ECEN321: Engineering Statistics

Assignment 11

Due: 9:00 a.m., Wednesday 24 June 2020

Hypothesis Tests

1. (Navidi 6.11.4) A machine that fills beverage cans is supposed to put 12 ounces of beverage in each can. The variance of the amount in each can is 0.01. The machine is moved to a new location. The determine whether the variance has changed, 10 cans are filled. Following are the amounts in the 10 cans. Assume them to be a random sample from a normal population.

   12.18 11.77 12.09 12.03 11.87 11.96 12.03 12.36 12.28 11.85

   Perform a hypothesis test to determine whether the variance differs from 0.01. What do you conclude?

   [4 marks]

2. (Navidi 6.14.6) Five new paint additives have been tested to see if any of them can reduce the mean drying time from the current value of 12 minutes. Ten specimens have been painted with each of the bew types of paint, and then drying times (in minutes) have been measured. The results are as follows:

Additive	$\bar{X}$	s
A	12.938	1.1168
B	10.890	1.2395
C	11.721	2.3433
D	10.473	1.3996
E	11.524	1.0892

   For each additive, perform a hypothesis test of the null hypothesis $H_0 : \mu \geq 12$ against the alternate hypothesis $H_1 : \mu < 12$. You may consider that each population is approximately normal.

   (a) What are the P-values for the five tests?

   [5 marks]

   (b) On the basis of the results, which of the three following conclusions seems most appropriate? Explain your answer.

   [2 marks]

   i. At least one of the new additives is an improvement
   ii. None of the new additives result in an improvement
   iii. Some of the new additives may result in improvement, but the evidence is inconclusive.

Regression

3. (Navidi 7.3.8) The article "application of Radial Basis Function Neural Networks in Optimization of Hard Turning of AISI D2 Cold-Worked Tool Steel With a Ceramic Tool" (S. Basak, U. Dixit, and J.Davim, *Journal of Engineering Manufacture,* 2007:987–998) presents the results of an experiment in which the surface roughness (in μm) was measured for 27 D2 steel specimesn and compared with the roughness predicted by a neural network model. The results are presented in the following table.

True value (x)	Predicted value (y)	True value (x)	Predicted value (y)	True value (x)	Predicted value (y)
0.45	0.42	0.52	0.51	0.57	0.55
0.82	0.70	1.02	0.91	1.14	1.01
0.54	0.52	0.60	0.71	0.74	0.81
0.41	0.39	0.58	0.50	0.62	0.66
0.77	0.74	0.87	0.91	1.15	1.06
0.79	0.78	1.06	1.04	1.27	1.31
0.25	0.27	0.45	0.52	1.31	1.40
0.62	0.60	1.09	0.97	1.33	1.41
0.91	0.87	1.35	1.29	1.46	1.46

To check the accuracy of the prediction method, the linear model $y = \beta_0 + \beta_1 x + \epsilon$ is fit. If the prediction method is accurate, the value of β_0 will be 0 and the value of β_1 will be 1.

(a) Compute the least-squares estimates $\widehat{\beta}_0$ and $\widehat{\beta}_1$.

[2 marks]

(b) Can you reject the null hypothesis $H_0 : \beta_0 = 0$?

[2 marks]

(c) Can you reject the null hypothesis $H_0 : \beta_1 = 1$?

[2 marks]

(d) Do the date provide sufficient evidence to conclude thatthe prediction method is not accurate?

[1 mark]

(e) Compute a 95% confidence interval for the mean prediction when the roughness is $0.8\,\mu$m.

[2 marks]

(f) Someone claims that when the true roughness is $0.8\,\mu$m, the mean prediction is only $0.75\,\mu$m, Do these data provide sufficient evidence for you to conclude that this claim is false? Explain.

[3 marks]

4. (Navidi 7.supplementary.10) The article "The Role of Niche Breadth, Resource Availability and Range Position on the Life History of Butterflies" (A. Komonen, A. Grapputo, et al., *Oikos,* 2004:41–54) describes a study of several species of butterflies found in Finland. The following table presents the mean wingspan (in mm) and the flight period, defined as the mean number of days of appearance in the winged state, for 23 species in the family *Lycaenidae.*

Wingspan	Flight period (y)	Wingspan	Flight period (y)	Wingspan	Flight period (y)	Wingspan	Flight period (y)
35.5	19.8	25.9	32.5	28.8	25.9	28.1	18.5
30.6	17.3	31.3	27.5	35.9	23.1	25.9	32.3
30.0	27.5	23.0	31.0	23.0	53.1	28.8	29.1
32.3	22.4	26.3	37.4	24.6	38.8	31.4	37.0
33.9	40.7	23.7	22.6	28.1	36.5	28.5	33.7
27.7	18.3	27.1	23.1	25.4	24.0		

(a) Compute the least-squares line for predicting the flight period (y) from wingspan (x).

[2 marks]

(b) Compute 95% confidence intervals for β_0 and β_1.

[4 marks]

(c) Two butterflies differ in wingspan by 2 mm. By how much do you estimate that their flight periods will differ?

[1 mark]

(d) Can you conclude that species of butterflies with larger wingspans have shorter flight periods on average?

[3 marks]

(e) Can you conclude that the mean flight period for buterflies with a wingspan of 30 mm is less than 28 days?

[3 marks]

(f) A certain butterfly species has a wingspan of 28.5 mm. Find a 95% prediction interval for its flight period.

[2 marks]