

# Elementary Statistics (15060101)

## Hypothesis Tests

In hypothesis testing we begin by making a tentative assumption about a population parameter. This tentative assumption is called the **null hypothesis** and is denoted by  $H_0$ .

We then define another hypothesis, called the alternative hypothesis, which is the opposite of what is stated in the null hypothesis.

**The alternative hypothesis is denoted by  $H_a$  or  $H_1$ .**

The hypothesis testing procedure uses data from a sample to test the two competing statements indicated by  $H_0$  and  $H_a$ .

**Note: The null hypothesis  $H_0$  includes (=):**

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Ex:  $H_0: \mu = 5$  Versus  $H_a: \mu \neq 5$

Ex:  $H_0: \mu \leq 5$  Versus  $H_a: \mu > 5$

Ex:  $H_0: \mu \geq 5$  Versus  $H_a: \mu < 5$

This  $H_a$  is called: **Two tailed hypothesis**

This  $H_a$  is called: **One tailed hypothesis**

This  $H_a$  is called: **One tailed hypothesis**

# Note:

The null hypothesis  $H_0$  is a **negative sentence** that formulated to **denial** any of the relationship, effect, or differences:

**Ex.** The null hypothesis  $H_0$  is formulated to say that: there is no relationship between variables, or no differences between groups, or no effect of a variable or a method

**Example:**

$H_0$ : There is **No Linear relationship** between X & Y ( $r = 0$ ).

**Versus**  $H_a$ : There is a Linear relationship between X & Y ( $r \neq 0$ ).

**Example:**

$H_0$ : There is **No effect** of gender variable on the student marks ( $\mu_{male} = \mu_{female}$ ).

**Versus**  $H_a$ : There is an effect of gender variable on the student marks ( $\mu_{male} \neq \mu_{female}$ ).

# The **Alternative** Hypothesis as a Research Hypothesis

Many applications of hypothesis testing involve an attempt to gather evidence in support of a research hypothesis.

in these situations, it is often best to begin with the alternative hypothesis and make it the conclusion that the researcher hopes to support. consider a particular automobile that currently attains a fuel efficiency of 24 miles per gallon in city driving.

a product research group has developed a new fuel injection system designed to increase the miles-per-gallon rating. the group will run controlled tests with the new fuel injection system looking for statistical support for the conclusion that the new fuel injection system provides more miles per gallon than the current system.

Several new fuel injection units will be manufactured, installed in test automobiles, and subjected to research-controlled driving conditions. the sample mean miles per gallon for these automobiles will be computed and used in a hypothesis test to determine if it can be concluded that the new system provides more than 24 miles per gallon. In terms of the **population mean** miles per gallon  $\mu$ , the **research hypothesis**  $\mu > 24$  becomes the **alternative hypothesis**  $H_a$ . Since the current system provides an average or mean of 24 miles per gallon, we will make the tentative assumption that the new system is not any better than the current system and choose  $\mu \leq 24$  as the **null hypothesis**  $H_0$ .

The null and alternative hypotheses are:

$$H_0: \mu \leq 24 \quad Vs \quad H_a: \mu > 24$$

## Example:

Write the null and alternative hypotheses in the following cases:

- a) A researcher needs to test if the student marks mean is more than 75:  $H_0: \mu \leq 75$  Vs  $H_a: \mu > 75$   
Here, we write  $H_a$  first, and then  $H_0$  is the opposite.
- b) A researcher needs to test if the student marks mean equals to 75:  $H_0: \mu = 75$  Vs  $H_a: \mu \neq 75$   
Here, we write  $H_0$  first, and then  $H_a$  is the opposite.
- c) A researcher needs to test if the student marks mean is less than 75:  $H_0: \mu \geq 75$  Vs  $H_a: \mu < 75$   
Here, we write  $H_a$  first, and then  $H_0$  is the opposite.
- d) A company wants to test if there product can be used after one year (product life>1):  $H_0: \mu \leq 1$  Vs  $H_a: \mu > 1$   
Here, we write  $H_a$  first, and then  $H_0$  is the opposite.
- e) A company wants to test if there batteries have a mean life of 112 hours:  $H_0: \mu = 112$  Vs  $H_a: \mu \neq 112$

# Summary of Forms for Null and Alternative Hypotheses

*Assuming  $\mu_0$  be the hypothesized value*

$$H_0: \mu \geq \mu_0$$

$$H_0: \mu \leq \mu_0$$

$$H_0: \mu = \mu_0$$

$$H_a: \mu < \mu_0$$

$$H_a: \mu > \mu_0$$

$$H_a: \mu \neq \mu_0$$

**OR:**

$$H_0: \mu = \mu_0$$

$$\text{Vs. } H_1: \mu < \mu_0$$

**OR:**

$$H_0: \mu = \mu_0$$

$$\text{Vs. } H_1: \mu > \mu_0$$

**Example:** Here  $\mu_0=600$  be the hypothesized value

$$H_0: \mu \geq 600$$

$$H_0: \mu \leq 600$$

$$H_0: \mu = 600$$

$$H_a: \mu < 600$$

$$H_a: \mu > 600$$

$$H_a: \mu \neq 600$$

# The **Null** Hypothesis as an Assumption to be Challenged

Of course, not all hypothesis tests involve research hypotheses.

In the following discussion we consider applications of hypothesis testing where we begin with a belief or an assumption that a statement about the value of a population parameter is true. We will then use a hypothesis test to challenge the assumption and determine if there is statistical evidence to conclude that the assumption is incorrect. In these situations, it is helpful to develop the **null** hypothesis first. The null hypothesis  $H_0$  expresses the belief or assumption about the value of the population parameter. The alternative hypothesis  $H_a$  is that the belief or assumption is incorrect.

As an example, consider the situation of a manufacturer of soft drink products. The label on a soft drink bottle states that it contains 67.6 fluid ounces. we consider the label correct provided the population mean filling weight for the bottles is at least 67.6 fluid ounces. Without any reason to believe otherwise, we would give the manufacturer the benefit of the doubt and assume that the statement provided on the label is correct. Thus, in a hypothesis test about the population mean fluid weight per bottle, we would begin with the assumption that the label is correct and state the **null hypothesis** as  $\mu \geq 67.6$ .

The challenge to this assumption would imply that the label is incorrect and the bottles are being underfilled. This challenge would be stated as the **alternative hypothesis**  $\mu < 67.6$ .

Thus, the null and alternative hypotheses are:

$$\mathbf{H_0: \mu \geq 67.6 \quad Vs. \quad H_1: \mu < 67.6}$$

# Type I and Type II Errors

The null and alternative hypotheses are competing statements about the population.

Either the null hypothesis  $H_0$  is true or the alternative hypothesis  $H_a$  is true, but **NOT BOTH**.

Ideally the hypothesis testing procedure should lead to [**correct conclusions**]

>> the **acceptance of  $H_0$**  when  **$H_0$  is true ( $H_a$  is false)**.

and

>> the **rejection of  $H_0$**  when  **$H_a$  is true ( $H_0$  is false)**.

Unfortunately, the correct conclusions are not always possible, because hypothesis tests are based on sample information, we must allow for the possibility of errors.

