

10.1.1: Exercises

1. The proportion of smokers among persons who graduated from a four-year university has been widely reported as 22%. A sociologist student wonders if this is still true. They randomly sample 785 four-year university graduates and finds that 157 are smokers. We test their claim at a 5% level of significance. The beginning of the solution is shown below.

Step 1: p represents the proportion of four-year university graduates who are smokers.

$$H_0 : p = 0.22$$

$$H_a : p \neq 0.22$$

We perform a two-tailed test since there is a not equal to symbol in the alternative hypothesis.

Step 2: There are $785(0.22)=172.7$ expected successes in the sample and $785-172.7=612.3$ expected failures in the sample. These are greater than or equal to 10 expected successes and failures in the sample so the sampling distribution of sample proportions is approximately normal.

$$\hat{p} = \frac{157}{785} = 0.2$$

$$\text{Step 3: } Z = \frac{0.2 - 0.22}{\sqrt{\frac{0.22(1 - 0.22)}{785}}} \approx -1.35271$$

- a. Use the normal distribution to compute the P-value.
- b. Use the Chi-Square distribution to compute the P-value (Use this desmos graph, <https://www.desmos.com/calculator/bjohldwaym>, to compute the P-value). Remember the test statistic here is the Z-score squared.
- c. What is the benefit of using the Chi-Square distribution instead of the normal distribution?
- d. What are the limitations of using the Chi-Square distribution instead of the normal distribution?

2. In 2022, Governor Ron DeSantis signed a bill into law prohibiting critical race theory from being taught in public schools. A random survey of 300 people found that 183 believe that critical race theory should be a part of public school curricula and the rest (117 people) did not. We will test the claim that the proportion of people in support of critical race theory being included in curricula is different from the proportion who are not in support. Use a 5% level of significance.

a. The outcome for each of the trials (a randomly selected person) above is the support or non-support of critical race theory being a part of public school curricula. How many possible outcomes (k) are there per trial?

b. What are the hypothetical proportions for each outcome (to be used in the null hypothesis)?

$H_0 :$

$p_1 =$ (The proportion that supports)

$p_2 =$ (The proportion that does not support)

c. Express the alternative hypothesis in a sentence (do not use mathematical symbolism).

$H_a :$

d. Fill in the expected counts in the table below:

	Observed Counts	Expected Counts
Support	183	
Does not support	117	

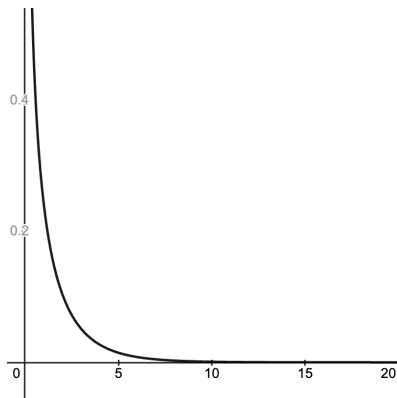
e. Can we use the Chi-Square distribution? Explain.

f. How many degrees of freedom?

g. Compute the test statistic $\chi^2 = \sum \frac{(O-E)^2}{E}$ using the table below:

	Observed Counts O	Expected Counts E	$\frac{(O-E)^2}{E}$
Support	183	150	
Does not support	117	150	
Total:			$\chi^2 =$

h. Below is a desmos graph of the Chi-Square distribution. Label the test statistic and shade the area that represents the P-value.



Images are created with the graphing calculator, used with permission from Desmos Studio PBC.

i. Use this desmos graph, <https://www.desmos.com/calculator/bjohldwaym>, to compute the P-value.

j. What conclusions can we make about the null and alternative hypothesis?

k. Write a conclusion in context.

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