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**Practical 1. SAMPLING DISTRIBUTION**

Q1. Find confidence interval of mean assuming normal distribution for following data.

Height:

78 55 68 48 65 76 57 55 65 75 51 61 68 67 76 78 71 56 57 67 58 51 50 58 50 77 55 48 70 55 58 70 56 52 74 61 69 76 61 68 78 56 78 57 66 66 74 66 48 73 71 70 62 74 76 50 69 75 65 48

**Solution,**

**SYNTAX**

EXAMINE VARIABLES=height

/PLOT BOXPLOT STEMLEAF

/COMPARE GROUPS

/STATISTICS DESCRIPTIVES

/CINTERVAL 95

/MISSING LISTWISE

/NOTOTAL.

**OUTPUT**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Descriptives** | | | | |
|  | | | Statistic | Std. Error |
| height | Mean | | 63.88 | 1.233 |
| 95% Confidence Interval for Mean | Lower Bound | 61.42 |  |
| Upper Bound | 66.35 |  |
| 5% Trimmed Mean | | 63.98 |  |
| Median | | 65.50 |  |
| Variance | | 91.257 |  |
| Std. Deviation | | 9.553 |  |
| Minimum | | 48 |  |
| Maximum | | 78 |  |
| Range | | 30 |  |
| Interquartile Range | | 17 |  |
| Skewness | | -.136 | .309 |
| Kurtosis | | -1.258 | .608 |

**CONCLUSION**

Therefore, lower limit is 61.42 and upper limit is 66.35.

**Practical 2. TESTING OF HYPOTHESIS FOR SINGLE SAMPLE MEAN**

Q2. The time (in minutes) spent by 10 randomly selected customers using internet in a cybercafé is as follows: 35, 20, 30, 45, 60, 40, 65, 40, 25, 50. Can you say that the average time spent by customers is more than 30 minutes at 5% level of significance?

**Solution,**

**SYNTAX**

T-TEST

/TESTVAL=30

/MISSING=ANALYSIS

/VARIABLES=timeinminutes

/CRITERIA=CI(.95).

**Problem to Test**

H0: The average time spent by customers is not more than 30 minutes.

H1: The average time spent by customers is more than 30 minutes.

**OUTPUT**

**T-Test**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **One-Sample Statistics** | | | | | | |
|  | N | Mean | Std. Deviation | | Std. Error Mean | |
| timeinminutes | 10 | 41.00 | 14.491 | | 4.583 | |
| **One-Sample Test** | | | | | | | | |
|  | Test Value = 30 | | | | | | | |
| t | df | Sig. (2-tailed) | Mean Difference | | 95% Confidence Interval of the Difference | | |
| Lower | | Upper |
| timeinminutes | 2.400 | 9 | .040 | 11.000 | | .63 | | 21.37 |

**DECISION**

Since p = 0.040 < α = 0.05, reject H0 at α=5%

**CONCLUSION**

The average time spent by customers is more than 30 minutes.

**Practical 3. PAIRED T TEST**

Q3. Memory capacity of 10 students was tested before and after training, state whether the training was effective or not from the following scores:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Roll No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Before training | 12 | 14 | 11 | 8 | 7 | 10 | 3 | 0 | 5 | 6 |
| After training | 15 | 16 | 10 | 7 | 5 | 12 | 10 | 2 | 3 | 8 |

**Solution,**

**SYNTAX**

T-TEST PAIRS=Beforetraining WITH Aftertraining (PAIRED)

/CRITERIA=CI(.9500)

/MISSING=ANALYSIS.

**Problem To Test**

H0: There is no significant difference between training.

H1: There is significant difference between training.

**OUTPUT**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Paired Samples Statistics** | | | | | |
|  | | Mean | N | Std. Deviation | Std. Error Mean |
| Pair 1 | Beforetraining | 7.60 | 10 | 4.300 | 1.360 |
| Aftertraining | 8.80 | 10 | 4.733 | 1.497 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Paired Samples Correlations** | | | | |
|  | | N | Correlation | Sig. |
| Pair 1 | Beforetraining & Aftertraining | 10 | .815 | .004 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Paired Samples Test** | | | | | | | | | |
|  | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
| Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | |
| Lower | Upper |
| Pair 1 | Beforetraining - Aftertraining | -1.200 | 2.781 | .879 | -3.189 | .789 | -1.365 | 9 | .206 |

**DECISION**

Since |t| = 1.365 < tα/2(n-1) = 2.262, accept H0 at α = 5%

**CONCLUSION**

There is no significant difference between training.

**Practical 4. TWO SAMPLE MEAN**

Q4. Two kinds of manure were applied to sixteen one-hectare plot, other condition remaining the same. The yields in quintals are given below:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Manure I | 18 | 20 | 36 | 50 | 49 | 36 | 34 | 49 | 41 |
| Manure II | 29 | 28 | 26 | 35 | 30 | 44 | 46 |  |  |

Is there any significant difference between the mean yields? Use 5% level of significance.

**Solution,**

**SYNTAX**

DATASET NAME DataSet1 WINDOW=FRONT.

T-TEST GROUPS=type(1 2)

/MISSING=ANALYSIS

/VARIABLES=value

/CRITERIA=CI(.95).

**Problem To Test**

H0: There is no significant difference between the mean yields.

H1: There is significant difference between the mean yields.

**OUTPUT**

**T-Test**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Group Statistics** | | | | | |
|  | type | N | Mean | Std. Deviation | Std. Error Mean |
| value | Manure 1 | 9 | 37.00 | 11.906 | 3.969 |
| Manure 2 | 7 | 34.00 | 8.021 | 3.032 |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Independent Samples Test** | | | | | | | | | | | |
|  | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
| F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| Lower | Upper |
| value | Equal variances assumed | .756 | .399 | .571 | 14 | .577 | 3.000 | 5.251 | -8.262 | 14.262 |
| Equal variances not assumed |  |  | .601 | 13.797 | .558 | 3.000 | 4.994 | -7.726 | 13.726 |

D**ECISION**

p = 0.558 > α = 0.05, accept H0 at α = 5%

**CONCLUSION**

There is no significant difference between the mean yields.

**Practical 5. BINOMIAL TEST**

Q5. Test whether the coin is unbiased from the following observations.

Tail Tail Head Head Tail Head Tail Head Head Tail

Head Head Head Tail Head Head Head Head Head Head

Tail Tail Tail Tail Head Tail Tail Tail Tail Tail

Tail Tail Head Tail Tail Tail Head Tail Tail Tail

Tail Head Tail Tail Head Tail Head Tail Tail Tail

**Solution.**

**SYNTAX**

NPAR TESTS

/BINOMIAL (0.50)=code

/STATISTICS DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**OUTPUT**

**NPar Tests**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| code | 50 | .60 | .495 | 0 | 1 | .00 | 1.00 | 1.00 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Binomial Test** | | | | | | |
|  | | Category | N | Observed Prop. | Test Prop. | Exact Sig. (2-tailed) |
| code | Group 1 | Tail | 30 | .60 | .50 | .203 |
| Group 2 | Head | 20 | .40 |  |  |
| Total |  | 50 | 1.00 |  |  |

**DECISION**

Since p = 0.203 > 0.05, the null hypothesis of equality of proportion of head and tail can be accepted.

**CONCLUSION**

The coin is unbiased.

**Practical 6. COCHRAN Q TEST**

Q6. Five housewives were asked for the acceptability of four brands of lipsticks for daily use. The response of acceptability and rejection are given below;

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| House wives | Lipstick Brands | | | |
| Alfa | Beta | Gamma | Delta |
| H1 | A | R | A | R |
| H2 | R | A | A | R |
| H3 | R | A | R | A |
| H4 | A | R | R | R |
| H5 | A | A | R | A |

Test whether there is a significant difference between brands with respect to acceptability.

**Solution,**

**SYNTAX**

NPAR TESTS

/COCHRAN=Alfa Beta Gamma Delta

/MISSING LISTWISE.

**Problem to Test**

H0: There is no significant difference between brands.

H1: There is significant difference between brands.

**OUTPUT**

**Cochran Test**

|  |  |  |
| --- | --- | --- |
| **Frequencies** | | |
|  | Value | |
| 1 | 2 |
| Alfa | 3 | 2 |
| Beta | 3 | 2 |
| Gamma | 2 | 3 |
| Delta | 2 | 3 |

|  |  |
| --- | --- |
| **Test Statistics** | |
| N | 5 |
| Cochran's Q | .667a |
| df | 3 |
| Asymp. Sig. | .881 |
| a. 1 is treated as a success. | |

**CONCLUSION**

Here the analysis shows the p value associated with the test statistics Q is 0.881 that indicates acceptance of the null hypothesis.

