***SPEA V506 Homework Exercise 5***

*Authors: Jivitesh Poojary and Qiwen Zhu*

*PART – I*

1. One way ANOVA with α = 0.05

H0 : µ1 = µ2 = µ3

H1 : Not H0 (Treatment means are not all the same)

2. Rejection statement

- Calculated F > Critical F

- Critical F ---- for df(2,12) = 3.89

3. ANOVA table 

4. Since 5.118 > 3.89, we can reject the H0 at the significance level of 0.05

5. Interpretations:

- There is difference in the mean of the treatments.

1. :
2. One way ANOVA with α = 0.05

H0 : µ1 = µ2 = µ3

H1 : Not H0 (Treatment means are not all the same)

2. Rejection statement

- Calculated F > Critical F

- Critical F ---- for df(2,9) = 4.26

3. ANOVA table

4. Since 14.17 > 4.26, we can reject the H0 at the significance level of 0.05

5. Interpretations:

- Yes, we can conclude that there is a difference in the mean number of surgeries performed by hospital or by day of the week.

1. :
2. Two way ANOVA with α = 0.05

H0 : µ1 = µ2 = µ3

H1 : Not H0 (Shift means are not all the same)

H0 : µ1 = µ2 = µ3 = µ4 = µ5

H1 : Not H0 (Employee means are not all the same)

2. Rejection statements:

- Calculated F > Critical F

- Critical F ---- for Shifts df(2,8) = 4.46

- Critical F ---- for Employees df(2,4) = 3.84

3. ANOVA table:



4. Since 5.7546 > 4.46, we can reject the H0 at the significance level of 0.05

Since 1.5521 < 3.84, we cannot reject the H0 at the significance level of 0.05

5. Interpretations:

- Yes, we can conclude that there is a difference in shifts, but not by employee.

1. :
2. Two way ANOVA with α = 0.05

H0 : µ1 = µ2 = µ3

H1 : Not H0 (Day of surgery means are not all the same)

H0 : µ1 = µ2 = µ3 = µ4 = µ5

H1 : Not H0 (Surgeries in Hospitals means are not all the same)

2. Rejection statements:

- Calculated F > Critical F

- Critical F ---- for Day of surgery df(2,8) = 4.46

- Critical F ---- for Surgeries in Hospitals df(2,4) = 3.84

3. ANOVA table:



4. Since 1.9728 < 4.46, we cannot reject the H0 at the significance level of 0.05

Since 1.2850 < 3.84, we cannot reject the H0 at the significance level of 0.05

5. Interpretations:

- Yes, we can conclude that there is a no difference in means of day of surgery or of surgeries in Hospitals.

*PART – II*

1. :

* H0: µ1 = µ2 = µ3

H1: Not all mean maintenance costs are equal.

* Df in the numerator = 17-1 = 16

Df in the denominator = 216-17 = 199

* Rejection Statements :

Reject H0 if F Value > 1.70

Also, Reject if p-value < alpha i.e. p-value < 0.05

* **SAS Output:**

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.temp;

SET V506.EZD;

**RUN**;

**PROC** **UNIVARIATE**;

VAR NEWHIRED;

**RUN**;

**PROC** **ANOVA** plots=none;

CLASS STATE;

MODEL NEWHIRED = STATE;

MEANS STATE / BON;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The UNIVARIATE Procedure**

**Variable: NEWHIRED (NEWHIRED)**

| **Moments** | | | |
| --- | --- | --- | --- |
| **N** | 216 | **Sum Weights** | 216 |
| **Mean** | 267.606481 | **Sum Observations** | 57803 |
| **Std Deviation** | 511.90902 | **Variance** | 262050.844 |
| **Skewness** | 6.16529058 | **Kurtosis** | 52.5658981 |
| **Uncorrected SS** | 71809389 | **Corrected SS** | 56340931.6 |
| **Coeff Variation** | 191.291712 | **Std Error Mean** | 34.830997 |

| **Basic Statistical Measures** | | | |
| --- | --- | --- | --- |
| **Location** | | **Variability** | |
| **Mean** | 267.6065 | **Std Deviation** | 511.90902 |
| **Median** | 129.0000 | **Variance** | 262051 |
| **Mode** | 0.0000 | **Range** | 5460 |
|  |  | **Interquartile Range** | 247.50000 |

| **Tests for Location: Mu0=0** | | | | |
| --- | --- | --- | --- | --- |
| **Test** | **Statistic** | | **p Value** | |
| **Student's t** | **t** | 7.682998 | **Pr > |t|** | <.0001 |
| **Sign** | **M** | 105 | **Pr >= |M|** | <.0001 |
| **Signed Rank** | **S** | 11077.5 | **Pr >= |S|** | <.0001 |

| **Quantiles (Definition 5)** | |
| --- | --- |
| **Level** | **Quantile** |
| **100% Max** | 5460.0 |
| **99%** | 2245.0 |
| **95%** | 906.0 |
| **90%** | 576.0 |
| **75% Q3** | 283.5 |
| **50% Median** | 129.0 |
| **25% Q1** | 36.0 |
| **10%** | 9.0 |
| **5%** | 3.0 |
| **1%** | 0.0 |
| **0% Min** | 0.0 |

| **Extreme Observations** | | | |
| --- | --- | --- | --- |
| **Lowest** | | **Highest** | |
| **Value** | **Obs** | **Value** | **Obs** |
| 0 | 154 | 1689 | 82 |
| 0 | 146 | 1912 | 128 |
| 0 | 61 | 2245 | 72 |
| 0 | 54 | 2739 | 65 |
| 0 | 42 | 5460 | 98 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **STATE** | 17 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 |

|  |  |
| --- | --- |
| **Number of Observations Read** | 216 |
| **Number of Observations Used** | 216 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: NEWHIRED NEWHIRED**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 16 | 21662823.66 | 1353926.48 | 7.77 | <.0001 |
| **Error** | 199 | 34678107.89 | 174261.85 |  |  |
| **Corrected Total** | 215 | 56340931.55 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **NEWHIRED Mean** |
| --- | --- | --- | --- |
| 0.384495 | 155.9928 | 417.4468 | 267.6065 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **STATE** | 16 | 21662823.66 | 1353926.48 | 7.77 | <.0001 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for NEWHIRED**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experiment wise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 199 |
| **Error Mean Square** | 174261.8 |
| **Critical Value of t** | 3.62450 |

