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STAT 641
Assignment 08
12/8/21

Read H.O.13; Devore Book chps 9, 10, 14 & 15

1.) In each of the following studies, state whether the study uses an independent samples or a matched pairs design: (NOTE see pg 20 H.O.13)

(a) In an evaluation of the efficiency of algorithms, two algorithms are evaluated in terms of CPU times required to complete the same six test problems.

Independent

(b) A survey is conducted of 16 year old students from inner city public schools and suburban public schools to compare the proportion who had experimented w/ marijuana.

Independent

(c) A psychologist designs a study to assess whether a visual or audio stimulus produces a more rapid response. A group of 250 undergraduates are randomly assigned to the order in which they are exposed to the two stimuli, audio then visual or vice versa. The response times to the stimuli are then recorded.

paired

(d) The effect of two types of viruses on tobacco leaves was studied by rubbing a preparation containing one of the viruses onto a different half of each of 8 tobacco leaves. The # of lesions counted on the two halves of these leaves were recorded.

paired.

2) An Experiment is run to study the effects of PCB on the reproductive ability of owls. The shell thickness (mm) of eggs produced by 10 owls exposed to PCB are compared to the shell thickness of eggs produced by 10 owls which did not have PCB exposure.

OWL	1	2	3	4	5	6	7	8	9	10
PCB-Exposed	3.6	3.2	3.8	3.6	4.1	3.8	4.2	3.4	3.7	3.8
Unexposed	4.3	4.4	3.6	3.5	4.4	3.5	3.4	3.6	4.1	4.3

(see H.0.13 pgs 2-4)

(1) Is there significant ($\alpha = 0.05$) evidence that the PCB exposed owls have thinner egg shells than those of the unexposed owls? Use a t-test in reaching your conclusion & report the p-value.

· Let $\bar{X} = E[\text{PCB Exposed}]$, $\bar{Y} = E[\text{Unexposed}]$

Then our estimated parameter is

$$\hat{\theta} = \bar{X} - \bar{Y}$$

and we are testing:

$H_0: \hat{\theta} \geq 0$, $H_a: \hat{\theta} < 0$

* Calculations done using R.

$T = -1.162298$

$t_{0.05, 18+10-2} = -1.734064$ $\Rightarrow$ Fail to reject H_0 @ $0.05 = \alpha$ level

p-value $= 0.130147$

(2) Compute the power that your test committed a Type II error for the following values of θ:

$\theta = \mu_{\text{exposed}} - \mu_{\text{unexposed}} = 0, -0.5\sigma, -\sigma, -1.5\sigma, -2\sigma$.

(H.0.12 pg 4) → [* Recall: Type II Error $= P[\text{fail to reject } H_0 \mid H_1 \text{ is true}] = 1 - \gamma(\theta)$ where $\gamma(\theta)$ is the power]

* see H.0.13 pg 4 case 2 for power calculation.

$\theta_0 = 0$: $P[\text{fail to reject } H_0 \mid H_1 \text{ is true}] = 0.7006162$

$\theta_0 = -0.5\sigma$: " " $= 0.9454469$

$\theta_0 = -\sigma$: " " $= 0.9962153$

$\theta_0 = -1.5\sigma$: " " $= 0.9999145$

$\theta_0 = -2\sigma$: " " $= 0.9999993$

2.) (cont'd)

(3) In designing a new study, the researchers want to determine necessary sample sizes for exposed and unexposed owls s.t. an $\alpha = 0.05$ test will have power of at least 80% to detect a shell difference of more than 0.13 mm. The researchers want to examine 3 times as many exposed owls as unexposed owls. That is $m = 3n$

(** see pg. 23 of H.0.13) $\alpha = 0.05$, $\beta = 1 - 0.80 = 0.20$

$$n = \frac{k+1}{k}\left[\frac{\sigma(z_\alpha + z_\beta)}{\delta}\right]^2$$

$n = 12.2379 \Rightarrow$ **$n = 13$, $m = 39$**

* ask about this (manual calculation not working)

(4) Is there significant evidence ($\alpha = 0.05$) that the PCB exposed owls have thinner egg shells than those of the unexposed owls? Use a Wilcoxon test in reaching your conclusion & report the p-value. (* see H.0.13 pg 14)

There is not significant evidence ($\alpha = 0.5$) to reject the null hypothesis that the egg shells of the two groups have the same thickness.

p-value = 0.2347

(5) Is there significant ($\alpha = 0.05$) evidence that the PCB exposed owls have greater variability in egg shell thickness than those of unexposed owls? Report the p-value of your test.

(* see pg 71 & pg 60 of H.0.13)

Yes, there is significant evidence, that the PCB exposed owls have variability in egg shell thickness.

p-value: 0.02645

(6) Which test, t-test or Wilcoxon, is more appropriate for testing the difference in egg shell thickness?

- Wilcoxon test b/c the unexposed data is not normally distributed.

3.) In a study of the effect of vitamin B on learning, 12 pairs of children were matched on IQ, age, size and general health. Within each pair one child was randomly selected to receive a vitamin B tablet every day and the other child received a placebo tablet. The following table shows the change in IQ score over the 6 months of the study.

Pair	1	2	3	4	5	6	7	8	9	10	11	12
Vitamin B	14	26	2	4	-5	14	3	-1	1	6	3	4
Placebo	8	18	-7	-1	2	9	0	-4	13	3	3	3

- ~~T-test for paired data~~ (see 4.0.13 pg. 19-21) *
  - $T = 1.143211$

    $P[T \geq 1.143211] = 1 - P[T \leq 1.143211] = 1 - pt(1.143211, df = 10-1)$

    $P[T \geq 1.143211] = \boxed{0.1386109 = p\text{-value}}$
- ~~Wilcoxon signed rank test:~~

  $\boxed{p\text{-value} = 0.1144}$

- The wilcoxon rank test produces the most reliable conclusion b/c the data are not normally distributed.

