IV. Hypothesis Testing

i. Procedure

Ho can say "H zero" or "H null"

Steps: 1. Find H_0 and H_1. Usually, H_0 is easier to find.

H_1 also means H_a, a for alternative

2. Test H_1 by Test Statistics. (T.S.) ← formula in the old days

3. Conclude: H_1 rejects H_0 or H_1 fails to reject H_0.

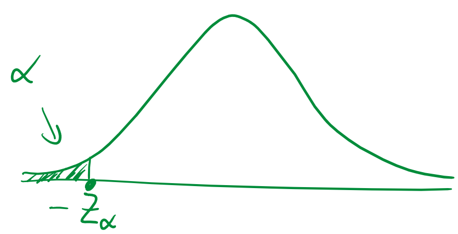
Note: We usually follow these steps, and draw the 'bell-curve' and write as clear as possible.

Step 1:

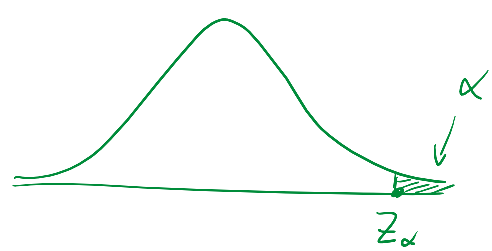
Tails:

points to the left

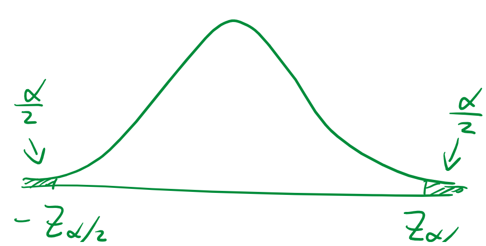
$<$ means left tail

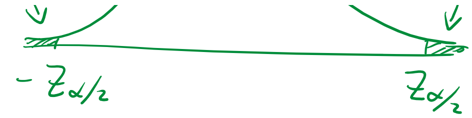


$>$ means right tail



$\neq$ means two tails





Claims:

= is same every time

eg $H_0: p = 0.2$ ← "old facts"

$H_1: p > 0.2$ ← tail that will be testing

eg $H_0: p = 0.07$ ← ...

$H_1: p < 0.07$ ← ...

eg $H_0: p = 0.39$ ← ...

$H_1: p \neq 0.39$ ← ...

eg Claim: The proportion of people who have smoked once is less than 0.6.

Prob ↓ less than → <

H_0: $p = 0.6$

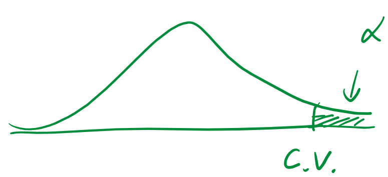
H_1: $p < 0.6$

eg Claim: The proportion of people who have smoked once is at least 0.6.

at least → >

H_0: $p = 0.6$

H_1: $p > 0.6$



eg Claim: The proportion of people who have smoked once is exactly 0.6.

H_0: $p = 0.6$

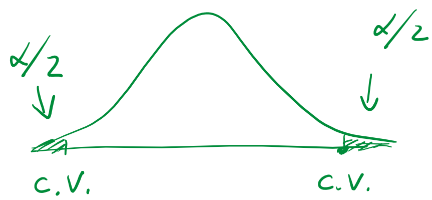
H_1:

eg claim: The proportion of people who have smoked once is exactly 0.6.

Oppose to is

H_0: $p = 0.6$

H_1: $p \neq 0.6$



eg Assume that 100 babies are born to 100 couples treated with gender selection that is claimed to make girls more likely. We observe 58 girls in 100 babies. Write the claim that the "The proportion of girls is greater than the 50% that occurs without any treatment."

0.5

S:

$H_0: p = 0.5$ ← usually easier to find

$H_1: p > 0.5$

tricky

eg In recent years, there has been increasing concern about the health effects of computer terminals. It is known that the miscarriage rate under general conditions is about 20%. A random sample of 650 pregnant women working with a computer 1 to 20 hours per week was taken. For this sample, there were 155 miscarriages. Find the claim that computer terminals detrimentally affect pregnant women.

S:

$H_0: p = 0.2$

$H_1: p > 0.2$

✓ we learned it!

eg Now we consider the claim that the gender selection increases the likelihood of having a baby girl. Preliminary results from a test of gender selection involved 100 couples who gave birth to 58 girls and 42 boys. Find the claim.

S:

$H_0: p = 0.5$ ← 50% of the gender on the birth. "tricky"

$H_1: p > 0.5$

$H_1: p > 0.5$ the birth. "tricky"

eg Based on information from the National Cyber Security Alliance, 93% of computer owners believe they have antivirus programs installed on their computers. In a random sample of 400 scanned computers, it is found that 380 of them actually have antivirus software programs. Use the sample data from the scanned computers to find the claim that 93% of computers have antivirus software.

or not   or not

S:

$H_0: p = 0.93$

$H_1: p \neq 0.93$

V. Testing Procedure

We test on probability first.

Once we have H_0 & H_1, we'd do the test statistics to determine whether H_1 rejects H_0 or H_1 fails to reject H_0.

