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CREATE CHANGE

ECON1310
Introductory Statistics for Social Sciences

Tutorial 9: HYPOTHESIS TESTING I

Tutor: Francisco Tavares Garcia

LBRT #2 is open!

LBRT #2 (First Attempt) now available

Posted on: Tuesday, 17 January 2023 09:00:00 o'clock AEST

Dear Students,

A reminder that **LBRT #2 (First Attempt)** is now available and will be open until **4pm Wednesday 18 January.** This LBRT can be accessed via Blackboard under Assessment > LBRTs (Lecture Block Review Tasks) > Semester 3 (Summer) LBRTs > LBRT #2.

Please note that you will have **90 minutes (1.5 hrs)** to complete the quiz. The quiz will **automatically submit** once the 90 minutes have elapsed. It should also be noted that **no access will be available after 4pm Wednesday**. Therefore, please give yourself enough time to complete the quiz (i.e. start at 2:30pm Wednesday at the latest to give yourself a full 90 minutes).

You will be able to **view your score** (but not feedback) at **4pm Wednesday 18 January**, and able to view both your **score and feedback** at **9am Monday 23 January**.

Note there is an **optional second attempt** for LBRT #2, which will be available from 9am Thursday 19 January until 4pm Friday 20 January. Only your best score from the 2 attempts will contribute towards your final grade.

In preparation for LBRT #2, please familiarise yourself with the **Practice LBRT test**, (which shows you how the questions will appear) and the **General Information for Completing LBRTs** document. Details can be found under Assessment > LBRTs (Lecture Block Review Tasks).

Best of luck!

Dominic

CML 04 (2^{nd}) and 05 (1^{st})

ECON1310 - Week 7: CML 4 (1st Attempt) Closing Today

Posted on: Monday, 16 January 2023 06:00:00 o'clock AEST

Dear Students,

Welcome to Week 7!

1. **CML 4 (1st Attempt)** will **close at 4pm** today (16 January). Please read the **CML Information Sheet** carefully, especially the CML **rules** (located under the CML Administrative Folder). Remember to **CHECK, SAVE and SUBMIT** your CML before the closing time, as the quiz does NOT auto-submit. You will be able to **view your answers** to CML 4 (1st Attempt) **after the closing time at 4pm today** through the My Grades tab. **Instructions** on how to access your answers are located on page 7 of the CML Information Sheet.

2. **CML 4 (2nd Attempt)** will be **open at 9am this Wednesday** (18 January) and **close at 4pm this Friday** (20 January).

3. **CML 5 (1st Attempt)** will also be **open at 9am this Wednesday** (18 January) and **close at 4pm next Monday** (23 January).

4. **LBRT #2 (First Attempt)** will open tomorrow at 9am and close at 4pm on Wednesday, 18 January, 2023. Please refer to my previous announcement for further details about the assessment.

Feel free to email me for clarification on any of the above.

Best of luck!

Dominic

adm T09 Q1 Q2 Q3 Q4

ECON1310

Tutorial 9 – Week 10

HYPOTHESIS TESTING I

At the end of this tutorial you should be able to

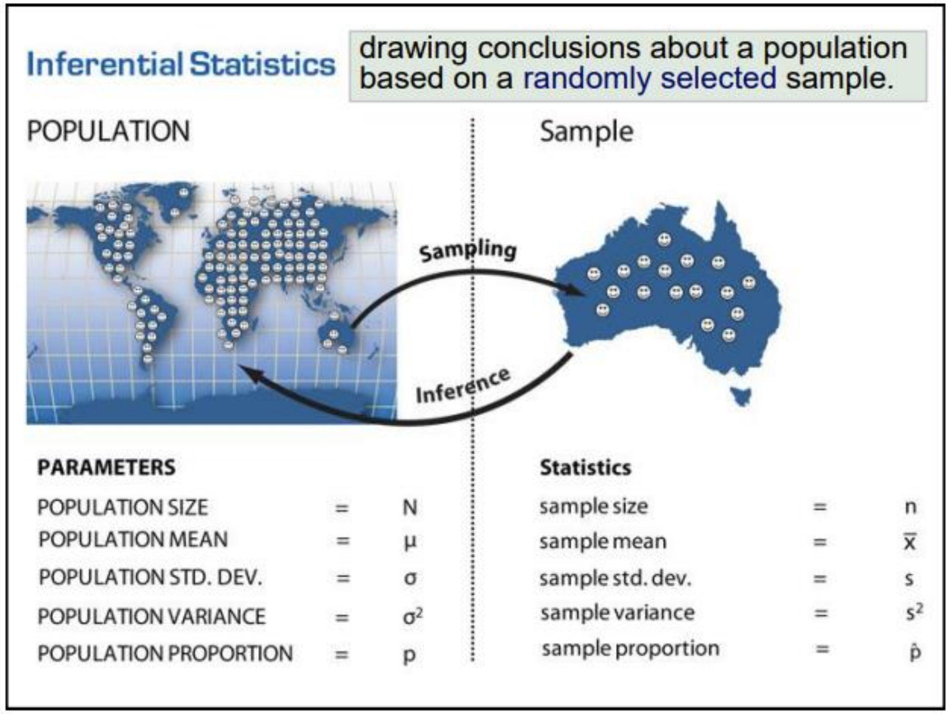
- Formulate a hypothesis as a two-tail test or a one-tail test
- Determine whether it is appropriate to use a Z statistic or a *t* statistic
- Carry out one-tail and two-tail hypothesis tests using the 5-step method
- Describe Type I and Type II errors.

