Significance Tests on a Proportion: The 4-Step Process

April 10th, 2020

Objectives:

- Students will be able to follow the 4-Step Process for one-sided significance tests on a proportion.
- Students will learn how to use their graphing calculator to do a One Proportion Z Test.

Review #1:

Explain what is wrong in the hypotheses in the problem below. Then write the correct hypotheses.

Better parking A change is made that should improve student satisfaction with the parking situation at a local high school. Right now, 37% of students approve of the parking that's provided. The null hypothesis H_0: $p > 0.37$ is tested against the alternative H_a: $p = 0.37$.

Review #1 Answer:

Remember that the null hypothesis (first statement) is always the "statement of no difference" which means it will always have an equal sign.

Correct Answer

The alternative hypothesis gives the current situation rather than what we are looking for evidence for. H_0: $p = 0.37$; H_a: $p > 0.37$.

Review #2:

T9.1. An opinion poll asks a random sample of adults whether they favor banning ownership of handguns by private citizens. A commentator believes that more than half of all adults favor such a ban. The null and alternative hypotheses you would use to test this claim are

(a) $H_0: \hat{p} = 0.5$; $H_a: \hat{p} > 0.5$

(b) H_0: $p = 0.5$; H_a: $p > 0.5$

(c) H_0: $p = 0.5$; H_a: $p < 0.5$

(d) H_0: $p = 0.5$; H_a: $p \neq 0.5$

(e) H_0: $p > 0.5$; H_a: $p = 0.5$

Review #2 Answer:

T9.1. An opinion poll asks a random sample of adults whether they favor banning ownership of handguns by private citizens. A commentator believes that more than half of all adults favor such a ban. The null and alternative hypotheses you would use to test this claim are

(a) $H_0: \hat{p} = 0.5; H_a: \hat{p} > 0.5$

Always use parameter notation in the hypotheses!

(b) H_0: $p = 0.5$; H_a: $p > 0.5$

B is the correct answer

(c) H_0: $p = 0.5$; H_a: $p < 0.5$

(d) H_0: $p = 0.5$; H_a: $p \neq 0.5$

(e) H_0: $p > 0.5$; H_a: $p = 0.5$

Equal sign only belongs in the first statement (null hypothesis)

Significance Tests: A Four-Step Process

State: What *hypotheses* do you want to test, and at what significance level? Define any *parameters* you use.

Plan: Choose the appropriate inference *method*. Check *conditions*.

Do: If the conditions are met, perform *calculations*.

- Compute the **test statistic**.
- Find the ***P*-value**.

Conclude: *Interpret* the results of your test in the context of the problem.

Example: *One Potato, Two Potato*

The potato-chip producer of **Section 9.1** has just received a truckload of potatoes from its main supplier. Recall that if the producer determines that more than 8% of the potatoes in the shipment have blemishes, the truck will be sent away to get another load from the supplier. A supervisor selects a random sample of 500 potatoes from the truck. An inspection reveals that 47 of the potatoes have blemishes. Carry out a significance test at the $\alpha = 0.10$ significance level. What should the producer conclude?

Example: *One Potato, Two Potato*

State: What *hypotheses* do you want to test, and at what significance level? Define any *parameters* you use.

STATE: We want to perform a test at the $\alpha = 0.10$ significance level of

$$H_0: p = 0.08$$
$$H_a: p > 0.08$$

where *p* is the actual proportion of potatoes in this shipment with blemishes.

Example: *One Potato, Two Potato*

Plan: Choose the appropriate inference *method*. Check *conditions*.

PLAN: If conditions are met, we should do a one-sample z test for the population proportion p.

- ***Random*** The supervisor took a random sample of 500 potatoes from the shipment.
- ***Normal*** Assuming H_0: $p = 0.08$ is true, the expected numbers of blemished and unblemished potatoes are $np_0 = 500(0.08) = 40$ and $n(1 - p_0) = 500(0.92) = 460$, respectively. Because both of these values are at least 10, we should be safe doing Normal calculations.
- ***Independent*** Because we are sampling without replacement, we need to check the *10% condition*. It seems reasonable to assume that there are at least $10(500) = 5000$ potatoes in the shipment.

Example: *One Potato, Two Potato*

Do: If the conditions are met, perform *calculations*.