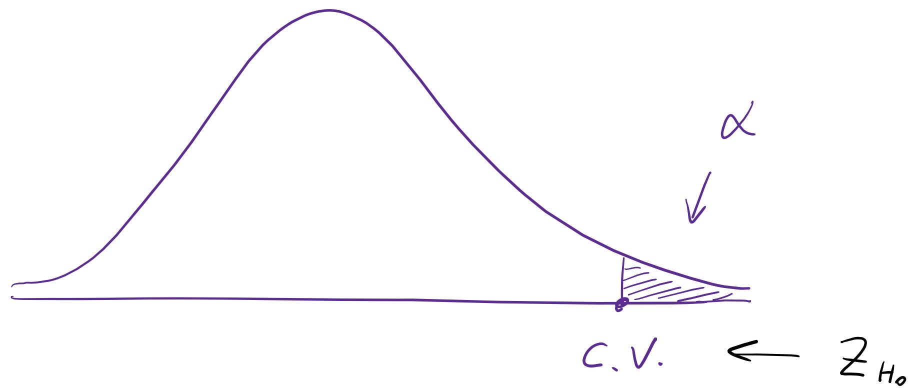
use this   use this

Then, we conclude the problem.

rejects: this is enough evidence to support H_1 that ...

fails to reject: this is not enough evidence to support H_1 that ...

eg



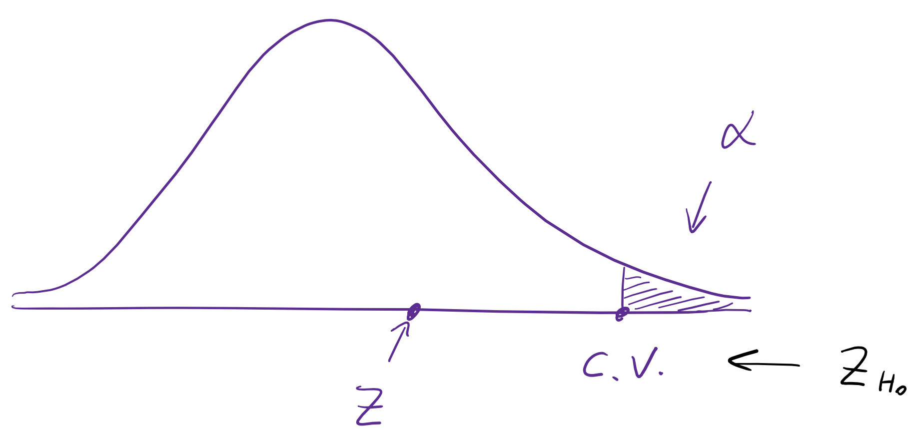
p' for our text

Test Statistics: $Z = \dfrac{\hat{p} - p}{\sqrt{\frac{pq}{n}}}$, where $\hat{p}$ is problem's prob., $\hat{p} = \dfrac{x}{n}$
(formula)

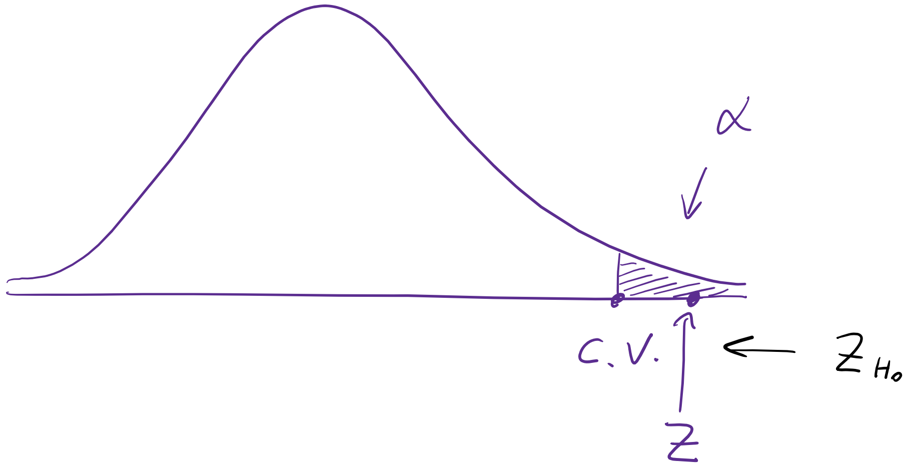
p is the H_0's prob. (claim)

Z_{H_1}

Now,



If $Z <$ C.V., it means H_1 fails to reject H_0.

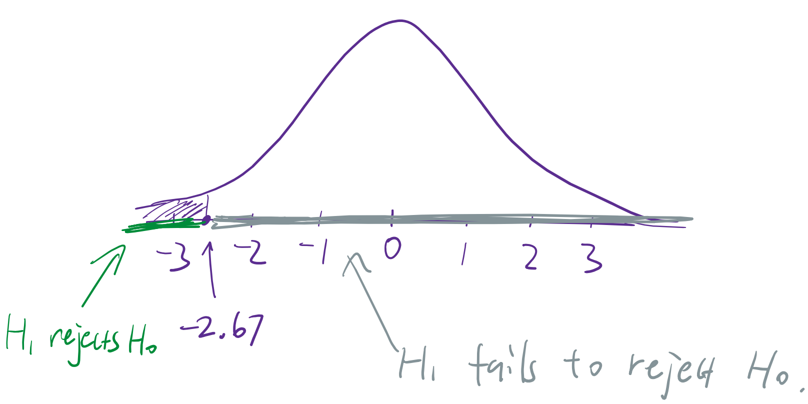


If $Z > c.v.$, it means H_1 rejects H_0.