(Poll)

Q1. A small computer software business puts an advertisement into 9 different computer magazines and keeps track of the total orders generated by each separate advertisement. Mean sales are found to be \$1200 with a standard deviation of \$450. Is this sufficient evidence to refute the assertion using 5% level of significance that expected the mean sales from advertising are \$1500?

1. What symbol would you give to the value 9 different computer magazines? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n



2. What symbol would you give to the value \$1200? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

3. What symbol would you give to the value \$450? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

4. What symbol would you give to the value 5% level of significance? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

5. What symbol would you give to the value \$1500? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

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(Poll)

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2. What symbol would you give to the value $1200? (Single Choice) *

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3. What symbol would you give to the value $450? (Single Choice) *

- σ (sigma)
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5. What symbol would you give to the value $1500? (Single Choice) *

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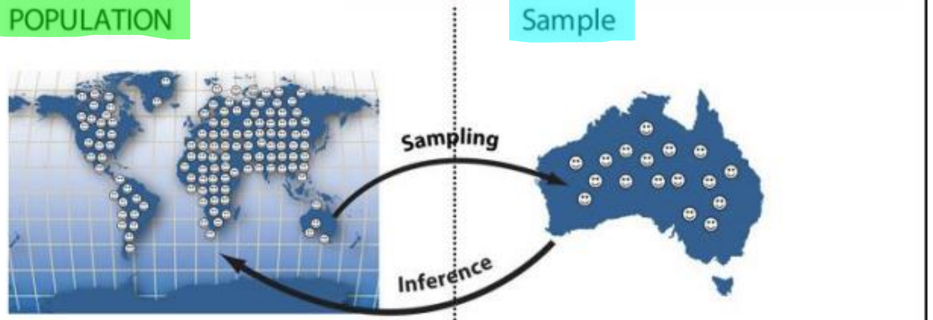
Inferential Statistics — drawing conclusions about a population based on a randomly selected sample.



PARAMETERS			Statistics		
POPULATION SIZE	=	N	sample size	=	n
POPULATION MEAN	=	μ	sample mean	=	$\bar{x}$
POPULATION STD. DEV.	=	σ	sample std. dev.	=	s
POPULATION VARIANCE	=	σ^2	sample variance	=	s^2
POPULATION PROPORTION	=	p	sample proportion	=	$\hat{p}$

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$n = 9$
$\bar{X} = \$1200$
$s = \$450$
$\alpha = 5\%$
$\mu = \$1500$

Q1. A small computer software business puts an advertisement into 9 different computer magazines and keeps track of the total orders generated by each separate advertisement. Mean sales are found to be \$1200 with a standard deviation of \$450. Is this sufficient evidence to refute the assertion using 5% level of significance that expected the mean sales from advertising are \$1500?

1. What type of problem is it? (Single Choice) *

- ◯ Population Mean (Seagull) (no sample)
- ◯ Population Mean (Pelican) (σ is known)
- ◯ Population Mean (Shag) (σ is unknown but s is known)
- ◯ Population Proportion (Freaky fish) (proportion)

2. What table will we use? (Single Choice) *

- ◯ Z table (standard normal distribution)
- ◯ t table (Student's t-distribution)

(Poll)

3. What is the value of α (alpha)? (Single Choice) *

- ◯ 0.01
- ◯ 0.02
- ◯ 0.03
- ◯ 0.04
- ◯ 0.05
- ◯ 0.1

4. What type of test is it? (Single Choice) *

- ◯ one tail test (upper tail >)
- ◯ one tail test (lower tail <)
- ◯ two tail test (=)

adm T09 Q1 Q2 Q3 Q4

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$n = 9$
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$\alpha = 5\% = 0.05$
$\mu = \$1500$

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Five Steps for Hypothesis Testing.

1. State H_0 and H_1
2. State the decision rule for the appropriate test statistic and sampling distribution
3. Calculate the test statistic
4. Make a decision (reject H_0 or do not reject H_0)
5. State a conclusion

Note:
steps 1 and 2 are prior to any sample information.

26

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Step 1: State H_0 and H_1
H_0: $\mu = \$1500$
H_1: $\mu \neq \$1500$

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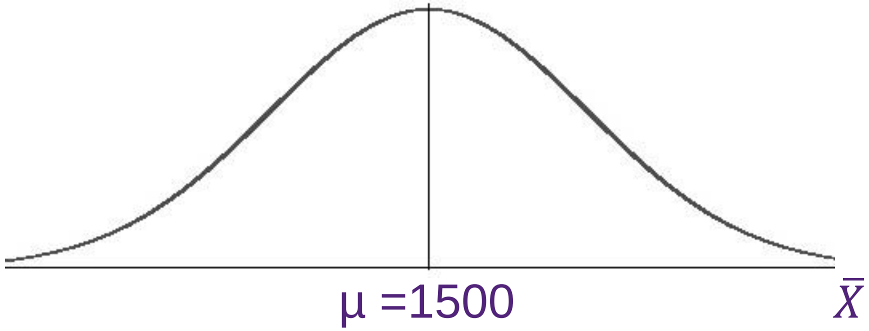
Step 1: State H_0 and H_1

