$\boxed{\text{Guideline}}$ The 5-step Hyp. Test (Short Version)

Step 1 State H_0 and H_A

Step 2 Conditions Check

Step 3 Test statistic

Step 4 P-value AND decision to reject H_0 or fail to reject H_0.

Step 5 Full sentance conclusion that interprets the decision made in Step 4 in the context of the problem.

The longer version is after this page

You may use this handout on the test and final exam.

How to do a hyp. test

Step 1 Write the null and alt. hypotheses.

The hypotheses should be mathematical statements involving one of the parameters p, μ, or σ, for example. Also the null hyp (H_0) has to have the equals symbol (or $\le$ or $\ge$) in it. The alt. hyp is usually the claim given in the statement of the word problem. Also, the same number must be used in both hypotheses: for example

$H_0: p = 0.15$

$H_A: p < 0.139$ is <u>incorrect</u> because

both these numbers should be the same!

Step 1

How to translate the claim into the H_A or H_0

* Most problems have the claim as the H_A.
* The H_0 can only have one of these 3 symbols in it: $=, \leq, \geq$

(Ho always has the "equals case")

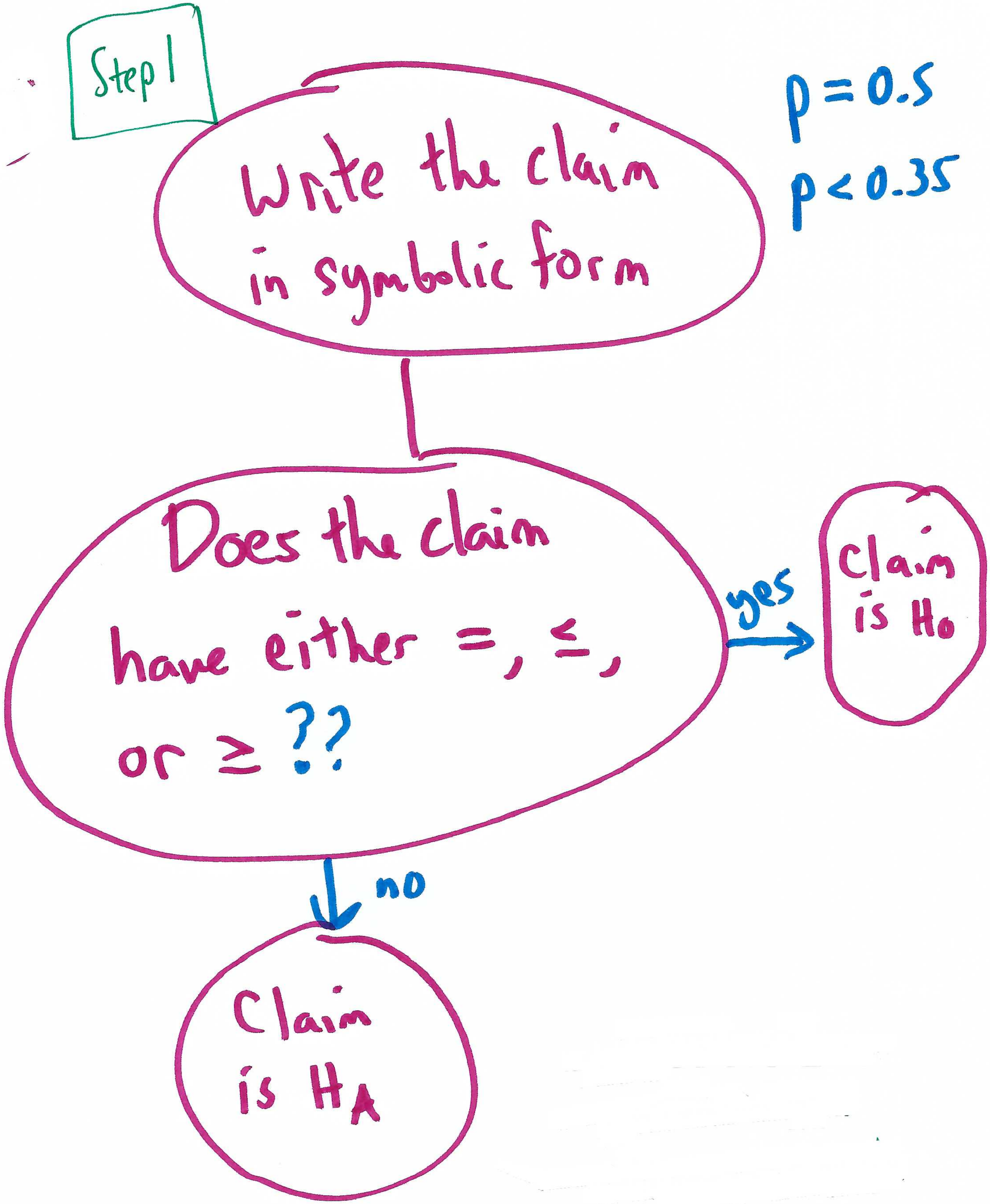
* The H_A can only have one of these 3 symbols in it: $\neq, <, >$