**Practical 7. FRIEDMAN F TEST**

Q7. A survey was conducted in four hospitals in a particular city to obtain the number of babies born over a 12-month period. This time period was divided into Four Seasons to test the hypothesis that the birth rate is constant over all Four Seasons. The results of the survey were as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Hospital | No. of births | | | |
| Winter | Spring | Summer | Fall |
| A | 92 | 72 | 94 | 77 |
| B | 15 | 16 | 10 | 17 |
| C | 58 | 71 | 51 | 62 |
| D | 19 | 26 | 20 | 18 |

Analyze the data using Friedman two-way ANOVA test.

**Solution,**

**SYNTAX**

NPAR TESTS

/FRIEDMAN=Winter Spring Summer Fall

/MISSING LISTWISE.

**Problem To Test**

H0: There is no significant difference between the seasons.

H1: There is significant difference between the seasons.

**OUTPUT**

**Friedman Test**

|  |  |
| --- | --- |
| **Ranks** | |
|  | Mean Rank |
| Winter | 2.25 |
| Spring | 3.00 |
| Summer | 2.25 |
| Fall | 2.50 |

|  |  |
| --- | --- |
| **Test Statisticsa** | |
| N | 4 |
| Chi-Square | .900 |
| df | 3 |
| Asymp. Sig. | .825 |
| a. Friedman Test | |

**DECISION**

As from the Friedman test the p-value of the test is 0.825, we conclude that the null hypothesis is correct.

**CONCLUSION**

There is no significant difference between the seasons.

**Practical 8. FRIEDMAN TEST FOR REPEATED RANKS**

Q8. Three different advertising media TV, radio and newspaper are being compared to study their effectiveness in promoting sales of WaiWai noodles. Each advertising media is exposed for a specified period of time and sales (000 package) from 10 stores located at different areas are recorded.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Advertising media | Stores | | | | | | | | | |
| A | B | C | D | E | F | G | H | I | J |
| T.V. | 20 | 21 | 15 | 12 | 14 | 17 | 21 | 16 | 20 | 18 |
| Radio | 7 | 9 | 11 | 12 | 10 | 10 | 14 | 12 | 8 | 7 |
| Newspaper | 8 | 6 | 11 | 12 | 9 | 6 | 8 | 10 | 8 | 6 |

Are three advertising media equally effective, use Friedman two-way ANOVA test.

**Solution,**

**SYNTAX**

NPAR TESTS

/FRIEDMAN=TV Radio Newspaper

/MISSING LISTWISE.

**Problem To Test**

H0: Three advertising media are equally effective.

H1: Three advertising media are not equally effective.

**OUTPUT**

**Friedman Test**

|  |  |
| --- | --- |
| **Ranks** | |
|  | Mean Rank |
| TV | 2.90 |
| Radio | 1.80 |
| Newspaper | 1.30 |

|  |  |
| --- | --- |
| **Test Statisticsa** | |
| N | 10 |
| Chi-Square | 15.765 |
| df | 2 |
| Asymp. Sig. | .000 |
| a. Friedman Test | |

**DECISION**

χ2 = 15.765 > χ2 0.05(2) = 5.991 , so reject H0 at α = 5%

**CONCLUSION**

Three advertising media are not equally effective.

**Practical 9. KRUSKAL WALLIS H TEST FOR NON-REPEATED RANKS**

Q9. Following a discourse obtained by trainees in three different categories. Test whether three categories have performed equally.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Categories | Scores | | | | | | | | | |
| A | 68 | 65 | 92 | 82 | 62 | 64 | 68 | 92 | 86 | 64 |
| B | 93 | 86 | 73 | 87 | 76 | 85 | 67 | 79 | 75 | 75 |
| C | 95 | 72 | 85 | 70 | 80 | 80 | 78 | 85 | 72 | 90 |

**Solution,**

**SYNTAX**

NPAR TESTS

/K-W=scores BY categories(1 3)

/STATISTICS DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**Problem To Test**

H0: There is no significant difference between three categories.

H1: There is significant difference between three categories.

**OUTPUT**

**NPar Tests**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| scores | 15 | 64.53 | 8.493 | 50 | 79 | 57.00 | 66.00 | 70.00 |
| categories | 15 | 2.00 | .845 | 1 | 3 | 1.00 | 2.00 | 3.00 |

**Kruskal-Wallis Test**

|  |  |  |  |
| --- | --- | --- | --- |
| **Ranks** | | | |
|  | categories | N | Mean Rank |
| scores | 1 | 5 | 11.60 |
| 2 | 5 | 3.00 |
| 3 | 5 | 9.40 |
| Total | 15 |  |

|  |  |
| --- | --- |
| **Test Statisticsa,b** | |
|  | scores |
| Kruskal-Wallis H | 9.980 |
| df | 2 |
| Asymp. Sig. | .007 |
| a. Kruskal Wallis Test | |
| b. Grouping Variable: categories | |

**DECISION**

As we found that p value for Chi-square test with tie is 0.007 which is smaller than 0.05 we can conclude that the scores among three categories null hypothesis is rejected.

**CONCLUSION**

There is significant difference between three categories.

**Practical 10. KRUSKAL WALLIS H TEST FOR REPEATED RANKS**

Q10. Following are the scores obtained by trainees in 3 different categories. Test whether 3 categories are equally performed.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Categories | Scores | | | | | | | | | |
| A | 68 | 65 | 92 | 82 | 62 | 64 | 68 | 92 | 86 | 64 |
| B | 93 | 86 | 73 | 87 | 76 | 85 | 67 | 79 | 75 | 75 |
| C | 95 | 72 | 85 | 70 | 80 | 80 | 78 | 85 | 72 | 90 |

**Solution,**

**SYNTAX**

NPAR TESTS

/K-W=scores BY categories(1 3)

/STATISTICS DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**Problem To Test**

H0: There is no significant difference between 3 categories.

H1: There is significant difference between 3 categories.

**OUTPUT**

**NPar Tests**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| scores | 30 | 78.20 | 9.739 | 62 | 95 | 69.50 | 78.50 | 86.00 |
| categories | 30 | 2.00 | .830 | 1 | 3 | 1.00 | 2.00 | 3.00 |

**Kruskal-Wallis Test**

|  |  |  |  |
| --- | --- | --- | --- |
| **Ranks** | | | |
|  | categories | N | Mean Rank |
| scores | A | 10 | 12.05 |
| B | 10 | 16.95 |
| C | 10 | 17.50 |
| Total | 30 |  |

|  |  |
| --- | --- |
| **Test Statisticsa,b** | |
|  | scores |
| Kruskal-Wallis H | 2.329 |
| df | 2 |
| Asymp. Sig. | .312 |
| a. Kruskal Wallis Test | |
| b. Grouping Variable: categories | |

**DECISION**

As we found that p value we tie for the chi square test is 0.312 which is larger than 0.05 we can conclude that this course among three categories null hypothesis is accepted.

**CONCLUSION**

There is no significant difference between 3 categories.

**Practical 11. MANN - WHITNEY U TEST**

Q11. The following are discourse which random samples of students from two minority groups obtained on their current event test:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Minority Group I | 73 | 82 | 39 | 68 | 91 | 75 | 89 | 67 | 50 | 86 | 57 | 65 | 70 |
| Minority Group II | 51 | 42 | 36 | 53 | 88 | 59 | 49 | 66 | 25 | 64 | 18 | 76 | 74 |

Use Mann Whitney U test at the 0.05 level of significance to test whether or not students from the two minority groups can be expected to score equally well on the test.

**Solution,**

**SYNTAX**

NPAR TESTS

/M-W= scores BY group(1 2)

/STATISTICS=DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**OUTPUT**

**NPar Tests**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| scores | 26 | 62.0385 | 19.45761 | 18.00 | 91.00 | 49.7500 | 65.5000 | 75.2500 |
| group | 26 | 1.5000 | .50990 | 1.00 | 2.00 | 1.0000 | 1.5000 | 2.0000 |

**Mann-Whitney Test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ranks** | | | | |
|  | group | N | Mean Rank | Sum of Ranks |
| scores | 1.00 | 13 | 16.62 | 216.00 |
| 2.00 | 13 | 10.38 | 135.00 |
| Total | 26 |  |  |

|  |  |
| --- | --- |
| **Test Statisticsa** | |
|  | scores |
| Mann-Whitney U | 44.000 |
| Wilcoxon W | 135.000 |
| Z | -2.077 |
| Asymp. Sig. (2-tailed) | .038 |
| Exact Sig. [2\*(1-tailed Sig.)] | .039b |
| a. Grouping Variable: group | |
| b. Not corrected for ties. | |

**CONCLUSION**

Analysis results showed the p-value for Z test is 0.0378. This indicates that our null hypothesis of no difference in male and female is rejected.