H_0: μ = \$1500

H_1: $\mu \neq$ \$1500

Two tail test



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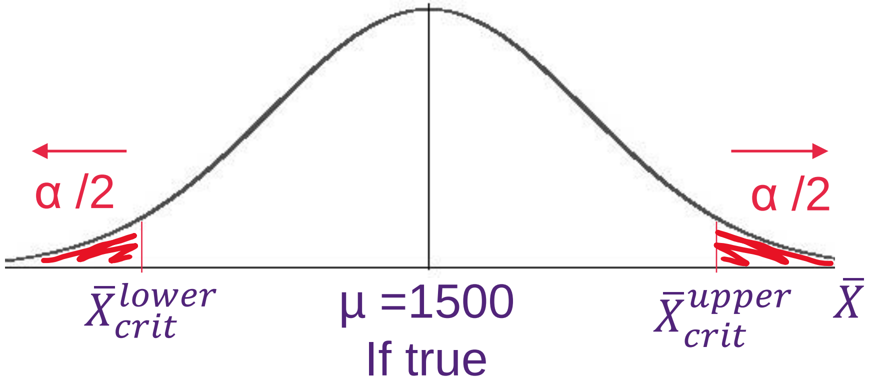
Step 1: State H_0 and H_1
H_0: μ = \$1500
H_1: μ ≠ \$1500

Two tail test

Rejection regions



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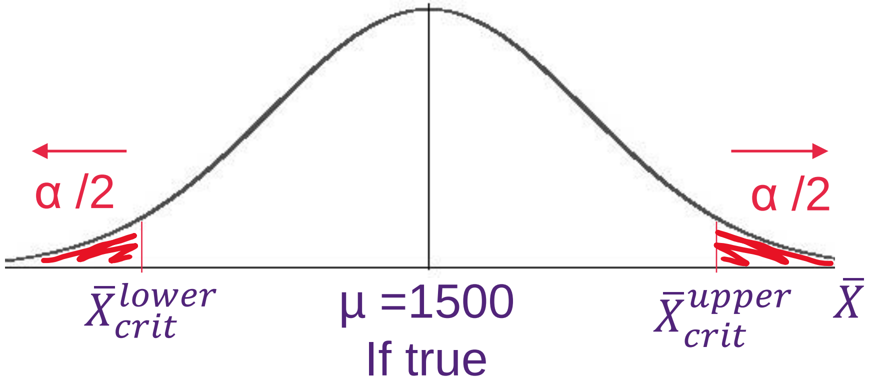
H_1: $\mu \neq \$1500$

Step 2: Decision rule
Reject H_0 if

Rejection regions



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Step 1: State H_0 and H_1
H_0: μ = \$1500
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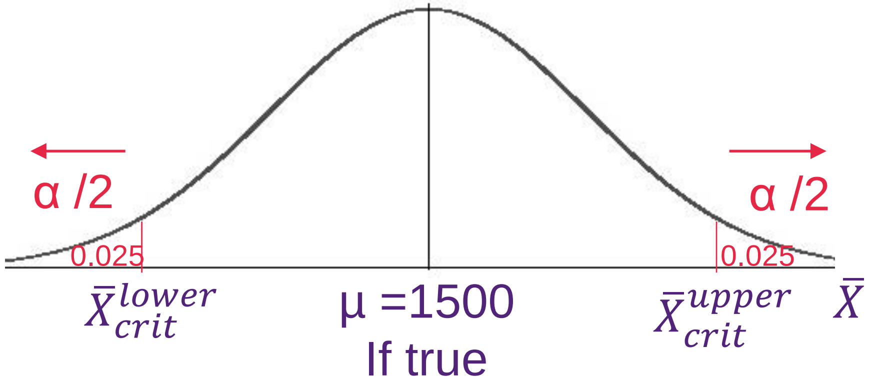
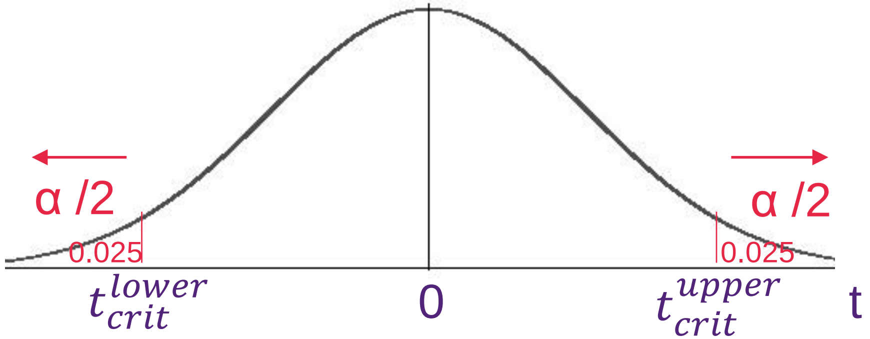
Step 2: Decision rule
Reject H_0 if $|t_{calc}| > t_{crit}$