First,

Write the claim as a hypothesis

$(p < 0.5)$ or $(\mu < 340 \text{ min})$

Then, if the claim has $=, \leq,$ or $\geq$, it's H_0, but if it has $\neq, <$ or $>$, then your claim is H_A


Step 1
Write the claim in symbolic form
p = 0.5
p < 0.35
Does the claim have either =, ≤, or ≥??
yes
Claim is H_0
no
Claim is H_A

	Two-tailed test	Left-tailed test	Right-tail test
The null hyp, H_0	$=$	$=$ or $\geq$	$=$ or $\leq$
The Alt. hyp, H_A	$\neq$	$<$	$>$

useful in Steps 1 & 4.

How to tell if you have a left-tailed, right-tailed, or 2-tailed test.

Conditions Check

Step 2 Check to see if the sampling dist is normal. The way to do this is to check if there are at least 10 successes and 10 failures in the sample.

Another way to check this is to check if both $n \cdot p_0$ and $n \cdot (1 - p_0)$ are both ≥ 10. (where p_0 is the percent listed in Ho and H_A.)

The other condition to check is:

Is the sample random or representative of the population?

If either of the 2 conditions above are not valid (satisfied) then we cannot conduct a hyp. test!! As no meaningful result will come from doing so

(Step 2 side note)

If both conditions from step 2 are true, then we have evidence that the sampling dist. is approx. normal, and we assume the sampling dist. curve is centered at the value stated in the null hyp. Because the sample is random or representative, we will be making a valid scientific conclusion when we do the hyp test (although nothing is proven absolutely)

$\boxed{\text{Step 3}}$ Find the value of the test statistic. The test statistic is the z-score of your sample statistic, given by the formula

$$z = \frac{(\text{sample stat}) - \left(\begin{array}{c}\text{value stated} \\ \text{in the } H_0\end{array}\right)}{\left(\begin{array}{c}\text{st dev of the sampling} \\ \text{distribution.}\end{array}\right)}$$

Step 4 Find the p-value, and use the p-value to make a decision as to whether or not to reject H_0.

$$\boxed{\begin{array}{l}\text{If the p-value} \le \alpha\text{, reject } H_0\\ \text{If the p-val} > \alpha\text{, fail to reject } H_0.\end{array}}$$

