Introduction to Significance Tests

April 8th, 2020

Objectives:

- Review the purpose of a confidence interval
- Understand the purpose of a significance test
- Get a “big picture” overview of what the 4-Step Process for conducting a Significance Test looks like

**The purpose of this lesson is to provide an introduction/overview of the unit. The following lessons will give a more in-depth look at the basics for constructing a significance test.

Review Questions:

1. When constructing a confidence interval, what information do you need to know?

2. What is the purpose of constructing a confidence interval?

Review Question Answers:

1. To construct a confidence interval you need a statistic, usually a sample proportion (or sample mean) from a given population. You also need a confidence level. If one is not given, you can default to a 95% confidence level. As long as you verify that the three conditions (random, normal, independent) are met you can proceed with calculating the confidence interval.
2. Your confidence interval tells you a range of values that the population parameter (usually population proportion or mean) might be within. In other words, your confidence interval allows you to estimate a population parameter.

Confidence Intervals vs. Significance Tests

Confidence Intervals - the population parameter is NOT known so your goal is to construct an interval of values that will estimate the population parameter

Significance Tests - a claim about a population parameter is given upfront and your goal is to assess (using data) whether or not the claim is true.

Activity: Virtual Basketball Player's Claim

<u>The Claim</u>: A basketball player claims that he makes 80% of his free throws.

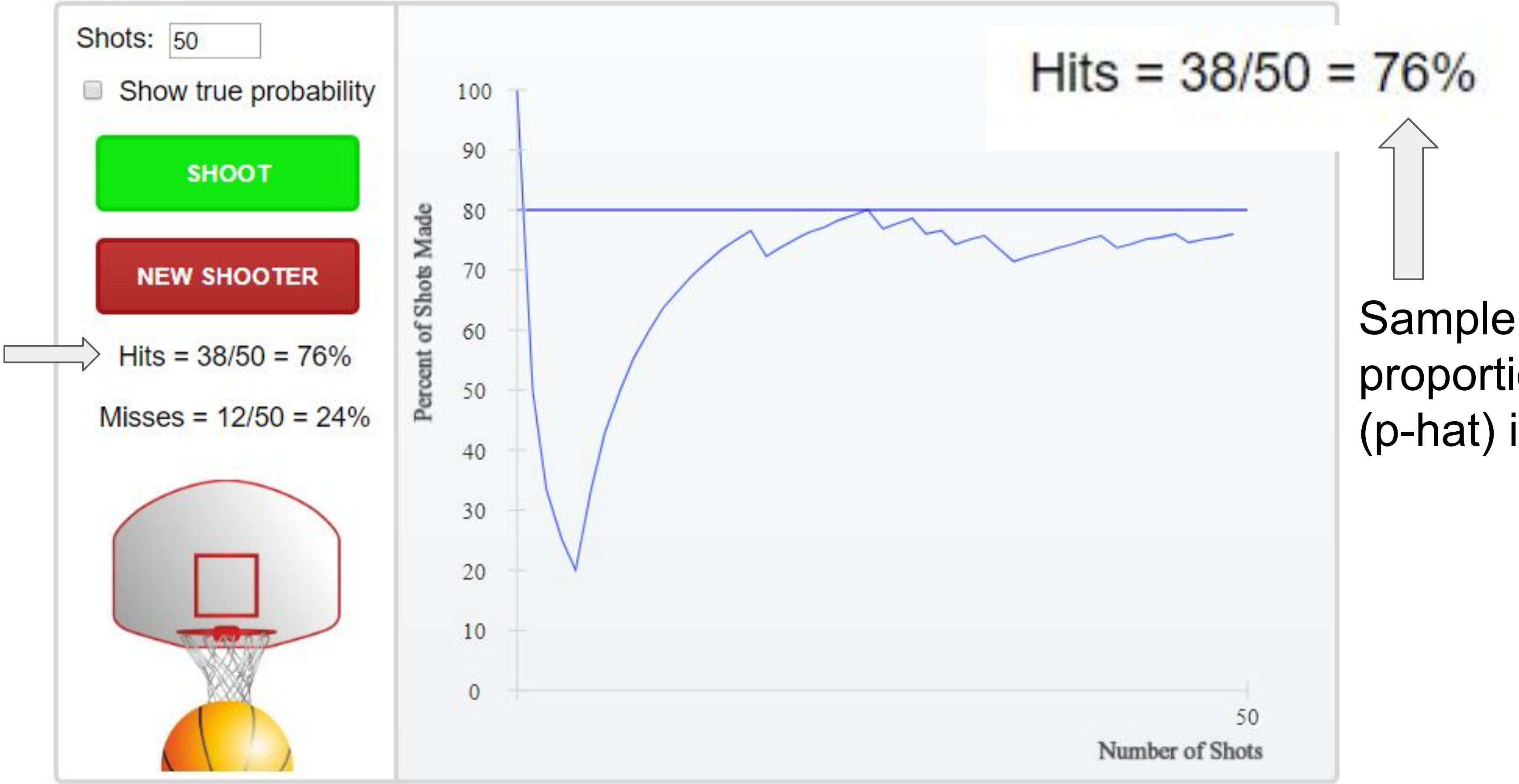
You think that he is exaggerating.