Rejection regions





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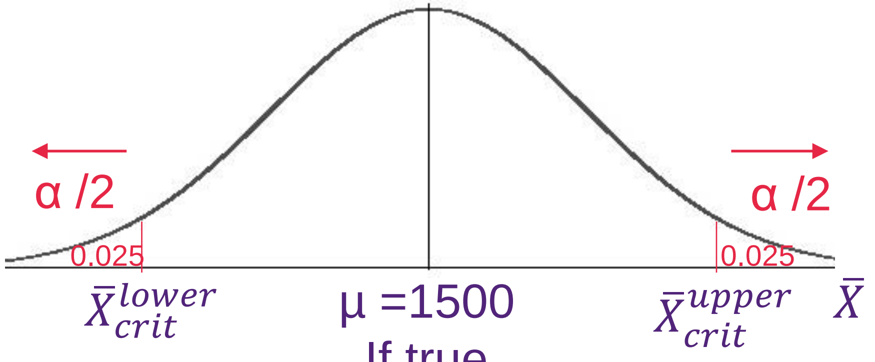
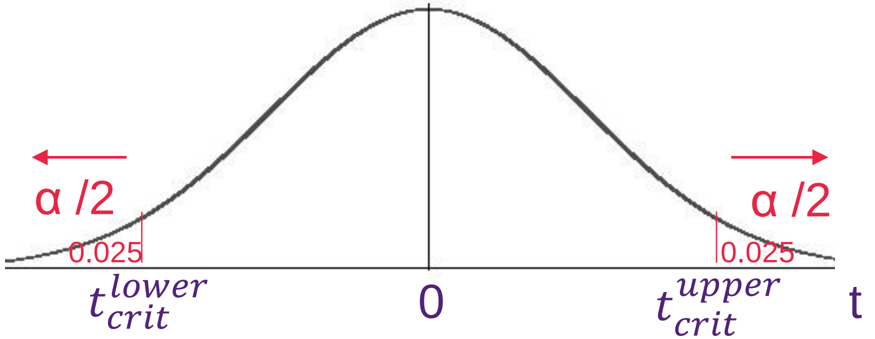
Step 1: State H_0 and H_1
H_0: μ = \$1500
H_1: μ ≠ \$1500

Step 2: Decision rule
Reject H_0 if $|t_{calc}| > t_{crit} = t_{\alpha/2,n-1} = t_{0.025,8}$ = ?

Rejection regions





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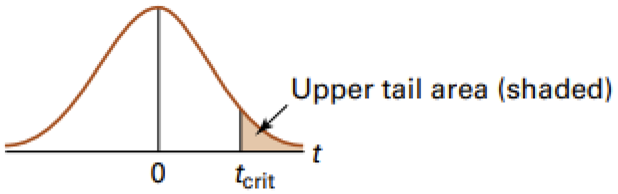
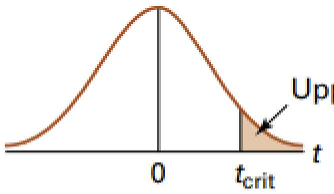


$t_{0.025,\,8}$

	Upper tail areas					
df	$t_{.10}$	$t_{.05}$	$t_{.025}$	$t_{.01}$	$t_{.005}$	$t_{.001}$
1	3.078	6.314	12.706	31.821	63.657	318.309
2	1.886	2.920	4.303	6.965	9.925	22.327
3	1.638	2.353	3.182	4.541	5.841	10.215
4	1.533	2.132	2.776	3.747	4.604	7.173
5	1.476	2.015	2.571	3.365	4.032	5.893
6	1.440	1.943	2.447	3.143	3.707	5.208
7	1.415	1.895	2.365	2.998	3.499	4.785
8	1.397	1.860	2.306	2.896	3.355	4.501
9	1.383	1.833	2.262	2.821	3.250	4.297
10	1.372	1.812	2.228	2.764	3.169	4.144
11	1.363	1.796	2.201	2.718	3.106	4.025
12	1.356	1.782	2.179	2.681	3.055	3.930
13	1.350	1.771	2.160	2.650	3.012	3.852
14	1.345	1.761	2.145	2.624	2.977	3.787
15	1.341	1.753	2.131	2.602	2.947	3.733
16	1.337	1.746	2.120	2.583	2.921	3.686
17	1.333	1.740	2.110	2.567	2.898	3.646
18	1.330	1.734	2.101	2.552	2.878	3.610
19	1.328	1.729	2.093	2.539	2.861	3.579
20	1.325	1.725	2.086	2.528	2.845	3.552
21	1.323	1.721	2.080	2.518	2.831	3.527
22	1.321	1.717	2.074	2.508	2.819	3.505
23	1.319	1.714	2.069	2.500	2.807	3.485
24	1.318	1.711	2.064	2.492	2.797	3.467
25	1.316	1.708	2.060	2.485	2.787	3.450



