AP® STATISTICS
2010 SCORING GUIDELINES (Form B)

Question 5

Intent of Question

The primary goals of this question were to assess students' ability to (1) calculate appropriate probabilities, including conditional probabilities, from a two way table; (2) determine from a two way table whether two events are independent; (3) identify an appropriate test procedure for assessing independence between two categorical variables.

Solution

Part (a):

Using the addition rule, the probability that the randomly selected adult is a college graduate or obtains news primarily from the internet is:

P(college graduate or internet) = P(college graduate) + P(internet) − P(college graduate and internet)

$$= \frac{693}{2500} + \frac{687}{2500} - \frac{245}{2500} = \frac{1135}{2500} = 0.454.$$

Part (b):

Reading values from the table, the conditional probability that the selected adult receives news primarily from the internet given that he or she is a college graduate is: $\frac{245}{693} = 0.354$.

Part (c):

$P(I) \cdot P(CG) = P(I \cap CG)$

These events are not independent. One way to establish this is to note that the unconditional probability equals P(obtains news primarily from the internet) $= \frac{687}{2500} = 0.275$, but the conditional probability equals P(obtains news primarily from the internet / is a college graduate) $= 0.354$. Because these two probabilities are not equal, the events "is a college graduate" and "obtains news primarily from the internet" are not independent.

$P(I) \neq P(I|CG)$

$P(I) = \frac{687}{2500} = .275$

$P(I|CG) = \frac{245}{693} = .354$

Part (d):

Chi square test of association (or independence), with degrees of freedom = (# of rows − 1) × (# of columns − 1) = (5 − 1) × (3 − 1) = 8.

Scoring

Parts (a), (b), (c) and (d) are each scored as essentially correct (E), partially correct (P) or incorrect (I).

Part (a) is scored as follows:

Essentially correct (E) if the probability is computed correctly and appropriate work is shown *OR* the probability calculation is set up correctly but a minor computational error is made.

		CG	
I		245	687
		693	2500

$$E = \frac{687(693)}{2500} =$$

H_o: Level of education and news source are ind. (no assoc.)

H_a: " " " " " " are NOT ind. (is an assoc.)

$\boxed{\text{list exp. values on chart}}$

Cond: · all exp. values ≥ 5 (smallest is 41.44)

· random sample of adults in the city

$$\chi^2 = \frac{(49-65.42)^2}{65.42} + \frac{(205-254.06)^2}{254.06} + \dots + \frac{(38-77.62)^2}{77.62}$$

$$\chi^2 = 217.77$$

p-value ≈ 0

$df = (5-1)(3-1) = 8$

With a p-value of ≈ 0, this is enough evid. at any reasonable level to reject H_o. There is evid. of an assoc. between educ. achievement & primary source of news for adults in this city.

For many years, the medically accepted practice of giving aid to a person experiencing a heart attack was to have the person who placed the emergency call administer chest compression (CC) plus standard mouth-to-mouth resuscitation (MMR) to the heart attack patient until the emergency response team arrived. However, some researchers believed that CC alone would be a more effective approach.

In the 1990s a study was conducted in Seattle in which 518 cases were randomly assigned to treatments: 278 to CC plus standard MMR and 240 to CC alone. A total of 64 patients survived the heart attack: 29 in the group receiving CC plus MMR, and 35 in the group receiving CC alone.

a. Conduct a significance test to see if there is evidence to support the researchers belief that CC alone is a more effective approach.

	CC+MMR	CC only	
S	29	35	64
NS			
	278	240	518

p_M = prop. of heart attack patients who would survive using CC+MMR (old way)

p_N = " " " " " using CC alone (new way)

$H_0: p_M = p_N$ No change in effectiveness

$H_a: p_M < p_N$ new method inc. chance of survival.

$\hat{p}_M = \frac{29}{278} = .1043$

$\hat{p}_N = \frac{35}{240} = .1458$

$\hat{p}_C = \frac{64}{518} = .1236$

$z = \frac{.1043 - .1458}{\sqrt{.1236(1-.1236)\left(\frac{1}{278}+\frac{1}{240}\right)}} = -1.43$ $Pr(z < -1.43) = .0761$

cond:
- patients were randomly assigned to the 2 treatments
- $278(.1236) \geq 5$ $240(.1236) \geq 5$
  $278(1-.1236) \geq 5$ $240(1-.1236) \geq 5$
  smallest 29.664 ≥ 5

with a p-value = .0761, this is not sign. evid. at $\alpha = .05$, fail to reject H_0. There is not suff. evid. to show CC alone is more effective.

b. Interpret what this p-value measures in the context of this study.