4.) A study evaluated the urinary thromboglobulin in 12 normal & 12 diabetic patients. The excretions were summarized w/ a value of 20 or less as "low" & values of 20 and above as "High".

	Excretion	
	Low	High
normal	10	2
Diabetic	4	8

(1) Set up hypotheses to test whether there is substantial evidence of a difference in the urinary-thr. excretion btwn normal & diabetic patients.

* NOTE: See Pearson chi squared Test of Hom. Prop. (H.O.H pg 26)
See special case where t=2 (H.O.13 pg 29)

- Let p_1 = proportion of patients w/ diabetes & High Excretion
  p_2 = proportion of patients w/ normal & High Excretion
- $H_0: p_1 = p_2$, $H_A: p_1 \neq p_2$

(2) At the $\alpha = 0.05$ level what can you conclude? Report a p-value. (H.O.13 pg 33)

* NOTE: before conducting Pearson Chi-squared test, check conditions.
Namely, if any of the $\hat{E}_{i,j} < 1$ or more than 20% of the $E_{i,j} < 5$
=> need to use fisher exact test

We would reject the null at the $\alpha = 0.05$ level and conclude that there is a difference in the urinary-thromboglobulin excretion btwn normal & diabetic patients.
p-value = 0.036017

5) A study was conducted to compare two topical anesthetic drugs for use in dentistry. The two drugs were applied on the oral mucous membrane of the two sides of each patients mouth and after a fixed period of time it was recorded whether or not the membrane remained anesthetized. Data from the 45 patients is recorded below:

		Drug 2 Response: Anesthetized	Drug 2 Response: Not Anesthetized
Drug 1 Response	Anesthetized	15	13
	Not Anesthetized	3	14

NOTE: Use McNemars Test for Matched pairs: (H.O. 13 pg 54) ←

(1) Set up Hypotheses to assess whether there is substantial evidence of a difference btwn the two drugs.

H_0: $p_{1.} = p_{.1}$, H_A = $p_{1.} \neq p_{.1}$

(2) We would reject the null at the $\alpha = 0.05$ level and conclude there is substantial evidence of a difference btwn the two drugs.

P-value = 0.004180908

(see H.0.13 pg 27) *

6) A genetics experiment on the characteristics of tomato plants provided the following data on the number of offspring expressing 4 phenotypes:

phenotype	Tall cut	Dwarf cut	Tall Potato	Dwarf Potato	Total
Frequency	926	293	288	104	1611

The researcher wants to determine if there is substantial evidence that the tomato plants deviate from the current theory that the four phenotypes will appear in the proportion 9:3:3:1. Use $\alpha = 0.01$.

H_0: $p_1 = 9/16$, $p_2 = 3/16$, $p_3 = 3/16$, $p_4 = 1/16$

H_A: At least one of these proportions is different than stated.

$\chi^2 = 1.46877 < 11.34487 = qchisq(1-0.01, 4-1)$

pvalue $= 1 - pchisq(1.46877, 4-1) = 0.6895079$

7.) A company is trying to automate the determination of the amount of active ingredient in the tablets it produces. Two labs were asked to make 20 determinations on a composite sample which had a nominal dosage level of 4 mg. The purpose of the experiment was to study the consistency between labs and the variability of the determination procedure w/in labs. The data is given in the following table.

(1) Do the data from the labs appear to have a normal distribution?

Using the Shapiro Wilks test we see that Lab 1 does not have a normal distribution while the data from lab 2 & the differences from the data appear to be normally distributed.

ask about using paired → (2) Do the data from the two labs appear to have the same level of variability (see H.0.13 pg 71; 80) *

Yes, using the BFL test we fail to reject the null that the data from the two labs have the same level of variability.

7.) (Contd)

don't use p-value b/c runs to small, need to look at table ☐

(3) Do the daily determinations w/in each lab appear to be correlated?

* (See H.O. 13 pg 87-89) Do Run Test.

Lab1: the daily readings do not appear to be correlated. (p-value = 0.76006521)

Lab2: the daily readings do not appear to be correlated (p-value = 0.11436866)

(4) Do the readings from the two labs appear to have different average determinations?

* use wilcoxon rank sum test *

in R: wilcox.test(data$lab1, data$Lab2, alternative = "two.sided" paired = F)

p-value = 0.0003827; Yes the readings from the two labs appear to have different average determinations.

(5) Provide 95% CI's on the average determination for both the labs.

CI Lab1 = (4.031506, 4.032591)

CI Lab2 = (3.960210, 3.960793)

8.) A study was conducted to investigate whether there is a relationship btwn tonsil size and carriers of a particular bacterium. The following table contains the results from 1398 children

Tonsil Size	Carrier Status		Row Total
	Carrier	Noncarrier	
Normal	19	497	516
Large	29	560	589
very large	24	269	293
Column Total	72	1326	1398

Is there significant evidence that tonsil size and carrier status are associated? Use $\alpha = 0.05$.

* (See H.O. 18 pg 38) *

$TS = 7.884843$

$\chi^2_{0.05}$ $df = (3-1)(2-1) = 5.991465$

$7.884843 > 5.991465 \Rightarrow$ Reject null, there is significant evidence that tonsil size and carrier status are associated at the $\alpha = 0.05$ level

9) (1) C

(2) D

(3) C

(4) B

(5) A

(6) D

(7) D

(8) D