$t_{0.025,\,8}$

	Upper tail areas					
df	$t_{.10}$	$t_{.05}$	$t_{.025}$	$t_{.01}$	$t_{.005}$	$t_{.001}$
1	3.078	6.314	12.706	31.821	63.657	318.309
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3	1.638	2.353	3.182	4.541	5.841	10.215
4	1.533	2.132	2.776	3.747	4.604	7.173
5	1.476	2.015	2.571	3.365	4.032	5.893
6	1.440	1.943	2.447	3.143	3.707	5.208
7	1.415	1.895	2.365	2.998	3.499	4.785
8	1.397	1.860	2.306	2.896	3.355	4.501
9	1.383	1.833	2.262	2.821	3.250	4.297
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15	1.341	1.753	2.131	2.602	2.947	3.733
16	1.337	1.746	2.120	2.583	2.921	3.686
17	1.333	1.740	2.110	2.567	2.898	3.646
18	1.330	1.734	2.101	2.552	2.878	3.610
19	1.328	1.729	2.093	2.539	2.861	3.579
20	1.325	1.725	2.086	2.528	2.845	3.552
21	1.323	1.721	2.080	2.518	2.831	3.527
22	1.321	1.717	2.074	2.508	2.819	3.505
23	1.319	1.714	2.069	2.500	2.807	3.485
24	1.318	1.711	2.064	2.492	2.797	3.467
25	1.316	1.708	2.060	2.485	2.787	3.450

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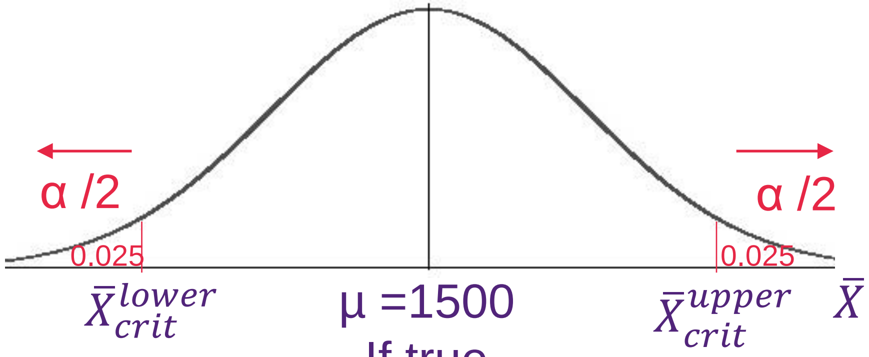
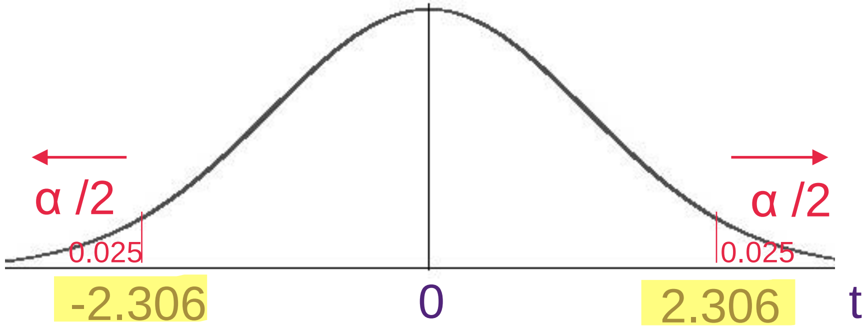
Step 1: State H_0 and H_1
H_0: μ = \$1500
H_1: μ ≠ \$1500

Step 2: Decision rule
Reject H_0 if $|t_{calc}| > t_{crit} = t_{\alpha/2,n-1} = t_{0.025,8} = 2.306$

Rejection regions





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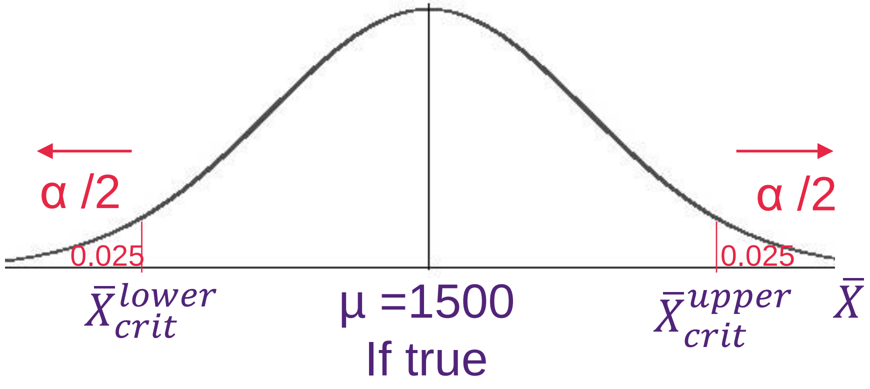
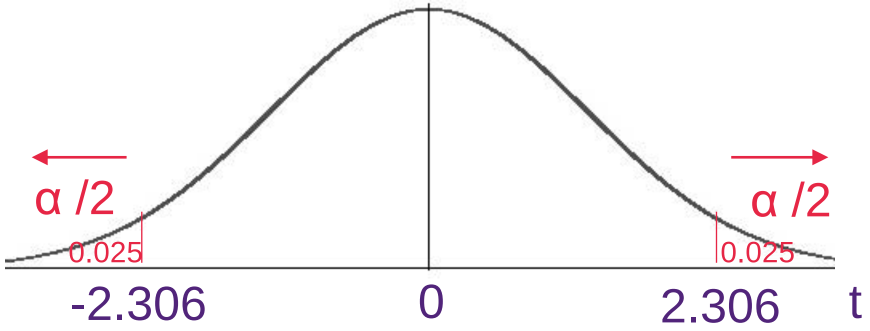
Step 3: Calculate t_{calc}

Rejection regions





Five Steps for Hypothesis Testing.

