502949

zoo 2.010808043

zoo 1.994386516

run;

proc glm data=ninetwelvelogs;

Class environment;

Model weight=environment;

Means environment / lsd;

output out=resids r=res;

run;

proc univariate normal plot data=resids;

var res;

run;

proc glm data=ninetwelvelogs;

Class environment;

Model weight=environment;

Means environment / hovtest=Levene;

run;

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tests for Normality** | | | | |
| **Test** | **Statistic** | | **p Value** | |
| **Shapiro-Wilk** | **W** | 0.902749 | **Pr < W** | 0.0246 |
| **Kolmogorov-Smirnov** | **D** | 0.192383 | **Pr > D** | 0.0214 |
| **Cramer-von Mises** | **W-Sq** | 0.131372 | **Pr > W-Sq** | 0.0408 |
| **Anderson-Darling** | **A-Sq** | 0.785301 | **Pr > A-Sq** | 0.0374 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tests for Normality** | | | | |
| **Test** | **Statistic** | | **p Value** | |
| **Shapiro-Wilk** | **W** | 0.94269 | **Pr < W** | 0.1872 |
| **Kolmogorov-Smirnov** | **D** | 0.195582 | **Pr > D** | 0.0184 |
| **Cramer-von Mises** | **W-Sq** | 0.104929 | **Pr > W-Sq** | 0.0929 |
| **Anderson-Darling** | **A-Sq** | 0.582275 | **Pr > A-Sq** | 0.1202 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Levene's Test for Homogeneity of weight Variance**  **ANOVA of Squared Deviations from Group Means** | | | | | |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **environment** | 2 | 7.413E-6 | 3.707E-6 | 2.04 | 0.1555 |
| **Error** | 21 | 0.000038 | 1.82E-6 |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Means with the same letter**  **are not significantly different.** | | | |
| **Tukey Grouping** | **Mean** | **N** | **environment** |
| A | 2.05525 | 8 | wild |
| A |  |  |  |
| A | 2.04654 | 8 | ranch |
| A |  |  |  |
| A | 2.02580 | 8 | zoo |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 21 |
| **Error Mean Square** | 0.00093 |
| **Critical Value of t** | 2.07961 |
| **Least Significant Difference** | 0.0317 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Means with the same letter**  **are not significantly different.** | | | |
| **t Grouping** | **Mean** | **N** | **environment** |
| A | 2.05525 | 8 | wild |
| A |  |  |  |
| A | 2.04654 | 8 | ranch |
| A |  |  |  |
| A | 2.02580 | 8 | zoo |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 2 | 0.00366441 | 0.00183220 | 1.97 | 0.1644 |
| **Error** | 21 | 0.01953359 | 0.00093017 |  |  |
| **Corrected Total** | 23 | 0.02319799 |  |  |  |

data fifteensix;

input subject nomusic hardrock classical;

cards;

1 20 20 24

2 17 18 20

3 24 23 27

4 20 18 22

5 22 21 24

6 25 22 28

7 18 19 16

run;

data fifteensixs;

set fifteensix; /\* stacking \*/

length treatment $10;

treatment="No Music"; score=nomusic; output;

treatment="Hard Rock"; score=hardrock; output;

treatment="Classical"; score=classical; output;

keep subject treatment score;

run;

proc glm data=fifteensixs;

class treatment subject;

model score = treatment subject;

means treatment / lsd;

means subject / lsd;

means treatment / hovtest=levene;

output out=resids r=res;

run;

quit;

proc univariate data=resids plot normal;

var res;

run;

proc glm data=fifteensixs;

class treatment;

model score = treatment;

means treatment / hovtest=levene;

run;

