1. **Statistical Inference**
   1. **Parametric Testing of Hypothesis**
      1. **Testing for Mean of a Normal Population**
         1. **When Variance is known**

**Case 1:** Based on the following sample of size 10 from a Normal Population (with variance = 3) of Monthly  
Exenditure Students of Delhi University: 5000, 2000, 3000, 3456, 3623, 5200, 3400, 1200, 4500, 3500, I  
want to test the following hypotheses:

1. Average Monthly Expenditure of the students of Delhi University is 3500 or not.
2. Average Monthly Expenditure of the students of Delhi University is 3500 or more than that.

* + - 1. **When Variance is unknown**

**Case 2:** Based on the following sample of size 10 from a Normal Population (variance is unknown) of Monthly  
Expenditure Students of Delhi University: 5000, 2000, 3000, 3456, 3623, 5200, 3400, 1200, 4500, 3500, I  
want to test the following hypotheses:

1. Average Monthly Expenditure of the students of Delhi University is 3500 or not.
2. Average Monthly Expenditure of the students of Delhi University is 3500 or more than that.

**Case 3:** The mean weekly sales of soap bars in a chain of departmental stores was 146.3 bars per store. After  
an advertising campaign the mean weekly sales in 22 stores for a typical week increased to 153.7 and  
showed a standard deviation of 17.2. Was the campaign successful?

* + 1. **Testing for Variance of a Normal Population**

**Case 4:** It is believed that the precision (as measured by the variance) of an instrument is no more than 0.16.  
Write down the null and alternative hypothesis for testing this belief. Carry out the test at 1% level  
given 11 measurements of the sample subject on the instrument: 2.5, 2.3, 2.4, 2.3, 2.5, 2.6, 2.5, 2.6, 2.6,  
2.7, 2.5.

* + 1. **Testing for Equality of Means of two Normal Populations**
       1. **When Population Variances are known**

**Case 5:** The means of two samples of 1000 and 2000 members (from Normal Population) are 67.5 inches and  
68.9 inches respectively. Can the samples be regarded as drawn from the same population of standard  
deviation 2.5 inches?

* + - 1. **When Population Variances are unknown**

**Case 6:** The heights of six randomly chosen sailors are (in inches): 63, 65, 68, 69, 71, 72 and those of 10  
randomly chosen soldiers are: 61, 62, 65, 66, 69, 69, 70, 71, 72, and 73. Assuming that the samples are  
coming from Normal populations test if sailors are on the average taller than soldiers.

* + - 1. **When Two Samples are Related**

**Case 7:** Consider the *sleep* data available in R. Under the assumption of normality, can we say that the effect of the two soporific drugs is same?

* + 1. **Testing for Equality of Variances of two Normal Populations**

**Case 8:** Verify equality of variance in Case 6.

* + 1. **Testing for Equality of Means of several Normal Populations**

**Case 9:** Consider the *ChickWeight* data available in R. Under the assumption of normality, can we say that all the different diets have same effect on the weight of Chicken? If not, then find the best one for mass production.

* 1. **Non-Parametric Testing of Hypothesis**
     1. **Testing for Population Median – Frank Wilcoxon One-Sample Sign Test**

**Case 10:** The following table represents observations on heights and weights of 15 females:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Obs** | **Height (in inches)** | **Weight (in lbs)** | **Obs** | **Height (in inches)** | **Weight (in lbs)** |
| 1 | 58 | 115 | 9 | 66 | 139 |
| 2 | 59 | 117 | 10 | 67 | 142 |
| 3 | 60 | 120 | 11 | 68 | 146 |
| 4 | 61 | 123 | 12 | 69 | 150 |
| 5 | 62 | 126 | 13 | 70 | 154 |
| 6 | 63 | 129 | 14 | 71 | 159 |
| 7 | 64 | 132 | 15 | 72 | 164 |
| 8 | 65 | 135 |  |  |  |

Use sign test to test the following two hypothesis:

1. The Height of the females can be taken to be equal to 64 inches.
2. The Weight of the females can be taken to be equal to 135 lbs.

**Case 11:** Win/Loss records of a certain basketball team during their 50 consecutive games are given in the following table:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Game** | **Outcome** | **Game** | **Outcome** | **Game** | **Outcome** | **Game** | **Outcome** | **Game** | **Outcome** |
| 1 | 1 | 11 | 1 | 21 | 0 | 31 | 0 | 41 | 1 |
| 2 | 1 | 12 | 1 | 22 | 1 | 32 | 1 | 42 | 0 |
| 3 | 1 | 13 | 1 | 23 | 1 | 33 | 1 | 43 | 0 |
| 4 | 1 | 14 | 0 | 24 | 1 | 34 | 1 | 44 | 0 |
| 5 | 1 | 15 | 1 | 25 | 1 | 35 | 1 | 45 | 1 |
| 6 | 1 | 16 | 0 | 26 | 0 | 36 | 1 | 46 | 1 |
| 7 | 0 | 17 | 1 | 27 | 1 | 37 | 1 | 47 | 0 |
| 8 | 1 | 18 | 1 | 28 | 1 | 38 | 0 | 48 | 1 |
| 9 | 1 | 19 | 1 | 29 | 1 | 39 | 0 | 49 | 1 |
| 10 | 1 | 20 | 0 | 30 | 0 | 40 | 1 | 50 | 1 |

Using Sign Test to test the hypothesis that win and loss are equally likely.