		Population Condition	
		$H_0$ True	$H_a$ True
Conclusion	Accept $H_0$	Correct Conclusion	Type II Error
	Reject $H_0$	Type I Error	Correct Conclusion

		Population Condition	
		$H_0$ True	$H_a$ True
Conclusion	Accept $H_0$	Correct Conclusion	Type II Error
	Reject $H_0$	Type I Error	Correct Conclusion

Note: The hypothesis:  $H_0$  &  $H_a$  are two competing statements.  
 If one is true; the another is false. If one is false; the another is true.

The **first row** of this table shows what can happen if the conclusion is to **accept  $H_0$** .  
 If  $H_0$  is true, this conclusion is correct.  
 However, if  $H_a$  is true, we make a **Type II error; that is, we accept  $H_0$  when it is false.**

The **second row** of this table shows what can happen if the conclusion is to **reject  $H_0$** .  
 If  $H_0$  is true, we make a **Type I error; that is, we reject  $H_0$  when it is true.**  
 However, if  $H_a$  is true, rejecting  $H_0$  is correct.



The **probability** of making a **type I error** when the null hypothesis is true as an equality is called the **level of significance ( $\alpha$ )**.

Where

**Type I error**; when we reject  $H_0$  when it is true.

The **level of significance** is the probability of making a type I error when the null hypothesis is true as an equality.

The common choices for ( $\alpha$ ) are .05 and .10

The **probability** of making a **type II error** is called ( $\beta$ ).

Where:

**Type II error**; when we Accept  $H_0$  when it is false.

**Type II error**; when we [Don't Reject]  $H_0$  when it is false.

The **probability** of making a **type II error** is called  $(\beta)$ .

The **power** of the test: is the probability of correctly rejecting  $H_0$  when it is false. [*power* =  $1 - \beta$  ]

For any particular value of  $\mu$ , **The Power** is  $(1 - \beta)$ ; that is, the probability of correctly rejecting the null hypothesis is 1 minus the probability of making a type II error.

Such a graph is called a power curve. note that the power curve extends over the values of  $\mu$  for which the null hypothesis is false.

The height of the power curve at any value of  $\mu$  indicates the probability of correctly rejecting  $H_0$  when  $H_0$  is false.

Value of $\mu$	$z = \frac{116.71 - \mu}{12/\sqrt{36}}$	Probability of a Type II Error ( $\beta$ )	Power ( $1 - \beta$ )
112	2.36	.0091	.9909
114	1.36	.0869	.9131
115	.86	.1949	.8051
116.71	.00	.5000	.5000
117	-.15	.5596	.4404
118	-.65	.7422	.2578
119.999	-1.645	.9500	.0500

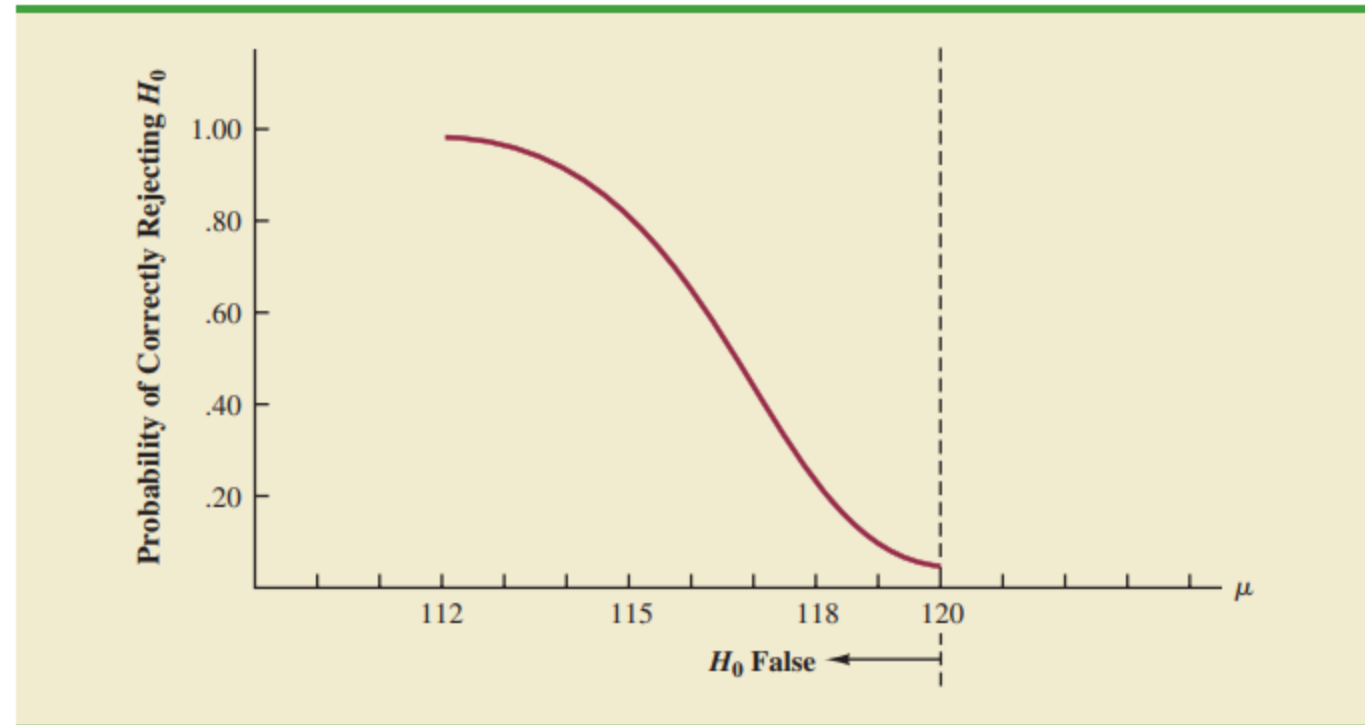
The probability of making a type II error is called ( $\beta$ ).

Where:

**Type II error**; when we Accept  $H_0$  when it is false.

**Type II error**; when we [Don't Reject]  $H_0$  when it is false.

POWER CURVE FOR THE LOT-ACCEPTANCE HYPOTHESIS TEST



In practice, the person responsible for the hypothesis test specifies the level of significance. By selecting  $(\alpha)$ , that person is controlling the probability of making a type I error.

If the cost of making a type I error is high, small values of  $(\alpha)$  are preferred.

if the cost of making a type I error is not too high, larger values of  $(\alpha)$  are typically used.

Applications of hypothesis testing that only control for the type I error are called **significance tests**.

Many applications of hypothesis testing are of this type.

Although most applications of hypothesis testing control for the probability of making a type I error, they do not always control for the probability of making a type II error. Hence, if we decide to accept  $H_0$ , we cannot determine how confident we can be with that decision.

**Because** of the uncertainty associated with making a type II error when conducting significance tests, statisticians usually recommend that we use the statement “**do not reject  $H_0$** ” instead of “**accept  $H_0$** .”

Using the statement “do not reject  $H_0$ ” carries the recommendation to with hold both judgment and action. In effect, by not directly accepting  $H_0$ , the statistician avoids the risk of making a type II error.

Whenever the probability of making a type II error has not been determined and controlled, we will not make the statement “accept  $H_0$ .”

In such cases, only **two conclusions** are possible: **Do not reject  $H_0$**  or **reject  $H_0$** .

