# Week 4 Quiz

Quiz, 12 questions

**Congratulations! You passed!**

Next Item

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1.

Which of the following is **not** required for the distribution of the sample **proportion** to be nearly normal?

- Observations should be independent.
- Sample size should be at least 30 and the population distribution should not be extremely skewed.

**Correct**

Recognize that the Central Limit Theorem (CLT) is about the distribution of point estimates, and that given certain conditions, this distribution will be nearly normal.

- In the case of the proportion the CLT tells us that if

(1) the observations in the sample are independent,

(2) the sample size is sufficiently large (checked using the success/failure condition: $np \geq 10$ and $n(1-p) \geq 10$),

then the distribution of the sample proportion will be nearly normal, centered at the true population proportion and with a standard error of $\sqrt{\frac{p(1-p)}{n}}$.

$$\hat{p} \sim N\left(mean = p, SE = \sqrt{\frac{p(1-p)}{n}}\right)$$

When considering the distribution of the sample proportion, we don't have a requirement of $n \geq 30$. To determine if the sample size of categorical data is high enough, we instead check the success-failure condition.

- There should be at least 10 failures.
- There should be at least 10 successes.

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2.

When performing a hypothesis test on proportions (either where $H_0 : p = p_0$ or where $H_0 : p_1 = p_2$) you should use the **observed** number of successes and failures when checking conditions.

- True

**This should not be selected**

For confidence intervals use $\hat{p}$ (observed sample proportion) when calculating the standard error and checking the success/failure condition. For hypothesis tests use $p_0$ (null value) when calculating the standard error and checking the success/failure condition.

Use the observed number of successes and failures when calculating a confidence interval for a proportion, but not when doing a hypothesis test. In a hypothesis test for a proportion, you should use $np_0$ and $n(1 - p_0)$ successes and failures; that is, the expected number based on the **null proportion**.

- False
- Depends on the context
- Observed proportion for one sample, expected proportion for two samples.

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3.

Scientists researching the effect of dietary supplements such as multivitamins and supplements of folic acid, magnesium or zinc on the health of elderly women followed 38,772 women, whose average age was 62 at the start of the study, over a period of 19 years and recorded the death rates of those who did and did not use dietary supplements. The researchers found that women using supplements were more likely than women who did not to have died during that period. Write the hypotheses for testing if the death rate of elderly women who use dietary supplements is different than the death rate of elderly women who do not use dietary supplements.

- $H_0: p_{used} = p_{not}$ ; $H_A: p_{used} > p_{not}$
- $H_0: \hat{p}_{used} = \hat{p}_{not}$; $H_A: \hat{p}_{used} \neq \hat{p}_{not}$
- $H_0: p_{used} = p_{not}$; $H_A: p_{used} \neq p_{not}$

**Correct**

This question revisits the setup of hypothesis testing within the categorical data / proportions.

- $H_0: \mu_{used} = \mu_{not}$; $H_A: \mu_{used} \neq \mu_{not}$

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4.

You and a friend are about to visit the aviary at the local zoo for the first time. A trustworthy zookeeper says the aviary holds about 3,000 birds. Your friend read somewhere that 10% of those birds are cardinals, but he thinks there are really more cardinals than that. You're both great at identifying cardinals so you decide to test this claim with a hypothesis test on the true proportion $p$ of cardinals in the aviary. You walk around the aviary together and get a simple random sample by spotting 250 birds. Of these, 35 were cardinals and 215 were not cardinals. The p-value is 0.0175. Which of the following is **false**?

- If in fact 10% of the birds in the aviary are cardinals, the probability of obtaining a random sample of 250 birds where exactly 14% are cardinals is 0.0175.

**Correct**

p-value = P(observed or more extreme test statistic | $H_0$ true)

- $H_0 : p = 0.10$
- $\hat{p} = 0.14$
- The success-failure condition is met.

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5.