* + 1. **Testing for Equality of two Populations**
       1. **Wald-Wolfowitz Run Test**
       2. **Mann-Whitney-Wilcoxon U Test**

**Case 12:** An experiment on reading ability of students was conducted, where at the beginning of the year a class was randomly divided into two groups. One group was taught to read using a uniform method, where all the students progressed from one stage to the next at the same time, following the instructor’s direction. The second group was taught to read using an individual method, where each student progressed at his own rate according to a programmed work book under the supervision of the instructor. At the end of the year each student was given a reading ability test and following were their scores:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **First Group** | 227 | 176 | 252 | 149 | 16 | 55 | 234 | 194 | 247 | 92 | 184 | 147 | 88 | 161 | 171 |
| **Second Group** | 202 | 14 | 165 | 171 | 292 | 271 | 151 | 235 | 147 | 99 | 63 | 284 | 53 | 228 | 271 |

Use U-test to test if two different teaching methods for reading ability can be taken as equally effective.

* + - 1. **Kolmogorov-Smirnov Test**

**Case 13:** For the following two samples test if they can be taken to be coming from same population:

|  |  |  |
| --- | --- | --- |
| **Observation** | **Sample 1** | **Sample 2** |
| 1 | 0.075204597 | 1.319177696 |
| 2 | 0.282203071 | 0.255423126 |
| 3 | 0.473605304 | 0.250284353 |
| 4 | 0.171775727 | 0.941835437 |
| 5 | 0.084642496 | 3.078396099 |
| 6 | 0.601160542 | 0.270368067 |
| 7 | 0.212552515 | 0.413272132 |
| 8 | 0.294969478 | 0.05425652 |
| 9 | 0.026919861 | 1.340734424 |
| 10 | 0.054462148 | 0.127618122 |
| 11 | 0.076084169 | 0.060699583 |
| 12 | 0.021943532 | 0.208278913 |
| 13 | 0.486042232 | 0.104869289 |
| 14 | 0.083376869 | 1.126610877 |
| 15 | 0.62800881 | 1.179774988 |
| 16 | 1.317637268 | 2.015836491 |
| 17 | 0.431532897 | 0.43267859 |
| 18 | 0.151809043 | 0.686019322 |
| 19 | 0.645182388 | 1.210587738 |
| 20 | 0.018898663 | 0.230682213 |

* + - 1. **Two-Sample Sign Test**

**Case 14:** Following data represents the marks given to the same set 22 students by two different professors in the same examination:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Student** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| **Professor A** | 79 | 87 | 24 | 41 | 59 | 12 | 91 | 78 | 63 | 30 | 09 | 64 | 50 | 92 | 64 | 39 | 49 | 86 | 23 | 45 | 12 | 88 |
| **Professor B** | 83 | 91 | 18 | 39 | 67 | 34 | 78 | 89 | 38 | 45 | 10 | 45 | 56 | 89 | 67 | 35 | 40 | 82 | 32 | 38 | 23 | 92 |

Using Sign Test, test if the grading of both the professors can be taken to be same.

* + 1. **Testing for Equality of several Populations – Kruskal Wallis Test**

**Case 15:** Consider the *ChickWeight* data available in R. Under no assumption of normality, can we say that all the different diets have same effect on the weight of Chicken? If not, then find the best one for mass production.

* + 1. **Goodness of Fit – Kolmogorov-Smirnov Test**

**Case 16:** For the following four samples test if they are drawn from Normal, Exponential, Poisson and Uniform distributions respectively.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Observation | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
| 1 | 1.089781309 | 0.046136443 | 4 | 10.25068427 |
| 2 | 1.962787672 | 0.296905535 | 2 | 10.12379195 |
| 3 | 1.724451834 | 0.013852846 | 1 | 17.81733259 |
| 4 | 1.63955842 | 0.149763684 | 1 | 18.87337658 |
| 5 | 0.144050286 | 0.216846562 | 2 | 15.32347378 |
| 6 | 0.232942589 | 0.549152735 | 3 | 11.97729205 |
| 7 | 1.68271611 | 0.075868307 | 4 | 16.79090476 |
| 8 | 3.633887711 | 0.147932045 | 3 | 14.40535435 |
| 9 | 1.81341443 | 0.29035859 | 3 | 14.10547096 |
| 10 | 1.683039558 | 0.027180583 | 4 | 14.99055234 |
| 11 | 1.659612162 | 0.163903305 | 3 | 12.68408943 |
| 12 | 0.8396626 | 0.8104371 | 1 | 10.62609998 |
| 13 | 3.427254188 | 0.078686029 | 8 | 15.59840961 |
| 14 | 1.127955432 | 0.153359897 | 4 | 17.59452935 |
| 15 | 1.552543896 | 0.141724322 | 5 | 10.60249139 |
| 16 | 0.214796062 | 0.066255849 | 2 | 17.17324608 |
| 17 | 0.475882672 | 0.085298693 | 4 | 11.59441059 |
| 18 | 3.013061127 | 0.507875983 | 5 | 14.11860911 |
| 19 | 2.73502768 | 0.104899753 | 0 | 19.68738385 |
| 20 | 2.583921184 | 0.020127363 | 5 | 17.20303417 |

* + 1. **Independence of Attributes – Chi-Square Test**

**Case 17:** Out of 8000 graduates in a town 800 are females, out of 1600 graduate employees 120 are females. Use Chi – Square test to test if any sex discrimination is made in the employment.