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **STATE Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **7 - 4** | 2548.50 | 1035.46 | 4061.54 | \*\*\* |
| **7 - 14** | 2621.33 | 1240.13 | 4002.54 | \*\*\* |
| **7 - 2** | 2709.17 | 1473.78 | 3944.56 | \*\*\* |
| **7 - 17** | 2806.80 | 1634.81 | 3978.79 | \*\*\* |
| **7 - 5** | 2816.19 | 1705.93 | 3926.46 | \*\*\* |
| **7 - 6** | 2877.70 | 1705.71 | 4049.69 | \*\*\* |
| **7 - 16** | 2900.70 | 1728.71 | 4072.69 | \*\*\* |
| **7 - 9** | 2902.56 | 1803.36 | 4001.75 | \*\*\* |
| **7 - 8** | 3010.33 | 1774.94 | 4245.72 | \*\*\* |
| **7 - 10** | 3018.30 | 1846.31 | 4190.29 | \*\*\* |
| **7 - 12** | 3033.78 | 1850.98 | 4216.57 | \*\*\* |
| **7 - 3** | 3070.86 | 1857.73 | 4283.99 | \*\*\* |
| **7 - 15** | 3082.91 | 1919.83 | 4245.99 | \*\*\* |
| **7 - 13** | 3086.64 | 1923.55 | 4249.72 | \*\*\* |
| **7 - 1** | 3125.39 | 2032.50 | 4218.28 | \*\*\* |
| **7 - 11** | 3139.09 | 1976.01 | 4302.17 | \*\*\* |
| **4 - 7** | -2548.50 | -4061.54 | -1035.46 | \*\*\* |
| **4 - 14** | 72.83 | -1308.37 | 1454.04 |  |
| **4 - 2** | 160.67 | -1074.72 | 1396.06 |  |
| **4 - 17** | 258.30 | -913.69 | 1430.29 |  |
| **4 - 5** | 267.69 | -842.57 | 1377.96 |  |
| **4 - 6** | 329.20 | -842.79 | 1501.19 |  |
| **4 - 16** | 352.20 | -819.79 | 1524.19 |  |
| **4 - 9** | 354.06 | -745.14 | 1453.25 |  |
| **4 - 8** | 461.83 | -773.56 | 1697.22 |  |
| **4 - 10** | 469.80 | -702.19 | 1641.79 |  |
| **4 - 12** | 485.28 | -697.52 | 1668.07 |  |
| **4 - 3** | 522.36 | -690.77 | 1735.49 |  |
| **4 - 15** | 534.41 | -628.67 | 1697.49 |  |
| **4 - 13** | 538.14 | -624.95 | 1701.22 |  |
| **4 - 1** | 576.89 | -516.00 | 1669.78 |  |
| **4 - 11** | 590.59 | -572.49 | 1753.67 |  |
| **14 - 7** | -2621.33 | -4002.54 | -1240.13 | \*\*\* |
| **14 - 4** | -72.83 | -1454.04 | 1308.37 |  |
| **14 - 2** | 87.83 | -982.05 | 1157.71 |  |
| **14 - 17** | 185.47 | -810.54 | 1181.47 |  |
| **14 - 5** | 194.86 | -727.72 | 1117.43 |  |
| **14 - 6** | 256.37 | -739.64 | 1252.37 |  |
| **14 - 16** | 279.37 | -716.64 | 1275.37 |  |
| **14 - 9** | 281.22 | -628.00 | 1190.44 |  |
| **14 - 8** | 389.00 | -680.88 | 1458.88 |  |
| **14 - 10** | 396.97 | -599.04 | 1392.97 |  |
| **14 - 12** | 412.44 | -596.25 | 1421.14 |  |
| **14 - 3** | 449.52 | -594.57 | 1493.62 |  |
| **14 - 15** | 461.58 | -523.92 | 1447.08 |  |
| **14 - 13** | 465.30 | -520.20 | 1450.80 |  |
| **14 - 1** | 504.06 | -397.53 | 1405.65 |  |
| **14 - 11** | 517.76 | -467.74 | 1503.26 |  |
| **2 - 7** | -2709.17 | -3944.56 | -1473.78 | \*\*\* |
| **2 - 4** | -160.67 | -1396.06 | 1074.72 |  |
| **2 - 14** | -87.83 | -1157.71 | 982.05 |  |
| **2 - 17** | 97.63 | -683.70 | 878.96 |  |
| **2 - 5** | 107.03 | -578.25 | 792.30 |  |
| **2 - 6** | 168.53 | -612.80 | 949.86 |  |
| **2 - 16** | 191.53 | -589.80 | 972.86 |  |
| **2 - 9** | 193.39 | -473.80 | 860.58 |  |
| **2 - 8** | 301.17 | -572.39 | 1174.72 |  |
| **2 - 10** | 309.13 | -472.20 | 1090.46 |  |
| **2 - 12** | 324.61 | -472.83 | 1122.05 |  |
| **2 - 3** | 361.69 | -480.09 | 1203.47 |  |
| **2 - 15** | 373.74 | -394.15 | 1141.64 |  |
| **2 - 13** | 377.47 | -390.43 | 1145.37 |  |
| **2 - 1** | 416.22 | -240.52 | 1072.97 |  |
| **2 - 11** | 429.92 | -337.97 | 1197.82 |  |
| **17 - 7** | -2806.80 | -3978.79 | -1634.81 | \*\*\* |
| **17 - 4** | -258.30 | -1430.29 | 913.69 |  |
| **17 - 14** | -185.47 | -1181.47 | 810.54 |  |
| **17 - 2** | -97.63 | -878.96 | 683.70 |  |
| **17 - 5** | 9.39 | -553.62 | 572.40 |  |
| **17 - 6** | 70.90 | -605.75 | 747.55 |  |
| **17 - 16** | 93.90 | -582.75 | 770.55 |  |
| **17 - 9** | 95.76 | -445.10 | 636.61 |  |
| **17 - 8** | 203.53 | -577.80 | 984.86 |  |
| **17 - 10** | 211.50 | -465.15 | 888.15 |  |
| **17 - 12** | 226.98 | -468.22 | 922.17 |  |
| **17 - 3** | 264.06 | -481.58 | 1009.69 |  |
| **17 - 15** | 276.11 | -384.98 | 937.20 |  |
| **17 - 13** | 279.84 | -381.26 | 940.93 |  |
| **17 - 1** | 318.59 | -209.32 | 846.51 |  |
| **17 - 11** | 332.29 | -328.80 | 993.38 |  |
| **5 - 7** | -2816.19 | -3926.46 | -1705.93 | \*\*\* |
| **5 - 4** | -267.69 | -1377.96 | 842.57 |  |
| **5 - 14** | -194.86 | -1117.43 | 727.72 |  |
| **5 - 2** | -107.03 | -792.30 | 578.25 |  |
| **5 - 17** | -9.39 | -572.40 | 553.62 |  |
| **5 - 6** | 61.51 | -501.50 | 624.52 |  |
| **5 - 16** | 84.51 | -478.50 | 647.52 |  |
| **5 - 9** | 86.36 | -303.05 | 475.77 |  |
| **5 - 8** | 194.14 | -491.13 | 879.41 |  |
| **5 - 10** | 202.11 | -360.90 | 765.12 |  |
| **5 - 12** | 217.59 | -367.58 | 802.75 |  |
| **5 - 3** | 254.66 | -389.61 | 898.94 |  |
| **5 - 15** | 266.72 | -277.49 | 810.93 |  |
| **5 - 13** | 270.44 | -273.77 | 814.66 |  |
| **5 - 1** | 309.20 | -62.04 | 680.44 |  |
| **5 - 11** | 322.90 | -221.31 | 867.11 |  |
| **6 - 7** | -2877.70 | -4049.69 | -1705.71 | \*\*\* |
| **6 - 4** | -329.20 | -1501.19 | 842.79 |  |
| **6 - 14** | -256.37 | -1252.37 | 739.64 |  |
| **6 - 2** | -168.53 | -949.86 | 612.80 |  |
| **6 - 17** | -70.90 | -747.55 | 605.75 |  |
| **6 - 5** | -61.51 | -624.52 | 501.50 |  |
| **6 - 16** | 23.00 | -653.65 | 699.65 |  |
| **6 - 9** | 24.86 | -516.00 | 565.71 |  |
| **6 - 8** | 132.63 | -648.70 | 913.96 |  |
| **6 - 10** | 140.60 | -536.05 | 817.25 |  |
| **6 - 12** | 156.08 | -539.12 | 851.27 |  |
| **6 - 3** | 193.16 | -552.48 | 938.79 |  |
| **6 - 15** | 205.21 | -455.88 | 866.30 |  |
| **6 - 13** | 208.94 | -452.16 | 870.03 |  |
| **6 - 1** | 247.69 | -280.22 | 775.61 |  |
| **6 - 11** | 261.39 | -399.70 | 922.48 |  |
| **16 - 7** | -2900.70 | -4072.69 | -1728.71 | \*\*\* |
| **16 - 4** | -352.20 | -1524.19 | 819.79 |  |
| **16 - 14** | -279.37 | -1275.37 | 716.64 |  |
| **16 - 2** | -191.53 | -972.86 | 589.80 |  |
| **16 - 17** | -93.90 | -770.55 | 582.75 |  |
| **16 - 5** | -84.51 | -647.52 | 478.50 |  |
| **16 - 6** | -23.00 | -699.65 | 653.65 |  |
| **16 - 9** | 1.86 | -539.00 | 542.71 |  |
| **16 - 8** | 109.63 | -671.70 | 890.96 |  |
| **16 - 10** | 117.60 | -559.05 | 794.25 |  |
| **16 - 12** | 133.08 | -562.12 | 828.27 |  |
| **16 - 3** | 170.16 | -575.48 | 915.79 |  |
| **16 - 15** | 182.21 | -478.88 | 843.30 |  |
| **16 - 13** | 185.94 | -475.16 | 847.03 |  |
| **16 - 1** | 224.69 | -303.22 | 752.61 |  |
| **16 - 11** | 238.39 | -422.70 | 899.48 |  |
| **9 - 7** | -2902.56 | -4001.75 | -1803.36 | \*\*\* |
| **9 - 4** | -354.06 | -1453.25 | 745.14 |  |
| **9 - 14** | -281.22 | -1190.44 | 628.00 |  |
| **9 - 2** | -193.39 | -860.58 | 473.80 |  |
| **9 - 17** | -95.76 | -636.61 | 445.10 |  |
| **9 - 5** | -86.36 | -475.77 | 303.05 |  |