<u>Testing the Claim:</u> First we need a statistic. To collect some data, we are going to have the basketball player complete a SRS of 50 free throws using a simulation app.

<u>Next Steps</u>: We will use the player's sample proportion from his sample of 50 free throws to statistically determine if his claim is valid.

Notes over the entire activity can be found here. This will be a helpful reference as you continue looking over these slides and also as you continue learning about this chapter.

SRS of 50 Free Throws



Sample proportion (p-hat) is .76

Significance Test Step 1: **State the Problem**

State	
State	The basketball player claims he makes 80% of free throws. We write the claim as the ***null hypothesis, H_0***. $H_0: \quad p = .80$ → the claim, we always assume this is true at first We believe he is exaggerating. We write this as the ***alternative hypothesis, H_a***. $H_a: \quad p < .80$ → what we hope to find evidence to conclude Define p as the true proportion of free throws the player can make. We will use a ***significance level*** of $\alpha = .05$

Significance Test Step 2: **PLAN**

Plan

Inference Method: **One-Sample Z Test for a Proportion**

- *Random* We can view this set of 50 shots as a simple random sample from the population of all possible shots that the virtual shooter takes.
- *Normal* Assuming H_0 is true, $p = 0.80$. Then $np = (50)(0.80) = 40$ and $n(1 - p) = (50)(0.20) = 10$ are both at least 10, so the Normal condition is met.
- *Independent* The outcome of each shot is determined by the computer's random number generator, so individual observations are independent. We're not sampling without replacement from a finite population (since the applet can keep on shooting), so we don't need to check the *10% condition*.

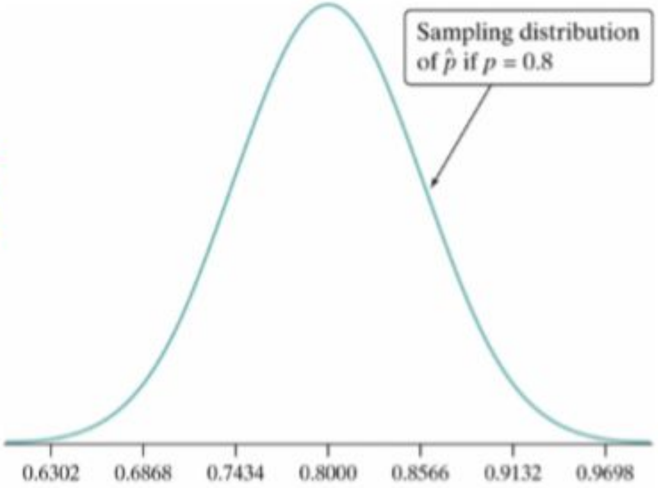
Significance Test Step 3: **DO**

If the null hypothesis is true and H_0: $p = .80$, then the player's sample proportion $\hat{p}$ of made free throws in a SRS of 50 should vary with an approximately normal **sampling distribution** with

Mean $\mu_{\hat{p}} =$ 0.80

Standard Deviation $\sigma_{\hat{p}} = \sqrt{\frac{(0.8)(0.2)}{50}}$

$= 0.0566$



Significance Test Step 3: **DO**

We need to assess how far the statistic $\hat{p}$ is from the claimed parameter $p = .80$, so we must standardize or find how many standard deviations the sample proportion is from the claimed proportion. This standardized value is called the **test statistic**.