Although controlling for a type II error in hypothesis testing is not common, it can be done.

**In summary, the following step-by-step procedure can be used to compute the probability of making a type II error in hypothesis tests about a population mean ( $\mu$ ):**

1. formulate the null and alternative hypotheses.
2. use the level of significance ( $\alpha$ ) and the critical value approach to determine the critical value and the rejection rule for the test.
3. use the rejection rule to solve for the value of the sample mean corresponding to the critical value of the test statistic.
4. use the results from step 3 to state the values of the sample mean that lead to the acceptance of  $H_0$ . these values define the acceptance region for the test.
5. use the sampling distribution of  $\bar{x}$  for a value of  $\mu$  satisfying the alternative hypothesis, and the acceptance region from step 4, to compute the probability that the sample mean will be in the acceptance region.

This probability is the probability of making a type II error at the chosen value of  $\mu$ .

**In summary, the following step-by-step to test any hypothesis about the population mean ( $\mu$ ):**

- 1) Write the hypothesis:  $H_0$  &  $H_a$**
- 2) Compute the test statistic**
- 3) Draw **Acceptance-Rejection regions** of  $H_0$  [**This is based on  $H_a$** ]**
- 4) Make your conclusion:**  
[Reject  $H_0$ ] OR [Accept  $H_0 = Don't$  Reject  $H_0$ ]  
we Reject  $H_0$  if test statistic  $\in$  **Rejection regions**

# Acceptance-Rejection regions of $H_0$

(One Tail Test)

This is based on  $H_a$ :

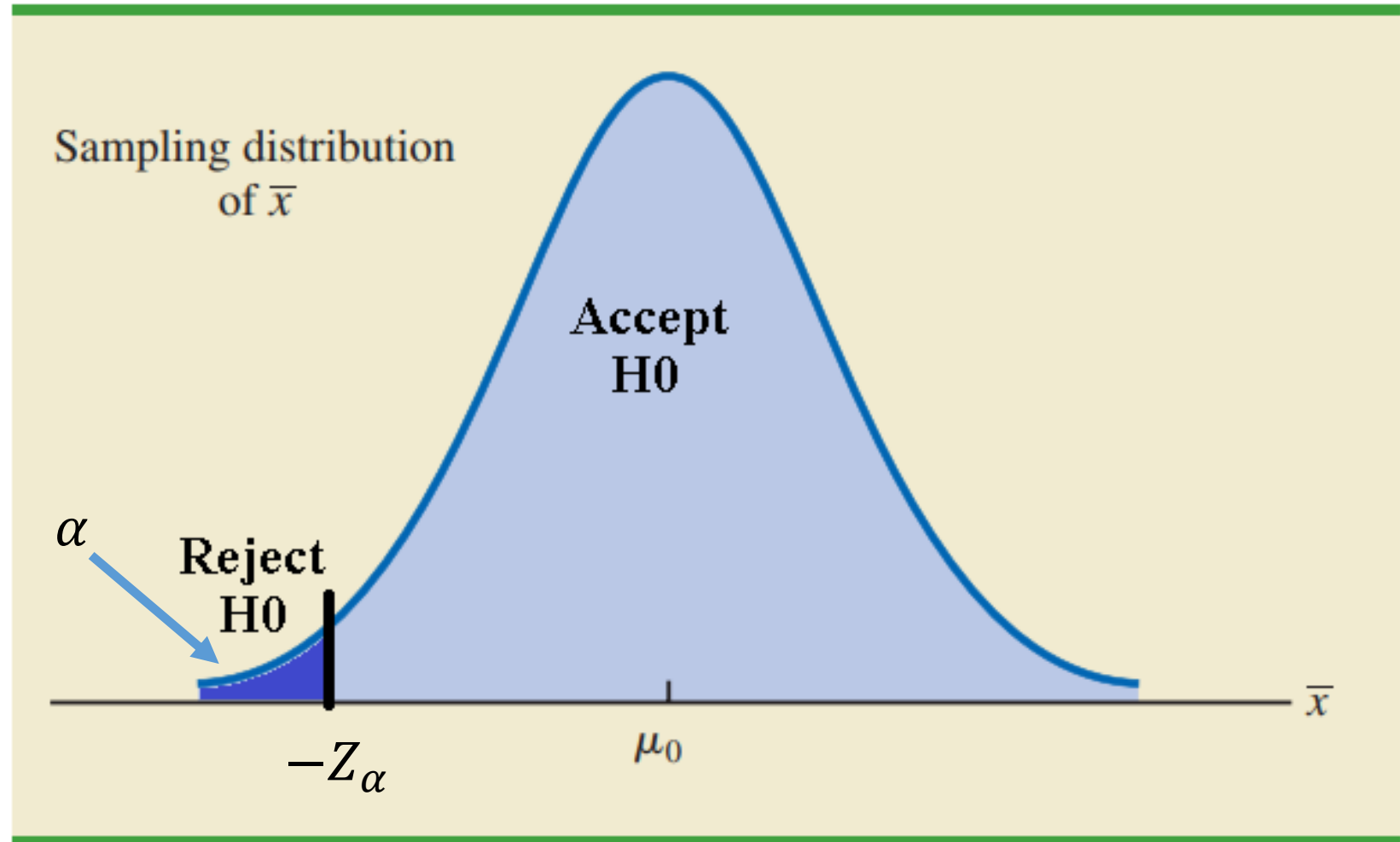
If  $H_a: \mu < \mu_0$

The Rejection region  
is on the left

Lower Tail Test

Left Tail Test  
(One Tail Test)

