Ve401 Probabilistic Methods in Engineering

Summer 2018 — Assigment 7

Date Due: 12:10 PM, Wednesday, the 11th of July 2018

This assignment has a total of **(34 Marks)**.

Exercise 7.1

An article in *Knee Surgery, Sports Traumatology, Arthroscopy* (2005, Vol. 13, pp. 273279), considered arthroscopic meniscal repair with an absorbable screw. Results showed that for tears greater than 25 millimeters, 14 of 18 (78%) repairs were successful while for shorter tears, 22 of 30 (73%) repairs were successful.

i) Is there evidence that the success rate is greater for longer tears? What type of Hypothesis test are you using?
(2 Marks)

ii) Calculate a one-sided 95% confidence bound on the difference in proportions that can be used to answer the question in part i).
(2 Marks)

Exercise 7.2

The burning rates of two different solid-fuel propellants used in aircrew escape systems are being studied. It is known that both propellants have approximately the same standard deviation of burning rate; that is $\sigma_1 = \sigma_2 = 3$ centimeters per second. Two random samples of $n_1 = 20$ and $n_2 = 20$ specimens are tested; the sample mean burning rates are $\bar{x}_1 = 18$ centimeters per second and $\bar{x}_2 = 24$ centimeters per second.

i) Construct a 95% confidence interval on the difference in means $\mu_1 - \mu_2$. What is the practical meaning of this interval?
(2 Marks)

ii) Use the data above to decide between the hypotheses

$$H_0 : \mu_1 = \mu_2, \qquad H_1 : |\mu_1 - \mu_2| \geq 2.5\,\text{cm}\,.$$

Use $\alpha = 5\%$.
(2 Marks)

iii) Assuming equal sample sizes, what sample size is needed to obtain a power of 0.9 at a true difference in means of 14 cm/s?
(2 Marks)

Exercise 7.3

Two chemical companies can supply a raw material. The concentration of a particular element in this material is important. The mean concentration for both suppliers is the same, but we suspect that the variability in concentration may differ between the two companies. The standard deviation of concentration in a random sample of $n_1 = 10$ batches produced by company 1 is $s_1 = 4.7$ grams per liter, while for company 2, a random sample of $n_2 = 16$ batches yields $s_2 = 5.8$ grams per liter.
Is there sufficient evidence to conclude that the two population variances differ by at least 0.5 grams per liter? Use $\alpha = 5\%$.
(3 Marks)

Exercise 7.4

Prices for regular unleaded gasoline can vary widely from day to day and location to location. These data were obtained on June 1, 2001, from a sample of stations across the respective states (price is in dollars per gallon):

South Carolina					Michigan					
1.46	1.47	1.42	1.51	1.55	1.69	1.79	1.72	1.76	1.80	1.91
1.52	1.48	1.47	1.53	1.50	1.59	1.89	1.72	1.63	1.55	1.71

Use these data to test for equality of variances. What is the P-value of your test, and what conclusions do you draw?
(4 Marks)

Exercise 7.5

Water and other nonaqueous volatiles are present in differing concntrations in coal from different seams. To measure the percentage by weight of these substances for a particular seam, readings are taken at two different temperatures. These data result:

Water

105° C	15.11	15.30	15.44	15.23	15.32	15.48	15.27	15.37	15.36
160° C	15.14	15.33	15.40	15.28	15.34	15.77	15.26	15.38	15.52

Nonaqueuous Volatiles

105° C	0.343	0.601	0.676	0.481	0.543	0.541	0.475	0.108	0.106
160° C	1.533	1.780	1.625	1.190	1.636	1.692	2.015	1.464	1.991

i) Use the water data to test

$$H_0 \colon \mu_1 = \mu_2.$$

Does the temperature at which the readings are taken appear to affect the mean reading of the water concentraton of the coal? Explain. Be ready to defend your choice of a test statistic.
(3 Marks)

ii) Use the nonaqueous volatiles data to test

$$H_0 \colon \mu_1 = \mu_2.$$

Does the temperature at which the readings are taken appear to affect the mean reading of the concentraton of nonaqueous volatiles in the coal? Explain.
(3 Marks)

Exercise 7.6

Environmental testing is an attempt to test a component under conditions that closely simulate the environment in which the component will be used. An electrical component is to be used in two different locations in Alaska. Before environmental testing can be conducted, it is necessary to determine the soil composition in these locations. These data are obtained on the percentage of $\mathrm{Si\,O_2}$ by weight of the soil:

$$\begin{aligned} \text{Anchorage:} \quad & n_1 = 10, \quad \overline{x}_1 = 64.95, \quad s_1^2 = 9 \\ \text{Kodiak:} \quad & n_2 = 16, \quad \overline{x}_2 = 57.06, \quad s_2^2 = 7.29 \end{aligned}$$

i) Test $H_0 \colon \sigma_1^2 = \sigma_2^2$ at the $\alpha = 0.2$ level.
(2 Marks)

ii) Find s_p^2.
(1 Mark)

iii) Find a 99% confidence interval on $\mu_1 - \mu_2$.
(2 Marks)

iv) Based on this interval, does there appear to be a difference between μ_1 and μ_2? Explain.
(2 Marks)

Exercise 7.7

Polychlorinated Biphenyls (PCB) are worldwide environmental contaminants of industrial origin that ar related to DDT. They are being phased out in the United States but they will remain in the environment for many years. An experiment is being run to study the effects of PCB on the reproductive ability of screech owls. The purpose is to compare the shell thickness of eggs produced by birds exposed to PCB to that of birds not exposed to the contaminant. It is thought that shells of the former group will be thinner than those of the latter. Do these data support this research hypothesis? Explain.

Shell thickness, mm

Exposed to PCB	0.21	0.223	0.25	0.19	0.20	0.226	0.215	0.24	0.136
Free of PCB	0.22	0.265	0.217	0.256	0.20	0.27	0.18	0.187	0.23

(4 Marks)