There is a .0761 probability of randomly obtaining survival rates this diff. (or more), if there is no diff in the two methods.

c. Based on your conclusion, which type of error, Type I or Type II, could have been made? What is one potential consequence of this error?

Since I failed to reject, it's possible that H_0 was really false and I was wrong. This is a Type II error. The CC does work better alone & I didn't implement it.

d. Calculate and interpret a 95% confidence interval for this study.

$(.1043 - .1458) \pm 1.96\sqrt{\frac{.1043(1-.1043)}{278} + \frac{.1458(1-.1458)}{240}}$

$(-.0988, .0158)$

I am 95% conf. the difference in the prop. of all potential heart attack patients who would survice using CC+MMR vs. just CC is in this interval. Because 0 is included there is potentially no difference in the above population proportions.

One sample t-test for means (matched pairs)

μ_d = mean diff. in dext. scores (before - after)

$H_0: \mu_d = 0$ no improvement

$H_a: \mu_d < 0$ mean dext impr. after training

$\bar{x}_d = -.375$

$s_d = .3671$

$n = 12$

$d.f. = 11$

$t = \dfrac{-.375 - 0}{.3671/\sqrt{12}} = -3.54$

p-value $= pr(t < -3.54) = .0023$

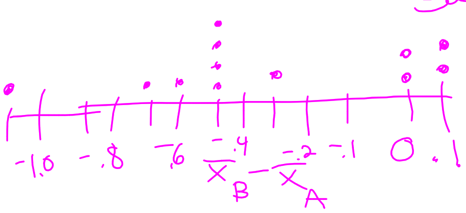
Since the p-value (.0023) is sign. at the .01 level, I reject H_0. There is evid that mean dext. does improve after training.

Cond:

$n \geq 30$

No → $12 < 30$

ok if pop. of diff in dext. is normal → safe to assume because the sample doesn't display obvious skewness or outlier



• told the 12 people are a random sample cond

✓ $77 \geq 30$

$73 \geq 30$

2 ind

random samples of heart attack patients that arrived by amb. and by self.

$$(8.3-6.04) \pm t^* \sqrt{\frac{4.3^2}{77}+\frac{5.16^2}{73}}$$

$(.229, 4.29)$

$df = 140.37$

(smaller n-1)

OR $df = 72$

(use 60 on chart)

$$(8.3-6.04) \pm 2.66\sqrt{}$$

$(.19, 4.33)$

we are 99% conf. that the true diff. in the populations' mean (amb vs. self) wait time is between .19 and 4.33 min. shorter for those who arrive by amb.

b) Since 0 is not included in this interval, (99% conf) I think there is a diff. in mean wait times

I would reject $H_0: \mu_A = \mu_S$ at the .01 level for $H_a: \mu_A \neq \mu_S$

must say one or other

a) $\left(\frac{3}{4}\right)^3 = .422$

b)

$800 + 500 = 1300(.25)$

$800 + 200 = 1000(.25)$

$800 + 100 = 900(.25)$

$0 = 0(.25)$

$= \$800$

obs	33	21	20	26	= 100
exp	25	25	25	25	

$X^2 = \frac{(33-25)^2}{25} +$

$X^2 = 4.24$

$df = 4 - 1 = 3$

p-value $= .2367$

Review B

a) $\left(\frac{3}{4}\right)^3 = .4219$

0	900	1000	1300
.25	.25	.25	.25

b) $E(x) = 0(.25) + 900(.25) + 1000(.25) + 1300(.25) = \$800$

c)

	5K	100	200	500	
obs	33	21	20	26	100
exp	25	25	25	25	100

H_0: Each of the 4 outcomes are = likely

H_a: at least one is not = likely

- all exp. values = 25 ≥ 5
- consider the 100 spins as an SRS of all possible spins.

df = 4 − 1 = 3

$\chi^2 = \frac{(33-25)^2}{25} + \frac{(21-25)^2}{25} + \cdots + \frac{(26-25)^2}{25}$

$\chi^2 = 4.24$ $\quad Pr(\chi^2 > 4.24) = .2367$ (p-value)

Because the p-value (.2367) is not sign. @ $\alpha = .10$, I fail to reject H_0.

There is not convincing evidence that the four outcomes on the wheel are not = likely.

☆ 2 - Prop (21) ⇒ ex. (MMR/CC)

☆ 2 - Means (22) (23) ⇒ ex. (AMB/SELF)

→ matched pairs ex. (Before/After diet)

☆ χ^2 - GOF (24) ⇒ $ (Skunk)

χ^2 - ind ⇒ (25) (3 - χ^2 . . .)

$$\left[\text{Num correct } (40) \; \cancel{(1/4)} \right] \times 1.25 = \underline{\quad 50 \quad}$$