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Exam #1 – QSCI 482 –KEY.

Winter Quarter 2011

Read each question carefully and thoroughly before attempting to answer. Show all work in order to receive partial credit. Put your name or ASUW number on EACH page of your answers. Exam is open book, open notes, and calculators required. Turn in your answers at the beginning of class, Friday 11 Feb 2011.

1. [20 points] For the following experimental situations, tell what measurement scale (nominal, ordinal, interval, or ratio) will likely be used to collect the data described and whether the data will be discrete or continuous.

   a) A forester wants to compare the mean heights of western hemlock seedlings after growing two years in a nursery under two different fertilization regimes. ratio, continuous

   b) A company that packages salted peanuts in 8-oz jars is interested in knowing whether or not its jars actually contain on average 8-oz of peanuts. ratio, continuous

   c) A fisheries scientist would like to determine the species composition of all spawning *salmonids* in a particular stream in western Washington, U.S.A., by measuring the species of each fish in several large samples. nominal, discrete

   d) An ornithologist would like to determine how many eggs are found most often in nests of breeding pairs of the very, very rare, tropical Foo bird. ratio, discrete

   e) Why is it important to know the measurement scale used in collecting experimental data? It ~~con~~ constrains the types of analyses that can be done.

2. [25 points] An apple grower wants to evaluate whether or not this year's crop can be sold for premium prices, which requires that the average diameter of the apples has to be greater than 2.5 inches. A random sample of n = 12 apples from the crop gave a mean diameter of 2.76 inches with standard deviation of 0.3942 inches.

   12 a) Set up appropriate hypotheses to address the research question, choosing an appropriate test statistic, and stating the assumptions for using it.

   8 b) Find the critical value of the test statistic using a significance level of 0.05 and test the hypothesis. State your conclusions and state a p-value (bracketing OK).

   5 c) Construct a 95% confidence interval for the variance of apple diameters.

12 a) H_0: mean diameter of apples is less than or equal to 2.5" } $H_0: \mu \leq 2.5$ 2
H_a: mean diameter of apples is greater than 2.5" } $H_a: \mu > 2.5$
2 Choose one-sample t; 5 random & indep. sample, σ^2 unknown, data are ratio scale & continuous, assumed to be normally dist'd.

8 b) 2 $t_{.05(1),11} = 1.7959$ $t_{obs} = \frac{2.76 - 2.5}{(0.3942/\sqrt{12})} = 2.2848$ Reject H_0 concluding mean diameter of apples is greater than 2.5 inches ($p = 0.02158$).

5 c) $\chi^2_{.975,11} = 3.8157$ 2 ; $\chi^2_{.025,11} = 21.9200$ 2 $\Rightarrow$ 95% CI $\left\{\frac{11(.3942)^2}{21.9200} \leq \sigma^2 \leq \frac{11(.3942)^2}{3.8157}\right\} \Rightarrow$ 95% CI $\{0.07798, 0.4480\}$

3. [20 points] Suppose that the wing length of houseflies has a normal distribution with mean μ = 45.4 (mm x 10^{-1}) and a standard deviation, σ, of 5.18 (mm x 10^{-1}).

10 a) Determine an interval of wing length values such that the probability of observing a wing at random within this interval is 0.90 (mm x 10^{-1}).

$Z_{.05} = 1.645$ $\quad -1.645 \le \frac{X-45.4}{5.18} \le 1.645$ $\quad 36.9 \le X \le 53.9$

10 b) If 20 wings are measured for length, what is the probability that their average length will be greater than 50.6 (mm x 10^{-1})?

$P\left(\frac{\bar{X}-\mu}{\sigma_{\bar{X}}} \ge \frac{50.6-45.4}{5.18/\sqrt{20}}\right) = ?$ $\quad P(Z \ge 4.489) = 0.0000036$

4. [20 pts] The following data came from a study on the diffusion rates of carbon dioxide through soil profiles. Diffusion rate was measured on each of 12 samples from a fine textured soil (f), and 12 samples of coarse (c) soil were also measured. This resulted in a mean diffusion rate for fine soil of 22.8, with standard deviation of 5.34 and a mean diffusion rate for coarse soil of 27.0 with a standard deviation of 6.78.

