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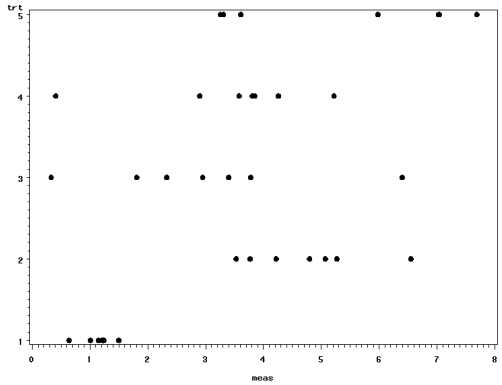
ST511 S1
HW 7

1a:

```
                  The GLM Procedure
Dependent Variable: meas
                     Sum of
Source            DF     Squares   Mean Square  F Value  Pr > F
Model             4   75.9663257   18.9915814    8.78  <.0001
Error            30   64.9145429    2.1638181
Corrected Total       34   140.8808686
```

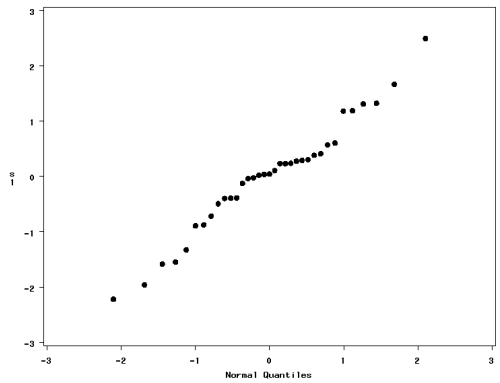
Since $F_{.05,6,28} = 2.45 < 8.78$, reject and conclude that there are differences. Residual plot:




Levene's test:

```
                     Sum of    Mean
Source    DF   Squares   Square  F Value  Pr > F
trt      4   9.1644   2.2911    3.42  0.0205
Error     30   20.1245   0.6708
```

1b. QQ plot:




```
                        Tests for Normality

Test                  --Statistic---    -----p Value------

Shapiro-Wilk          W     0.972664    Pr < W      0.5205
```

| | | | | |
|---|---|---|---|---|
| Kolmogorov-Smirnov | D | 0.114139 | Pr > D | >0.1500 |
| Cramer-von Mises | W-Sq | 0.097056 | Pr > W-Sq | 0.1214 |
| Anderson-Darling | A-Sq | 0.502534 | Pr > A-Sq | 0.2014 |

Conclude that data is normally distributed.

1c.

t Tests (LSD) for meas

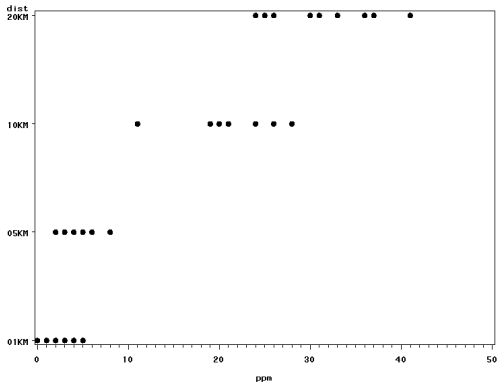
| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 30 |
| Error Mean Square | 2.163818 |
| Critical Value of t | 2.04227 |
| Least Significant Difference | 1.6058 |

Means with the same letter are not significantly different.

| t Grouping | Mean | N | trt |
|---|---|---|---|
| A | 5.4171 | 7 | 5 |
| A | | | |
| B A | 4.7443 | 7 | 2 |
| B | | | |
| B C | 3.4329 | 7 | 4 |
| C | | | |
| C | 3.0000 | 7 | 3 |
| D | 1.1786 | 7 | 1 |

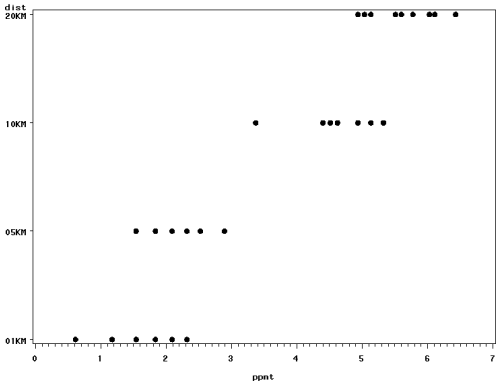
2a. Original scale:

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 3 | 5793.100000 | 1931.033333 | 129.70 | <.0001 |
| Error | 36 | 536.000000 | 14.888889 | | |
| Corrected Total | 39 | 6329.100000 | | | |



YT scale:

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 3 | 113.0952731 | 37.6984244 | 153.30 | <.0001 |
| Error | 36 | 8.8526665 | 0.2459074 | | |
| Corrected Total | 39 | 121.9479396 | | | |




2bi.

| Contrast | DF | Contrast SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| 10 vs 1 and 5 | 1 | 50.58461199 | 50.58461199 | 205.71 | <.0001 |
| 5 vs 1 | 1 | 2.11106280 | 2.11106280 | 8.58 | 0.0059 |

Conclude that these are different.

2biii. $(-.5)(-1)[1] + (1)(-1)[5] + (-1)(0)[10] + (0)(0)[20] \neq 0$. Contrasts are not mutually orthogonal.

2c.

