Practice exercises for STA3123:

Note: A complete hypothesis test includes H0, Ha, test statistic value, rejection region, (or p-value), decision and conclusion.

CH.8:

1. The length of stay (in days) in hospital for 100 randomly selected patients are presented in the table. Based on the following SPSS output, conduct a test of hypothesis to determine if the true mean length of stay (LOS) at the hospital is less than 5 days. Use significance level .

|  |  |
| --- | --- |
| LOS for 100 hospital patients | 2, 3, 8, 6, 4, 4, 6, ………, 10, 2, 4, 2 |

SPSS output for HOSPLOS,

**One-Sample Statistics**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
| **LOS** | **100** | **4.53** | **3.678** | **.368** |

**One-Sample Test**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Test Value = 5** | | | | | |
|  | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** | **95% Confidence Interval of the Difference** | |
|  |  |  |  |  | **Lower** | **Upper** |
| **LOS** | **-1.278** | **99** | **.204** | **-.470** | **-1.20** | **.26** |

**2. Mongolian desert ants**

To study the ants in Mongolia, the botanists placed seed baits at 11 sites and observed the number of ant species attracted to each site. Do the data indicate that the average number of ant species at Mongolian desert sites is greater than 5 species? Use  = 0.10.

|  |  |
| --- | --- |
| # of ant species | 3, 3, 52, 7, 5, 49, 5, 4, 4, 5, 4 |

SPSS output Mongolian desert ants,

**One-Sample Statistics**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
| **ANTS** | **11** | **12.82** | **18.675** | **5.631** |

**One-Sample Test**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Test Value = 5** | | | | | |
|  | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** | **95% Confidence Interval of the Difference** | |
|  |  |  |  |  | **Lower** | **Upper** |
| **ANTS** | **1.388** | **10** | **.195** | **7.818** | **-4.73** | **20.36** |

CH. 9: Comparing two population means

* **Comparing two population means: independent sampling**

1: READING

Suppose we wish to compare a new method of teaching reading to “slow learners” to the current standard method. The response variable is the reading test score after 6 months. 22 slow learners are randomly selected, 10 are taught by the new method, 12 by the standard method. The test score is listed below.

|  |  |
| --- | --- |
| New method (1) | 80, 80, 79, 81, 76, 66, 71, 76, 70, 85 |
| Standard method (2) | 79, 62, 70, 68, 73, 76, 86, 73, 72, 68, 75, 66 |

Based on the SPSS output, answer the following questions.

a. Give a 95% confidence interval to estimate the mean test score difference between the new method and the standard method. Interpret the interval.

b. Based on the 95% confidence interval for mean difference (), can we infer the new teaching method leads to a higher score than the standard method?

c. Conduct a test of hypothesis to determine whether the standard method has a lower test score than the new method. (p-value = ?) Use.

SPSS output for READING

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Group Statistics | | | | | |
|  | METHOD | N | Mean | Std. Deviation | Std. Error Mean |
| SCORE | NEW | 10 | 76.40 | 5.835 | 1.845 |
| STD | 12 | 72.33 | 6.344 | 1.831 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| SCORE | Equal variances assumed | .002 | .967 | 1.552 | 20 | .136 | 4.067 | 2.620 | -1.399 | 9.533 |
| Equal variances not assumed |  |  | 1.564 | 19.769 | .134 | 4.067 | 2.600 | -1.360 | 9.493 |

* **Comparing two population means: paired difference experiment**

Example 2, NEW PROTEIN DIET: To investigate a new protein diet on weight-loss, FDA randomly choose five individuals and record their weight (in pounds), then instruct them to follow the protein diet for three weeks. At the end of this period, their weights are recorded again.

|  |  |  |  |
| --- | --- | --- | --- |
| Person | Weight before (1) | Weight after (2) | Difference |
| 1 | 148 | 141 |  |
| 2 | 193 | 188 |  |
| 3 | 186 | 183 |  |
| 4 | 195 | 189 |  |
| 5 | 202 | 198 |  |

Based on the SPSS output, answer the following questions.

a. Give a 95% confidence interval for the difference between the mean weights before and after the diet is used. Interpret the interval.

b. Based on the 95% confidence interval for mean difference (), can we infer that the new protein diet has effect on weight loss?

c. Do the data provide sufficient evidence that the protein diet has effect on the weight loss? Use. (p-value = ? )

