Assignment 5

Due date : 6/10/2022

21102052 Lee Jeong-Yun

1. (Ex 12-16, p 488) The article "Characterization of Highway Runoff in Austin, Texas, Area" (J. of Envir. Engr., 1998: 131–137) gave a scatter plot, along with the least squares line, of x = rainfull volume ($m^3$) and y = runoff volume ($m^3$) for a particular location. The accompanying values were read from the plot.

| $x$ | 5 | 12 | 14 | 17 | 23 | 30 | 40 | 47 |
|---|---|---|---|---|---|---|---|---|
| $y$ | 4 | 10 | 13 | 15 | 15 | 25 | 27 | 46 |

| $x$ | 55 | 67 | 72 | 81 | 96 | 112 | 127 |
|---|---|---|---|---|---|---|---|
| $y$ | 38 | 46 | 53 | 70 | 82 | 99 | 100 |

a) Does a scatter plot of the data support the use of the simple linear regression model?

b) Calculate point estimates of the slope and intercept of the population regression line.

c) Calculate a point estimate of the true average runoff volume when rainfall volume is 50.

d) Calculate a point estimate of the standard deviation $\sigma$.

e) What proportion of the observed variation in runoff volume can be attributed to the simple linear regression relationship between runoff and rainfall?

2. (Slightly modified version of Ex 12-52, p 507) Plasma etching is essential to the fine-line pattern transfer in current semiconductor processes. The article "Ion Beam- Assisted Etching of Aluminum with Chlorine" (J. of the Electrochem. Soc., 1985: 2010– 2012) gives the accompanying data (read from a graph) on chlorine flow (x, in SCCM) through a nozzle used in the etching mechanism and etch rate (y, in 100 A/min).

| $x$ | 1.5 | 1.5 | 2.0 | 2.5 | 2.5 | 3.0 | 3.5 | 3.5 | 4.0 |
|---|---|---|---|---|---|---|---|---|---|
| $y$ | 23.0 | 24.5 | 25.0 | 30.0 | 33.5 | 40.0 | 40.5 | 47.0 | 49.0 |

a) Fit the simple linear regression model to this data.

b) Estimate the true average change in etch rate associated with a 1-SCCM increase in flow rate using a 95% confidence interval, and interpret the interval.

c) What proportion of observed variation in % removed can be attributed to the model relationship?

d) Does the simple linear regression model specify a useful relationship? Carry out an appropriate test of hypotheses using a significance level of 0.05.

e) Calculate a 95% CI for $\mu_{Y \cdot 3.0}$, the true average etch rate when flow = 3.0. Has this average been precisely estimated?

f) Calculate a 95% PI for a single future observation on etch rate to be made when flow = 3.0. Is the prediction likely to be accurate?

g) Would the 95% CI and PI when flow = 2.5 be wider or narrower than the corresponding intervals of parts (c) and (d)? Answer without actually computing the intervals.

h) Would you recommend calculating a 95% PI for a flow of 6.0? Explain.

3. (Ex 10-6, p 401) The article "Origin of Precambrian Iron Formations" (Econ. Geology, 1964: 1025–1057) reports the following data on total Fe for four types of iron formation (1 = carbonate, 2 = silicate, 3 = magnetite, 4 = hematite).

| | | | | | |
|---|---|---|---|---|---|
| 1: | 20.5 | 28.1 | 27.8 | 27.0 | 28.0 |
| | 25.2 | 25.3 | 27.1 | 20.5 | 31.3 |
| 2: | 26.3 | 24.0 | 26.2 | 20.2 | 23.7 |
| | 34.0 | 17.1 | 26.8 | 23.7 | 24.9 |
| 3: | 29.5 | 34.0 | 27.5 | 29.4 | 27.9 |
| | 26.2 | 29.9 | 29.5 | 30.0 | 35.6 |
| 4: | 36.5 | 44.2 | 34.1 | 30.3 | 31.4 |
| | 33.1 | 34.1 | 32.9 | 36.3 | 25.5 |

Carry out an analysis of variance F test at significance level .01, and summarize the results in an ANOVA table.

4. (A slightly changed form of Ex 10-18, p 408) Consider the accompanying data on plant growth after the application of five different types of growth hormone.

1: 12 17 7 14

2: 20 13 20 17

3: 18 15 20 17

4: 7 11 18 10

5: 6 11 15 8

a. Perform an $F$ test at level $\alpha=0.05$.

b. What happens when Tukey's procedure is applied?

5. (Ex 14-30, p 620) Three different design configurations are being considered for a particular component. There are four possible failure modes for the component. An engineer obtained the follow- ing data on number of failures in each mode for each of the three configurations. Does the configuration appear to have an effect on type of failure?

| | | Failure Mode | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Configuration | 1 | 20 | 44 | 17 | 9 |
| | 2 | 4 | 17 | 7 | 12 |
| | 3 | 10 | 31 | 14 | 5 |

6. (Ex 14-16, p 612) In a genetics experiment, investigators looked at 300 chromosomes of a particular type and counted the number of sister-chromatid exchanges on each ("On the Nature of Sister-Chromatid Exchanges in 5-Bromodeoxyuridine- Substituted Chromosomes," Genetics, 1979: 1251–1264). A Poisson model was hypothesized for the distribution of the number of exchanges. Test the fit of a Poisson distribution to the data by first estimating $\mu$ and then combining the counts for x = 8 and x = 9 into one cell.

| $x$ = Number of Exchanges | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Observed Counts | 6 | 24 | 42 | 59 | 62 | 44 | 41 | 14 | 6 | 2 |