통계분석
Statistical Analysis

Assignment 05

Hypotheses Testing / ANOVA

Q1. Hypotheses Testing on One Sample

Automatic identification of the boundaries of significant structures within a medical image is an area of ongoing research. The paper “Automatic Segmentation of Medical Images Using Image Registration: Diagnostic and Simulation Applications” (J. of Medical Engr. and Tech.,2005: 53–63) discussed a new technique for such identification. A measure of the accuracy of the automatic region is the average linear displacement (ALD). The paper gave the following ALD observations for a sample of 49 kidneys (units of pixel dimensions).

1.38, 0.44, 1.09, 0.75, 0.66, 1.28, 0.51, 0.39, 0.70, 0.46,
0.54, 0.83, 0.58, 0.64, 1.30, 0.57, 0.43, 0.62, 1.00, 1.05,
0.82, 1.10, 0.65, 0.99, 0.56, 0.56, 0.64, 0.45, 0.82, 1.06,
0.41, 0.58, 0.66, 0.54, 0.83, 0.59, 0.51, 1.04, 0.85, 0.45,
0.52, 0.58, 1.11, 0.34, 1.25, 0.38, 1.44, 1.28, 0.51, 0.46,

1. Show that this sample data satisfies the normality by using normality probability plot.
2. Calculate the confidence interval of the population mean for the $(1 - \alpha = 0.95)$ confidence level.
3. Verify the hypothesis that the population mean is 1.0 by using the above sample data. For hypothesis testing, use the significance level $\alpha = 0.05$.

Q2. Inferences based on Two Samples

Here are Sample #1 and Sample #2 drawn from Population #1 and Population #2, respectively.

Sample #1: 1.2, 0.9, 0.7, 1.0, 1.7, 1.7, 1.1, 0.9, 1.7, 1.9, 1.3, 2.1,
1.6, 1.8, 1.4, 1.3, 1.9, 1.6, 0.8, 2.0, 1.7, 1.6, 2.3, 2.0

Sample #2: 1.6, 1.5, 1.1, 2.1, 1.5, 1.3, 1.0, 2.6

1. Show that Samples #1 and # 2 satisfy the normality by using normality probability plot.
2. Verify that the population mean of the Population #1 is equal to that of the Population #2 by using the two-sample t-Test.
3. When we assume that Populations #1 and #2 have the same population variance, we can use the pooled t-test. Verify the hypothesis that the population mean of the Population #1 is equal to that of the Population #2 by using the pooled t-test. Here set up the significance level $\alpha = 0.05$.

Q3. Single-Factor ANOVA

Numerous factors contribute to the smooth running of an electric motor ("Increasing Market Share Through Improved Product and Process Design: An Experimental Approach," Quality Engineering,1991: 361–369). In particular, it is desirable to keep motor noise and vibration to a minimum. To study the effect that the brand of bearing has on motor vibration, five different motor bearing brands were examined by installing each type of bearing on different random samples of six motors. The amount of motor vibration (measured in microns) was recorded when each of the 30 motors was running. The data for this study follows.

Brand 1: 13.1, 15.0, 14.0, 14.4, 14.0, 11.6
Brand 2: 16.3, 15.7, 17.2, 14.9, 14.4, 17.2
Brand 3: 13.7, 13.9, 12.4, 13.8, 14.9, 13.3
Brand 4: 15.7, 13.7, 14.4, 16.0, 13.9, 14.7
Brand 5: 13.5, 13.4, 13.2, 12.7, 13.4, 12.3

1. Calculate Mean and Standard Deviation for each brand.
2. Calculate SST (The Total Sum of Squares), SSTr (The Treatment Sum of Squares), SSE (The Error Sum of Squares), MSTr (Mean Square for Treatments), and MSE (Mean Square for Errors).
3. By using $\boldsymbol{F = MSTr/MSE}$, verify the hypothesis that brands of bearing do not affect vibration of motors. Here significance level $\alpha = 0.05$.