| **9 - 6** | -24.86 | -565.71 | 516.00 |  |
| **9 - 16** | -1.86 | -542.71 | 539.00 |  |
| **9 - 8** | 107.78 | -559.41 | 774.96 |  |
| **9 - 10** | 115.74 | -425.11 | 656.60 |  |
| **9 - 12** | 131.22 | -432.65 | 695.10 |  |
| **9 - 3** | 168.30 | -456.70 | 793.31 |  |
| **9 - 15** | 180.35 | -340.90 | 701.61 |  |
| **9 - 13** | 184.08 | -337.18 | 705.34 |  |
| **9 - 1** | 222.84 | -113.85 | 559.52 |  |
| **9 - 11** | 236.54 | -284.72 | 757.79 |  |
| **8 - 7** | -3010.33 | -4245.72 | -1774.94 | \*\*\* |
| **8 - 4** | -461.83 | -1697.22 | 773.56 |  |
| **8 - 14** | -389.00 | -1458.88 | 680.88 |  |
| **8 - 2** | -301.17 | -1174.72 | 572.39 |  |
| **8 - 17** | -203.53 | -984.86 | 577.80 |  |
| **8 - 5** | -194.14 | -879.41 | 491.13 |  |
| **8 - 6** | -132.63 | -913.96 | 648.70 |  |
| **8 - 16** | -109.63 | -890.96 | 671.70 |  |
| **8 - 9** | -107.78 | -774.96 | 559.41 |  |
| **8 - 10** | 7.97 | -773.36 | 789.30 |  |
| **8 - 12** | 23.44 | -774.00 | 820.89 |  |
| **8 - 3** | 60.52 | -781.25 | 902.30 |  |
| **8 - 15** | 72.58 | -695.32 | 840.47 |  |
| **8 - 13** | 76.30 | -691.59 | 844.20 |  |
| **8 - 1** | 115.06 | -541.69 | 771.80 |  |
| **8 - 11** | 128.76 | -639.14 | 896.65 |  |
| **10 - 7** | -3018.30 | -4190.29 | -1846.31 | \*\*\* |
| **10 - 4** | -469.80 | -1641.79 | 702.19 |  |
| **10 - 14** | -396.97 | -1392.97 | 599.04 |  |
| **10 - 2** | -309.13 | -1090.46 | 472.20 |  |
| **10 - 17** | -211.50 | -888.15 | 465.15 |  |
| **10 - 5** | -202.11 | -765.12 | 360.90 |  |
| **10 - 6** | -140.60 | -817.25 | 536.05 |  |
| **10 - 16** | -117.60 | -794.25 | 559.05 |  |
| **10 - 9** | -115.74 | -656.60 | 425.11 |  |
| **10 - 8** | -7.97 | -789.30 | 773.36 |  |
| **10 - 12** | 15.48 | -679.72 | 710.67 |  |
| **10 - 3** | 52.56 | -693.08 | 798.19 |  |
| **10 - 15** | 64.61 | -596.48 | 725.70 |  |
| **10 - 13** | 68.34 | -592.76 | 729.43 |  |
| **10 - 1** | 107.09 | -420.82 | 635.01 |  |
| **10 - 11** | 120.79 | -540.30 | 781.88 |  |
| **12 - 7** | -3033.78 | -4216.57 | -1850.98 | \*\*\* |
| **12 - 4** | -485.28 | -1668.07 | 697.52 |  |
| **12 - 14** | -412.44 | -1421.14 | 596.25 |  |
| **12 - 2** | -324.61 | -1122.05 | 472.83 |  |
| **12 - 17** | -226.98 | -922.17 | 468.22 |  |
| **12 - 5** | -217.59 | -802.75 | 367.58 |  |
| **12 - 6** | -156.08 | -851.27 | 539.12 |  |
| **12 - 16** | -133.08 | -828.27 | 562.12 |  |
| **12 - 9** | -131.22 | -695.10 | 432.65 |  |
| **12 - 8** | -23.44 | -820.89 | 774.00 |  |
| **12 - 10** | -15.48 | -710.67 | 679.72 |  |
| **12 - 3** | 37.08 | -725.42 | 799.58 |  |
| **12 - 15** | 49.13 | -630.93 | 729.19 |  |
| **12 - 13** | 52.86 | -627.20 | 732.92 |  |
| **12 - 1** | 91.61 | -459.87 | 643.10 |  |
| **12 - 11** | 105.31 | -574.75 | 785.37 |  |
| **3 - 7** | -3070.86 | -4283.99 | -1857.73 | \*\*\* |
| **3 - 4** | -522.36 | -1735.49 | 690.77 |  |
| **3 - 14** | -449.52 | -1493.62 | 594.57 |  |
| **3 - 2** | -361.69 | -1203.47 | 480.09 |  |
| **3 - 17** | -264.06 | -1009.69 | 481.58 |  |
| **3 - 5** | -254.66 | -898.94 | 389.61 |  |
| **3 - 6** | -193.16 | -938.79 | 552.48 |  |
| **3 - 16** | -170.16 | -915.79 | 575.48 |  |
| **3 - 9** | -168.30 | -793.31 | 456.70 |  |
| **3 - 8** | -60.52 | -902.30 | 781.25 |  |
| **3 - 10** | -52.56 | -798.19 | 693.08 |  |
| **3 - 12** | -37.08 | -799.58 | 725.42 |  |
| **3 - 15** | 12.05 | -719.49 | 743.60 |  |
| **3 - 13** | 15.78 | -715.77 | 747.32 |  |
| **3 - 1** | 54.53 | -559.31 | 668.38 |  |
| **3 - 11** | 68.23 | -663.31 | 799.78 |  |
| **15 - 7** | -3082.91 | -4245.99 | -1919.83 | \*\*\* |
| **15 - 4** | -534.41 | -1697.49 | 628.67 |  |
| **15 - 14** | -461.58 | -1447.08 | 523.92 |  |
| **15 - 2** | -373.74 | -1141.64 | 394.15 |  |
| **15 - 17** | -276.11 | -937.20 | 384.98 |  |
| **15 - 5** | -266.72 | -810.93 | 277.49 |  |
| **15 - 6** | -205.21 | -866.30 | 455.88 |  |
| **15 - 16** | -182.21 | -843.30 | 478.88 |  |
| **15 - 9** | -180.35 | -701.61 | 340.90 |  |
| **15 - 8** | -72.58 | -840.47 | 695.32 |  |
| **15 - 10** | -64.61 | -725.70 | 596.48 |  |
| **15 - 12** | -49.13 | -729.19 | 630.93 |  |
| **15 - 3** | -12.05 | -743.60 | 719.49 |  |
| **15 - 13** | 3.73 | -641.43 | 648.89 |  |
| **15 - 1** | 42.48 | -465.34 | 550.30 |  |
| **15 - 11** | 56.18 | -588.98 | 701.34 |  |
| **13 - 7** | -3086.64 | -4249.72 | -1923.55 | \*\*\* |
| **13 - 4** | -538.14 | -1701.22 | 624.95 |  |
| **13 - 14** | -465.30 | -1450.80 | 520.20 |  |
| **13 - 2** | -377.47 | -1145.37 | 390.43 |  |
| **13 - 17** | -279.84 | -940.93 | 381.26 |  |
| **13 - 5** | -270.44 | -814.66 | 273.77 |  |
| **13 - 6** | -208.94 | -870.03 | 452.16 |  |
| **13 - 16** | -185.94 | -847.03 | 475.16 |  |
| **13 - 9** | -184.08 | -705.34 | 337.18 |  |
| **13 - 8** | -76.30 | -844.20 | 691.59 |  |
| **13 - 10** | -68.34 | -729.43 | 592.76 |  |
| **13 - 12** | -52.86 | -732.92 | 627.20 |  |
| **13 - 3** | -15.78 | -747.32 | 715.77 |  |
| **13 - 15** | -3.73 | -648.89 | 641.43 |  |
| **13 - 1** | 38.75 | -469.07 | 546.58 |  |
| **13 - 11** | 52.45 | -592.71 | 697.62 |  |
| **1 - 7** | -3125.39 | -4218.28 | -2032.50 | \*\*\* |
| **1 - 4** | -576.89 | -1669.78 | 516.00 |  |
| **1 - 14** | -504.06 | -1405.65 | 397.53 |  |
| **1 - 2** | -416.22 | -1072.97 | 240.52 |  |
| **1 - 17** | -318.59 | -846.51 | 209.32 |  |
| **1 - 5** | -309.20 | -680.44 | 62.04 |  |
| **1 - 6** | -247.69 | -775.61 | 280.22 |  |
| **1 - 16** | -224.69 | -752.61 | 303.22 |  |
| **1 - 9** | -222.84 | -559.52 | 113.85 |  |
| **1 - 8** | -115.06 | -771.80 | 541.69 |  |
| **1 - 10** | -107.09 | -635.01 | 420.82 |  |
| **1 - 12** | -91.61 | -643.10 | 459.87 |  |
| **1 - 3** | -54.53 | -668.38 | 559.31 |  |
| **1 - 15** | -42.48 | -550.30 | 465.34 |  |
| **1 - 13** | -38.75 | -546.58 | 469.07 |  |
| **1 - 11** | 13.70 | -494.12 | 521.52 |  |
| **11 - 7** | -3139.09 | -4302.17 | -1976.01 | \*\*\* |
| **11 - 4** | -590.59 | -1753.67 | 572.49 |  |
| **11 - 14** | -517.76 | -1503.26 | 467.74 |  |
| **11 - 2** | -429.92 | -1197.82 | 337.97 |  |
| **11 - 17** | -332.29 | -993.38 | 328.80 |  |
| **11 - 5** | -322.90 | -867.11 | 221.31 |  |
| **11 - 6** | -261.39 | -922.48 | 399.70 |  |
| **11 - 16** | -238.39 | -899.48 | 422.70 |  |
| **11 - 9** | -236.54 | -757.79 | 284.72 |  |
| **11 - 8** | -128.76 | -896.65 | 639.14 |  |
| **11 - 10** | -120.79 | -781.88 | 540.30 |  |
| **11 - 12** | -105.31 | -785.37 | 574.75 |  |
| **11 - 3** | -68.23 | -799.78 | 663.31 |  |
| **11 - 15** | -56.18 | -701.34 | 588.98 |  |
| **11 - 13** | -52.45 | -697.62 | 592.71 |  |
| **11 - 1** | -13.70 | -521.52 | 494.12 |  |