The critical value is  $-Z_\alpha$



# Acceptance-Rejection regions of $H_0$

## (One Tail Test)

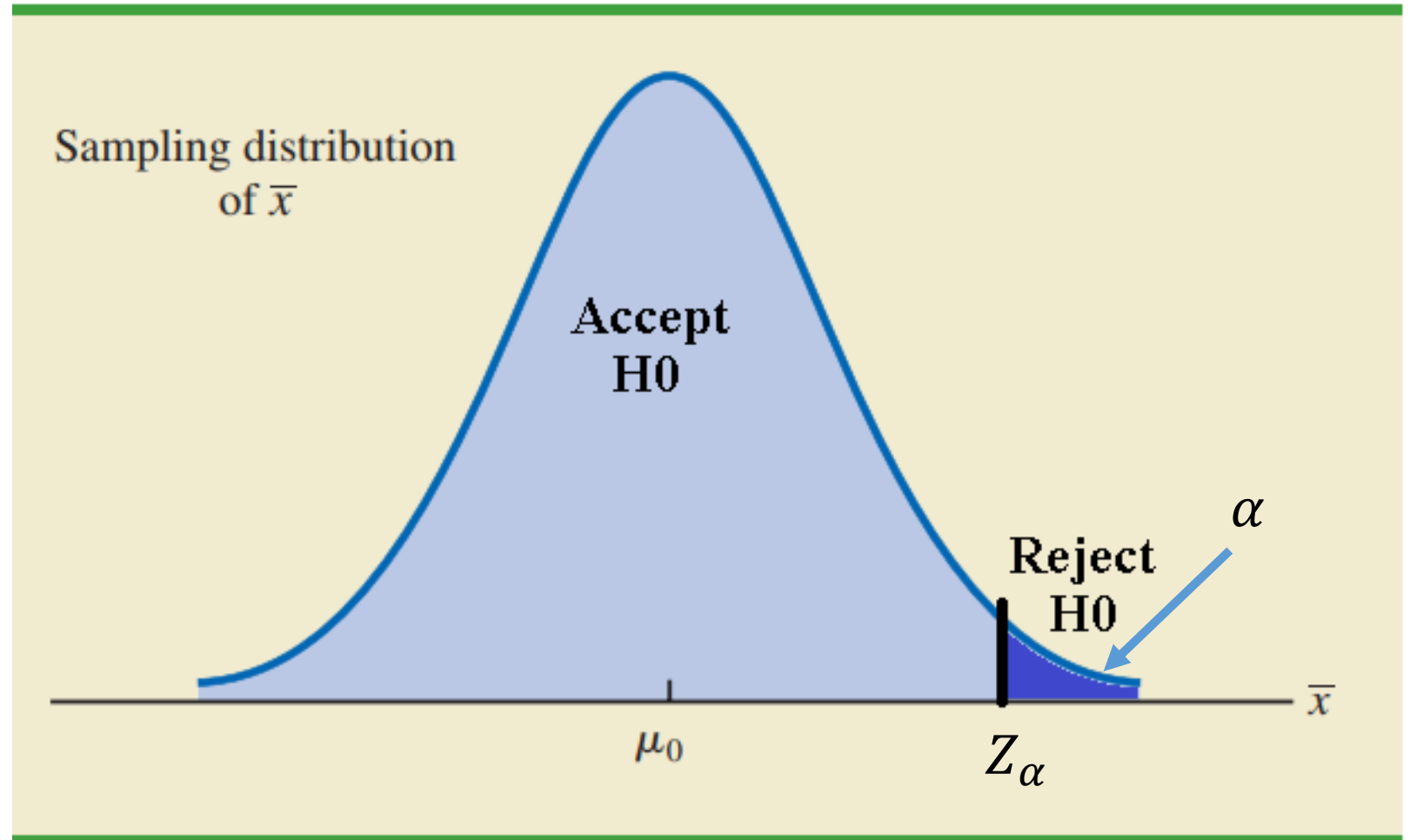
This is based on  $H_a$ :

If  $H_a: \mu > \mu_0$

The Rejection region  
is on the Right

Upper Tail Test  
Right Tail Test  
(One Tail Test)

The critical value is  $Z_\alpha$





# Acceptance-Rejection regions of $H_0$ (Two Tail Test)

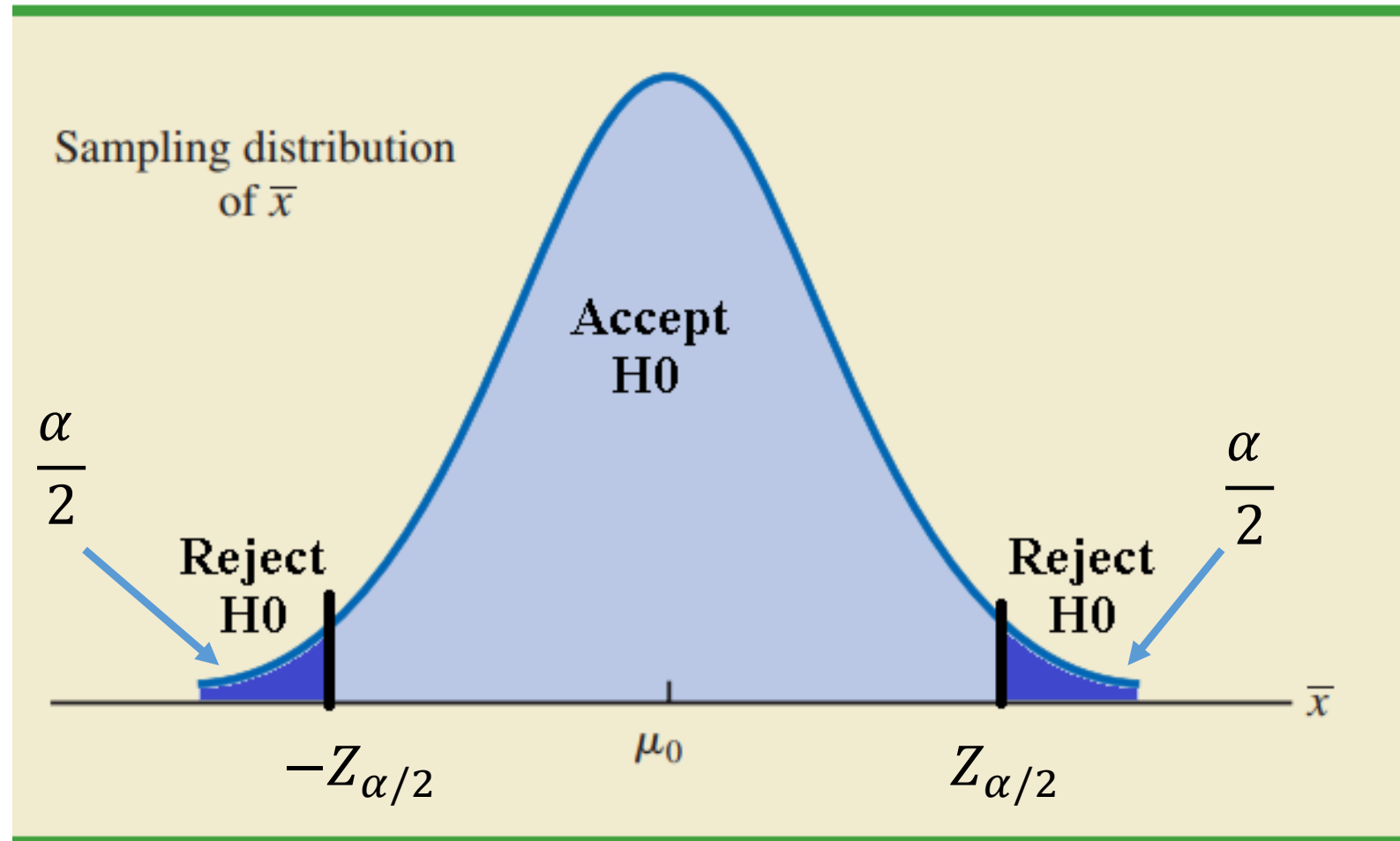
This is based on  $H_a$ :

If  $H_a: \mu \neq \mu_0$   
(Two Tail Test)

Then May be  
 $\mu < \mu_0$

OR

$\mu > \mu_0$



TEST STATISTIC FOR HYPOTHESIS TESTS ABOUT A POPULATION MEAN:  
 $\sigma$  KNOWN

$$z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} \quad (9.1)$$

If ( $\sigma$ ) is unknown, we replace it value by (**S**) when the sample size is large

TEST STATISTIC FOR HYPOTHESIS TESTS ABOUT A POPULATION MEAN:  
 $\sigma$  UNKNOWN **t distribution with (n - 1) degrees of freedom**

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} \quad (9.2)$$

TEST STATISTIC FOR HYPOTHESIS TESTS ABOUT A POPULATION  
PROPORTION

$$z = \frac{\bar{p} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}} \quad (9.4)$$

## *p*-VALUE

A *p*-value is a probability that provides a measure of the evidence against the null hypothesis provided by the sample. Smaller *p*-values indicate more evidence against  $H_0$ .