Furthermore,

α = significant level (usually given, otherwise automatically 0.05)

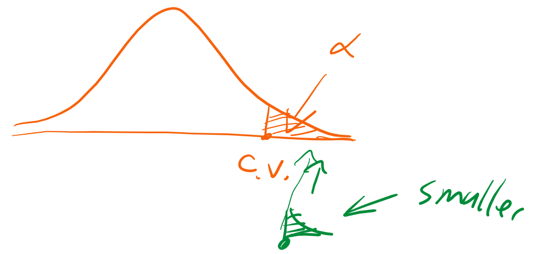
eg



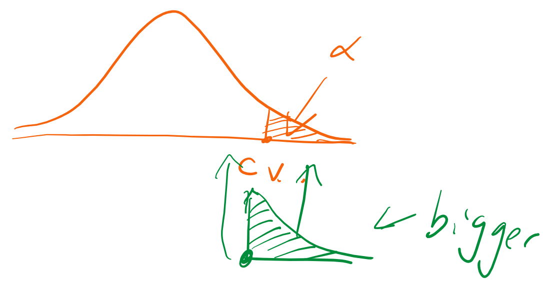
P-Value Test (another way) ← usually skip

P-value is the probability value. It is converted from Z (Z_{H_1}) from above:

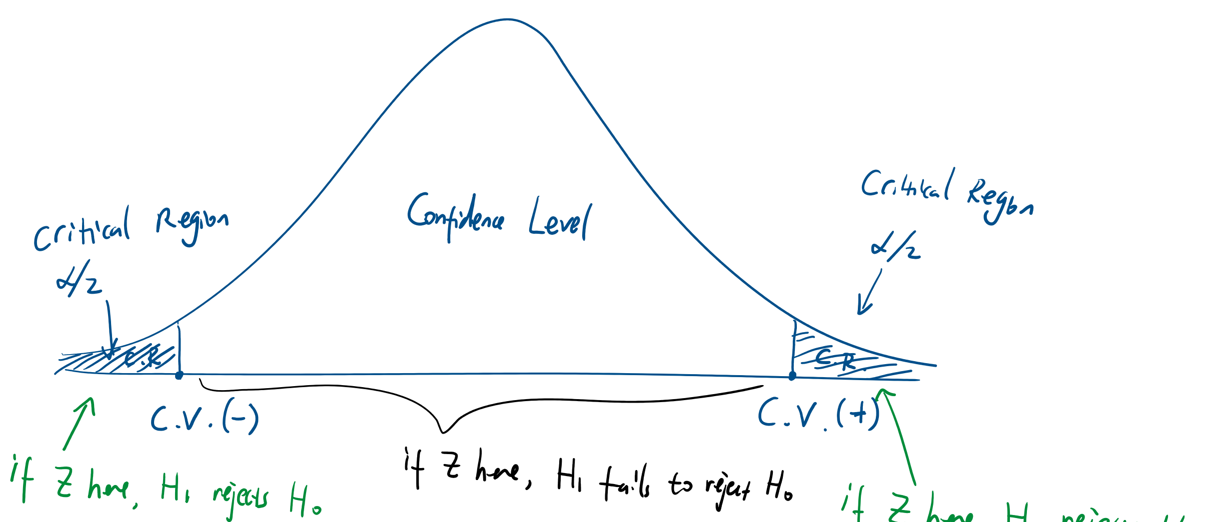
- if P-value $< \alpha$. H_1 rejects H_0.



- if P-value $> \alpha$. H_1 fails to H_0.



Overall:



- $Z = \dfrac{\hat{p} - p}{\sqrt{\frac{pq}{n}}}$, where $\hat{p} = \frac{x}{n}$ (new data)
  $p = H_0$'s Prob (old data)

— If p-value $< \alpha$, H_1 rejects H_0

If p-value $> \alpha$, H_1 fails to reject H_0.

(p-value was converted from $Z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}}$)

eg. Given that $\alpha = 0.1$, and Test Statistics $Z = 1.3$, with H_0: $p = 0.2$ and H_1: $p > 0.2$.

S:

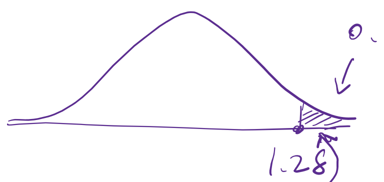
1 tail

right tail

$H_0: p = 0.2$

$H_1: p > 0.2$

$\alpha = 0.1$ with $>$:



$Z = 1.3 > C.V. = 1.28$

then, H_1 rejects H_0.

Thus, there is enough evidence to support H_1 that ...