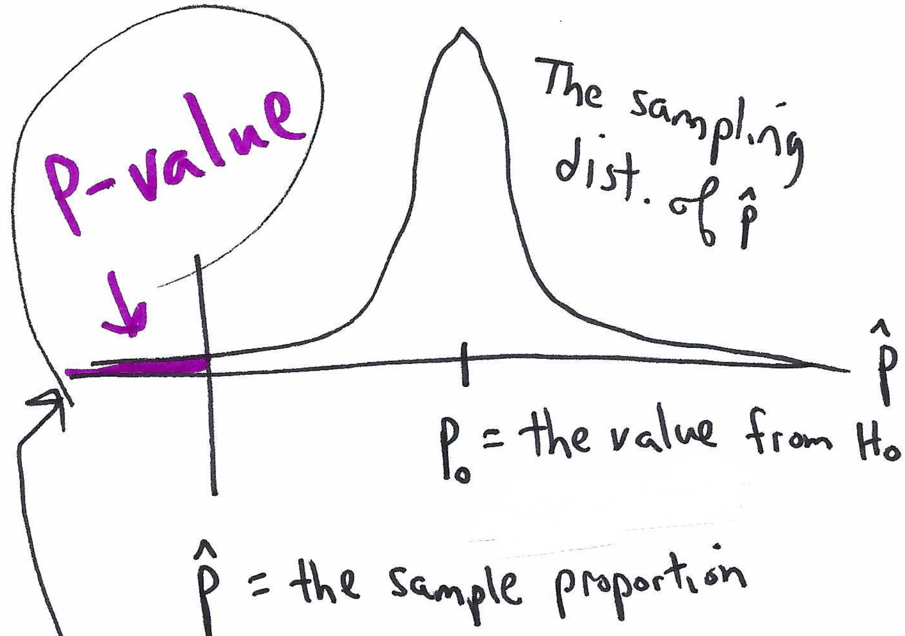
Case 1 (Left-tailed test)

If the H_A has a less than symbol, then you have a left-tailed test AND the p-value is the prob. of getting a sample statistic < the one we got, assuming H_0 is correct.

Moreover, the p-value is also equal to the prob. that $Z <$ test statistic. In this case the p-val is the area under the sampling dist. graph that is <u>left</u> of $\hat{p}$, or equivalently, the area under the standard normal distribution that is <u>left</u> of the test statistic

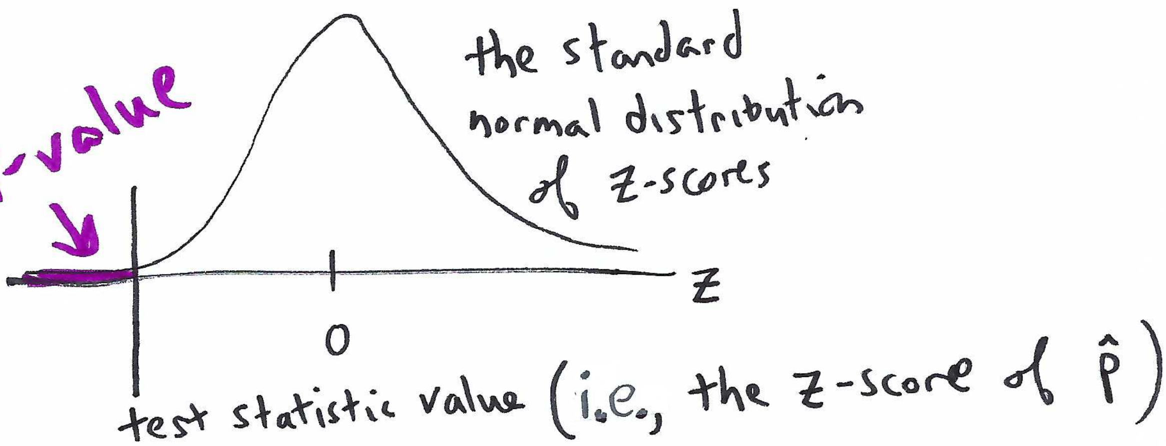
Case 1 (Left-tailed test) Step 4 (Continued)

Here is a picture of the p-value for the left-tailed test.