1. State H_0 and H_1
2. State the decision rule for the appropriate test statistic and sampling distribution
3. Calculate the test statistic
4. Make a decision (reject H_0 or do not reject H_0)
5. State a conclusion

Note:
steps 1 and 2 are prior to any sample information.

26

n = 9
$\bar{X}$ = $1200
s = $450
α = 5% = 0.05
μ = $1500

Q1. A small computer software business puts an advertisement into 9 different computer magazines and keeps track of the total orders generated by each separate advertisement. Mean sales are found to be $1200 with a standard deviation of $450. Is this sufficient evidence to refute the assertion using 5% level of significance that expected the mean sales from advertising are $1500?

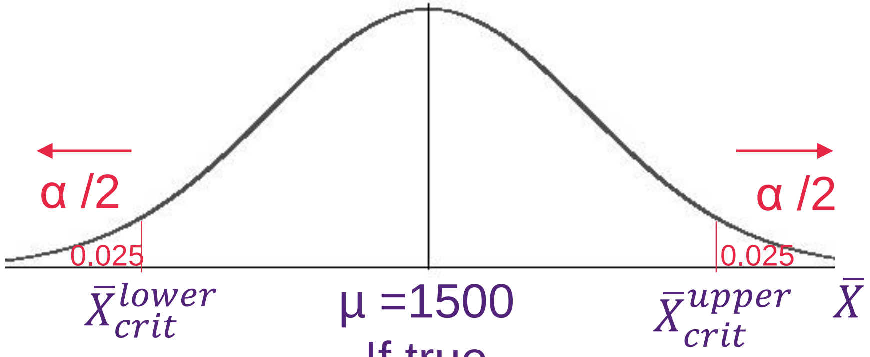
Step 1: State H_0 and H_1
H_0: μ = $1500
H_1: μ ≠ $1500

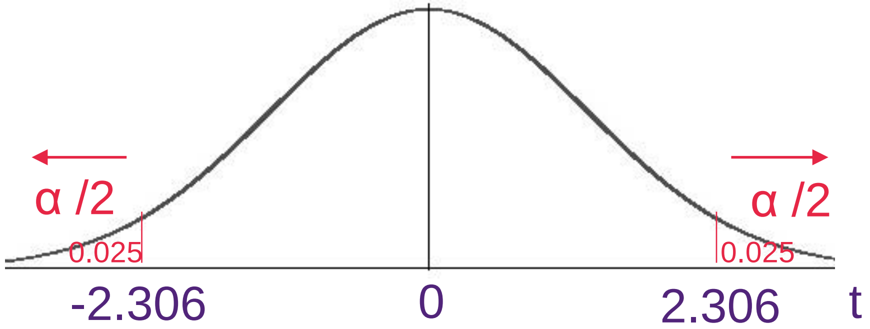
Step 2: Decision rule
Reject H_0 if $|t_{calc}| > t_{crit} = t_{\alpha/2,n-1} = t_{0.025,8} = 2.306$

Step 3: Calculate t_{calc}

$$t_{calc} = \frac{\bar{X} - \mu}{s_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} = ?$$

Rejection regions





Five Steps for Hypothesis Testing.

1. State H_0 and H_1
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Note:
steps 1 and 2 are prior to any sample information.

26

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$n = 9$
$\bar{X} = \$1200$
$s = \$450$
$\alpha = 5\% = 0.05$
$\mu = \$1500$

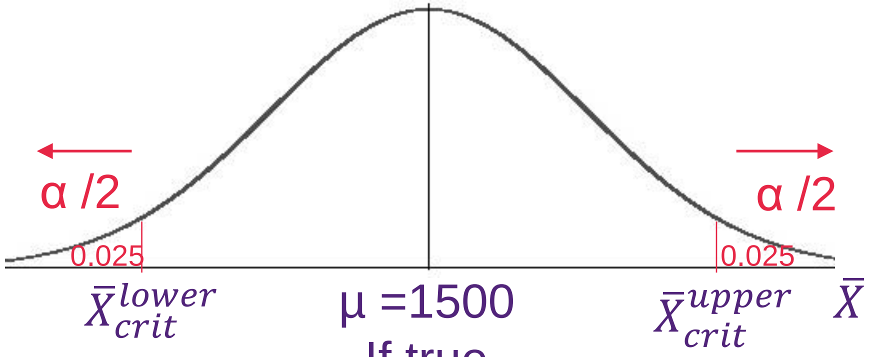
Q1. A small computer software business puts an advertisement into 9 different computer magazines and keeps track of the total orders generated by each separate advertisement. Mean sales are found to be \$1200 with a standard deviation of \$450. Is this sufficient evidence to refute the assertion using 5% level of significance that expected the mean sales from advertising are \$1500?