## REJECTION RULE USING *p*-VALUE

Reject  $H_0$  if *p*-value  $\leq \alpha$

## STEPS OF HYPOTHESIS TESTING

**Step 1.** Develop the null and alternative hypotheses.

**Step 2.** Specify the level of significance.

**Step 3.** Collect the sample data and compute the value of the test statistic.

### *p*-Value Approach

**Step 4.** Use the value of the test statistic to compute the *p*-value.

**Step 5.** Reject  $H_0$  if the *p*-value  $\leq \alpha$ .

**Step 6.** Interpret the statistical conclusion in the context of the application.

### *Critical Value Approach*

**Step 4.** Use the level of significance to determine the critical value and the rejection rule.

**Step 5.** Use the value of the test statistic and the rejection rule to determine whether to reject  $H_0$ .

**Step 6.** Interpret the statistical conclusion in the context of the application.

## Relation between (Two Tail Test) & Confidence intervals:

If the hypothesized value falls outside the interval, we reject the null hypothesis.

**The population variance is known. (using Z-tables)**

$\bar{x} \pm$  margin of error :  $\bar{x} \pm Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$  ,  $Z_{\frac{\alpha}{2}}$  value providing an area of  $\alpha/2$  in the upper tail of the Z distribution

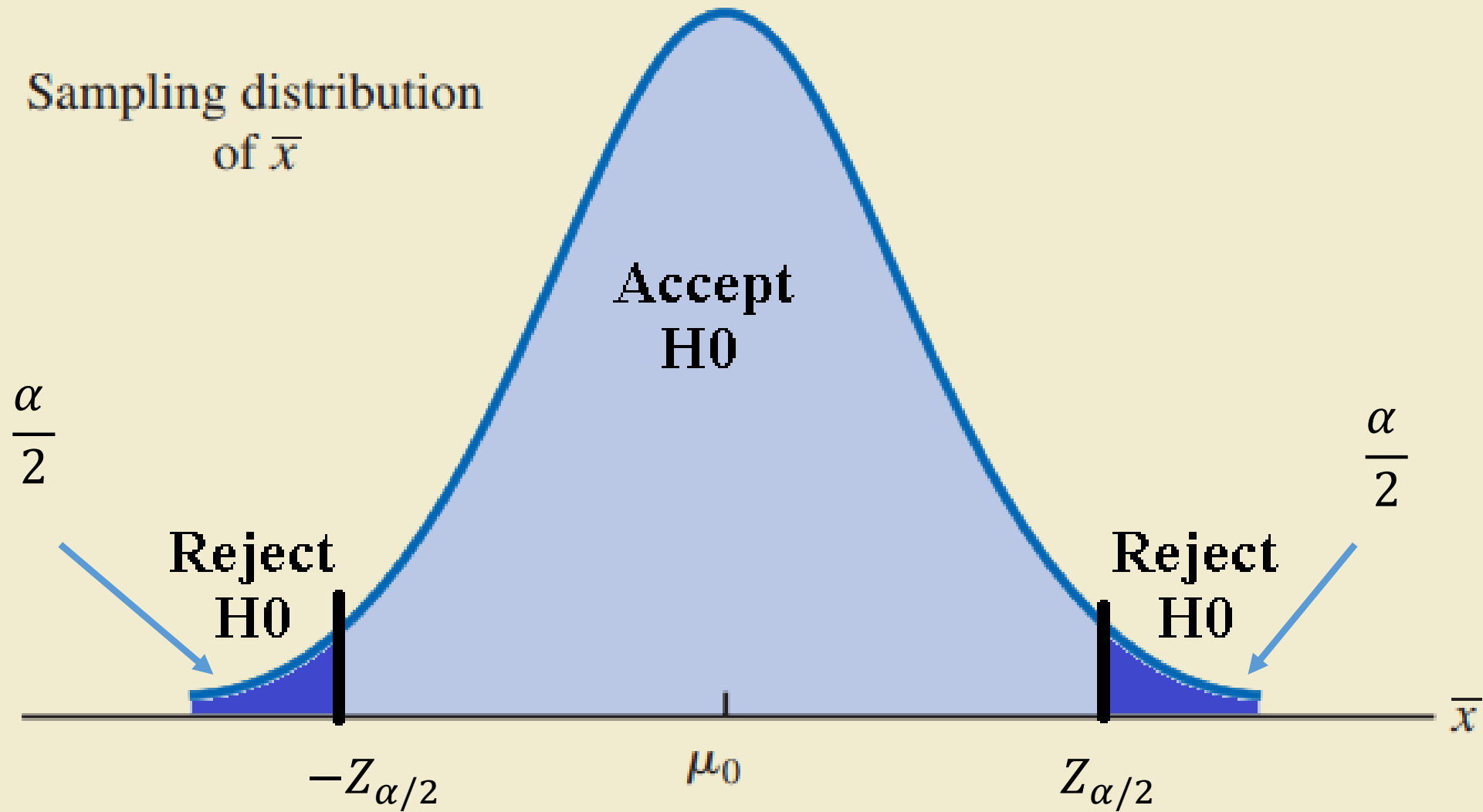
**The population variance is Unknown. (using t-tables)**

$\bar{x} \pm$  margin of error:  $\bar{x} \pm t_{\frac{\alpha}{2}} \frac{S}{\sqrt{n}}$  ,  $t_{\frac{\alpha}{2}}$  value providing an area of  $\alpha/2$  in the upper tail of the t distribution with  $(n - 1)$  degrees of freedom

**\* Confidence intervals for population proportion ( $p$ ) . (using Z-tables)**

$\bar{p} \pm$  margin of error :  $\bar{p} \pm Z_{\frac{\alpha}{2}} \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

Sampling distribution  
of  $\bar{x}$



What is P\_value: = a Probability of rejection using the test statistics calculated under  $H_1$

#### *p*-VALUE

A *p*-value is a probability that provides a measure of the evidence against the null hypothesis provided by the sample. Smaller *p*-values indicate more evidence against  $H_0$ .

How the P\_Value calculated?