The p-value = $P\left(\hat{p} < \text{the sample proportion}, \text{ assuming } H_0 \text{ is correct}\right)$

The p-value is also equal to $P(Z < \text{the test statistic})$



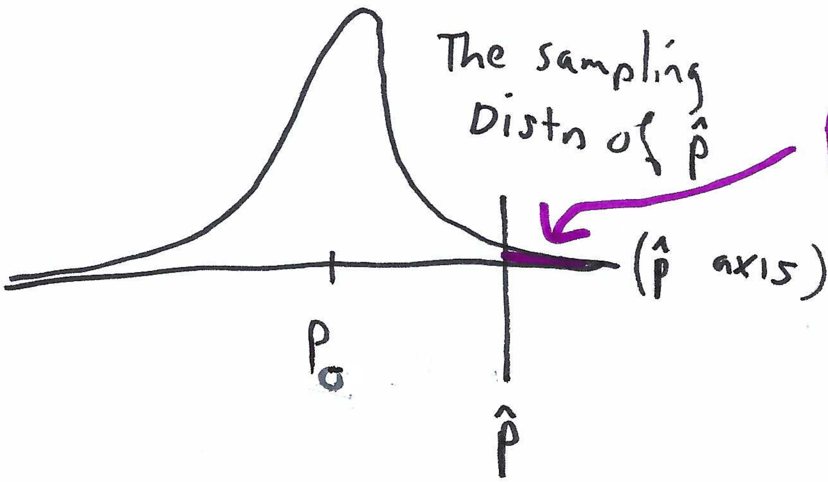
Step 4 | Case 2 (the right-tailed test)

If the H_A has a greater than symbol, then you have a right-tailed test. The p-value is then the probability of getting a sample statistic greater than the one we got, assuming H_0 is correct. Moreover, the p-value is also equal to the probability that $Z >$ the test statistic.

In this case, the p-val is the area under the sampling dist. graph that is <u>right</u> of $\hat{p}$, or equivalently, the area under the standard normal dist. that is <u>right</u> of the test statistic

Case 2 (Right-tailed test) (Step 4 Continued)

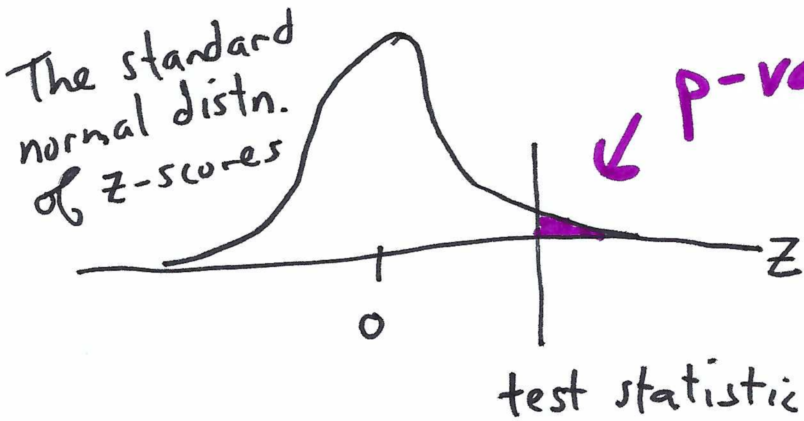
Here is a picture of the p-value for the right-tailed test.



(p_0 = the value from H_0)

The p-value = P($\hat{p}$ > the sample proportion, assuming H_0 is correct)

The p-value is also equal to P(z > the test statistic)



Step 4 — Case 3: the 2-tailed test

If the H_A has the $\neq$ symbol, then you have a 2-tailed test. There are 2 types of two tailed tests:

(1) When the sample statistic is left of the center of the sampling distr., or equivalently, when the test statistic is negative, AND

(2) When the sample statistic is right of the center of the sampling distn., or equivalently, when the test statistic is positive.