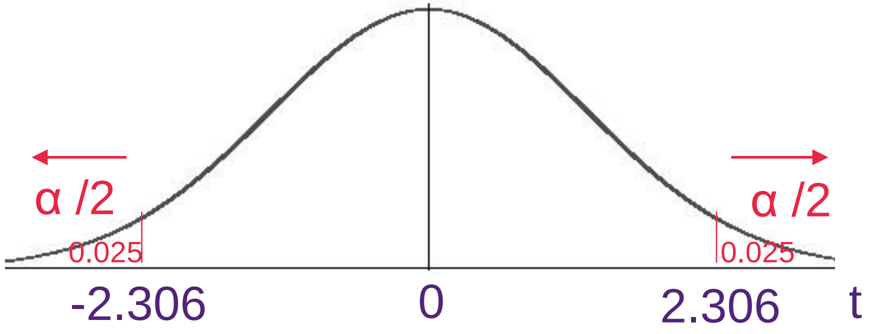
Step 1: State H_0 and H_1
H_0: $\mu = \$1500$
H_1: $\mu \neq \$1500$

Step 2: Decision rule
Reject H_0 if $|t_{calc}| > t_{crit} = t_{\alpha/2,n-1} = t_{0.025,8} = 2.306$

Step 3: Calculate t_{calc}
$$t_{calc} = \frac{\bar{X} - \mu}{s_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{1200 - 1500}{\frac{450}{\sqrt{9}}} = -2$$

Rejection regions





Five Steps for Hypothesis Testing.

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5. State a conclusion

Note:
steps 1 and 2 are prior to any sample information.

26

adm T09 Q1 Q2 Q3 Q4

$n = 9$
$\bar{X} = \$1200$
$s = \$450$
$\alpha = 5\% = 0.05$
$\mu = \$1500$

Q1. A small computer software business puts an advertisement into 9 different computer magazines and keeps track of the total orders generated by each separate advertisement. Mean sales are found to be \$1200 with a standard deviation of \$450. Is this sufficient evidence to refute the assertion using 5% level of significance that expected the mean sales from advertising are \$1500?

Step 1: State H_0 and H_1
H_0: $\mu = \$1500$
H_1: $\mu \neq \$1500$

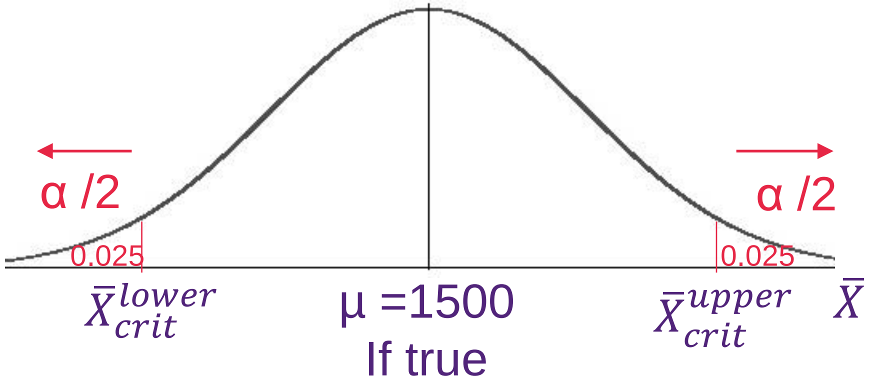
Step 2: Decision rule
Reject H_0 if $|t_{calc}| > t_{crit} = t_{\alpha/2,n-1} = t_{0.025,8} = 2.306$

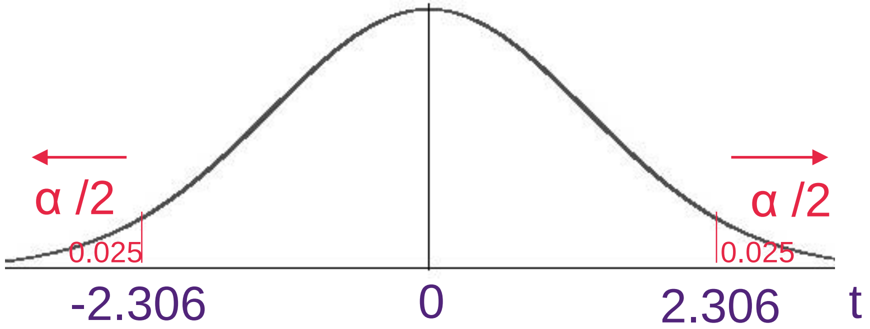
Step 3: Calculate t_{calc}

$$t_{calc} = \frac{\bar{X} - \mu}{s_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{1200 - 1500}{\frac{450}{\sqrt{9}}} = -2$$

Step 4: Make a decision
$|t_{calc}| > t_{crit}$

Rejection regions





Five Steps for Hypothesis Testing.

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26

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Q1. A small computer software business puts an advertisement into 9 different computer magazines and keeps track of the total orders generated by each separate advertisement. Mean sales are found to be $1200 with a standard deviation of $450. Is this sufficient evidence to refute the assertion using 5% level of significance that expected the mean sales from advertising are $1500?

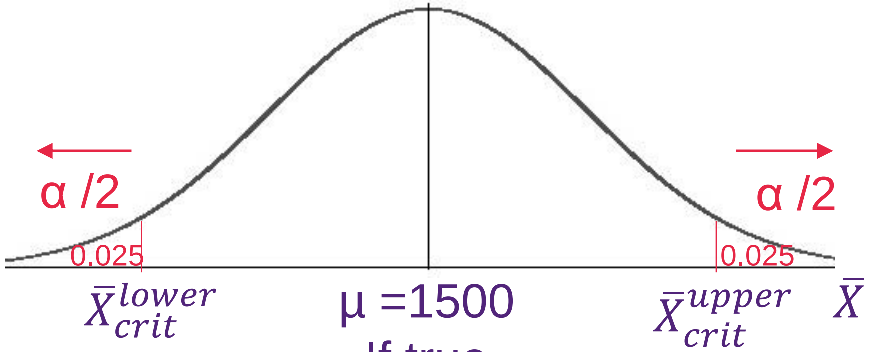
Step 1: State H_0 and H_1
H_0: μ = $1500
H_1: μ ≠ $1500