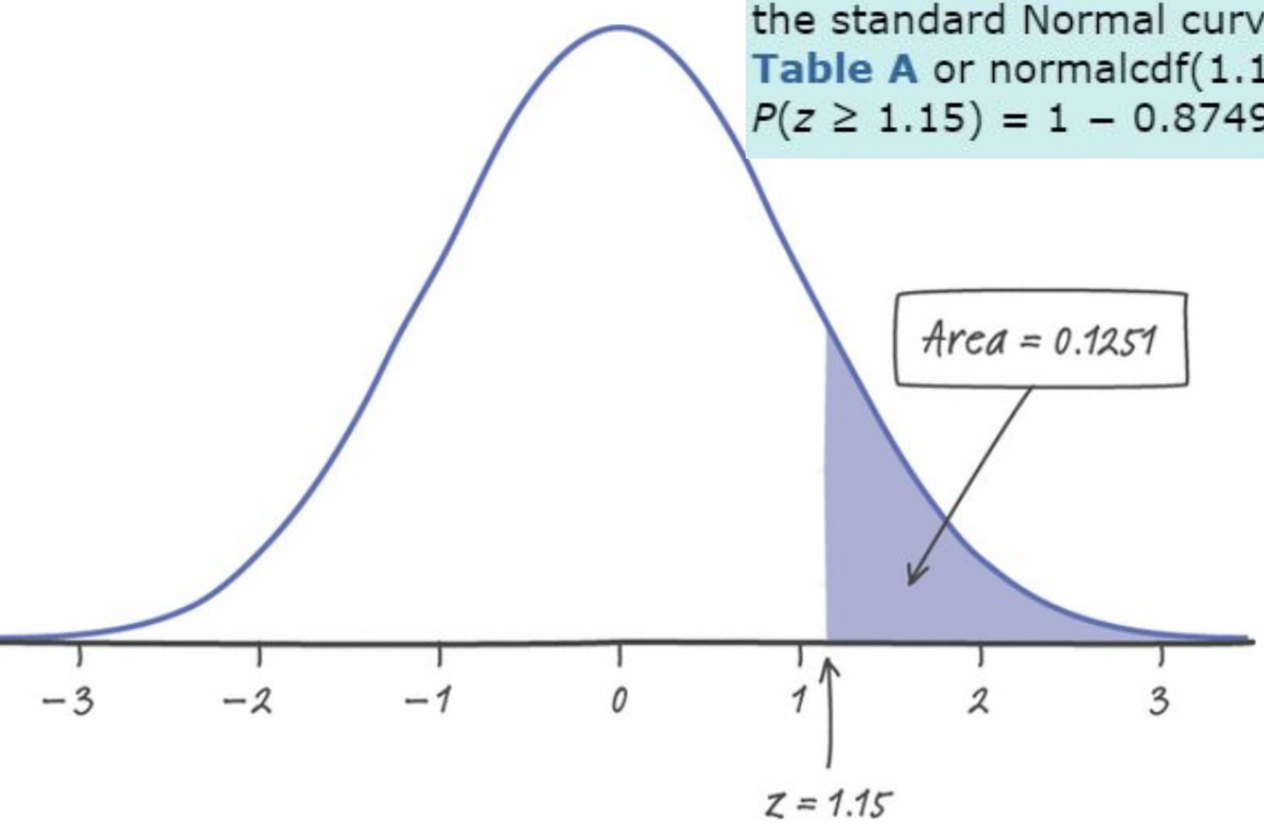
- Compute the **test statistic**.
- Find the ***P*-value**.

DO: The sample proportion of blemished potatoes is $\hat{p} = 47/500 = 0.094$

- Test statistic $z = \dfrac{\hat{p} - p_0}{\sqrt{\dfrac{p_0(1-p_0)}{n}}} = \dfrac{0.094 - 0.08}{\sqrt{\dfrac{0.08(0.92)}{500}}} = 1.15$

Example: *One Potato, Two Potato*

P-value **Figure 9.7** displays the *P*-value as an area under the standard Normal curve for this one-sided test. Using **Table A** or normalcdf(1.15, 100), the desired *P*-value is $P(z \geq 1.15) = 1 - 0.8749 = 0.1251$.



Example: *One Potato, Two Potato*

Conclude: *Interpret* the results of your test in the context of the problem.

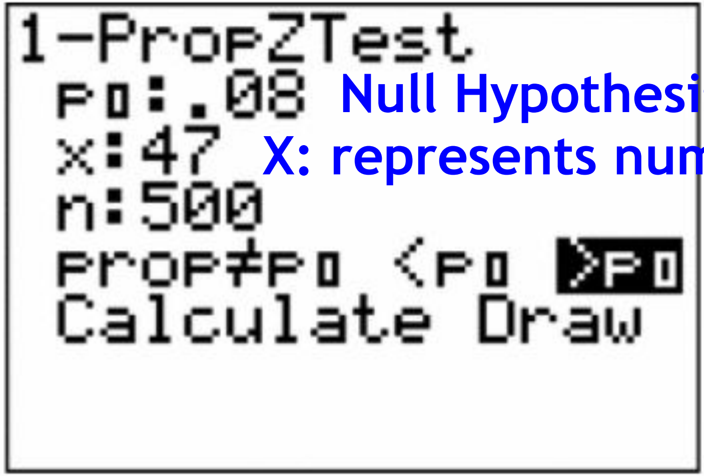
CONCLUDE: Since our *P*-value, 0.1251, is greater than the chosen significance level of $\alpha = 0.10$, we fail to reject H_0.

There is not sufficient evidence to conclude that the shipment contains more than 8% blemished potatoes. The producer will use this truckload of potatoes to make potato chips.

Check with your Graphing Calculator

TI-83/84

Press STAT, then choose TESTS and 5:1-PropZTest.