Gallup conducts an annual poll of U.S. residents. Approximately 1,000 residents across all 50 states and Washington D.C. are asked "Do you believe the use of marijuana should be made legal?" The distribution of responses by date of survey is shown in the table below. Imagine a hypothesis test evaluating whether there is a difference from 2012 to 2013 between proportions of "yes" responses. Using the information in the table below, calculate the standard error for this hypothesis test. Choose the closest answer.

| | | *time of survey* | |
|---|---|---|---|
| | | Nov 2012 | October 2013 |
| *response* | yes | 493 | 596 |
| | no | 514 | 401 |
| | undecided | 30 | 31 |
| | total | 1037 | 1028 |

- 0.5274
- 0.00048
- 0.5798
- 0.022

**Correct**

First calculate

$\hat{p}_{\text{pool}}$

$= \frac{493 + 596}{1037 + 1028} \approx 0.53$

Then $SE =$

$$\sqrt{\frac{0.53 \times (1-0.53)}{1037} + \frac{0.53 \times (1-0.53)}{1028}}$$

$= 0.022$

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6.

"In statistical inference for proportions, standard error (SE) is calculated differently for hypothesis tests and confidence intervals." Which of the following is the **best** justification for this statement?

- Because in hypothesis testing we're interested in the variability of the true population distribution, and in confidence intervals we're interested in the variability of the sampling distribution.
- Because if we used the same method for hypothesis tests as we did for confidence intervals, the calculation would be impossible.
- Because statistics is full of arbitrary formulas.
- Because in hypothesis testing, we assume the null hypothesis is true, hence we calculate SE using the null value of the parameter. In confidence intervals, there is no null value, hence we use the sample proportion(s).

**Correct**

The question refers to the following learning objective(s):

Note that the reason for the difference in calculations of standard error is the same as in the case of the single proportion: when the null hypothesis claims that the two population proportions are equal, we need to take that into consideration when calculating the standard error for the hypothesis test, and use a common proportion for both samples.

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7.

An introductory stats professor hypothesizes that 50% of students learn best by watching the videos, 10% by reading the book, 20% by solving questions, and the rest from the discussion forums. She surveys a random sample of a large sample of students asking them how they learn best, and wants to use these data to evaluate her hypothesis. Which method should she use?

- $\chi^2$ test of independence
- Z-test
- F-test
- $\chi^2$ test of goodness of fit

**Correct**

The question refers to the following learning objective(s):

- Use a chi-square test of goodness of fit to evaluate if the distribution of levels of a single categorical variable follows a hypothesized distribution.
- When evaluating the independence of two categorical variables where at least one has more than two levels, use a chi-square test of independence.

- hypothesis test for a single mean
- ANOVA
- t-test

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8.

A report on your local TV news station claims that 60% of the city's residents support using limited city funds to hire and train more police officers. A second local news station has picked up this story, and they claim that certainly less than 60% of residents support the additional hiring. In order to test this claim the second news station takes a random sample of 100 residents and finds that 56 of them (56%) support the use of limited funds to hire additional police officers. Which of the following is the correct set-up for calculating the p-value for this test?

- Roll a 10-sided die 100 times and record the proportion of times you get a 6 or lower. Repeat this many times, and calculate the number of simulations where the sample proportion is 56% or less.

- In a bag place 100 chips, 56 red and 44 blue. Randomly sample 100 chips, with replacement, and record the proportion of red chips in the sample. Repeat this many times, and calculate the proportion of samples where at least 60% of the chips are red.

**This should not be selected**

The question refers to the following learning objective(s):

In hypothesis testing for one categorical variable, generate simulated samples based on the null hypothesis, and then calculate the number of samples that are at least as extreme as the observed data.

The chips in the bag should represent the null hypothesis (60% red chips) rather than the observed data (56% red chips).

- Randomly sample 100 residents of a nearby city, and record the number of residents in the sample who support the hiring of additional police officers. Repeat this many times and calculate the proportion of samples where at least 56% of the residents support the hiring.

- Roll a 10-sided die 100 times and record the proportion of times you get a 6 or lower. Repeat this many times,

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9.