**Practical 12. MANN – WHITNEY U TEST**

Q12. Test the hypothesis of no difference between the ages of male and female employees of a certain company, using the Mann-Whitney you test for the sample data below. Use α = 0.1.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Male | 35 | 43 | 26 | 44 | 40 | 42 | 33 | 38 | 25 | 26 |
| Female | 30 | 41 | 34 | 31 | 36 | 32 | 25 | 47 | 28 | 24 |

**Solution,**

**SYNTAX**

NPAR TESTS

/M-W= Age BY Gender(1 2)

/MISSING ANALYSIS.

**Problem To Test**

H0: There is no significant difference in male and female.

H1: There is significant difference in male and female.

**OUTPUT**

**Mann-Whitney Test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ranks** | | | | |
|  | Gender | N | Mean Rank | Sum of Ranks |
| Age | Male | 10 | 11.65 | 116.50 |
| Female | 10 | 9.35 | 93.50 |
| Total | 20 |  |  |

|  |  |
| --- | --- |
| **Test Statisticsa** | |
|  | Age |
| Mann-Whitney U | 38.500 |
| Wilcoxon W | 93.500 |
| Z | -.870 |
| Asymp. Sig. (2-tailed) | .384 |
| Exact Sig. [2\*(1-tailed Sig.)] | .393b |
| a. Grouping Variable: Gender | |
| b. Not corrected for ties. | |

**DECISION**

p = 0.3843 > α = 0.05, accept H0 at α = 5%

**CONCLUSION**

Analysis result shows the p-value for Z test is 0.3843. This indicates that our null hypothesis of no difference in male and female is accepted. i.e There is no significant difference in male and female.

**Practical 13. MEDIAN TEST FOR LARGE SAMPLE SIZE (n1>10, n2>10)**

Q13. An IQ test was given to a randomly selected 15 mail and 20 female students of university. Their course was recorded as follows;

Male: 56, 66, 62, 81, 75, 73, 83, 68, 48, 70, 60, 77, 86, 44, 72

Female: 63, 77, 65, 71, 74, 60, 76, 61, 67, 72, 64, 65, 55, 89, 45, 53, 67, 73, 50, 81

**Solution,**

**SYNTAX**

NPAR TESTS

/MEDIAN=scores BY Gender(1 2)

/STATISTICS DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**Problem To Test**

H0: There is no significant difference between male and female.

H1: There is significant difference between male and female.

**OUTPUT**

**NPar Tests**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| scores | 35 | 67.1429 | 11.31408 | 44.00 | 89.00 | 60.0000 | 68.0000 | 75.0000 |
| Gender | 35 | 1.57 | .502 | 1 | 2 | 1.00 | 2.00 | 2.00 |

**Median Test**

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequencies** | | | |
|  | | | |
|  | | Gender | |
| Male | Female |
| scores | > Median | 8 | 8 |
| <= Median | 7 | 12 |

|  |  |  |
| --- | --- | --- |
| **Test Statisticsa** | | |
|  | | scores |
| N | | 35 |
| Median | | 68.0000 |
| Chi-Square | | .614 |
| df | | 1 |
| Asymp. Sig. | | .433 |
| Yates' Continuity Correction | Chi-Square | .194 |
| df | 1 |
| Asymp. Sig. | .659 |
| a. Grouping Variable: Gender | | |

**DECISION**

p = 0.659 > α = 0.05, accept H0 at α = 5%

**CONCLUSION**

As the asymptotic significance related with the Chi-square test is found to be 0.659 which indicates that the null hypothesis is accepted for the given data. i.e There is no significant difference between male and female.

**Practical 14. MEDIAN TEST FOR SMALL SAMPLE (n1<10, n2<10)**

Q14. Data below shows one week growth (in cm) of maize plant from two different localities (sample I and sample II):

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sample I | 10 | 11 | 8 | 8 | 14 |  |  |
| Sample II | 9 | 12 | 13 | 9 | 15 | 9 | 17 |

Test whether the two samples have come from the same population with respect to their medians. Use median test and 0.05 level of significance.

**Solution,**

**SYNTAX**

NPAR TESTS

/MEDIAN=value BY sample(1 2)

/STATISTICS DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**Problem To Test**

H0: There is no significant difference between Sample I and II.

H1: There is significant difference between Sample I and II

**OUTPUT**

**NPar Tests**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| value | 12 | 11.2500 | 2.95804 | 8.00 | 17.00 | 9.0000 | 10.5000 | 13.7500 |
| sample | 12 | 1.5833 | .51493 | 1.00 | 2.00 | 1.0000 | 2.0000 | 2.0000 |

**Median Test**

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequencies** | | | |
|  | | sample | |
| 1.00 | 2.00 |
| value | > Median | 2 | 4 |
| <= Median | 3 | 3 |

|  |  |
| --- | --- |
| **Test Statisticsa** | |
|  | value |
| N | 12 |
| Median | 10.5000 |
| Exact Sig. | 1.000 |
| a. Grouping Variable: sample | |

**CONCLUSION**

The p value associated with the median test is about 1 which indicates that null hypothesis is accepted for the given data.

**Practical 15. NORMAL DISTRIBUTION**

Q15. Weight:

19.5 20 26.9 27.1 28.1 30 31.6 32.7 34.4 37.2

37.5 37.9 38 38.4 38.6 38.8 38.9 40.1 41.6 42.6

42.9 45 45.2 45.5 46.5 46.8 47.3 48.1 48.3 48.4

48.8 49 49.1 49.3 49.4 49.5 49.9 50.4 51.8 54.4

54.9 55.3 55.6 57.3 57.4 57.5 58.7 58.8 59.7 59.9

**Solution,**

**SYNTAX**

NPAR TESTS

/K-S(NORMAL)=weight

/STATISTICS DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**Problem To Test**

H0: There is no significant difference between weights.

H1: There is significant difference between weights.

**OUTPUT**

**NPar Tests**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| weight | 50 | 44.412 | 10.3139 | 19.5 | 59.9 | 37.975 | 46.650 | 50.750 |

|  |  |  |
| --- | --- | --- |
| **One-Sample Kolmogorov-Smirnov Test** | | |
|  | | weight |
| N | | 50 |
| Normal Parametersa,b | Mean | 44.412 |
| Std. Deviation | 10.3139 |
| Most Extreme Differences | Absolute | .103 |
| Positive | .067 |
| Negative | -.103 |
| Test Statistic | | .103 |
| Asymp. Sig. (2-tailed) | | .200c,d |
| a. Test distribution is Normal. | | |
| b. Calculated from data. | | |
| c. Lilliefors Significance Correction. | | |
| d. This is a lower bound of the true significance. | | |

**DECISION**

Since p = 0.200 > α = 0.05, accept H0 at α = 5%

**CONCLUSION**

There is no significant difference between weights.

**Practical 16. RUN TEST**

Q16. In 30 toss of a coin the following sequence of heads (H) and tails (T) is obtained.

HTTHTHHHTHHTTHTHTHHTHTTHTHHTHT

Test at 0.05 level of significance level whether the sequence is random.

**Solution,**

**SYNTAX**

NPAR TESTS

/RUNS(MEDIAN)=Code

/STATISTICS DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**Problem To Test**

H0: The sequence of H and T is in random order.

H1: The sequence of H and T is not in random order.

**OUTPUT**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| Code | 30 | .53 | .507 | 0 | 1 | .00 | 1.00 | 1.00 |

|  |  |
| --- | --- |
| **Runs Test** | |
|  | Code |
| Test Valuea | 1 |
| Cases < Test Value | 14 |
| Cases >= Test Value | 16 |
| Total Cases | 30 |
| Number of Runs | 22 |
| Z | 2.078 |
| Asymp. Sig. (2-tailed) | .038 |
| a. Median | |

No. of heads (n1) = 16

No. of tails (n2) = 14

No. of runs (r) = 22

**Critical Value**

At α = 0.05 level of significance, the critical value for n1 = 16 and n2 = 14 degree of freedom are r̲ = 10 and r̅ = 22 for two tailed test.

**DECISION**

r = 22 ϵ (r̲ = 10 , r̅ = 22), accept H0 at 0.05 level of significance.

**CONCLUSION**

The sequence of H and T is in random order.

**Practical 17. WILCOXON MATCHED PAIR SIGNED RANK TEST**

Q17. Use Wilcoxon matched pair signed rank test to determine the equality of oxygen level of patients in ICU on the day of admission and seven days after admission from following data.

**Solution,**

**SYNTAX**

NPAR TESTS

/WILCOXON=Day1 WITH Day7 (PAIRED)

/STATISTICS DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**Problem To Test**

H0: There is no significant difference between Day 1 and Day 7.

H1: There is significant difference between Day 1 and Day 7.