* Decision Rule- Since F Value = 7.77 > 1.70, reject H0.
* Interpretation: Not all mean maintenance costs are equal.
* Statistical significance (F) = 7.7 and p-value = 0.0053 , The F value is less than the critical value and hence we can also consider it to be statistically insignificant at the given significant level
* Practical significance (R2) = 0.384495, We come to know the degree of variation in the categories, as the value as more than 20% we can consider it to be significant at the given significant level

1. :
2. Conduct a test of hypothesis to reveal whether the mean maintenance cost is equal for each of the bus manufacturers. Use the 0.01 significance level.

* H0: µ1 = µ2 = µ3

H1: Not all mean maintenance costs are equal.

* Df in the numerator = 3-1 = 2

Df in the denominator = 80-3 = 77

* Alpha = 0.01
* Thus if F > 4.98, reject H0.
* Rejection Statements :

Reject if p-value < alpha i.e. p-value<0.01

* SAS Output:

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Btemp;

SET V506.Buses;

IF BUS\_MFG = “Bluebird” THEN BUS\_MFG = 1;

IF BUS\_MFG = “Keiser” THEN BUS\_MFG = 2;

IF BUS\_MFG = “Thompson” THEN BUS\_MFG = 3;

**RUN**;

**PROC** **ANOVA** plots=none;

CLASS BUS\_MFG;

MODEL MAINTENANCE = BUS\_MFG;

MEANS BUS\_MFG / BON ALPHA=**0.01**;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **Bus\_Mfg** | 3 | Bluebird Keiser Thompson |

|  |  |
| --- | --- |
| **Number of Observations Read** | 80 |
| **Number of Observations Used** | 80 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: Maintenance**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 2 | 28996.2509 | 14498.1255 | 5.62 | 0.0053 |
| **Error** | 77 | 198696.1366 | 2580.4693 |  |  |
| **Corrected Total** | 79 | 227692.3875 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **Maintenance Mean** |
| --- | --- | --- | --- |
| 0.127348 | 11.28131 | 50.79832 | 450.2875 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Bus\_Mfg** | 2 | 28996.25090 | 14498.12545 | 5.62 | 0.0053 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for Maintenance**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experiment wise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.01 |
| **Error Degrees of Freedom** | 77 |
| **Error Mean Square** | 2580.469 |
| **Critical Value of t** | 3.02953 |

| **Comparisons significant at the 0.01 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **Bus\_Mfg Comparison** | **Difference Between Means** | **Simultaneous 99% Confidence Limits** | |  |
| **3 – 2** | 58.59 | -3.92 | 121.10 |  |
| **3 – 1** | 64.94 | 6.08 | 123.80 | \*\*\* |
| **2 – 3** | -58.59 | -121.10 | 3.92 |  |
| **2 - 1** | 6.35 | -31.74 | 44.45 |  |
| **1 – 3** | -64.94 | -123.80 | -6.08 | \*\*\* |
| **1 - 2** | -6.35 | -44.45 | 31.74 |  |

* The values highlighted in the above table are the pairs where the means differ significantly.
* Decision Rule: Since F Value = 5.62 > 4.98, reject H0.
* Interpretation: Not all mean maintenance costs are equal.
* Statistical significance (F) = 5.62 and p-value = 0.0053 , The F value is less than the critical value and hence we can also consider it to be statistically insignificant at the given significant level
* Practical significance (R2) = 0.127348, We come to know the degree of variation in the categories, as the value as less than 20% we can consider it to be insignificant at the given significant level

1. Conduct a test of hypothesis to determine whether the mean miles traveled is equal for each bus manufacturer. Use the 0.05 significance level.

H0: µ1 = µ2 = µ3

H1: not all mean miles are equal

Df in the numerator = 3-1 = 2

Df in the denominator = 80-3 = 77

Alpha = 0.05

Thus if F > 3.15, reject H0.

**SAS OUTPUT:**

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Btemp;

SET V506.Buses;

IF BUS\_MFG = “Bluebird” THEN BUS\_MFG = 1;

IF BUS\_MFG = “Keiser” THEN BUS\_MFG = 2;

IF BUS\_MFG = “Thompson” THEN BUS\_MFG = 3;

**RUN**;

**PROC** **ANOVA** plots=none;

CLASS BUS\_MFG;

MODEL MILES = BUS\_MFG;

MEANS BUS\_MFG / BON;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **Bus\_Mfg** | 3 | Bluebird Keiser Thompson |

|  |  |
| --- | --- |
| **Number of Observations Read** | 80 |
| **Number of Observations Used** | 80 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: Miles**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 2 | 5094.5951 | 2547.2975 | 1.45 | 0.2415 |
| **Error** | 77 | 135513.3924 | 1759.9142 |  |  |
| **Corrected Total** | 79 | 140607.9875 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **Miles Mean** |
| --- | --- | --- | --- |
| 0.036233 | 5.053692 | 41.95133 | 830.1125 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Bus\_Mfg** | 2 | 5094.595053 | 2547.297527 | 1.45 | 0.2415 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for Miles**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 77 |
| **Error Mean Square** | 1759.914 |
| **Critical Value of t** | 2.44741 |

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **Bus\_Mfg Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **3 - 1** | 7.726 | -31.542 | 46.994 |  |
| **3 - 2** | 23.115 | -18.591 | 64.821 |  |
| **1 - 3** | -7.726 | -46.994 | 31.542 |  |
| **1 – 2** | 15.389 | -10.027 | 40.804 |  |
| **2 – 3** | -23.115 | -64.821 | 18.591 |  |
| **2 – 1** | -15.389 | -40.804 | 10.027 |  |

* Decision Rule - Since, F = 1.45 < 3.15, fail to reject H0.
* Interpretation: Not all mean miles are equal.
* Statistical significance (F) = 1.45 and p-value = 0.2415 , The F value is more than the critical value and hence we can also consider it to be statistically significant at the given significant level
* Practical significance (R2) = 0.036233, We come to know the degree of variation in the categories, as the value as less than 20% we can consider it to be insignificant at the given significant level

1. Develop a 95% confidence interval for the disparity in the average maintenance cost between buses made by Bluebird and Thompson.

