

Ve401 Probabilistic Methods in Engineering

Spring 2020 — Assignment 7

Date Due: 11:00 PM, Friday, the 24th of April 2020



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This assignment has a total of (27 Marks).

Exercise 7.1 Comparing Means – Variances Known

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.

- Construct a 95% confidence interval on the difference in means $\mu_1 - \mu_2$. What is the practical meaning of this interval?
(2 Marks)
- Use the data above to decide between the hypotheses

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

Use $\alpha = 5\%$.

(2 Marks)

- 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 Comparing Means – Variances Unknown

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:

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

It can be assumed that the variances are equal.

- 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 7.3 Comparing Means – Anything Goes

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 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 7.4 Comparing Means – Paired Tests

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)

Exercise 7.5 Fitting a Binomial Distributions

Define X as the number of underfilled bottles from a filling operation in a carton of 24 bottles. Seventy-five cartons are inspected and the following observations on X are recorded:

Values	0	1	2	3
Frequency	39	23	12	1

Based on these 75 observations, is a binomial distribution an appropriate model?

(3 Marks)

Exercise 7.6 Independence

A study is being made of the failures of an electronic component. There are four types of failures possible and two mounting positions for the device. The following data have been taken:

Mounting Position	Failure Type			
	A	B	C	D
1	22	46	18	9
2	4	17	6	12

Would you conclude that there is evidence that the type of failure is dependent of the mounting position?

(3 Marks)