If  $H_1$  is right tailed test:

$$P_{value} = P\{Z > Test\ Statistic\}$$

If  $H_1$  is left tailed test:

$$P_{value} = P\{Z < Test\ Statistic\}$$

If  $H_1$  is Two tailed test:

$$P_{value} = 2 * P\{Z > |Test\ Statistic|\}$$

**Note:**

**The most  $Z$  critical values for Confidence Intervals & Hypothesis Test**

**(Two tailed test):**

**from Normal Table**

**Assuming 95%** confidence interval (C.I.) >>>>  $Z_{\frac{0.05}{2}} = 1.96$  ,  $\alpha = 0.05$

**Assuming 90%** confidence interval (C.I.) >>>>  $Z_{\frac{0.10}{2}} = 1.645$  ,  $\alpha = 0.10$

**Assuming 85%** confidence interval (C.I.) >>>>  $Z_{\frac{0.15}{2}} = 1.44$  ,  $\alpha = 0.15$

**Assuming 80%** confidence interval (C.I.) >>>>  $Z_{\frac{0.20}{2}} = 1.28$  ,  $\alpha = 0.20$

**In summary, the following step-by-step to test any hypothesis about the population mean ( $\mu$ ):**

- 1) Write the hypothesis:  $H_0$  &  $H_a$**
- 2) Compute the test statistic**
- 3) Draw **Acceptance-Rejection regions** of  $H_0$  [**This is based on  $H_a$** ]**
- 4) Make your conclusion:**  
[Reject  $H_0$ ] OR [Accept  $H_0 = Don't$  Reject  $H_0$ ]  
we Reject  $H_0$  if test statistic  $\in$  **Rejection regions**



# Make your conclusion: [Reject $H_0$ ] OR [Accept $H_0 = Don't Reject H_0$ ]

3 ways to make your conclusion:

we Reject  $H_0$  if test statistic  $\in$  **Rejection regions**

**OR**

we Reject  $H_0$  if **the hypothesized value falls outside the confidence interval**

**OR**

we Reject  $H_0$  if  $P_{value} \leq \alpha$

### Example:

Consider the following hypothesis test  $H_0: \mu = 50$  Vs.  $H_1: \mu \neq 50$ . A sample of 64 provided a sample mean of 51.44. If the population standard deviation is 8.

- 1) What is the p-value of the test.
- 2) What is your decision about this hypothesis based on  $\alpha = 0.05$
- 3) What is your decision about this hypothesis based on the p\_value

### Solve

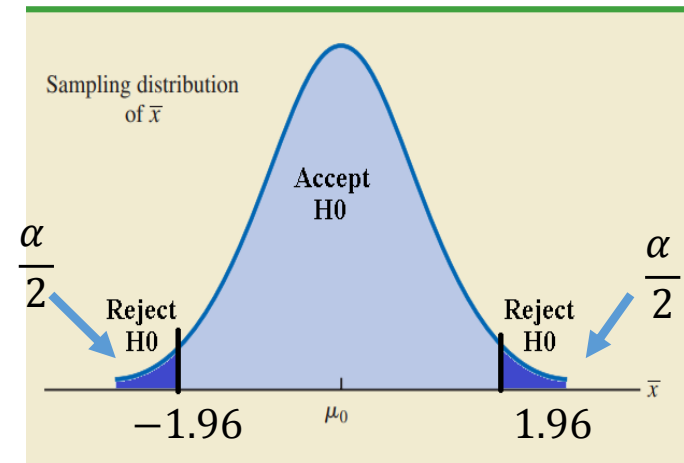
1)  
The hypothesis:  $H_0: \mu = 50$  Vs.  $H_1: \mu \neq 50$

The Test Statistic:  $z = \frac{51.44 - 50}{8/\sqrt{64}} = \frac{1.44}{1} = 1.44$

$P(Z > 1.44) = 0.0749$  &  $P(Z < -1.44) = 0.0749$

This is two tailed test Then  $P_{value} = P(Z > 1.44) + P(Z < -1.44) = 0.1498 = 0.15$

Draw Acceptance-Rejection region



TEST STATISTIC FOR HYPOTHESIS TESTS ABOUT A POPULATION MEAN:  
 $\sigma$  KNOWN

$$z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} \quad (9.1)$$

2) Make the conclusion:

the test statistics falls in the acceptance region Then, **Don't Reject  $H_0$**

3) Make the conclusion:

$P_{value} = 0.15 > \alpha = 0.05 \rightarrow$  Then, **Don't Reject  $H_0$**

Sampling distribution  
of  $\bar{x}$

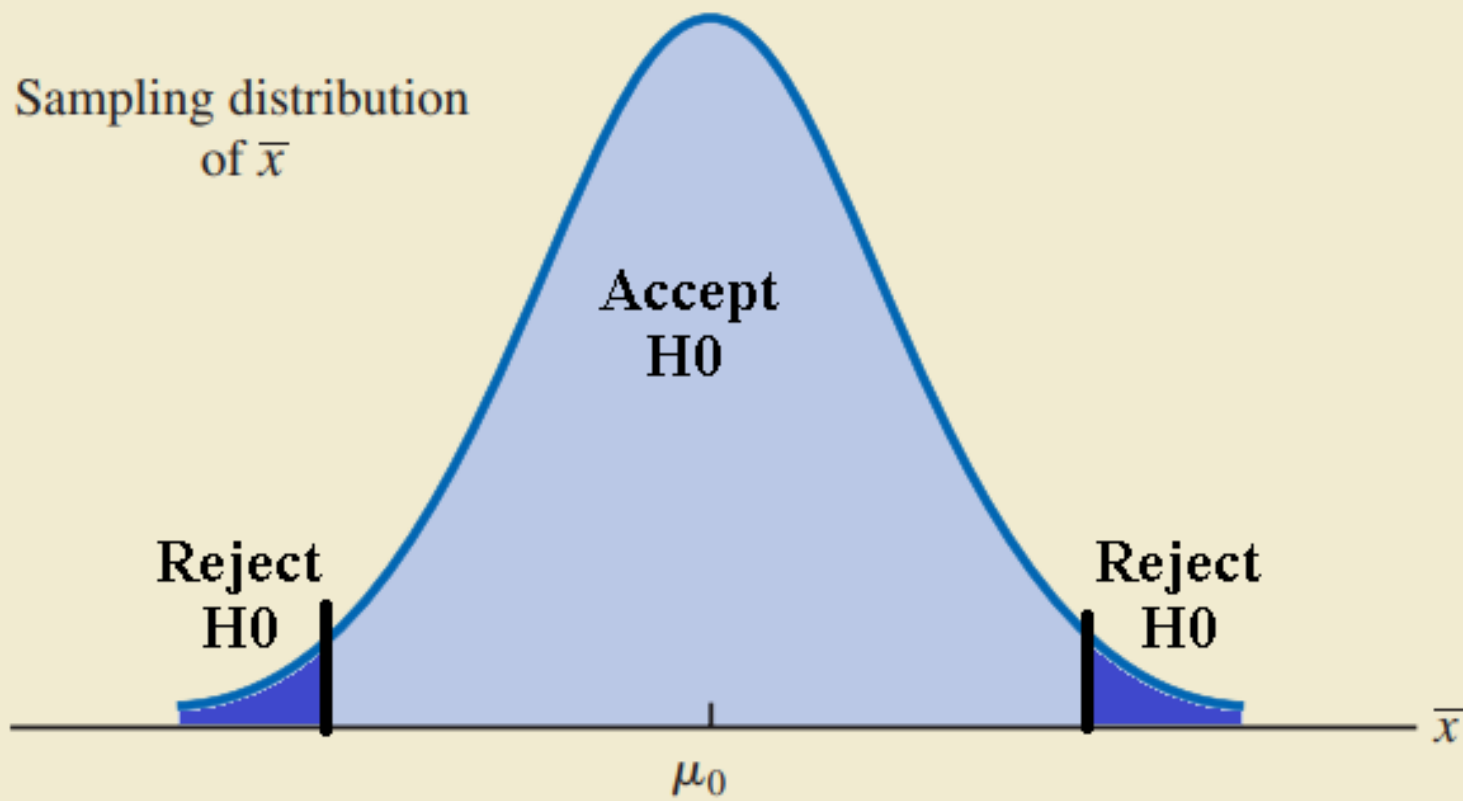
Accept  
 $H_0$

Reject  
 $H_0$

Reject  
 $H_0$

$\mu_0$

$\bar{x}$



### Example:

Consider the following hypothesis test  $H_0: \mu = 50$  Vs.  $H_1: \mu > 50$ . A sample of 64 provided a sample mean of 51.44. If the population standard deviation is 8.