SPSS output for NEW PROTEIN DIET

Paired Samples Statistics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | Mean | N | Std. Deviation | Std. Error Mean |
| Pair 1 | W1 | 184.80 | 5 | 21.347 | 9.547 |
| W2 | 179.80 | 5 | 22.354 | 9.997 |

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 | W1 - W2 | 5.000 | 1.581 | .707 | 3.037 | 6.963 | 7.071 | 4 | .002 |

Ch.10: Compare more than two population means: ANOVA, F-test, Multiple comparisons of means

Q1: A certain HMO is attempting to show the benefits of managed health care to an insurance company. The HMO believes that certain types of doctors are more cost-effective than others. One theory is that primary specialty is an important factor in measuring the cost-effectiveness of physicians. To investigate this, the HMO obtained independent random samples of 26 HMO physicians from each of four primary specialties-- General Practice (GP), Internal Medicine (IM), Pediatrics (PED), and Family Physician (FP)-- and recorded the total per-member, per-month charges for each. Identify the experiment unit, treatments, block and response variable for this study.

Q2. Exercise: Below is an incomplete ANOVA table for CRD.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | df | SS | MS | F |
| Diet | 2 |  |  |  |
| Error |  | 52.3 |  |  |
| Total | 25 | 156.7 |  |  |

1. Complete ANOVA table.
2. How many treatments are involved in this experiment?
3. How much is the MSE?
4. How much is the F test statistic used to compare the treatment means?
5. Write down the rejection region for hypothesis test of treatment means.
6. Conduct a hypothesis test to compare the treatment means. ()

Q3. Exercise: Below is an incomplete ANOVA table for RBD.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| source | df | SS | MS | F |
| Drug(treatment) | 2 | 329 |  |  |
| Patient(block) | 9 | 1207 |  |  |
| Error |  |  |  |  |
| Total | 29 | 1591 |  |  |

1. Complete ANOVA table.
2. How many treatments are involved in this experiment?
3. How many blocks are involved in this experiment?
4. How much is the MSE?
5. How much is the F test statistic used to compare drug means?
6. How much is the F test statistic used to compare patient means?
7. Write down the rejection region of hypothesis test to compare drug means.
8. Write down the rejection region of hypothesis test to compare patient means.
9. Conduct a hypothesis test to compare the treatment means. ()

Q4. multiple comparisons of means. (SPSS output: Post Hoc Test)

\_\_\_\_\_\_\_\_\_\_\_\_

means : 13.0 17.3 32.3

State: AL UT CAL

Question: 1. How manypair-wise comparisons of meansare there?

2. List those pairs of means which are sig. different.

3. List those pairs of means which are not sig. different.

****

Q5. Complete the ANOVA table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | df | SS | MS | F |
| c. Model |  |  |  |  |
| A | 3 |  | 0.75 |  |
| B | 1 | 0.95 |  |  |
| A\*B |  |  | 0.30 |  |
| Error |  |  |  |  |
| C. Total | 23 | 6.5 |  |  |

1. Complete the ANOVA table.

2. How many levels for factor A?

3. How many levels for factor B?

4. How many treatment combinations? How many total observations?

5. How much is the degree of freedom for the treatment, SST and MST.

6. How much is the MSE?

7. How much is the value of test statistic to compare treatment means?

\* Describe the procedure for ordered F tests to find out how the two factors have effect on the mean response.

**CH. 11: Simple linear regression (the straight –line model)**

Do the simple linear regression analysis for the following data. (FIREDAM)

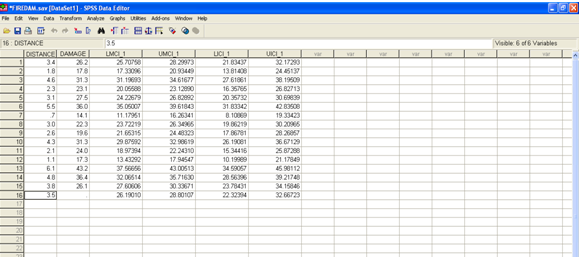
x (miles): the distance of a fire from the nearest fire station

y (thousand dollars): fire damage

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| x | 3.4 | 1.8 | 4.6 | 2.3 | 3.1 | 5.5 | 0.7 | 3.0 | 2.6 | 4.3 | 2.1 | 1.1 | 6.1 | 4.8 | 3.8 |
| y | 26.2 | 17.8 | 31.3 | 23.1 | 27.5 | 36.0 | 14.1 | 22.3 | 19.6 | 31.3 | 24.0 | 17.3 | 43.2 | 36.4 | 26.1 |







1. Write down the least squares line regression equation.

2. Give a practical interpretation for estimated slope and estimated intercept.

3. Give an estimate of the standard deviation  .

4. Conduct a test to determine if the data provide evidence that the distance and the damage have positive linear relationship? Use .