The GLM Procedure

t Tests (LSD) for ppmt

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

| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 36 |
| Error Mean Square | 0.245907 |
| Critical Value of t | 2.02809 |
| Least Significant Difference | 0.4498 |

Means with the same letter are not significantly different.

| t Grouping | Mean | N | dist |
|---|---|---|---|

| | | | |
|---|---|---|---|
| A | 5.6178 | 10 | 20KM |
| B | 4.6164 | 10 | 10KM |
| C | 2.1867 | 10 | 05KM |
| D | 1.5369 | 10 | 01KM |



The GLM Procedure
Least Squares Means

| dist | ppmt LSMEAN | LSMEAN Number |
|---|---|---|
| 01KM | 1.53691663 | 1 |
| 05KM | 2.18669549 | 2 |
| 10KM | 4.61638258 | 3 |
| 20KM | 5.61782835 | 4 |

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

Dependent Variable: ppmt

| i/j | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | -2.92998 | -13.8859 | -18.4016 |
| | | 0.0059 | <.0001 | <.0001 |
| 2 | 2.929981 | | -10.9559 | -15.4717 |
| | 0.0059 | | <.0001 | <.0001 |
| 3 | 13.88592 | 10.95594 | | -4.51572 |
| | <.0001 | <.0001 | | <.0001 |
| 4 | 18.40163 | 15.47165 | 4.515716 | |
| | <.0001 | <.0001 | <.0001 | |

NOTE: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.



The GLM Procedure

t Tests (LSD) for ppmt

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

| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 36 |
| Error Mean Square | 0.245907 |
| Critical Value of t | 2.02809 |

Least Significant Difference 0.4498

Means with the same letter are not significantly different.

| t Grouping | Mean | N | dist |
|---|---|---|---|
| A | 5.6178 | 10 | 20KM |
| B | 4.6164 | 10 | 10KM |
| C | 2.1867 | 10 | 05KM |
| D | 1.5369 | 10 | 01KM |



The GLM Procedure

Student-Newman-Keuls Test for ppmt

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 | 36 |
| Error Mean Square | 0.245907 |

| Number of Means | 2 | 3 | 4 |
|---|---|---|---|
| Critical Range | 0.4497724 | 0.5420693 | 0.5972744 |

Means with the same letter are not significantly different.

| SNK Grouping | Mean | N | dist |
|---|---|---|---|
| A | 5.6178 | 10 | 20KM |
| B | 4.6164 | 10 | 10KM |
| C | 2.1867 | 10 | 05KM |
| D | 1.5369 | 10 | 01KM |



The GLM Procedure

Ryan-Einot-Gabriel-Welsch Multiple Range Test for ppmt

NOTE: This test controls the Type I experimentwise error rate.

| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 36 |
| Error Mean Square | 0.245907 |

| Number of Means | 2 | 3 | 4 |
|---|---|---|---|
| Critical Range | 0.5175108 | 0.5420693 | 0.5972744 |

Means with the same letter are not significantly different.

| REGWQ Grouping | Mean | N | dist |
|---|---|---|---|
| A | 5.6178 | 10 | 20KM |
| B | 4.6164 | 10 | 10KM |
| C | 2.1867 | 10 | 05KM |
| D | 1.5369 | 10 | 01KM |



The GLM Procedure

Tukey's Studentized Range (HSD) Test for ppmt

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 | 36 |
| Error Mean Square | 0.245907 |
| Critical Value of Studentized Range | 3.80880 |
| Minimum Significant Difference | 0.5973 |

Means with the same letter are not significantly different.

| Tukey Grouping | Mean | N | dist |
|---|---|---|---|
| A | 5.6178 | 10 | 20KM |
| B | 4.6164 | 10 | 10KM |
| C | 2.1867 | 10 | 05KM |
| D | 1.5369 | 10 | 01KM |

2e.

The GLM Procedure

Tukey's Studentized Range (HSD) Test for ppmt

NOTE: This test controls the Type I experimentwise error rate.

| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 36 |
| Error Mean Square | 0.245907 |
| Critical Value of Studentized Range | 3.80880 |
| Minimum Significant Difference | 0.5973 |

Comparisons significant at the 0.05 level are indicated by ***.

| dist Comparison | Difference Between Means | Simultaneous 95% Confidence Limits | | |
|---|---|---|---|---|
| 20KM - 10KM | 1.0014 | 0.4042 | 1.5987 | *** |
| 20KM - 05KM | 3.4311 | 2.8339 | 4.0284 | *** |
| 20KM - 01KM | 4.0809 | 3.4836 | 4.6782 | *** |
| 10KM - 20KM | -1.0014 | -1.5987 | -0.4042 | *** |
| 10KM - 05KM | 2.4297 | 1.8324 | 3.0270 | *** |
| 10KM - 01KM | 3.0795 | 2.4822 | 3.6767 | *** |
| 05KM - 20KM | -3.4311 | -4.0284 | -2.8339 | *** |
| 05KM - 10KM | -2.4297 | -3.0270 | -1.8324 | *** |
| 05KM - 01KM | 0.6498 | 0.0525 | 1.2471 | *** |
| 01KM - 20KM | -4.0809 | -4.6782 | -3.4836 | *** |
| 01KM - 10KM | -3.0795 | -3.6767 | -2.4822 | *** |
| 01KM - 05KM | -0.6498 | -1.2471 | -0.0525 | *** |