8 a) Assuming equal variances and normal distributions of diffusion rates, test the null hypothesis of equal mean diffusion rates using a .10 significance level. State the results of your test in the context of the original research question.

6 b) Construct one or two 90% confidence interval(s) for either a pooled mean or two separate mean diffusion rates as appropriate based on the results of the test in (a) above.

6 c) Assuming now that the data cannot be said to be normally distributed with any certainty, OUTLINE (do NOT do!) the next most powerful method to test whether the diffusion rates are equal. Do this by writing out the test statistic, describing any terms and symbols you use. Also indicate the appropriate tabled critical value(s) for your test at the 0.05 level of significance.

5. [15 points] Perform the following power and sample size calculations.

a) What is the smallest possible difference between average apple diameter (question 2) and the 2.5-inch standard that would enable us to reject the null hypothesis with 90% probability, if indeed it is false (should be rejected)?

b) What power would we have to detect a difference of size 2 between mean diffusion rates for coarse and fine textured soils using the same experimental design as above (i.e., same sample sizes, variability and significance level)?

c) If we wanted to detect a difference of 5 (mm x 10-1) in wing length from the known mean value of 45.4 (question 3 above) holding both Type I and Type II error rates at 5%, how many samples would be necessary?

5 a) $\delta = \sqrt{\frac{s^2}{n}}\left(t_{\alpha(1),n-1} + t_{\beta(1),n-1}\right) \Rightarrow \delta = \sqrt{\frac{.3942^2}{12}}(1.796 + 1.363) = \cancel{0.572}\ 0.36$

$\alpha = 0.05 \quad \beta = 0.10$

5 b) $t_{\beta(1),n_1+n_2-2} = \frac{\delta}{\sqrt{s_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} - t_{\alpha,n_1+n_2-2} = \frac{2}{\sqrt{37.242\left(\frac{1}{12}+\frac{1}{12}\right)}} - 1.717 = -.914$

$P(t \ge -.914) = 0.815 = \beta$; $1-\beta = 0.185$, pretty low power.

5 c) $n = \frac{s^2}{\delta^2}\left(t_{\alpha(2),n-1} + t_{\beta(1),n-1}\right)$

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QSCI 482 Midterm Exam Key #3 and #4

3.

a.

Z =(170-178.1)/40.7 =-0.199, p-value= 0.50 -0.4207 = 0.0793

Z =(200-178.1)/40.7 = 0.538, p-value =0.5 - 0.2946 = 0.2054

Probability = 0.2847

b.

Z=(260-178.1)/40.7 = 2.012, p-value = 0.022

c.

Z=(170-178.1)/(40.7/3) = -0.597, p-value= 0.50-0.2743 = 0.2257

Z=(200-178.1)/(40.7/3) = 1.614, p-value= 0.50-0.0537 = 0.4463

Probability = 0.672

d.

p-value = 0.03 = Z = 2.75

x = 40.7(1.88) + 178.1

x = 254.61

4.

a.

Ho: The population mean of liquid amount per bottle is greater than or equal to 12 oz
Ha: The population mean of liquid amount per bottle is less than 12 oz

Ho: $\mu \geq 12$
Ha: $\mu < 12$

b.

For a hypothesis regarding a population mean or standard, when the population is known to be normal and variance σ^2 is not known, we use the t-test.

Assumptions:

Data are continuous.
Data are t distributed or are suspected normal with (n-1) degrees of freedom and an unknown population variance.
Sample observations are an independent random sample drawn independently from each other.
Objective is to test a hypothesis regarding a single sample.

c.

Alternative is one-sided

$\alpha = 0.01$

$t_{crit\ .01,\ 14} = 2.624$ or -2.624

$t_{obs} = (11.56 - 12)/\mathrm{sqrt}(0.139/15) = -4.592$

$(|t_{obs}| = 4.592) > 2.624$ or $\Pr(|t_{14}| > 4.592) < 0.0001$

We reject Ho; There is strong evidence that the true mean of liquid per bottle is less than 12 oz.

5. b) H_0: $\cancel{\mu \le 2.5}$ $\mu_E - \mu_F = 2$

H_a: $\cancel{\mu > 2.5}$ $\mu_c - \mu_F \neq 2$