**OUTPUT**

**NPar Tests**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| Day1 | 59 | 56.8897 | 13.01004 | 32.74 | 75.84 | 46.1700 | 54.4700 | 71.0300 |
| Day7 | 59 | 66.7202 | 11.15714 | 43.92 | 85.63 | 58.9300 | 67.2000 | 75.0000 |

**Wilcoxon Signed Ranks Test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ranks** | | | | |
|  | | N | Mean Rank | Sum of Ranks |
| Day7 - Day1 | Negative Ranks | 16a | 22.69 | 363.00 |
| Positive Ranks | 42b | 32.10 | 1348.00 |
| Ties | 1c |  |  |
| Total | 59 |  |  |
| a. Day7 < Day1 | | | | |
| b. Day7 > Day1 | | | | |
| c. Day7 = Day1 | | | | |

|  |  |
| --- | --- |
| **Test Statisticsa** | |
|  | Day7 - Day1 |
| Z | -3.813b |
| Asymp. Sig. (2-tailed) | .000 |
| a. Wilcoxon Signed Ranks Test | |
| b. Based on negative ranks. | |

**DECISION**

Since p<0.05, it is significant.

**CONCLUSION**

There is significant difference between Day 1 and Day 7.

**Practical 18. WILCOXON PAIR SIGNED RANK TEST**

Q18. Use Wilkerson matched pair sign rank test to determine the equality of effectiveness of two type of drugs in suppressing pain from following data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Patient No. | Drug A | Drug B | Patient No. | Drug A | Drug B |
| 1 | 6.5 | 3.5 | 11 | 5.4 | 5.5 |
| 2 | 3.7 | 3.7 | 12 | 4.0 | 4.1 |
| 3 | 3.9 | 4.7 | 13 | 5.7 | 4.1 |
| 4 | 6.7 | 5.0 | 14 | 3.9 | 4.2 |
| 5 | 6.2 | 5.6 | 15 | 3.6 | 3.7 |
| 6 | 6.7 | 4.3 | 16 | 4.9 | 4.1 |
| 7 | 6.1 | 5.4 | 17 | 3.9 | 5.4 |
| 8 | 4.3 | 5.8 | 18 | 5.8 | 3.7 |
| 9 | 5.5 | 4.3 | 19 | 4.9 | 4.1 |
| 10 | 6.8 | 4.3 | 20 | 4.9 | 4.1 |

**Solution,**

**SYNTAX**

NPAR TESTS

/WILCOXON=DrugA WITH DrugB (PAIRED)

/STATISTICS DESCRIPTIVES QUARTILES

/MISSING ANALYSIS.

**Problem To Test**

H0: There is no significant difference between Drug A and Drug B.

H1: There is significant difference between Drug A and Drug B.

**OUTPUT**

**NPar Tests**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | | | |
|  | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
| 25th | 50th (Median) | 75th |
| DrugA | 20 | 5.170 | 1.1164 | 3.6 | 6.8 | 3.925 | 5.150 | 6.175 |
| DrugB | 20 | 4.480 | .7157 | 3.5 | 5.8 | 4.100 | 4.250 | 5.300 |

**Wilcoxon Signed Ranks Test**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Ranks** | | | | | | |
|  | | | N | | Mean Rank | Sum of Ranks |
| DrugB - DrugA | Negative Ranks | | 12a | | 12.21 | 146.50 |
| Positive Ranks | | 7b | | 6.21 | 43.50 |
| Ties | | 1c | |  |  |
| Total | | 20 | |  |  |
| a. DrugB < DrugA | | | | | | |
| b. DrugB > DrugA | | | | | | |
| c. DrugB = DrugA | | | | | | |
| **Test Statisticsa** | | | |
|  | | DrugB - DrugA | |
| Z | | -2.076b | |
| Asymp. Sig. (2-tailed) | | .038 | |
| a. Wilcoxon Signed Ranks Test | | | |
| b. Based on positive ranks. | | | |

**DECISION**

Since p<0.05, it is significant.

**CONCLUSION**

There is significant difference between Drug A and Drug B.

**Practical 19. MULTIPLE CORRELATION AND REGRESSION**

Q19. From the following set of data

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Y | 6 | 10 | 9 | 14 | 7 | 5 |
| X1 | 1 | 3 | 2 | -2 | 3 | 6 |
| X2 | 3 | -1 | 4 | 7 | 2 | -4 |

1. Calculate the least square equation that best describes these three variables.
2. Calculate the standard error.
3. Predict Y when X1 = -10 and X2 = 4.
4. Test the significance of regression coefficients and overall fit of the regression equation.
5. Conduct the regression analysis.
6. Determine partial correlations, multiple correlation and coefficient of multiple determination. Interpret.

**Solution,**

**SYNTAX**

REGRESSION

/DESCRIPTIVES MEAN STDDEV CORR SIG N

/MISSING LISTWISE

/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE ZPP

/CRITERIA=PIN(.05) POUT(.10)

/NOORIGIN

/DEPENDENT Y

/METHOD=ENTER X1 X2

/PARTIALPLOT ALL

/RESIDUALS NORMPROB(ZRESID)

/SAVE PRED RESID.

**Problem To Test**

H0: There is no linear relationship between dependent variable y and independent variables.

H1: There is linear relationship between dependent variable y and independent variables.

**OUTPUT**

**Regression**

|  |  |  |  |
| --- | --- | --- | --- |
| **Descriptive Statistics** | | | |
|  | Mean | Std. Deviation | N |
| Y | 8.50 | 3.271 | 6 |
| X1 | 2.17 | 2.639 | 6 |
| X2 | 1.83 | 3.869 | 6 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Correlations** | | | | |
|  | | Y | X1 | X2 |
| Pearson Correlation | Y | 1.000 | -.776 | .672 |
| X1 | -.776 | 1.000 | -.937 |
| X2 | .672 | -.937 | 1.000 |
| Sig. (1-tailed) | Y | . | .035 | .072 |
| X1 | .035 | . | .003 |
| X2 | .072 | .003 | . |
| N | Y | 6 | 6 | 6 |
| X1 | 6 | 6 | 6 |
| X2 | 6 | 6 | 6 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables Entered/Removeda** | | | |
| Model | Variables Entered | Variables Removed | Method |
| 1 | X2, X1b | . | Enter |
| a. Dependent Variable: Y | | | |
| b. All requested variables entered. | | | |

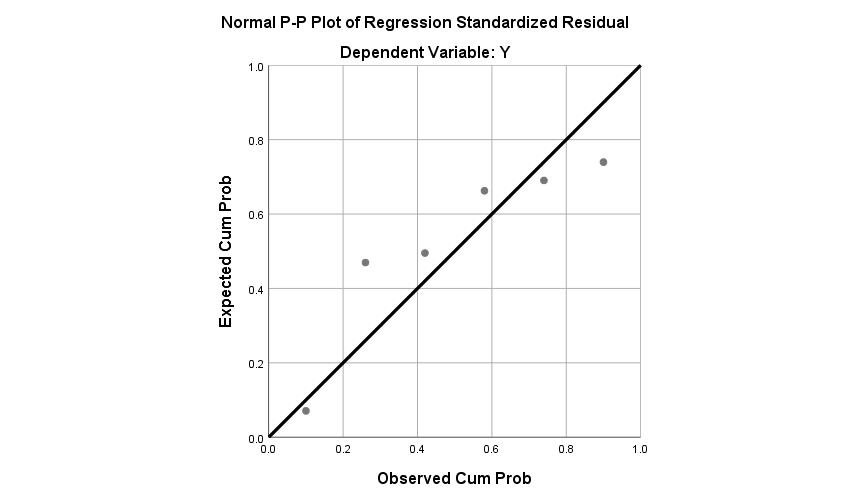
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Model Summaryb** | | | | | | | | | |
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
| R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .792a | .627 | .379 | 2.578 | .627 | 2.524 | 2 | 3 | .228 |
| a. Predictors: (Constant), X2, X1 | | | | | | | | | |
| b. Dependent Variable: Y | | | | | | | | | |