|  |  |  |  |
| --- | --- | --- | --- |
| **Means with the same letter are**  **not significantly different.** | | | |
| **t Grouping** | **Mean** | **N** | **treatment** |
| A | 23.0000 | 7 | Classical |
|  |  |  |  |
| B | 20.8571 | 7 | No Music |
| B |  |  |  |
| B | 20.1429 | 7 | Hard Rock |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Means with the same letter**  **are not significantly different.** | | | | |
| **t Grouping** | | **Mean** | **N** | **subject** |
|  | A | 25.000 | 3 | 6 |
|  | A |  |  |  |
|  | A | 24.667 | 3 | 3 |
|  | A |  |  |  |
| B | A | 22.333 | 3 | 5 |
| B |  |  |  |  |
| B |  | 21.333 | 3 | 1 |
| B |  |  |  |  |
| B | C | 20.000 | 3 | 4 |
|  | C |  |  |  |
|  | C | 18.333 | 3 | 2 |
|  | C |  |  |  |
|  | C | 17.667 | 3 | 7 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 8 | 180.2857143 | 22.5357143 | 9.53 | 0.0004 |
| **Error** | 12 | 28.3809524 | 2.3650794 |  |  |
| **Corrected Total** | 20 | 208.6666667 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **R-Square** | **Coeff Var** | **Root MSE** | **score Mean** |
| 0.863989 | 7.208819 | 1.537881 | 21.33333 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Type I SS** | **Mean Square** | **F Value** | **Pr > F** |
| **treatment** | 2 | 30.9523810 | 15.4761905 | 6.54 | 0.0120 |
| **subject** | 6 | 149.3333333 | 24.8888889 | 10.52 | 0.0003 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tests for Normality** | | | | |
| **Test** | **Statistic** | | **p Value** | |
| **Shapiro-Wilk** | **W** | 0.93831 | **Pr < W** | 0.2017 |
| **Kolmogorov-Smirnov** | **D** | 0.150767 | **Pr > D** | >0.1500 |
| **Cramer-von Mises** | **W-Sq** | 0.079177 | **Pr > W-Sq** | 0.2085 |
| **Anderson-Darling** | **A-Sq** | 0.517378 | **Pr > A-Sq** | 0.1747 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Levene's Test for Homogeneity of score Variance**  **ANOVA of Squared Deviations from Group Means** | | | | | |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **treatment** | 2 | 456.1 | 228.1 | 1.86 | 0.1850 |
| **Error** | 18 | 2211.8 | 122.9 |  |  |

15.10)

data fifteenten;

input model$ driver$ blend$ mpg;

cards;

1 1 A 15.5

1 2 B 16.3

1 3 C 10.5

1 4 D 14.0

2 1 B 33.8

2 2 C 26.4

2 3 D 31.5

2 4 A 34.5

3 1 C 13.7

3 2 D 19.1

3 3 A 17.5

3 4 B 19.7

4 1 D 29.2

4 2 A 22.5

4 3 B 30.1

4 4 C 21.6

run;

proc glm data=fifteenten;

class blend model driver;

model mpg = blend model driver / solution;

/\* means blend / hovtest=levene;

means model / hovtest=levene;

means driver / hovtest=levene;

the model must be copied and pasted in such a way that only one of these

statements can be tested at a time \*/

output out=resids r=res;

run;

proc univariate data=resids normal plot;

var res;

run;

proc glm data=fifteenten;

class blend;

model mpg = blend;

means blend /hovtest=levene;

output out=resid r=res;

run;

proc univariate data=resid normal plot;

var res;

run;

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 9 | 869.9756250 | 96.6639583 | 22.42 | 0.0006 |
| **Error** | 6 | 25.8637500 | 4.3106250 |  |  |
| **Corrected Total** | 15 | 895.8393750 |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Type I SS** | **Mean Square** | **F Value** | **Pr > F** |
| **blend** | 3 | 106.2718750 | 35.4239583 | 8.22 | 0.0151 |
| **model** | 3 | 755.3718750 | 251.7906250 | 58.41 | <.0001 |
| **driver** | 3 | 8.3318750 | 2.7772917 | 0.64 | 0.6143 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 3 | 106.2718750 | 35.4239583 | 0.54 | 0.6649 |
| **Error** | 12 | 789.5675000 | 65.7972917 |  |  |
| **Corrected Total** | 15 | 895.8393750 |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tests for Normality** | | | | |
| **Test** | **Statistic** | | **p Value** | |
| **Shapiro-Wilk** | **W** | 0.985159 | **Pr < W** | 0.9915 |
| **Kolmogorov-Smirnov** | **D** | 0.095798 | **Pr > D** | >0.1500 |
| **Cramer-von Mises** | **W-Sq** | 0.021093 | **Pr > W-Sq** | >0.2500 |
| **Anderson-Darling** | **A-Sq** | 0.150054 | **Pr > A-Sq** | >0.2500 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tests for Normality** | | | | |
| **Test** | **Statistic** | | **p Value** | |
| **Shapiro-Wilk** | **W** | 0.902694 | **Pr < W** | 0.0888 |
| **Kolmogorov-Smirnov** | **D** | 0.225604 | **Pr > D** | 0.0279 |
| **Cramer-von Mises** | **W-Sq** | 0.11372 | **Pr > W-Sq** | 0.0698 |
| **Anderson-Darling** | **A-Sq** | 0.648818 | **Pr > A-Sq** | 0.0777 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Levene's Test for Homogeneity of mpg Variance**  **ANOVA of Squared Deviations from Group Means** | | | | | |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **blend** | 3 | 532.3 | 177.4 | 0.11 | 0.9538 |
| **Error** | 12 | 19712.0 | 1642.7 |  |  |