K = 3 - 1 = 2

N = 80

Thus t = 1.991

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Btemp2;

SET V506.Btemp;

IF BUS\_MFG='Bluebird';

**RUN**;

**PROC** **MEANS**;

VAR MAINTENANCE;

**RUN**;

**DATA** V506.Btemp2;

SET V506.Btemp;

IF BUS\_MFG='Thompson';

**RUN**;

**PROC** **MEANS**;

VAR MAINTENANCE;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The MEANS Procedure**

| **Analysis Variable : Maintenance** | | | | |
| --- | --- | --- | --- | --- |
| **N** | **Mean** | **Std Dev** | **Minimum** | **Maximum** |
| 47 | 441.8085106 | 54.9251025 | 329.0000000 | 558.0000000 |

**The MEANS Procedure**

| **Analysis Variable : Maintenance** | | | | |
| --- | --- | --- | --- | --- |
| **N** | **Mean** | **Std Dev** | **Minimum** | **Maximum** |
| 8 | 506.7500000 | 45.5247186 | 457.0000000 | 570.0000000 |

Mean Square Error = 2580.4693 (from part a of the question)

K = 3-1 = 2

N = 80

95% confidence interval

Thus t = 1.991

Mean cost of Bluebird bus = 441.8085106

Mean cost of Thompson bus = 506.7500000

Number of Bluebird bus = 47

Number of Thompson bus = 8

(506.8 - 441.8) +/- 1.991 = 65 +/- 38.7 => (26.3, 103.7)

Thus the difference between mean maintenance costs of Bluebird and Thompson buses is between 26.3 and 103.7, meaning that Thompson’s bus is more expensive to maintain than Bluebird’s by any amount between 26.3 and 103.7.

1. A:

H0: µ1 = µ2 = µ3

H1: not all mean unemployment rates are equal

Df in the numerator = 3-1 = 2

Df in the denominator = 41-3 = 38

Alpha = 0.05

Rejection Statement: Thus if F > 3.32, reject H0.

**SAS OUTPUT,**

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Itemp;

SET V506.International;

**RUN**;

**PROC** **ANOVA** plots=none data=V506.Itemp2;

CLASS PETROLEUM;

MODEL PCUNEMP = PETROLEUM;

MEANS PETROLEUM / BON;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **Petroleum** | 3 | 0 1 2 |

|  |  |
| --- | --- |
| **Number of Observations Read** | 46 |
| **Number of Observations Used** | 41 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: PcUnemp PcUnemp**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 2 | 804.480836 | 402.240418 | 9.74 | 0.0004 |
| **Error** | 38 | 1568.594286 | 41.278797 |  |  |
| **Corrected Total** | 40 | 2373.075122 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **PcUnemp Mean** |
| --- | --- | --- | --- |
| 0.339004 | 66.67152 | 6.424858 | 9.636585 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Petroleum** | 2 | 804.4808362 | 402.2404181 | 9.74 | 0.0004 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for PcUnemp**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 38 |
| **Error Mean Square** | 41.2788 |
| **Critical Value of t** | 2.50461 |

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **Petroleum Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **2 - 0** | 11.229 | 4.206 | 18.252 | \*\*\* |
| **2 - 1** | 12.429 | 4.885 | 19.973 | \*\*\* |
| **0 - 2** | -11.229 | -18.252 | -4.206 | \*\*\* |
| **0 - 1** | 1.200 | -4.479 | 6.879 |  |
| **1 - 2** | -12.429 | -19.973 | -4.885 | \*\*\* |
| **1 - 0** | -1.200 | -6.879 | 4.479 |  |

* Decision Rule - Since, F = 9.74 > 3.32, reject H0.
* Interpretation: Not all mean unemployment rates with respect to Petroleum as a natural resource are the same.
* Statistical significance (F) = 9.74 and p-value = 0.0004, The F value is more than the critical value and hence we can also consider it to be statistically insignificant at the given significant level
* Practical significance (R2) = 0.339004, We come to know the degree of variation in the categories, as the value as more than 20% we can consider it to be significant at the given significant level

B. H0: µ1 = µ2 = µ3

H1: not all mean of life expectancies are equal

Df in the numerator = 3-1 = 2

Df in the denominator = 46-3 = 43

Alpha = 0.05

Rejection Statement: Thus if F > 3.15, reject H0.

**SAS OUTPUT:**

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Itemp;

SET V506.International;

**RUN**;

**PROC** **ANOVA** plots=none;

CLASS PETROLEUM;

MODEL LIFEEXPC = PETROLEUM;

MEANS PETROLEUM / BON;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **Petroleum** | 3 | 0 1 2 |

|  |  |
| --- | --- |
| **Number of Observations Read** | 46 |
| **Number of Observations Used** | 46 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: LifeExpc LifeExpc**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 2 | 265.375058 | 132.687529 | 3.03 | 0.0585 |
| **Error** | 43 | 1879.977873 | 43.720416 |  |  |
| **Corrected Total** | 45 | 2145.352930 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **LifeExpc Mean** |
| --- | --- | --- | --- |
| 0.123698 | 8.958855 | 6.612142 | 73.80565 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Petroleum** | 2 | 265.3750577 | 132.6875289 | 3.03 | 0.0585 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for LifeExpc**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 43 |
| **Error Mean Square** | 43.72042 |
| **Critical Value of t** | 2.49126 |

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **Petroleum Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **0 - 1** | 1.490 | -4.194 | 7.174 |  |
| **0 - 2** | 6.025 | -0.106 | 12.156 |  |
| **1 - 0** | -1.490 | -7.174 | 4.194 |  |
| **1 - 2** | 4.535 | -2.102 | 11.172 |  |
| **2 - 0** | -6.025 | -12.156 | 0.106 |  |
| **2 - 1** | -4.535 | -11.172 | 2.102 |  |

* Decision Rule - Since, F = 3.03 < 3.15, fail to reject H0.
* Interpretation: The mean life expectancies with respect to Petroleum as a natural resource can the same, we cannot reject it at the given significance level
* Statistical significance (F) = 3.03 and p-value = 0.0585, The F value is less than the critical value and hence we can also consider it to be statistically insignificant at the given significance level
* Practical significance (R2) = 0.123698, We come to know the degree of variation in the categories, as the value as less than 20% we can consider it to be insignificant at the given significant level

1. A – (2-0) and (2-1) are significant, while (0-1) is insignificant

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **Petroleum Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **2 - 0** | 11.229 | 4.206 | 18.252 | \*\*\* |
| **2 - 1** | 12.429 | 4.885 | 19.973 | \*\*\* |
| **0 - 2** | -11.229 | -18.252 | -4.206 | \*\*\* |
| **0 - 1** | 1.200 | -4.479 | 6.879 |  |
| **1 - 2** | -12.429 | -19.973 | -4.885 | \*\*\* |
| **1 - 0** | -1.200 | -6.879 | 4.479 |  |

B – None of the level are significant

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **Petroleum Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **0 - 1** | 1.490 | -4.194 | 7.174 |  |
| **0 - 2** | 6.025 | -0.106 | 12.156 |  |
| **1 - 0** | -1.490 | -7.174 | 4.194 |  |
| **1 - 2** | 4.535 | -2.102 | 11.172 |  |
| **2 - 0** | -6.025 | -12.156 | 0.106 |  |
| **2 - 1** | -4.535 | -11.172 | 2.102 |  |

4.