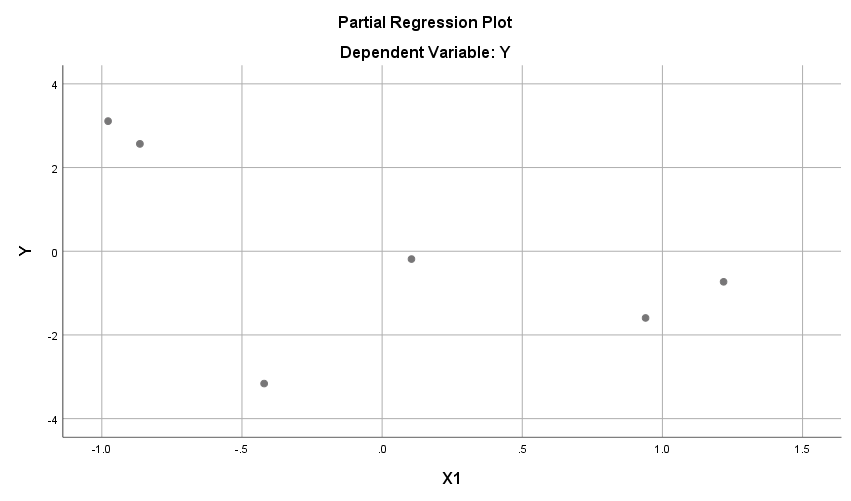
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **ANOVAa** | | | | | | |
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 33.559 | 2 | 16.779 | 2.524 | .228b |
| Residual | 19.941 | 3 | 6.647 |  |  |
| Total | 53.500 | 5 |  |  |  |
| a. Dependent Variable: Y | | | | | | |
| b. Predictors: (Constant), X2, X1 | | | | | | |

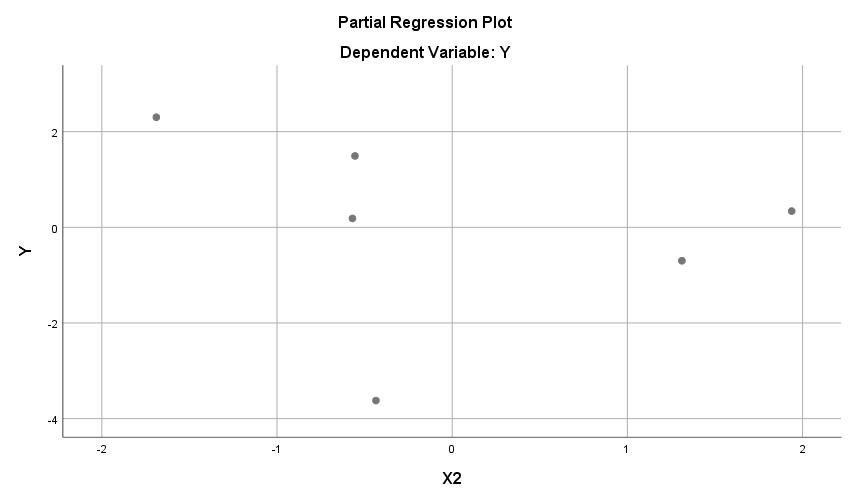
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Coefficientsa** | | | | | | | | | | | | |
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B | | Correlations | | |
| B | Std. Error | Beta | Lower Bound | Upper Bound | Zero-order | Partial | Part |
| 1 | (Constant) | 12.425 | 4.336 |  | 2.865 | .064 | -1.376 | 26.225 |  |  |  |
| X1 | -1.487 | 1.249 | -1.200 | -1.191 | .319 | -5.464 | 2.489 | -.776 | -.566 | -.420 |
| X2 | -.383 | .852 | -.453 | -.449 | .684 | -3.096 | 2.330 | .672 | -.251 | -.158 |
| a. Dependent Variable: Y | | | | | | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Residuals Statisticsa** | | | | | |
|  | Minimum | Maximum | Mean | Std. Deviation | N |
| Predicted Value | 5.03 | 12.72 | 8.50 | 2.591 | 6 |
| Residual | -3.789 | 1.655 | .000 | 1.997 | 6 |
| Std. Predicted Value | -1.339 | 1.629 | .000 | 1.000 | 6 |
| Std. Residual | -1.470 | .642 | .000 | .775 | 6 |
| a. Dependent Variable: Y | | | | | |

**Charts**







1. The regression equation of weight gain on Initial weight (pounds) and Initial age (weeks) is:

Y = 12.425 – 1.487 x1 - 0.383 x2

1. Standard error (Root MSE) = 2.578
2. Y = 25.763
3. The adjusted R2 is 0.379.

**DECISION**

F = 2.524 < Ftab = 9.552, accept H0 at α = 5%.

**CONCLUSION**

There is no linear relationship between dependent variable y and independent variables.

**Practical 20. MULTIPLE CORRELATION AND REGRESSION**

Q20. A developer of food for pig wish to determine what relationship exists among ‘age of a pig’ when it starts receiving a newly developed food supplement, the initial weight of the pig and the amount of weight it gains in a week period with the food supplement. The following information is the result of study of eight piglets.

|  |  |  |  |
| --- | --- | --- | --- |
| Piglet number | Initial weight(pounds) x1 | Initial age(weeks) x2 | Weight gain y |
| 1 | 39 | 8 | 7 |
| 2 | 52 | 6 | 6 |
| 3 | 49 | 7 | 8 |
| 4 | 46 | 12 | 10 |
| 5 | 61 | 9 | 9 |
| 6 | 35 | 6 | 5 |
| 7 | 25 | 7 | 3 |
| 8 | 55 | 4 | 4 |

1. Determine the least square equation that best describes these three variables.
2. Calculate the standard error.
3. How much gain in weight of a pig in a week can we expect with the food supplement if it were 9 weeks old and weighed 48 pounds?
4. Test the significance of regression coefficient and overall fit of the regression equation.
5. Conduct the residual analysis.
6. Determine partial correlations, multiple correlation and coefficient of multiple determination. Interpret.

**Solution,**

**SYNTAX**

REGRESSION

/DESCRIPTIVES MEAN STDDEV CORR SIG N

/MISSING LISTWISE

/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE ZPP

/CRITERIA=PIN(.05) POUT(.10)

/NOORIGIN

/DEPENDENT Weightgainy

/METHOD=ENTER Initialweightpoundsx1 Initialageweeksx2

/PARTIALPLOT ALL

/RESIDUALS NORMPROB(ZRESID)

/SAVE PRED RESID.

**Problem To Test**

H0: There is no linear relationship between dependent variable y and independent variables.

H1: There is linear relationship between dependent variable y and independent variables.

**OUTPUT**

**Regression**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | |
|  | | Mean | Std. Deviation | | N | |
| Weightgainy | | 6.50 | 2.449 | | 8 | |
| Initialweightpoundsx1 | | 45.25 | 11.696 | | 8 | |
| Initialageweeksx2 | | 7.38 | 2.387 | | 8 | |
| **Correlations** | | | | | | | | |
|  | | | | Weightgainy | | Initialweightpoundsx1 | | Initialageweeksx2 |
| Pearson Correlation | Weightgainy | | | 1.000 | | .514 | | .794 |
| Initialweightpoundsx1 | | | .514 | | 1.000 | | .017 |
| Initialageweeksx2 | | | .794 | | .017 | | 1.000 |
| Sig. (1-tailed) | Weightgainy | | | . | | .096 | | .009 |
| Initialweightpoundsx1 | | | .096 | | . | | .484 |
| Initialageweeksx2 | | | .009 | | .484 | | . |
| N | Weightgainy | | | 8 | | 8 | | 8 |
| Initialweightpoundsx1 | | | 8 | | 8 | | 8 |
| Initialageweeksx2 | | | 8 | | 8 | | 8 |

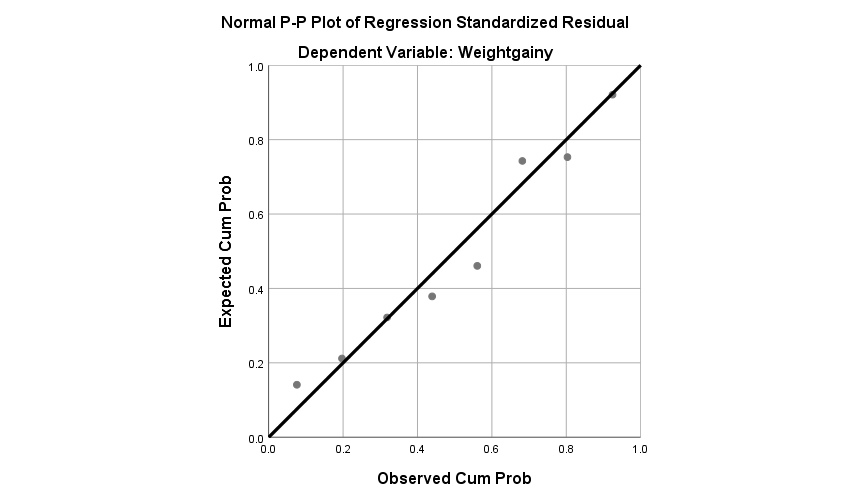
|  |  |  |  |
| --- | --- | --- | --- |
| **Variables Entered/Removeda** | | | |
| Model | Variables Entered | Variables Removed | Method |
| 1 | Initialageweeksx2, Initialweightpoundsx1b | . | Enter |
| a. Dependent Variable: Weightgainy | | | |
| b. All requested variables entered. | | | |