5. Construct a 95% confidence interval for and interpret the result.

6. Find the coefficient of correlation and give an interpretation.

7. Calculate the coefficient of determination and give an interpretation.

8. Suppose the insurance company wants to predict the fire damage if a major residential fire was to occur 3.5 miles from the nearest fire station. Find the prediction interval and give an interpretation.

9. Suppose the insurance company wants to estimate the mean fire damage for all the possible residential fires which were to occur 3.5 miles from the nearest fire station. Find the confidence interval and give an interpretation.

**CH.13: Categorical Data Analysis**

**One-way table analysis: test the multinomial probabilities**

**Example 1:** there are three candidates are running for the same elective position. We do a survey to determine the voting preferences of a random sample of 150 voters.

Results of voter-preference survey

|  |  |  |  |
| --- | --- | --- | --- |
| candidate | 1 | 2 | 3 |
| count | 61 | 53 | 36 |

At=0.05, do the sample data provide sufficient evidence that the voters have a preference for any of the candidates? (calculate the test statistic value by yourself and compare to the SPSS output)

SPSS OUTPUT for Example1: **Voter-preference**: **Chi-Square Test Frequencies**

|  |  |  |  |
| --- | --- | --- | --- |
| count | | | |
|  | **Observed N** | **Expected N** | **Residual** |
| **36** | 36 | 50.0 | -14.0 |
| **53** | 53 | 50.0 | 3.0 |
| **61** | 61 | 50.0 | 11.0 |
| **Total** | 150 |  |  |
| Test Statistics | | | |
|  | | | **count** |
| **Chi-Square(a)** | | | 6.520 |
| **df** | | | 2 |
| **Asymp. Sig.** | | | .038 |
| a 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 50.0. | | | |

**Example2: Violent crimes,** The U.S. FBI published the information in Crime in the United States. The distribution of violent crimes in 1995 is given below. A random sample of 500 violent-crime reports from last year yielded the frequency distribution shown also in the table.

|  |  |  |
| --- | --- | --- |
| Type of crime | Relative freq. of 1995 | Freq. of last year |
| Murder | 0.012 | 9 |
| Forcible rape | 0.054 | 26 |
| robbery | 0.323 | 144 |
| Aggressive assault | 0.611 | 321 |

* 1. Do the data provide sufficient evidence to conclude that last year’s distribution of violent crimes has changed from the 1995 distribution? Use=0.01.
  2. If the last year’s distribution has not changed from the 1995, how many crimes are expected to be murder out of these 500 violent crimes?

**Two-way table analysis: test the independence of row and column variables**

Example 1: Hiring status and Gender, Take a random sample of 80 job applicants at Mega-mart. The result is listed below. Consider hiring status and gender.

a. At, conduct a test of hypothesis to determine if gender and hiring status are dependent?

(calculate the test statistic value by yourself and compare to the SPSS output)

|  |  |  |
| --- | --- | --- |
|  | Hired | Not Hired |
| Male | 14 | 32 |
| Female | 14 | 20 |

b. If the gender and hiring status are independent, how many female are expected to be hired out of these 80 applicants?