**A**

H0: µ1 = µ2 = µ3

H1: not all mean miles are equal

Df in the numerator = 3-1 = 2

Df in the denominator = 94-3 = 91

Alpha = 0.05

Rejection Statement: Thus if F > 3.11, reject H0.

**SAS Output:**

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Stemp;

SET V506.Schools;

**RUN**;

**DATA** v506.Stemp2;

SET v506.Stemp;

IF STUDENTS<**1000** THEN SIZE='small';

ELSE IF STUDENTS<**3000** THEN SIZE='medium';

ELSE SIZE='large';

**RUN**;

**PROC** **UNIVARIATE**;

VAR SIZE;

**RUN**;

**PROC** **ANOVA** plots=none;

CLASS SIZE;

MODEL INSTRUCT = SIZE;

MEANS SIZE / BON;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **SIZE** | 3 | large mediu small |

|  |  |
| --- | --- |
| **Number of Observations Read** | 94 |
| **Number of Observations Used** | 94 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: Instruct Instruct**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 2 | 2348101.3 | 1174050.7 | 0.98 | 0.3799 |
| **Error** | 91 | 109205611.1 | 1200061.7 |  |  |
| **Corrected Total** | 93 | 111553712.4 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **Instruct Mean** |
| --- | --- | --- | --- |
| 0.021049 | 40.20666 | 1095.473 | 2724.606 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **SIZE** | 2 | 2348101.321 | 1174050.661 | 0.98 | 0.3799 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for Instruct**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 91 |
| **Error Mean Square** | 1200062 |
| **Critical Value of t** | 2.43904 |

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **SIZE Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **small - large** | 75.8 | -727.0 | 878.6 |  |
| **small - mediu** | 336.9 | -270.0 | 943.7 |  |
| **large - small** | -75.8 | -878.6 | 727.0 |  |
| **large - mediu** | 261.1 | -523.9 | 1046.1 |  |
| **mediu - small** | -336.9 | -943.7 | 270.0 |  |
| **mediu - large** | -261.1 | -1046.1 | 523.9 |  |

* Decision Rule - Since, F = 0.98 < 3.11, fail to reject H0.
* Interpretation: The mean amount spent on instruction for the three groups, we cannot reject it at the given significance level
* Statistical significance (F) = 0.98 and p-value = 0.3799, The F value is less than the critical value and hence we can also consider it to be statistically insignificant at the given significance level
* Practical significance (R2) = 0.021049, We come to know the degree of variation in the categories, as the value as less than 20% we can consider it to be insignificant at the given significant level

**B**

H0: µ1 = µ2 = µ3

H1: not all mean miles are equal

Df in the numerator = 3-1 = 2

Df in the denominator = 94-3 = 91

Alpha = 0.05

Rejection Statement: Thus if F > 3.11, reject H0.

**SAS Output:**

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Stemp;

SET V506.Schools;

**RUN**;

**DATA** v506.Stemp2;

SET v506.Stemp;

IF STUDENTS<**1000** THEN SIZE='small';

ELSE IF STUDENTS<**3000** THEN SIZE='medium';

ELSE SIZE='large';

**RUN**;

**PROC** **UNIVARIATE**;

VAR SIZE;

**RUN**;

**PROC** **ANOVA** plots=none;

CLASS SIZE;

MODEL SALARY = SIZE;

MEANS SIZE / BON;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **SIZE** | 3 | large mediu small |

|  |  |
| --- | --- |
| **Number of Observations Read** | 94 |
| **Number of Observations Used** | 94 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: Salary Salary**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 2 | 416321491 | 208160746 | 25.10 | <.0001 |
| **Error** | 91 | 754723654 | 8293667 |  |  |
| **Corrected Total** | 93 | 1171045145 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **Salary Mean** |
| --- | --- | --- | --- |
| 0.355513 | 8.679177 | 2879.873 | 33181.40 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **SIZE** | 2 | 416321491.0 | 208160745.5 | 25.10 | <.0001 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for Salary**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 91 |
| **Error Mean Square** | 8293667 |
| **Critical Value of t** | 2.43904 |

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **SIZE Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **large - mediu** | 2803.1 | 739.5 | 4866.7 | \*\*\* |
| **large - small** | 5856.6 | 3746.1 | 7967.1 | \*\*\* |
| **mediu - large** | -2803.1 | -4866.7 | -739.5 | \*\*\* |
| **mediu - small** | 3053.5 | 1458.1 | 4648.8 | \*\*\* |
| **small - large** | -5856.6 | -7967.1 | -3746.1 | \*\*\* |
| **small - mediu** | -3053.5 | -4648.8 | -1458.1 | \*\*\* |

* Decision Rule - Since, F = 25.10 > 3.11, reject H0.
* Interpretation: The mean salaries for the three groups, we cannot reject it at the given significance level
* Statistical significance (F) = 25.10 and p-value <.0001, The F value is more than the critical value and hence we can also consider it to be statistically insignificant at the given significance level
* Practical significance (R2) = 0.355513, We come to know the degree of variation in the categories, as the value as more than 20% we can consider it to be significant at the given significant level

5.

A- SAS OUTPUT

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Atemp;

SET V506.Appalachian;

**RUN**;

**PROC** **UNIVARIATE**;

VAR EDUCPRC;

**RUN**;

**PROC** **UNIVARIATE**;

VAR WELFPRC;

**RUN**;

**PROC** **UNIVARIATE**;

VAR HOUSQUAL;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The UNIVARIATE Procedure**

**Variable: EDUCPRC (EDUCPRC)**

| **Moments** | | | |
| --- | --- | --- | --- |
| **N** | 30 | **Sum Weights** | 30 |
| **Mean** | 69.9833333 | **Sum Observations** | 2099.5 |
| **Std Deviation** | 15.1378057 | **Variance** | 229.153161 |
| **Skewness** | -0.2535734 | **Kurtosis** | -0.9399375 |
| **Uncorrected SS** | 153575.45 | **Corrected SS** | 6645.44167 |
| **Coeff Variation** | 21.6305868 | **Std Error Mean** | 2.76377255 |

| **Basic Statistical Measures** | | | |
| --- | --- | --- | --- |
| **Location** | | **Variability** | |
| **Mean** | 69.98333 | **Std Deviation** | 15.13781 |
| **Median** | 68.05000 | **Variance** | 229.15316 |
| **Mode** | . | **Range** | 52.30000 |
|  |  | **Interquartile Range** | 23.40000 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The UNIVARIATE Procedure**

**Variable: WELFPRC (WELFPRC)**

| **Moments** | | | |
| --- | --- | --- | --- |
| **N** | 30 | **Sum Weights** | 30 |
| **Mean** | 0.24333333 | **Sum Observations** | 7.3 |
| **Std Deviation** | 0.21605129 | **Variance** | 0.04667816 |
| **Skewness** | 0.91067767 | **Kurtosis** | 0.35503017 |
| **Uncorrected SS** | 3.13 | **Corrected SS** | 1.35366667 |
| **Coeff Variation** | 88.7882023 | **Std Error Mean** | 0.03944539 |

| **Basic Statistical Measures** | | | |
| --- | --- | --- | --- |
| **Location** | | **Variability** | |
| **Mean** | 0.243333 | **Std Deviation** | 0.21605 |
| **Median** | 0.200000 | **Variance** | 0.04668 |
| **Mode** | 0.100000 | **Range** | 0.80000 |
|  |  | **Interquartile Range** | 0.20000 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The UNIVARIATE Procedure**

**Variable: HOUSQUAL (HOUSQUAL)**

| **Moments** | | | |
| --- | --- | --- | --- |
| **N** | 30 | **Sum Weights** | 30 |
| **Mean** | 43.4633333 | **Sum Observations** | 1303.9 |
| **Std Deviation** | 11.1363488 | **Variance** | 124.018264 |
| **Skewness** | 0.18136203 | **Kurtosis** | 0.539134 |
| **Uncorrected SS** | 60268.37 | **Corrected SS** | 3596.52967 |
| **Coeff Variation** | 25.6223992 | **Std Error Mean** | 2.03320981 |

| **Basic Statistical Measures** | | | |
| --- | --- | --- | --- |
| **Location** | | **Variability** | |
| **Mean** | 43.46333 | **Std Deviation** | 11.13635 |
| **Median** | 43.75000 | **Variance** | 124.01826 |
| **Mode** | . | **Range** | 52.70000 |
|  |  | **Interquartile Range** | 12.40000 |