- 1) What is the p-value of the test.
- 2) What is your decision about this hypothesis based on  $\alpha = 0.10$
- 3) What is your decision about this hypothesis based on the p\_value

### Solve

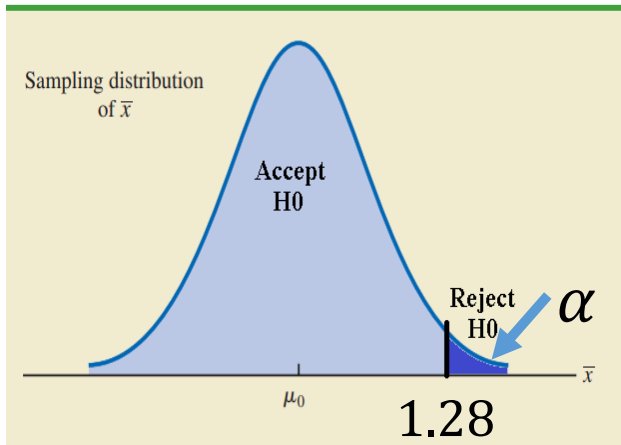
1)  
The hypothesis:  $H_0: \mu = 50$  Vs.  $H_1: \mu > 50$ ,

The Test Statistic:  $z = \frac{51.44 - 50}{8/\sqrt{64}} = \frac{1.44}{1} = 1.44$

$P(Z > 1.44) = 0.0749$

This is One tailed test Then  $P_{value} = P(Z > 1.44) = 0.0749$

### Draw Acceptance-Rejection region



TEST STATISTIC FOR HYPOTHESIS TESTS ABOUT A POPULATION MEAN:  
 $\sigma$  KNOWN

$$z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} \quad (9.1)$$

2) Make the conclusion:  
the test statistics falls in the Rejection region Then, **Reject  $H_0$**

3) Make the conclusion:  
 $P_{value} = 0.0749 < \alpha = 0.10 \rightarrow$  Then, **Reject  $H_0$**

Sampling distribution  
of  $\bar{x}$

$$H_1: \mu > 50,$$

Accept  
 $H_0$

$$\alpha = 0.10$$

Reject  
 $H_0$



$$\mu_0$$

$$Z_\alpha = 1.28$$

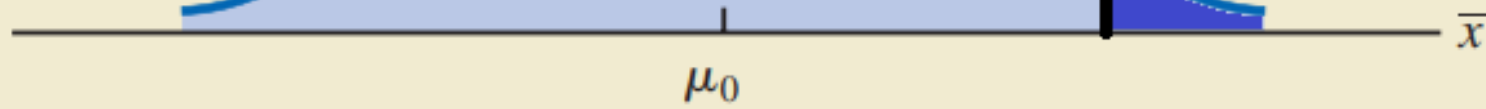
$\bar{x}$

Sampling distribution  
of  $\bar{x}$

$$H_1: \mu > 50,$$

Accept  
 $H_0$

Reject  
 $H_0$



## Example:

Assuming that a random sample of 240 students from PTUK university has been given a qualified exam, and 192 of these students had success in the exam by levels over than 70. Test if the population proportion of students in PTUK who passed the qualifying exam with graded over than 70 is more than 0.75 based on  $\alpha = 0.05$ .

### Solve

The hypothesis:  $H_0: p \leq 0.75$  Vs.  $H_a: p > 0.75$  , In our question:  $\bar{p} = \frac{192}{240} = 0.8$

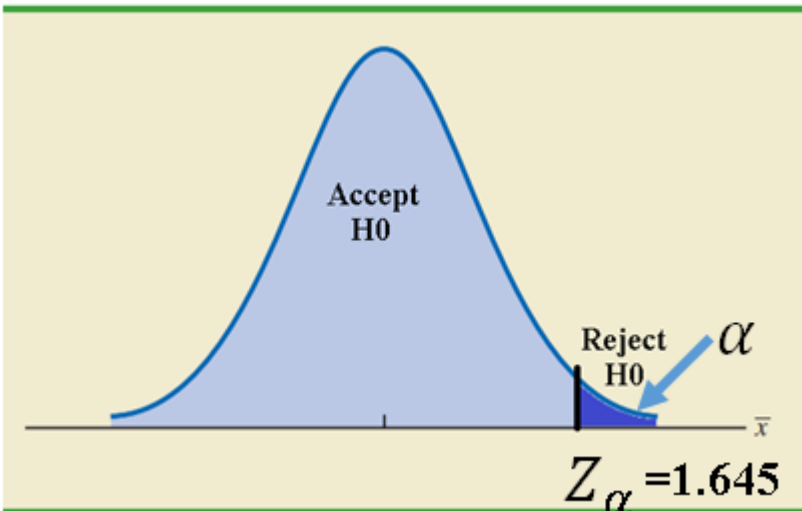
The Test Statistic:  $z = \frac{0.8 - 0.75}{\sqrt{\frac{0.75(1-0.75)}{240}}} = \frac{0.05}{\sqrt{0.00078125}} = 1.7889$

TEST STATISTIC FOR HYPOTHESIS TESTS ABOUT A POPULATION PROPORTION

$$z = \frac{\bar{p} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}}$$

(9.4)

### Draw Acceptance-Rejection region



Make the conclusion:  
**Reject  $H_0$**

### Example:

Consider the following hypothesis test  $H_0: \mu = 70$  Vs.  $H_1: \mu \neq 70$ . A sample of 100 provided a sample mean of 73. If the sample standard deviation is 8.

What is your decision about this hypothesis based on  $\alpha = 0.05$

TEST STATISTIC FOR HYPOTHESIS TESTS ABOUT A POPULATION MEAN:  
 $\sigma$  UNKNOWN

t distribution with  $(n - 1)$  degrees of freedom

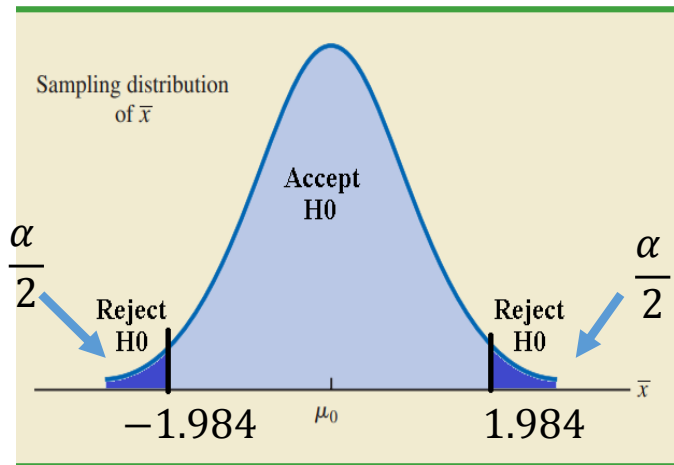
$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} \quad (9.2)$$