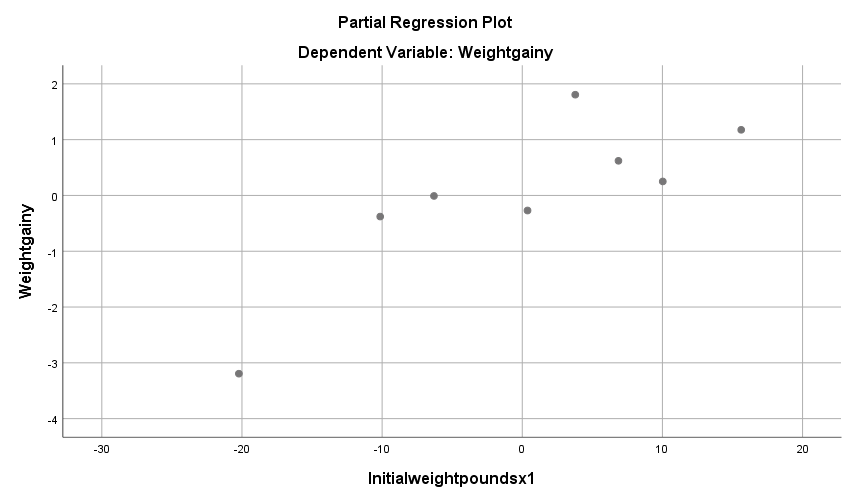
|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Model Summaryb** | | | | | | | | | |
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
| R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .939a | .881 | .834 | .999 | .881 | 18.539 | 2 | 5 | .005 |
| a. Predictors: (Constant), Initialageweeksx2, Initialweightpoundsx1 | | | | | | | | | |
| b. Dependent Variable: Weightgainy | | | | | | | | | |

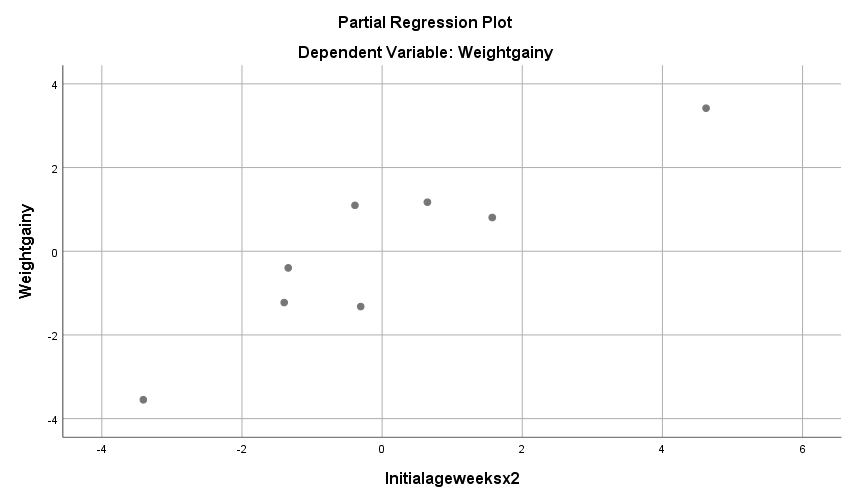
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **ANOVAa** | | | | | | |
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 37.009 | 2 | 18.505 | 18.539 | .005b |
| Residual | 4.991 | 5 | .998 |  |  |
| Total | 42.000 | 7 |  |  |  |
| a. Dependent Variable: Weightgainy | | | | | | |
| b. Predictors: (Constant), Initialageweeksx2, Initialweightpoundsx1 | | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Coefficientsa** | | | | | | | | | | | | |
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B | | Correlations | | | |
| B | Std. Error | Beta | Lower Bound | Upper Bound | Zero-order | Partial | Part |
| 1 | (Constant) | -4.192 | 1.888 |  | -2.220 | .077 | -9.045 | .662 |  |  |  |
| Initialweightpoundsx1 | .105 | .032 | .501 | 3.247 | .023 | .022 | .188 | .514 | .824 | .500 |
| Initialageweeksx2 | .807 | .158 | .786 | 5.097 | .004 | .400 | 1.213 | .794 | .916 | .786 |
| a. Dependent Variable: Weightgainy | | | | | | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Residuals Statisticsa** | | | | | |
|  | Minimum | Maximum | Mean | Std. Deviation | N |
| Predicted Value | 4.07 | 10.31 | 6.50 | 2.299 | 8 |
| Residual | -1.075 | 1.409 | .000 | .844 | 8 |
| Std. Predicted Value | -1.055 | 1.656 | .000 | 1.000 | 8 |
| Std. Residual | -1.076 | 1.411 | .000 | .845 | 8 |
| a. Dependent Variable: Weightgainy | | | | | |

**Charts**





1. The regression equation of weight gain on Initial weight (pounds) and Initial age (weeks) is:
   1. Y = -4.192 + 0.105 x1 + 0.807 x2
2. Standard error (Root MSE) = 0.999
3. Weight gain is 35.489 units.
4. The adjusted R2 is 0.834.

**DECISION**

F = 18.539 > Ftab = 5.786, reject H0 at α = 5%.

**CONCLUSION**

There is linear relationship between dependent variable y and independent variables.

**Practical 21. DESIGN OF EXPERIMENT**

Q21. The yield of treatments in different plots are as shown in the following plots. Carry out analysis using CRD.

|  |  |  |  |
| --- | --- | --- | --- |
| A(20) | B(30) | B(40) | C(10) |
| C(12) | A(30) | B(15) | B(16) |
| A(30) | C(40) | B(15) | A(18) |

**Solution,**

**SYNTAX**

ONEWAY Values BY Treatment

/MISSING ANALYSIS

/POSTHOC=LSD ALPHA(0.05).

**Problem To Test**

H0T: There is no significant difference between the treatments.

H1T: There is significant difference between the treatments.

**OUTPUT**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ANOVA** | | | | | |
| Values | | | | | |
|  | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 25.533 | 2 | 12.767 | .096 | .910 |
| Within Groups | 1200.467 | 9 | 133.385 |  |  |
| Total | 1226.000 | 11 |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | |
| Dependent Variable: Values | | | | | | |
| LSD | | | | | | |
| (I) Treatment | (J) Treatment | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| A | B | 1.300 | 7.747 | .870 | -16.23 | 18.83 |
| C | 3.833 | 8.821 | .674 | -16.12 | 23.79 |
| B | A | -1.300 | 7.747 | .870 | -18.83 | 16.23 |
| C | 2.533 | 8.434 | .771 | -16.55 | 21.61 |
| C | A | -3.833 | 8.821 | .674 | -23.79 | 16.12 |
| B | -2.533 | 8.434 | .771 | -21.61 | 16.55 |

**DECISION**

Ftab at 5% (2,9) = 4.256

Since Fcal = 0.096 < Ftab = 4.256, so H0 is accepted at 5% level of significance.

**CONCLUSION**

There is no significant difference between the treatments.

**Practical 22. DESIGN OF EXPERIMENT**

Q22. The yield of treatments in different plots are as shown in the following plots. Carry out analysis.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| t4(1401) | t3(2536) | t3(2459) | t1(2537) | t3(2827) | t1(2069) |
| t2(2211) | t1(1797) | t4(1170) | t4(1516) | t4(2104) | t3(2385) |
| t2(3366) | t1(2104) | t2(2591) | t3(2460) | t4(1077) | t2(2544) |

**Solution,**

**SYNTAX**

ONEWAY values BY treatment

/MISSING ANALYSIS

/POSTHOC=LSD ALPHA(0.05).

**Problem To Test**

H0T: There is no significant difference between the treatments.

H1T: There is significant difference between the treatments.

**OUTPUT**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ANOVA** | | | | | |
| values | | | | | |
|  | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 4265689.961 | 3 | 1421896.654 | 11.253 | .001 |
| Within Groups | 1768941.150 | 14 | 126352.939 |  |  |
| Total | 6034631.111 | 17 |  |  |  |

**Post Hoc Tests**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | |
| Dependent Variable: values | | | | | | |
| LSD | | | | | | |
| (I) treatment | (J) treatment | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| t1 | t2 | -551.250\* | 251.349 | .046 | -1090.34 | -12.16 |
| t3 | -406.650 | 238.451 | .110 | -918.08 | 104.78 |
| t4 | 673.150\* | 238.451 | .014 | 161.72 | 1184.58 |
| t2 | t1 | 551.250\* | 251.349 | .046 | 12.16 | 1090.34 |
| t3 | 144.600 | 238.451 | .554 | -366.83 | 656.03 |
| t4 | 1224.400\* | 238.451 | .000 | 712.97 | 1735.83 |
| t3 | t1 | 406.650 | 238.451 | .110 | -104.78 | 918.08 |
| t2 | -144.600 | 238.451 | .554 | -656.03 | 366.83 |
| t4 | 1079.800\* | 224.814 | .000 | 597.62 | 1561.98 |
| t4 | t1 | -673.150\* | 238.451 | .014 | -1184.58 | -161.72 |
| t2 | -1224.400\* | 238.451 | .000 | -1735.83 | -712.97 |
| t3 | -1079.800\* | 224.814 | .000 | -1561.98 | -597.62 |
| \*. The mean difference is significant at the 0.05 level. | | | | | | |

**DECISION**

Since Fcal = 11.253 > Ftab = 3.343, so accept H0 at 5% level of significance is rejected.