B –

H0: µ1 = µ2

H1: The state means are not the same

H0: µ1 = µ2 = µ3= µ4= µ5

H1: The education level means are not the same

H0: µse = µs + µe - µ … for all combinations

H1: The population cell means are not the same completely determined by the population marginal means (µs , µe)

Df in the STATE = 2-1 = 1

Df in the EDUCPRC = 5-1 = 4

Df in the Interaction = (2-1)(5-1) = 4

Df in the Error = 30-(2)(5) = 20

Alpha = 0.05

Factor S: Thus if F > 4.35, reject H0

Factor E: Thus if F > 2.87, reject H0

ISS: Thus if F > 2.87, reject H0

**SAS Output:**

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Atemp;

SET V506.Appalachian;

**RUN**;

**PROC** **ANOVA** plots=none;

CLASS STATE EDUCLVL;

MODEL EDUCPRC = STATE EDUCLVL STATE\*EDUCLVL;

MEANS STATE EDUCLVL / BON;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **STATE** | 2 | KY TN |
| **EDUCLVL** | 5 | 1 2 3 4 5 |

|  |  |
| --- | --- |
| **Number of Observations Read** | 30 |
| **Number of Observations Used** | 30 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: EDUCPRC EDUCPRC**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 8 | 5226.479000 | 653.309875 | 9.67 | <.0001 |
| **Error** | 21 | 1418.962667 | 67.569651 |  |  |
| **Corrected Total** | 29 | 6645.441667 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **EDUCPRC Mean** |
| --- | --- | --- | --- |
| 0.786476 | 11.74576 | 8.220076 | 69.98333 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **STATE** | 1 | 4735.120333 | 4735.120333 | 70.08 | <.0001 |
| **EDUCLVL** | 4 | 1107.803167 | 276.950792 | 4.10 | 0.0131 |
| **STATE\*EDUCLVL** | 3 | 0.000000 | 0.000000 | 0.00 | 1.0000 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for EDUCPRC**

|  |  |
| --- | --- |
| **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** | 21 |
| **Error Mean Square** | 67.56965 |
| **Critical Value of t** | 2.07961 |
| **Minimum Significant Difference** | 6.2421 |

| **Means with the same letter are not significantly different.** | | | |
| --- | --- | --- | --- |
| **Bon Grouping** | **Mean** | **N** | **STATE** |
| A | 82.547 | 15 | KY |
|  |  |  |  |
| B | 57.420 | 15 | TN |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for EDUCPRC**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 21 |
| **Error Mean Square** | 67.56965 |
| **Critical Value of t** | 3.13521 |

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **EDUCLVL Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **5 - 3** | 17.170 | 1.923 | 32.417 | \*\*\* |
| **5 - 2** | 17.275 | -0.948 | 35.498 |  |
| **5 - 1** | 17.725 | 1.943 | 33.507 | \*\*\* |
| **5 - 4** | 19.600 | 1.377 | 37.823 | \*\*\* |
| **3 - 5** | -17.170 | -32.417 | -1.923 | \*\*\* |
| **3 - 2** | 0.105 | -15.142 | 15.352 |  |
| **3 - 1** | 0.555 | -11.670 | 12.780 |  |
| **3 - 4** | 2.430 | -12.817 | 17.677 |  |
| **2 - 5** | -17.275 | -35.498 | 0.948 |  |
| **2 - 3** | -0.105 | -15.352 | 15.142 |  |
| **2 - 1** | 0.450 | -15.332 | 16.232 |  |
| **2 - 4** | 2.325 | -15.898 | 20.548 |  |
| **1 - 5** | -17.725 | -33.507 | -1.943 | \*\*\* |
| **1 - 3** | -0.555 | -12.780 | 11.670 |  |
| **1 - 2** | -0.450 | -16.232 | 15.332 |  |
| **1 - 4** | 1.875 | -13.907 | 17.657 |  |
| **4 - 5** | -19.600 | -37.823 | -1.377 | \*\*\* |
| **4 - 3** | -2.430 | -17.677 | 12.817 |  |
| **4 - 2** | -2.325 | -20.548 | 15.898 |  |
| **4 - 1** | -1.875 | -17.657 | 13.907 |  |

* Decision Rule –

Since, STATE: F = 70.08 > 4.35, reject H0, There is a direct relationship between STATE and EDUCPRC, we can reject the hypothesis at 0.05 significance level

EDUCLVL: F = 4.10 > 2.87, reject H0, There is a direct relationship between EDUCLVL and EDUCPRC, we can reject the hypothesis at 0.05 significance level

Interaction : F = 0.00 < 2.87, fail to reject H0, The null hypothesis that there is no direct relationship between STATE and EDUCLVL cannot be rejected at the 0.05 level of significance

* Statistical significance (F) = 9.67 and p-value <.0001, The F value is more than the critical value and hence we can also consider it to be statistically insignificant at the given significance level
* Practical significance (R2) = 0.786476, We come to know the degree of variation in the categories, as the value as more than 20% we can consider it to be significant at the given significant level

H0: µ1 = µ2

H1: The state means are not the same

H0: µ1 = µ2 = µ3= µ4= µ5

H1: The education level means are not the same

H0: µse = µs + µe - µ … for all combinations

H1: The population cell means are not the same completely determined by the population marginal means (µs , µe)

Df in the STATE = 2-1 = 1

Df in the EDUCPRC = 5-1 = 4

Df in the Interaction = (2-1)(5-1) = 4

Df in the Error = 30-(2)(5) = 20

Alpha = 0.05

Factor S: Thus if F > 4.35, reject H0

Factor E: Thus if F > 2.87, reject H0

ISS: Thus if F > 2.87, reject H0

**SAS Output:**

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Atemp;

SET V506.Appalachian;

**RUN**;

**PROC** **ANOVA** plots=none;

CLASS STATE EDUCLVL;

MODEL WELFPRC = STATE EDUCLVL STATE\*EDUCLVL;

MEANS STATE EDUCLVL / BON;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **STATE** | 2 | KY TN |
| **EDUCLVL** | 5 | 1 2 3 4 5 |

|  |  |
| --- | --- |
| **Number of Observations Read** | 30 |
| **Number of Observations Used** | 30 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: WELFPRC WELFPRC**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 8 | 0.62133333 | 0.07766667 | 2.23 | 0.0677 |
| **Error** | 21 | 0.73233333 | 0.03487302 |  |  |
| **Corrected Total** | 29 | 1.35366667 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **WELFPRC Mean** |
| --- | --- | --- | --- |
| 0.459000 | 76.74377 | 0.186743 | 0.243333 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **STATE** | 1 | 0.45633333 | 0.45633333 | 13.09 | 0.0016 |
| **EDUCLVL** | 4 | 0.17991667 | 0.04497917 | 1.29 | 0.3058 |
| **STATE\*EDUCLVL** | 3 | 0.00000000 | 0.00000000 | 0.00 | 1.0000 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for WELFPRC**

|  |  |
| --- | --- |
| **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** | 21 |
| **Error Mean Square** | 0.034873 |
| **Critical Value of t** | 2.07961 |
| **Minimum Significant Difference** | 0.1418 |

| **Means with the same letter are not significantly different.** | | | |
| --- | --- | --- | --- |
| **Bon Grouping** | **Mean** | **N** | **STATE** |
| A | 0.36667 | 15 | TN |
|  |  |  |  |
| B | 0.12000 | 15 | KY |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for WELFPRC**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 21 |
| **Error Mean Square** | 0.034873 |
| **Critical Value of t** | 3.13521 |