### Solve

1)  
The hypothesis:  $H_0: \mu = 70$  Vs.  $H_1: \mu \neq 70$ ,

The Test Statistic:  $t = \frac{73-70}{8/\sqrt{100}} = 3.75$  it is t distributed with 99 degrees of freedom

Draw Acceptance-Rejection region



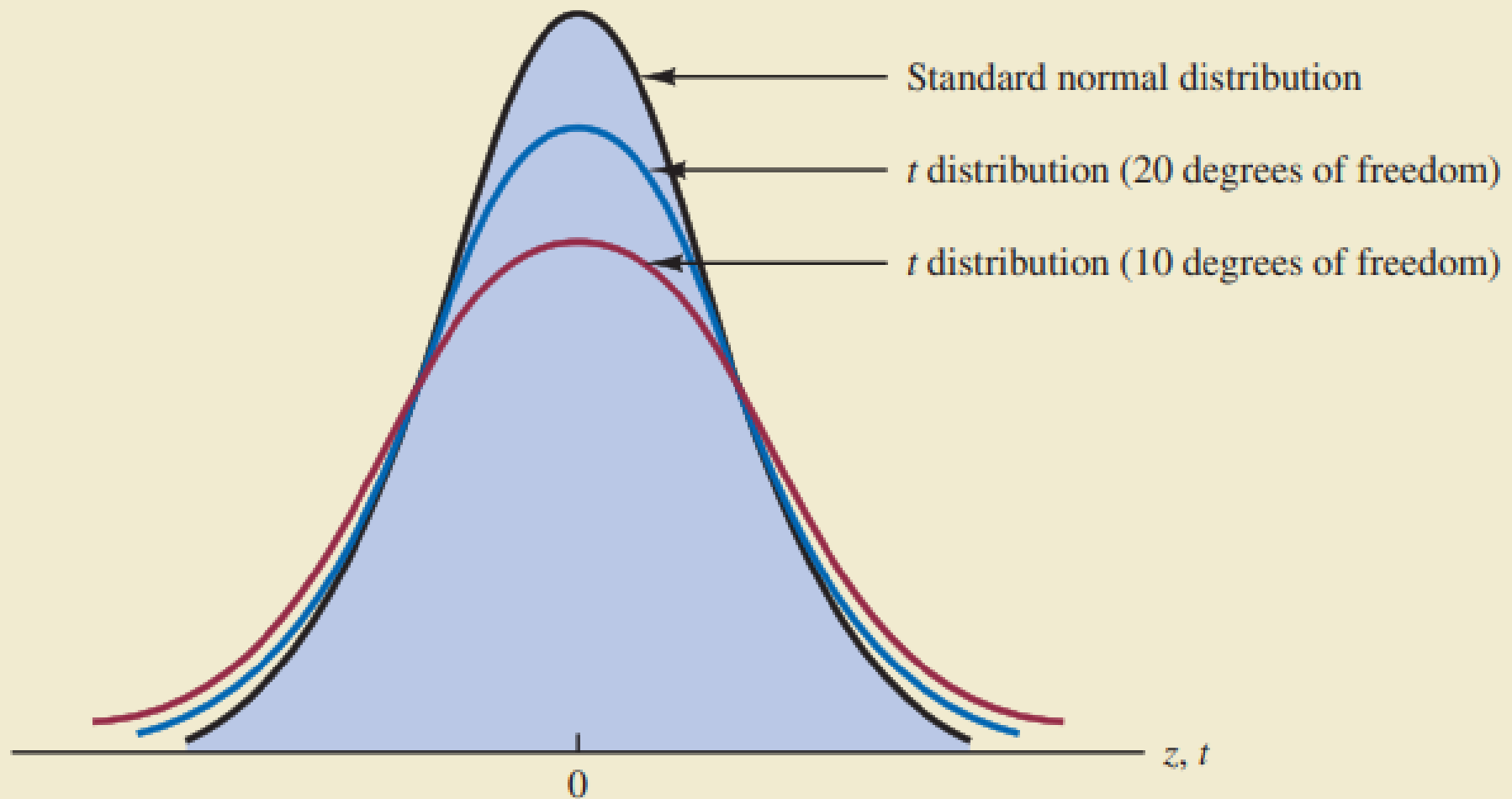
Make the conclusion:

The test statistics falls in the Rejection region

Then, **Reject  $H_0$**



## COMPARISON OF THE STANDARD NORMAL DISTRIBUTION WITH $t$ DISTRIBUTIONS HAVING 10 AND 20 DEGREES OF FREEDOM



**Example:**

If a p-value for your hypothesis testing about the population mean is 0.071, and the level of significance used was 5%, then the conclusion would be to:

- 1) Reject the null hypothesis  $H_0$  OR
- 2) **Don't Reject the null hypothesis  $H_0$**  OR
- 3) Not enough information to make conclusion

**Example:**

Consider a hypothesis  $H_0: \mu = 30$  Vs.  $H_a: \mu \neq 30$ , if the test critical value is 1.645, and the test statistic value ( $z=0.874$ ) then

- 1) The null hypothesis  $H_0$  should be rejected
- 2) **The null hypothesis  $H_0$  should not be rejected**
- 3) Not enough information is given to make conclusion
- 4) The alternative hypothesis  $H_a$  must be accepted.

**Example:**

A survey was conducted to get an estimate of the proportion of shisha smokers among the school students. A government report says that 8% of them are shisha smokers.

The school manager doubts the report result and thinks that the actual proportion is much less than this proportion.

Choose the correct choice of null and alternative hypothesis the school manager wants to test:

- 1)  $H_0: p = 0.08$  versus  $H_a: p \leq 0.08$
- 2)  $H_0: p = 0.08$  versus  $H_a: p > 0.08$ .
- 3)  **$H_0: p = 0.08$  versus  $H_a: p < 0.08$ .**
- 4)  $H_0: p = 0.08$  versus  $H_a: p \neq 0.08$

**Example:**

A hypothesis test is done in which the alternative hypothesis is that more than 8% of a population is left-handed. The p-value for the test is calculated to be (0.18).

Which statement is correct? we can :

- 1) conclude that more than 8% of the population is left-handed.
- :2) conclude that more than 18% of the population is left-handed
- 3) conclude that exactly 18% of the population is left-handed
- 4) Not conclude that more than 8% of the population is left-handed**

**Example:**

The test statistic for a population mean in a One-tailed test is  $z = -1.18$ , then the p-value is

- 1) 0.119**
- 2) 0.05
- 3) 0.118
- 4) 0.238

**Example:**

The test statistic for a population mean in a Two-tailed test is  $z = -1.18$ , then the p-value is

- 1) 0.119
- 2) 0.05
- 3) 0.118
- 4) 0.238**

**Example:**

Suppose 90% confidence interval for population mean ( $\mu$ ) is (42.3,56.7), If the test is  $H_0: \mu = 50$  Vs.  $H_a: \mu \neq 50$  at  $\alpha = 10\%$ , then, the p\_value of this test is : **1) more than 0.10** 2) less than 0.10 3) more than 0.90 3) equals to 0.05

**Example:**

Assuming the power of a test is 0.85 .The probability of [Don't Reject  $H_0$  when it is false] is: 1) 0.85 **2) 0.15** 3) 0.075 4)0.05.