**CONCLUSION**

There is significant difference between the treatments.

**Practical 23. DESIGN OF EXPERIMENT**

Q23. The following is the 5\*5 Latin square design for data taken from manurial experiment with sugarcane. The five treatments A = no manure, B = an inorganic manure, C, D, and E = three levels of farm yard manure. Plan and yield sugar cane (in a suitable unit) per plot.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Row |  | Column |  |  |  |
|  | I | II | III | IV | V |
| I | A(52.5) | E(46.3) | D(44.1) | C(48.1) | B(40.9) |
| II | D(44.2) | B(42.9) | A(51.3) | E(49.3) | C(32.6) |
| III | B(49.1) | A(47.3) | C(38.1) | D(41.0) | E(47.2) |
| IV | C(43.2) | D(42.5) | E(67.2) | B(55.1) | A(45.3) |
| V | E(47.0) | C(43.2) | B(46.7) | A(46.0) | D(43.2) |

**Solution,**

**SYNTAX**

UNIANOVA Values BY Row Column Treatment

/METHOD=SSTYPE(3)

/INTERCEPT=EXCLUDE

/POSTHOC=Row Column Treatment(LSD)

/CRITERIA=ALPHA(0.05)

/DESIGN=Row Column Treatment.

**Problem To Test**

H0R: There is no significant difference between the row.

H1R: There is significant difference between the row.

H0C: There is no significant difference between the column.

H1C: There is significant difference between the column.

H0T: There is no significant difference between the treatments.

H1T: There is significant difference between the treatments.

**OUTPUT**

|  |  |  |  |
| --- | --- | --- | --- |
| **Between-Subjects Factors** | | | |
|  | | Value Label | N |
| Row | 1 |  | 5 |
| 2 |  | 5 |
| 3 |  | 5 |
| 4 |  | 5 |
| 5 |  | 5 |
| Column | 1 |  | 5 |
| 2 |  | 5 |
| 3 |  | 5 |
| 4 |  | 5 |
| 5 |  | 5 |
| Treatment | 1 | A | 5 |
| 2 | B | 5 |
| 3 | C | 5 |
| 4 | D | 5 |
| 5 | E | 5 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: Values | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Model | 53969.415a | 13 | 4151.493 | 163.823 | .000 |
| Row | 141.078 | 4 | 35.270 | 1.392 | .295 |
| Column | 183.758 | 4 | 45.940 | 1.813 | .191 |
| Treatment | 348.238 | 4 | 87.060 | 3.435 | .043 |
| Error | 304.095 | 12 | 25.341 |  |  |
| Total | 54273.510 | 25 |  |  |  |
| a. R Squared = .994 (Adjusted R Squared = .988) | | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | |
| Dependent Variable: Values | | | | | | |
| LSD | | | | | | |
| (I) Row | (J) Row | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| 1 | 2 | 2.320 | 3.1838 | .480 | -4.617 | 9.257 |
| 3 | 1.840 | 3.1838 | .574 | -5.097 | 8.777 |
| 4 | -4.280 | 3.1838 | .204 | -11.217 | 2.657 |
| 5 | 1.160 | 3.1838 | .722 | -5.777 | 8.097 |
| 2 | 1 | -2.320 | 3.1838 | .480 | -9.257 | 4.617 |
| 3 | -.480 | 3.1838 | .883 | -7.417 | 6.457 |
| 4 | -6.600 | 3.1838 | .060 | -13.537 | .337 |
| 5 | -1.160 | 3.1838 | .722 | -8.097 | 5.777 |
| 3 | 1 | -1.840 | 3.1838 | .574 | -8.777 | 5.097 |
| 2 | .480 | 3.1838 | .883 | -6.457 | 7.417 |
| 4 | -6.120 | 3.1838 | .079 | -13.057 | .817 |
| 5 | -.680 | 3.1838 | .834 | -7.617 | 6.257 |
| 4 | 1 | 4.280 | 3.1838 | .204 | -2.657 | 11.217 |
| 2 | 6.600 | 3.1838 | .060 | -.337 | 13.537 |
| 3 | 6.120 | 3.1838 | .079 | -.817 | 13.057 |
| 5 | 5.440 | 3.1838 | .113 | -1.497 | 12.377 |
| 5 | 1 | -1.160 | 3.1838 | .722 | -8.097 | 5.777 |
| 2 | 1.160 | 3.1838 | .722 | -5.777 | 8.097 |
| 3 | .680 | 3.1838 | .834 | -6.257 | 7.617 |
| 4 | -5.440 | 3.1838 | .113 | -12.377 | 1.497 |
| Based on observed means.  The error term is Mean Square(Error) = 25.341. | | | | | | |

**DECISION**

Since FR  = 1.392 < Ftab = 3.259, so accept H0R at 5% level of significance.

Since FC = 1.813 < Ftab = 3.259, so accept H0C at 5% level of significance.

Since FT = 3.435 > Ftab = 3.259, so reject H0T at 5% level of significance.

**CONCLUSION**

There is no significant difference between row and column but there is significant difference treatment.

**Practical 24. DESIGN OF EXPERIMENT**

Q24. The yield of treatments in different plots are as shown in the following plots. Carry out analysis using LSD.

|  |  |  |  |
| --- | --- | --- | --- |
| A(10) | B(20) | C(30) | D(10) |
| B(12) | C(15) | D(18) | A(20) |
| C(30) | D(40) | A(15) | B(20) |
| D(16) | A(18) | B(20) | C(30) |

**Solution,**

**SYNTAX**

UNIANOVA Values BY Row Column Treatment

/METHOD=SSTYPE(3)

/INTERCEPT=INCLUDE

/POSTHOC=Row Column Treatment(LSD)

/CRITERIA=ALPHA(0.05)

/DESIGN=Row Column Treatment.

**Problem To Test**

H0R: There is no significant difference between the row.

H1R: There is significant difference between the row.

H0C: There is no significant difference between the column.

H1C: There is significant difference between the column.

H0T: There is no significant difference between the treatments.

H1T: There is significant difference between the treatments.

**OUTPUT**

|  |  |  |  |
| --- | --- | --- | --- |
| **Between-Subjects Factors** | | | |
|  | | Value Label | N |
| Row | 1 |  | 4 |
| 2 |  | 4 |
| 3 |  | 4 |
| 4 |  | 4 |
| Column | 1 |  | 4 |
| 2 |  | 4 |
| 3 |  | 4 |
| 4 |  | 4 |
| Treatment | 1 | A | 4 |
| 2 | B | 4 |
| 3 | C | 4 |
| 4 | D | 4 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: Values | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 567.500a | 9 | 63.056 | .806 | .630 |
| Intercept | 6561.000 | 1 | 6561.000 | 83.847 | .000 |
| Row | 240.500 | 3 | 80.167 | 1.024 | .446 |
| Column | 79.500 | 3 | 26.500 | .339 | .799 |
| Treatment | 247.500 | 3 | 82.500 | 1.054 | .435 |
| Error | 469.500 | 6 | 78.250 |  |  |
| Total | 7598.000 | 16 |  |  |  |
| Corrected Total | 1037.000 | 15 |  |  |  |
| a. R Squared = .547 (Adjusted R Squared = -.132) | | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | |
| Dependent Variable: Values | | | | | | |
| LSD | | | | | | |
| (I) Row | (J) Row | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| 1 | 2 | 1.25 | 6.255 | .848 | -14.06 | 16.56 |
| 3 | -8.75 | 6.255 | .211 | -24.06 | 6.56 |
| 4 | -3.50 | 6.255 | .596 | -18.81 | 11.81 |
| 2 | 1 | -1.25 | 6.255 | .848 | -16.56 | 14.06 |
| 3 | -10.00 | 6.255 | .161 | -25.31 | 5.31 |
| 4 | -4.75 | 6.255 | .476 | -20.06 | 10.56 |
| 3 | 1 | 8.75 | 6.255 | .211 | -6.56 | 24.06 |
| 2 | 10.00 | 6.255 | .161 | -5.31 | 25.31 |
| 4 | 5.25 | 6.255 | .433 | -10.06 | 20.56 |
| 4 | 1 | 3.50 | 6.255 | .596 | -11.81 | 18.81 |
| 2 | 4.75 | 6.255 | .476 | -10.56 | 20.06 |
| 3 | -5.25 | 6.255 | .433 | -20.56 | 10.06 |
| Based on observed means.  The error term is Mean Square (Error) = 78.250. | | | | | | |

**DECISION**

Since FR  = 1.024 < Ftab = 4.757, so accept H0R at 5% level of significance.