SPSS output:Hiring status and Gender,

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Case Processing Summary | | | | | | |
|  | **Cases** | | | | | |
| **Valid** | | **Missing** | | **Total** | |
| **N** | **Percent** | **N** | **Percent** | **N** | **Percent** |
| **gender \* hire** | 80 | 100.0% | 0 | .0% | 80 | 100.0% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| gender \* hire Crosstabulation | | | | | |
|  |  |  | **hire** | | **Total** |
| **no** | **yes** |
| **gender** | **male** | **Count** | 32 | 14 | 46 |
| **Expected Count** | 29.9 | 16.1 | 46.0 |
| **female** | **Count** | 20 | 14 | 34 |
| **Expected Count** | 22.1 | 11.9 | 34.0 |
| **Total** | | **Count** | 52 | 28 | 80 |
| **Expected Count** | 52.0 | 28.0 | 80.0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Chi-Square Tests | | | | | |
|  | **Value** | **df** | **Asymp. Sig. (2-sided)** | **Exact Sig. (2-sided)** | **Exact Sig. (1-sided)** |
| **Pearson Chi-Square** | .992(b) | 1 | .319 |  |  |
| **Continuity Correction(a)** | .576 | 1 | .448 |  |  |
| **Likelihood Ratio** | .988 | 1 | .320 |  |  |
| **Fisher's Exact Test** |  |  |  | .351 | .224 |
| **N of Valid Cases** | 80 |  |  |  |  |
| a Computed only for a 2x2 table | | | | | |
| b 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.90. | | | | | |

CH. 14: Nonparametric Statistics

* **Wilcoxon rank sum test: comparing two population distribution (independent sampling)**

Example1: DRUGS:

At , Do the data provide sufficient evidence to indicate a shift in the probability distributions for drug A and B?

|  |  |
| --- | --- |
| Drug A () | Drug B () |
| Reaction time(seconds) | Reaction time(seconds) |
| 1.96 | 2.11 |
| 2.24 | 2.41 |
| 1.71 | 2.07 |
| 2.41 | 2.71 |
| 1.62 | 2.50 |
| 1.93 | 2.84 |
|  | 2.88 |
|  |  |

* **Wilcoxon Rank sum test for large sample (­­­­­­­­­):**

**Example:** Verbal SAT scores for students randomly selected from two different schools are listed below. Use the Wilcoxon rank sum procedure to test the claim that there is no difference in the scores from each school. Use .

|  |  |
| --- | --- |
| School 1 | 550, 520, 770, 480, 750, 530, 580, 780, 610, 590, 730, |
| School 2 | 490, 440, 680, 430, 750, 590, 690, 550, 530, 630, 640 |

* **Kruskal-Wallis H-test for CRD: comparing more than two population distributions**

**Example1: Vehicle miles:**

The U.S federal highway administration conducts annual survey on motor vehicle travel by type of vehicle and publishes in highway statistics. Independent random samples of cars, buses, and trucks provided the data on number of thousand miles driven last year.

At , do the data provide sufficient evidence to conclude that a **difference exists** in the probability distribution of last year’s miles among cars, buses, and trucks?

|  |  |  |
| --- | --- | --- |
| Cars | Buses | Trucks |
| 15.3 | 1.8 | 24.6 |
| 15.3 | 7.2 | 37.0 |
| 2.2 | 7.2 | 21.2 |
| 6.8 | 6.5 | 23.6 |
| 34.2 | 13.3 | 23.0 |
| 8.3 | 25.4 | 15.3 |
| 12.0 |  | 57.1 |
| 7.0 |  | 14.5 |
| 9.5 |  | 26.0 |
| 1.1 |  |  |

* **Friedman** **-test for RBD**: **comparing more than two population distributions**

**Example1**. In a study comparing the effects of four energy drinks on running speed, seven runners were timed (in seconds) running four miles. On each day, they were given a single energy drink. The data are listed below. Is there evidence of a difference in the probability distributions of the running times among the four drinks? Use .

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | drink | | | |
| runner | 1 | 2 | 3 | 4 |
| 1 | 1226 | 1226 | 1273 | 1244 |
| 2 | 1129 | 1035 | 1151 | 1159 |
| 3 | 1229 | 1229 | 1229 | 1229 |
| 4 | 1256 | 1217 | 1272 | 1267 |
| 5 | 1159 | 1121 | 1215 | 1220 |
| 6 | 1318 | 1295 | 1318 | 1318 |
| 7 | 1220 | 1261 | 1257 | 1243 |

* **Spearman’s rank correlation test: two numerical variable related or not**

**Example:** The number of absences and the final grades of 9 randomly selected students from a statistics class are given below. Can you conclude that there is a correlation between the final grade and the number of absences? Use .

|  |  |  |
| --- | --- | --- |
| student | absence | Final grade |
| 1 | 0 | 98 |
| 2 | 3 | 86 |
| 3 | 6 | 80 |
| 4 | 6 | 82 |
| 5 | 9 | 71 |
| 6 | 2 | 92 |
| 7 | 15 | 55 |
| 8 | 8 | 76 |
| 9 | 5 | 82 |