$$\text{Standardized test statistic: } \frac{\text{statistic} - \text{parameter}}{\text{standard deviation of statistic}}$$

z

This process is very similar to finding a z-score

Significance Test Step 3: **DO**

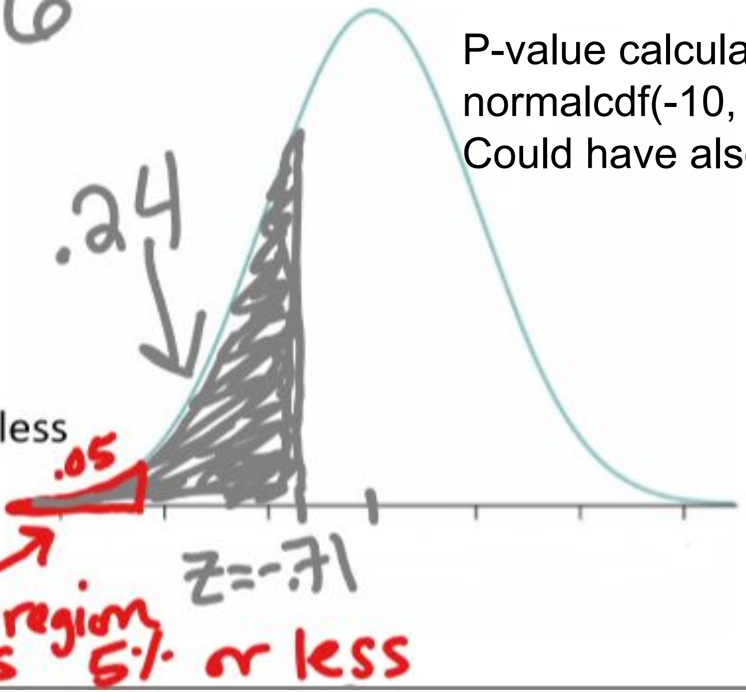
Test statistic = $\frac{(.76 - .80)}{.0566} = -.71$

z

P-value = .24

Assuming the H_0 is true and the player makes 80% of his free throws, the probability that he would make 38 or less out of 50 free throws is 24%

Significance Level: $\alpha = .05$



P-value calculated using normalcdf(-10, -.71)
Could have also used Table A

Significance Test Step 4: **Conclude**

Conclude

Since the p-value .24 is greater than the significance level of $\alpha = .05$, then we Fail to Reject the H_0.

Explain what this means in context.

This means there is not enough statistical evidence to reject the basketball player's claim that he makes 80% of his free throw shots.

Notes about the Conclusion

Reject H_0	When the **p-value is really small (less than α)**, you **REJECT the null hypothesis H_0**. This means there is *statistically significant* evidence against the claim, H_0, and in favor of the alternative hypothesis, H_a.
Fail to Reject H_0	When the **p-value is greater than or equal to α**, you **FAIL TO REJECT the null hypothesis H_0**. This means there is not enough evidence to reject the claim, H_0.

must use this language!

Never say you "accept" the Ho

Practice #1

Let's pretend that the basketball player actually made 32 out of 50 free throw shots.

That would make his sample proportion (p-hat) = .64

Calculate the **test statistic** and the **p-value** using this new sample proportion.

Practice #1 Answer

Test statistic = (.64 - .80)/.0566 = -2.83

P-Value = normalcdf(-10, -2.83) = .0023

**you could've also calculated the p-value with your z distribution table (Table A)

Practice #2

Since the p-value in practice #1 was .0023. What would the conclusion be?

Practice #2 Answer

Conclusion:

Since the p-value of .0023 is less than the significance level alpha=.05, then we can REJECT the null hypothesis. This means there is statistically significant evidence against the basketball player's claim that he can make 80% of his free throws. Therefore, we can conclude the alternative hypothesis, that the basketball player is exaggerating.

Practice #3

Which of the following conclusions are correctly written?

- Since the p-value .24 is greater than the the significance level alpha=.05, we can accept the null hypothesis.
- Since the p-value .24 is greater than the the significance level alpha=.05, we fail to reject the null hypothesis

Practice #3 Answer

The second sentence is correct. You NEVER “accept” the null hypothesis, you only REJECT or FAIL to REJECT the null hypothesis.