Since FC = 0.339 < Ftab = 4.757, so accept H0C at 5% level of significance.

Since FT = 1.054 < Ftab = 4.757, so accept H0T at 5% level of significance.

**CONCLUSION**

There is no significant difference between row, column and treatment.

**Practical 25. DESIGN OF EXPERIMENT**

Q25. The following table gives the result of the experiment on four varieties of a crop in 5 blocks of plot.

|  |  |  |  |
| --- | --- | --- | --- |
| A(10) | B(15) | C(20) | D(30) |
| C(30) | A(20) | B(15) | D(20) |
| B(30) | A(40) | C(15) | D(30) |

Analyse the above result to test whether there is significant difference between yields of four varieties.

**Solution,**

**SYNTAX**

UNIANOVA Values BY Block Treatment

/METHOD=SSTYPE(3)

/INTERCEPT=EXCLUDE

/POSTHOC=Block Treatment(LSD)

/CRITERIA=ALPHA(0.05)

/DESIGN=Block Treatment.

**Problem To Test**

H0T: There is no significant difference between the treatments.

H1T: There is significant difference between the treatments.

H0B: There is no significant difference between the blocks.

H1B: There is significant difference between the blocks.

**OUTPUT**

|  |  |  |  |
| --- | --- | --- | --- |
| **Between-Subjects Factors** | | | |
|  | | Value Label | N |
| Block | 1 | I | 4 |
| 2 | II | 4 |
| 3 | III | 4 |
| Treatment | 1 | A | 3 |
| 2 | B | 3 |
| 3 | C | 3 |
| 4 | D | 3 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: Values | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Model | 6591.667a | 6 | 1098.611 | 11.300 | .005 |
| Block | 216.667 | 2 | 108.333 | 1.114 | .388 |
| Treatment | 72.917 | 3 | 24.306 | .250 | .859 |
| Error | 583.333 | 6 | 97.222 |  |  |
| Total | 7175.000 | 12 |  |  |  |

|  |
| --- |
| a. R Squared = .919 (Adjusted R Squared = .837) |

**Post Hoc Tests**

**Block**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | |
| Dependent Variable: Values | | | | | | |
| LSD | | | | | | |
| (I) Block | (J) Block | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| I | II | -2.50 | 6.972 | .732 | -19.56 | 14.56 |
| III | -10.00 | 6.972 | .201 | -27.06 | 7.06 |
| II | I | 2.50 | 6.972 | .732 | -14.56 | 19.56 |
| III | -7.50 | 6.972 | .323 | -24.56 | 9.56 |
| III | I | 10.00 | 6.972 | .201 | -7.06 | 27.06 |
| II | 7.50 | 6.972 | .323 | -9.56 | 24.56 |

|  |
| --- |
| Based on observed means.  The error term is Mean Square(Error) = 97.222. |
|  |

**Homogeneous Subsets**

**Treatment**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | |
| Dependent Variable: Values | | | | | | |
| LSD | | | | | | |
| (I) Treatment | (J) Treatment | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| A | B | 3.33 | 8.051 | .693 | -16.37 | 23.03 |
| C | 1.67 | 8.051 | .843 | -18.03 | 21.37 |
| D | -3.33 | 8.051 | .693 | -23.03 | 16.37 |
| B | A | -3.33 | 8.051 | .693 | -23.03 | 16.37 |
| C | -1.67 | 8.051 | .843 | -21.37 | 18.03 |
| D | -6.67 | 8.051 | .439 | -26.37 | 13.03 |
| C | A | -1.67 | 8.051 | .843 | -21.37 | 18.03 |
| B | 1.67 | 8.051 | .843 | -18.03 | 21.37 |
| D | -5.00 | 8.051 | .557 | -24.70 | 14.70 |
| D | A | 3.33 | 8.051 | .693 | -16.37 | 23.03 |
| B | 6.67 | 8.051 | .439 | -13.03 | 26.37 |
| C | 5.00 | 8.051 | .557 | -14.70 | 24.70 |

|  |
| --- |
| Based on observed means.  The error term is Mean Square(Error) = 97.222. |

**DECISION**

FT = 0.250 < Ftab = 4.757, so accept H0T at 5% level of significance.

FB = 1.114 < Ftab = 5.143, so accept H0T at 5% level of significance.

**CONCLUSION**

There is no significant difference between treatments and blocks.

**Practical 26. DESIGN OF EXPERIMENT**

Q26. The following table gives the result of experiment on four varieties of a crop in 5 blocks of plot.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Block I | Block II | Block III | Block IV | Block V |
| A(32) | B(33) | D(30) | A(35) | C(36) |
| B(34) | C(34) | C(35) | C(32) | D(29) |
| C(31) | A(34) | B(36) | B(37) | A(37) |
| D(29) | D(26) | A(33) | D(28) | B(35) |

Analyze the above result to test whether there is significant difference between yields of four varieties.

**Solution,**

**SYNTAX**

UNIANOVA values BY Block Treatment

/METHOD=SSTYPE(3)

/INTERCEPT=EXCLUDE

/POSTHOC=Block Treatment(LSD)

/CRITERIA=ALPHA(0.05)

/DESIGN=Block Treatment.

**Problem To Test**

H0T: There is no significant difference between the treatments.

H1T: There is significant difference between the treatments.

H0B: There is no significant difference between the blocks.

H1B: There is significant difference between the blocks.

**OUTPUT**

|  |  |  |  |
| --- | --- | --- | --- |
| **Between-Subjects Factors** | | | |
|  | | Value Label | N |
| Block | 1 |  | 4 |
| 2 |  | 4 |
| 3 |  | 4 |
| 4 |  | 4 |
| 5 |  | 4 |
| Treatment | 1 | A | 5 |
| 2 | B | 5 |
| 3 | C | 5 |
| 4 | D | 5 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: values | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Model | 21672.500a | 8 | 2709.062 | 1101.992 | .000 |
| Block | 21.700 | 4 | 5.425 | 2.207 | .130 |
| Treatment | 134.000 | 3 | 44.667 | 18.169 | .000 |
| Error | 29.500 | 12 | 2.458 |  |  |
| Total | 21702.000 | 20 |  |  |  |
| a. R Squared = .999 (Adjusted R Squared = .998) | | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | |
| Dependent Variable: values | | | | | | |
| LSD | | | | | | |
| (I) Block | (J) Block | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| 1 | 2 | -.25 | 1.109 | .825 | -2.67 | 2.17 |
| 3 | -2.00 | 1.109 | .096 | -4.42 | .42 |
| 4 | -1.50 | 1.109 | .201 | -3.92 | .92 |
| 5 | -2.75\* | 1.109 | .029 | -5.17 | -.33 |
| 2 | 1 | .25 | 1.109 | .825 | -2.17 | 2.67 |
| 3 | -1.75 | 1.109 | .140 | -4.17 | .67 |
| 4 | -1.25 | 1.109 | .282 | -3.67 | 1.17 |
| 5 | -2.50\* | 1.109 | .044 | -4.92 | -.08 |
| 3 | 1 | 2.00 | 1.109 | .096 | -.42 | 4.42 |
| 2 | 1.75 | 1.109 | .140 | -.67 | 4.17 |
| 4 | .50 | 1.109 | .660 | -1.92 | 2.92 |
| 5 | -.75 | 1.109 | .512 | -3.17 | 1.67 |
| 4 | 1 | 1.50 | 1.109 | .201 | -.92 | 3.92 |
| 2 | 1.25 | 1.109 | .282 | -1.17 | 3.67 |
| 3 | -.50 | 1.109 | .660 | -2.92 | 1.92 |
| 5 | -1.25 | 1.109 | .282 | -3.67 | 1.17 |
| 5 | 1 | 2.75\* | 1.109 | .029 | .33 | 5.17 |
| 2 | 2.50\* | 1.109 | .044 | .08 | 4.92 |
| 3 | .75 | 1.109 | .512 | -1.67 | 3.17 |
| 4 | 1.25 | 1.109 | .282 | -1.17 | 3.67 |
| Based on observed means.  The error term is Mean Square(Error) = 2.458. | | | | | | |
| \*. The mean difference is significant at the 0.05 level. | | | | | | |

**DECISION**

FT = 18.169 > Ftab = 3.490, so reject H0T at 5% level of significance.

FB = 2.207 < Ftab = 3.259, so accept H0T at 5% level of significance.

**CONCLUSION**

There is significant difference between treatments but there is no significant difference blocks.