(1) The p-value $= 2 \cdot P\left(\hat{p} < \text{the sample proportion, assuming } H_0 \text{ is correct}\right)$

$= 2 \cdot P\left(z < \text{the test statistic}\right)$

(2) The p-value $= 2 \cdot P\left(\hat{p} > \text{the sample proportion, assuming } H_0 \text{ is correct}\right)$

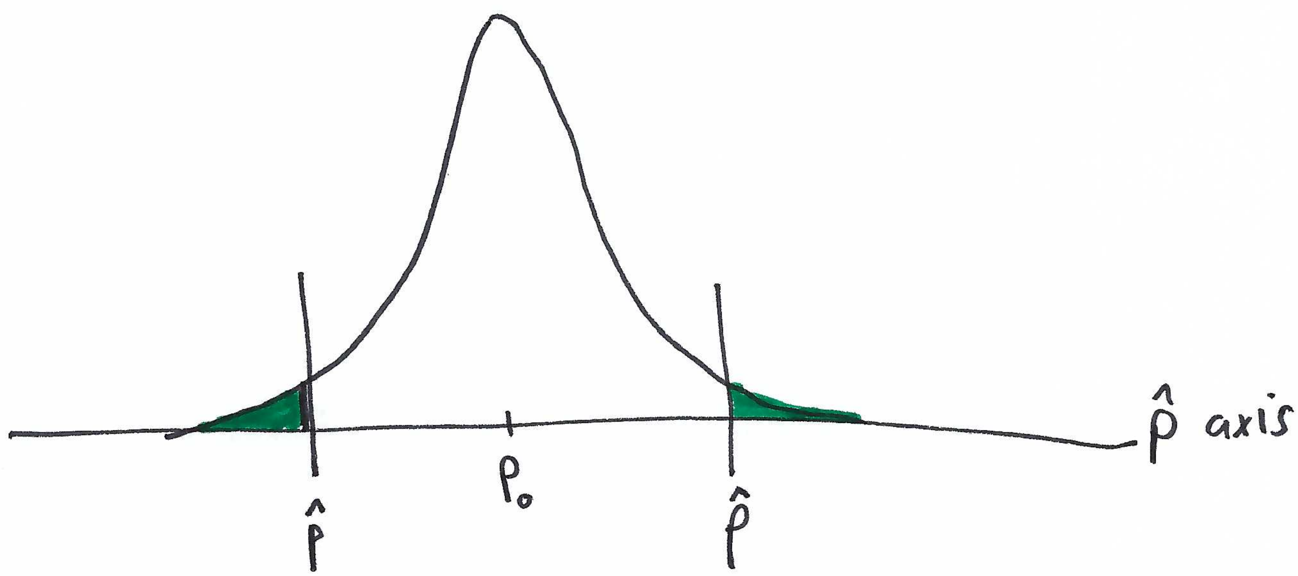
$= 2 \cdot P\left(z > \text{the test statistic}\right)$

I always let the calculator find the p-value for me!

Step 4

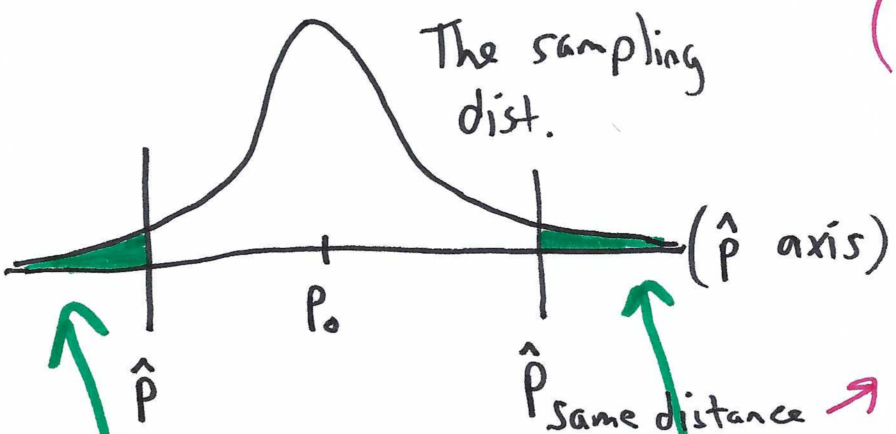
Case 3 (2-tailed test)

The 2-tailed test is used to detect sample proportions in either tail of the sampling distribution graph, which would be surprising.



