

Ve401 Probabilistic Methods in Engineering

Summer 2017 — Assignment 7

Date Due: 12:10 PM, Wednesday, the 26th of July 2017



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This assignment has a total of (36 Marks).

Exercise 7.1

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

$$H_0: \mu_1 = \mu_2,$$

$$H_1: |\mu_1 - \mu_2| \geq 2.5 \text{ cm}.$$

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 7.2

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 7.3

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 7.4

Water and other nonaqueous volatiles are present in differing concentrations 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
Nonaqueous 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

$$H_0: \mu_1 = \mu_2.$$

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

(3 Marks)

- ii) Use the nonaqueous volatiles data to test

$$H_0: \mu_1 = \mu_2.$$

Does the temperature at which the readings are taken appear to affect the mean reading of the concentration of nonaqueous volatiles in the coal? Explain.

(3 Marks)

Exercise 7.5

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 SiO_2 by weight of the soil:

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

- Test $H_0: \sigma_1^2 = \sigma_2^2$ at the $\alpha = 0.2$ level.
(2 Marks)
- Find s_p^2 .
(1 Mark)
- Find a 99% confidence interval on $\mu_1 - \mu_2$.
(2 Marks)
- Based on this interval, does there appear to be a difference between μ_1 and μ_2 ? Explain.
(2 Marks)

Exercise 7.6

Polychlorinated Biphenyls (PCB) are worldwide environmental contaminants of industrial origin that are 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)

Exercise 7.7

A study of visual and auditory reaction times is conducted for a group of college basketball players. Visual reaction time is measured by the time needed to respond to a light signal, and auditory reaction time is measured by the time needed to respond to the sound of an electric switch. Fifteen subjects were measured with time recorded to the nearest millisecond:

Subject	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Visual	161	203	235	176	201	188	228	211	191	178	159	227	193	192	212
Auditory	157	207	198	161	234	197	180	165	202	193	173	137	182	159	156

Is there evidence that the visual reaction time tends to be slower than the auditory reaction time? Use a paired T -test as well as a Wilcoxon signed rank test.

(6 Marks)