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **EDUCLVL Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **4 - 3** | 0.02500 | -0.32137 | 0.37137 |  |
| **4 - 1** | 0.08750 | -0.27103 | 0.44603 |  |
| **4 - 2** | 0.12500 | -0.28900 | 0.53900 |  |
| **4 - 5** | 0.25000 | -0.16400 | 0.66400 |  |
| **3 - 4** | -0.02500 | -0.37137 | 0.32137 |  |
| **3 - 1** | 0.06250 | -0.21522 | 0.34022 |  |
| **3 - 2** | 0.10000 | -0.24637 | 0.44637 |  |
| **3 - 5** | 0.22500 | -0.12137 | 0.57137 |  |
| **1 - 4** | -0.08750 | -0.44603 | 0.27103 |  |
| **1 - 3** | -0.06250 | -0.34022 | 0.21522 |  |
| **1 - 2** | 0.03750 | -0.32103 | 0.39603 |  |
| **1 - 5** | 0.16250 | -0.19603 | 0.52103 |  |
| **2 - 4** | -0.12500 | -0.53900 | 0.28900 |  |
| **2 - 3** | -0.10000 | -0.44637 | 0.24637 |  |
| **2 - 1** | -0.03750 | -0.39603 | 0.32103 |  |
| **2 - 5** | 0.12500 | -0.28900 | 0.53900 |  |
| **5 - 4** | -0.25000 | -0.66400 | 0.16400 |  |
| **5 - 3** | -0.22500 | -0.57137 | 0.12137 |  |
| **5 - 1** | -0.16250 | -0.52103 | 0.19603 |  |
| **5 - 2** | -0.12500 | -0.53900 | 0.28900 |  |

* Decision Rule –

Since, STATE: F = 13.09 > 4.35, reject H0, There is a direct relationship between STATE and WELFPRC, we can reject the hypothesis at 0.05 significance level

EDUCLVL: F = 1.29 < 2.87, fail to reject H0, There is no direct relationship between EDUCLVL and WELFPRC, we cannot reject the hypothesis at 0.05 significance level

Interaction : F = 0.00 < 2.87, fail to reject H0, The null hypothesis that there is no direct relationship between STATE and EDUCLVL cannot be rejected at the 0.05 level of significance

* Statistical significance (F) = 2.23 and p-value 0.0677, The F value is more than the critical value and hence we can also consider it to be statistically insignificant at the given significance level
* Practical significance (R2) = 0.459000, We come to know the degree of variation in the categories, as the value as more than 20% we can consider it to be significant at the given significant level.

H0: µ1 = µ2

H1: The state means are not the same

H0: µ1 = µ2 = µ3= µ4= µ5

H1: The education level means are not the same

H0: µse = µs + µe - µ … for all combinations

H1: The population cell means are not the same completely determined by the population marginal means (µs , µe)

Df in the STATE = 2-1 = 1

Df in the EDUCPRC = 5-1 = 4

Df in the Interaction = (2-1)(5-1) = 4

Df in the Error = 30-(2)(5) = 20

Alpha = 0.05

Factor S: Thus if F > 4.35, reject H0

Factor E: Thus if F > 2.87, reject H0

ISS: Thus if F > 2.87, reject H0

**SAS Output:**

TITLE "V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU";

**DATA** V506.Atemp;

SET V506.Appalachian;

**RUN**;

**PROC** **ANOVA** plots=none;

CLASS STATE EDUCLVL;

MODEL HOUSQUAL = STATE EDUCLVL STATE\*EDUCLVL;

MEANS STATE EDUCLVL / BON;

**RUN**;

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **STATE** | 2 | KY TN |
| **EDUCLVL** | 5 | 1 2 3 4 5 |

|  |  |
| --- | --- |
| **Number of Observations Read** | 30 |
| **Number of Observations Used** | 30 |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Dependent Variable: HOUSQUAL HOUSQUAL**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 8 | 2466.967333 | 308.370917 | 5.73 | 0.0006 |
| **Error** | 21 | 1129.562333 | 53.788683 |  |  |
| **Corrected Total** | 29 | 3596.529667 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **HOUSQUAL Mean** |
| --- | --- | --- | --- |
| 0.685930 | 16.87417 | 7.334077 | 43.46333 |

| **Source** | **DF** | **Anova SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **STATE** | 1 | 339.360333 | 339.360333 | 6.31 | 0.0203 |
| **EDUCLVL** | 4 | 2084.485917 | 521.121479 | 9.69 | 0.0001 |
| **STATE\*EDUCLVL** | 3 | 43.121083 | 14.373694 | 0.27 | 0.8483 |

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| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for HOUSQUAL**

|  |  |
| --- | --- |
| **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** | 21 |
| **Error Mean Square** | 53.78868 |
| **Critical Value of t** | 2.07961 |
| **Minimum Significant Difference** | 5.5693 |

| **Means with the same letter are not significantly different.** | | | |
| --- | --- | --- | --- |
| **Bon Grouping** | **Mean** | **N** | **STATE** |
| A | 46.827 | 15 | KY |
|  |  |  |  |
| B | 40.100 | 15 | TN |

|  |
| --- |
| **V506 HOMEWORK05 PART 2 - JIVITESH POOJARY AND QIWEN ZHU** |

**The ANOVA Procedure**

**Bonferroni (Dunn) t Tests for HOUSQUAL**

|  |  |
| --- | --- |
| **Note:** | This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons. |

|  |  |
| --- | --- |
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 21 |
| **Error Mean Square** | 53.78868 |
| **Critical Value of t** | 3.13521 |

| **Comparisons significant at the 0.05 level are indicated by \*\*\*.** | | | | |
| --- | --- | --- | --- | --- |
| **EDUCLVL Comparison** | **Difference Between Means** | **Simultaneous 95% Confidence Limits** | |  |
| **5 - 4** | 7.450 | -8.809 | 23.709 |  |
| **5 - 2** | 15.975 | -0.284 | 32.234 |  |
| **5 - 3** | 16.175 | 2.572 | 29.778 | \*\*\* |
| **5 - 1** | 25.863 | 11.782 | 39.943 | \*\*\* |
| **4 - 5** | -7.450 | -23.709 | 8.809 |  |
| **4 - 2** | 8.525 | -7.734 | 24.784 |  |
| **4 - 3** | 8.725 | -4.878 | 22.328 |  |
| **4 - 1** | 18.413 | 4.332 | 32.493 | \*\*\* |
| **2 - 5** | -15.975 | -32.234 | 0.284 |  |
| **2 - 4** | -8.525 | -24.784 | 7.734 |  |
| **2 - 3** | 0.200 | -13.403 | 13.803 |  |
| **2 - 1** | 9.888 | -4.193 | 23.968 |  |
| **3 - 5** | -16.175 | -29.778 | -2.572 | \*\*\* |
| **3 - 4** | -8.725 | -22.328 | 4.878 |  |
| **3 - 2** | -0.200 | -13.803 | 13.403 |  |
| **3 - 1** | 9.688 | -1.219 | 20.594 |  |
| **1 - 5** | -25.863 | -39.943 | -11.782 | \*\*\* |
| **1 - 4** | -18.413 | -32.493 | -4.332 | \*\*\* |
| **1 - 2** | -9.888 | -23.968 | 4.193 |  |
| **1 - 3** | -9.688 | -20.594 | 1.219 |  |

* Decision Rule –

Since, STATE: F = 6.31 > 4.35, reject H0, There is a direct relationship between STATE and HOUSQUAL, we can reject the hypothesis at 0.05 significance level

EDUCLVL: F = 9.69 > 2.87, reject H0, There is a direct relationship between EDUCLVL and HOUSQUAL, we can reject the hypothesis at 0.05 significance level

Interaction : F = 0.27 < 2.87, fail to reject H0, The null hypothesis that there is no direct relationship between STATE and EDUCLVL cannot be rejected at the 0.05 level of significance

* Statistical significance (F) = 5.73 and p-value 0.0006, The F value is more than the critical value and hence we can also consider it to be statistically insignificant at the given significance level
* Practical significance (R2) = 0.685930, We come to know the degree of variation in the categories, as the value as more than 20% we can consider it to be significant at the given significant level.

**APPENDIX:**

1. Calculation Snapshot:



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WgSS = TSS – BcSS - BrSS

1. Calculation Snapshot:





WgSS = TSS – BcSS - BrSS