One of the early studies linking smoking and lung cancer compared patients hospitalized with lung cancer to similar patients without lung cancer (hospitalized for other reasons), and recorded whether each patient smoked. For a hypothesis test testing whether the proportion of smokers is higher for the patients with lung cancer than for patients without lung cancer, the p-value is less than 0.000001. Does this provide significant evidence that smoking causes lung cancer?

| | | *smoking status* | | |
|---|---|---|---|---|
| | | smoker | non-smoker | total |
| *cancer* | lung cancer | 647 | 2 | 649 |
| | not sure | 622 | 27 | 649 |
| | total | 1269 | 29 | 1298 |

Study reference: Doll, R. & Hill, A.B. (1950) "Smoking and carcinoma of the lung: preliminary report", *British Medical Journal.*

- ◯ Based on this study we cannot conclude that smoking causes lung cancer,

  regardless of the p-value.

**Correct**

These data was not (and could not have ethically been!) collected through a controlled experiment; therefore no causal statements can be made using the study. Recall that a controlled experiment (as opposed to an observational study) is needed in order to determine causality.

- ◯ Yes, with the given p-value we would reject H0 in favor of HA, and conclude that smoking causes lung cancer.
- ◯ No, with the given p-value we would fail to reject H0 in favor of HA.
- ◯ Whether or not we can conclude that smoking causes lung cancer depends on the statistical method the researchers used to obtain the p-value.

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10.

Suppose in a population 20% of people wear contact lenses. What is the expected shape of the sampling distribution of proportion of contact lens wearers in random samples of 30 people from this population?

- left-skewed
- uniform
- nearly normal
- right-skewed

**Correct**

The question refers to the following learning objective(s):

Note that if the CLT doesn't apply and the sample proportion is low (close to 0) the sampling distribution will likely be right skewed, if the sample proportion is high (close to 1) the sampling distribution will likely be left skewed.

S-F condition not met, and the true population is closer to 0 than 1, so the sampling distribution will be right skewed.

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11.

At a stop sign, some drivers come to a full stop, some come to a 'rolling stop' (not a full stop, but slow down), and some do not stop at all. We would like to test if there is an association between gender and type of stop (full, rolling, or no stop). We collect data by standing a few feet from a stop sign and taking note of type of stop and the gender of the driver. Below is a contingency table summarizing the data we collected. If gender is not associated with type of stop, how many males would we expect to not stop at all? Choose the closest answer.

| | | *gender* | |
|---|---|---|---|
| | | female | male |
| *stop* | full stop | 6 | 6 |
| | rolling stop | 16 | 15 |
| | no stop | 4 | 3 |

- 5.76
- 3.64
- 3.36

**Correct**

Calculate expected counts in two-way tables as

$$E = \frac{rowtotal \times columntotal}{grandtotal}$$

- 6.24

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12.

Does Weight Watchers work? Researchers randomly divided 500 people into two equal-sized groups. One group spent 6 months on the Weight Watchers program. The other group received a pamphlet about controlling portion sizes. At the end of the study 35% of the subjects in the pamphlet group and 55% of the subjects in the Weight Watchers group had lost at least 10 pounds. To test whether Weight Watchers is more effective for weight loss than pamphlets, a statistician used an index card to represent each subject in the study and wrote whether or not the subject lost at least 10 pounds on the index card. He then shuffled these cards together, and dealt them into two equal-sized groups. Which of the following best describes the expected result?

- If Weight Watchers was effective, the difference between the proportions of cards indicating whether or not the subject lost at least 10 pounds will be more than 20%.
- The difference between the proportions of cards indicating whether or not the subject lost at least 10 pounds will be about 20%.
- The difference between the proportions of cards indicating whether or not the subject lost at least 10 pounds will be about 0.

**Correct**

The question refers to the following learning objective(s):

Use simulation methods when sample size conditions aren't met for inference for categorical variables.

- Note that the $t$-distribution is only appropriate to use for means. When sample size isn't sufficiently large, and the parameter of interest is a proportion or a difference between two proportions, we need to use simulation.

In hypothesis testing

- for one categorical variable, generate simulated samples based on the null hypothesis, and then calculate the number of samples that are at least as extreme as the observed data

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