Null Hypothesis value

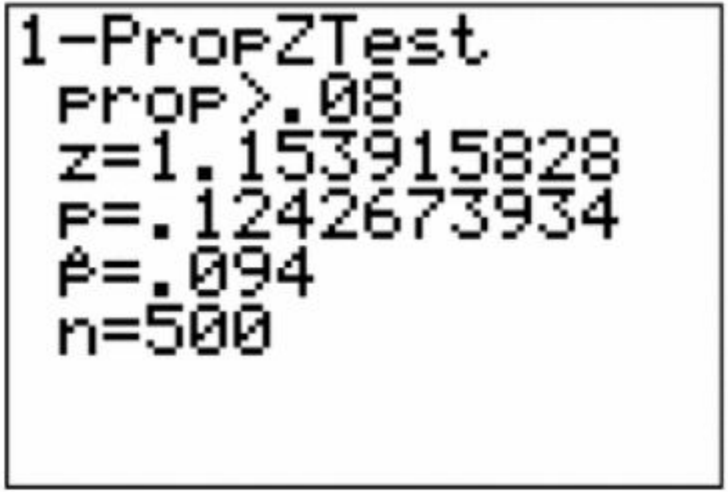
X: represents number of succe

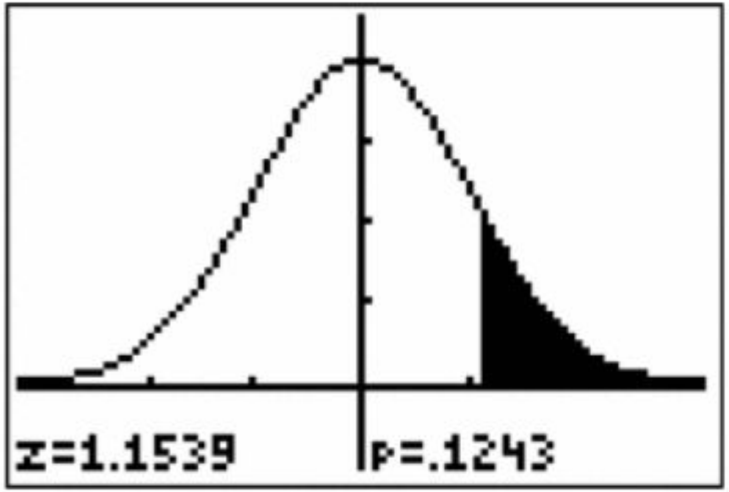
Matches the inequality in the alternative hypothesis

Check with your Graphing Calculator

If you select the "Calculate" choice and press ENTER, you will see that the test statistic is z = 1.15 and the P-value is 0.1243.

- If you select the "Draw" option, you will see the screen shown here. Compare these results with those in the example.





You Try #1: Practicing the "PLAN" Step

Check the three conditions (Random, Normal, Independent) to see if a 1 Proportion Z Test can be used.

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33. Lefties Simon reads a newspaper report claiming that 12% of all adults in the United States are left-handed. He wonders if 12% of the students at his large public high school are left-handed. Simon chooses an SRS of 100 students and records whether each student is rightor left-handed.

You Try #1 Answer:

All conditions are met!

Random: The sample was randomly selected. *Normal:* The expected numbers of successes (12) and failures (88) are at least 10. *Independent:* It is very likely that there are more than 10(100) = 1000 students in the population.

You Try #2: Practicing the “Do” Step

37. Lefties Refer to **ExerciseÂ 33**. In Simon’s SRS, 16 of the students were left-handed.

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(a) Calculate the test statistic.

(b) Find the *P*-value using **Table A**. Show this result as an area under a standard Normal curve.

Link to a Z Distribution table you can use.

You can also use normalcdf(lowerbound, upperbound) on your TI-84.

Or you can use the 1PropZTest that you learned about on slides 14-15.

You Try #2 Answer

(a) $z = 1.23$ **(b)** 0.2186

You Try #3: The 4-Step Process

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41. Better parking A local high school makes a change that should improve student satisfaction with the parking situation. Before the change, 37% of the school's students approved of the parking that was provided. After the change, the principal surveys an SRS of 200 of the over 2500 students at the school. In all, 83 students say that they approve of the new parking arrangement. The principal cites this as evidence that the change was effective. Perform a test of the principal's claim at the $\alpha = 0.05$ significance level.

You Try #3 Answer:

State: H_0: $p = 0.37$ versus H_a: $p > 0.37$, where p is the actual proportion of students who are satisfied with the parking situation. **Plan:** One-sample z test for p. *Random:* The sample was randomly selected. *Normal:* The expected number of successes $np_0 = 74$ and failures $n(1 - p_0) = 126$ are both at least 10. *Independent:* There were 200 in the sample, and since there are 2500 students in the population, the sample is less than 10% of the population. **Do:** $z = 1.32$, P-value = 0.0934. **Conclude:** Since our P-value is greater than 0.05, we fail to reject the null hypothesis. We do not have enough evidence to conclude that the new parking arrangement increased student satisfaction with parking at this school.

Note: **In the "Do" Step make sure you show the test statistic formula filled out with the appropriate numbers.**