Case 3 (2-tailed test) (Step 4 continued)

Here is a picture of the p-value for (1).



($\hat{p}_{\text{same distance}}$) is the sample proportion that is the same distance away from p_0 as the observed $\hat{p}$.

Technically, the p-value is

$$P\left(\hat{p} < \text{the sample statistic} \;\text{ OR }\; \hat{p} > \hat{p}_{\text{same distance}}, \text{ assuming } H_0 \text{ is correct.}\right)$$

And since $P(A \text{ or } B) = P(A) + P(B)$ when A and B are mutually exclusive, this probability is equal

$$P\left(\hat{p} < \text{the sample statistic}\right) + P\left(\hat{p} > p_{\text{same distance}}\right)$$

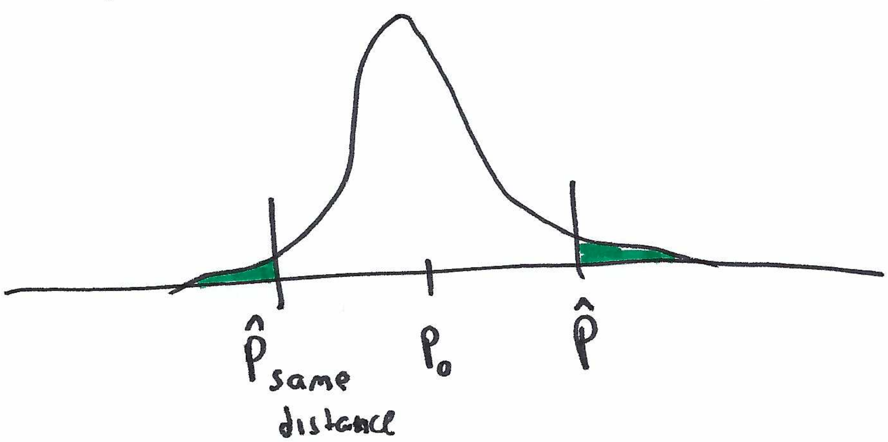
But because of symmetry, the area of one tail equals the area of the other tail, So this last probability is equal to $\boxed{\text{Step 4}}$

$$2 \cdot P\left(\hat{p} < \begin{matrix}\text{the observed sample} \\ \text{proportion}\end{matrix}, \text{ assuming } \begin{matrix}H_0 \\ \text{is correct}\end{matrix}\right)$$

but this is also equal to

$$2 \cdot P\left(Z < \begin{matrix}\text{the test} \\ \text{statistic}\end{matrix}\right)$$

For (2), the p-value is



$$P\left(\hat{p} < \hat{p}_{\text{same distance}} \text{ OR } \hat{p} > \begin{matrix}\text{the observed} \\ \text{sample proportion}\end{matrix}, \begin{matrix}\text{assuming} \\ H_0 \text{ is correct}\end{matrix}\right)$$

or equivalently,

$$2 \cdot P\left(\hat{p} > \begin{matrix}\text{the observed} \\ \text{sample prop}\end{matrix}\right),$$ or equivalently, $$2 \cdot P\left(Z > \begin{matrix}\text{the test} \\ \text{statistic}\end{matrix}\right)$$

Every hyp. test has you make a decisión as to whether or not to reject H_0.

Guideline: How to interpret your decisión

Step 5

(1) If you decide to reject H_0, then the interpretation is:

"There is convincing sample evidence to support [cut/copy/paste the H_A]".

(2) If you decide to fail to reject H_0 then the conclusion is:

". There is not convincing sample evidence to support [cut/copy/paste the H_A]