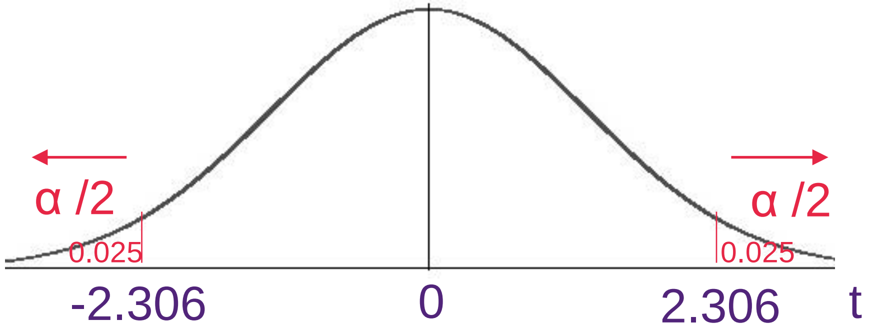
Step 2: Decision rule
Reject H_0 if $|t_{calc}| > t_{crit}$ = $t_{\alpha/2,n-1}$ = $t_{0.025,8}$ = 2.306

Step 3: Calculate t_{calc}
$$t_{calc} = \frac{\bar{X} - \mu}{s_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{1200 - 1500}{\frac{450}{\sqrt{9}}} = -2$$

Step 4: Make a decision
$|t_{calc}| > t_{crit}$ → |-2| > 2.306 → Do not reject.

Rejection regions





Five Steps for Hypothesis Testing.

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26

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$n = 9$
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Q1. A small computer software business puts an advertisement into 9 different computer magazines and keeps track of the total orders generated by each separate advertisement. Mean sales are found to be \$1200 with a standard deviation of \$450. Is this sufficient evidence to refute the assertion using 5% level of significance that expected the mean sales from advertising are \$1500?

Step 1: State H_0 and H_1
H_0: $\mu = \$1500$
H_1: $\mu \neq \$1500$

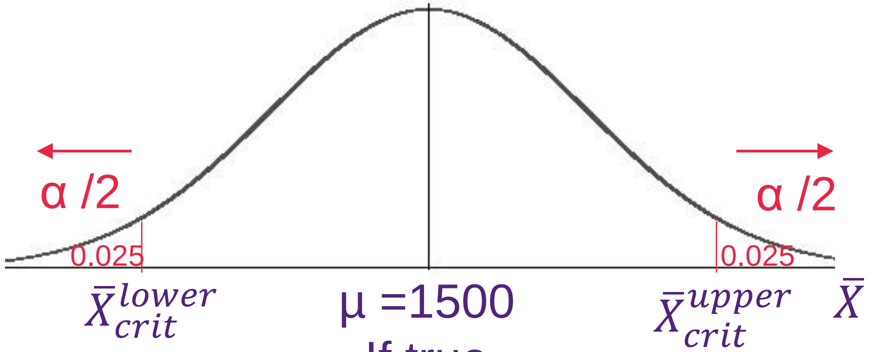
Step 2: Decision rule
Reject H_0 if $|t_{calc}| > t_{crit} = t_{\alpha/2,n-1} = t_{0.025,8} = 2.306$

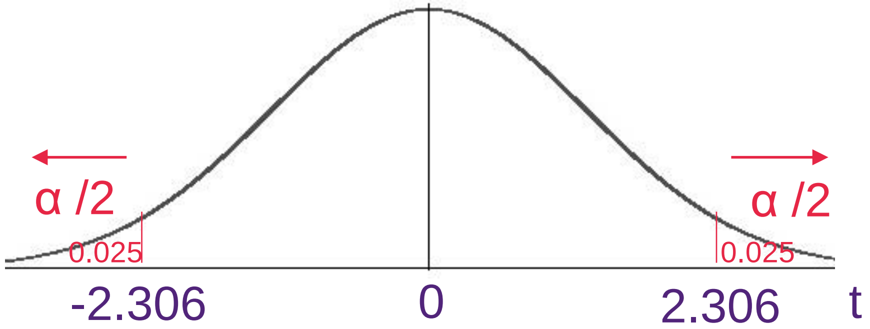
Step 3: Calculate t_{calc}

$$t_{calc} = \frac{\bar{X} - \mu}{s_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{1200 - 1500}{\frac{450}{\sqrt{9}}} = -2$$

Step 4: Make a decision
$|t_{calc}| > t_{crit} \rightarrow |-2| > 2.306 \rightarrow$ Do not reject.

Rejection regions





Five Steps for Hypothesis Testing.

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4. Make a decision (reject H_0 or do not reject H_0)
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steps 1 and 2 are prior to any sample information.

26

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$\bar{X} = \$1200$
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Step 1: State H_0 and H_1
H_0: μ = \$1500
H_1: μ ≠ \$1500

Step 2: Decision rule
Reject H_0 if $|t_{calc}| > t_{crit} = t_{\alpha/2,n-1} = t_{0.025,8} = 2.306$

Step 3: Calculate t_{calc}

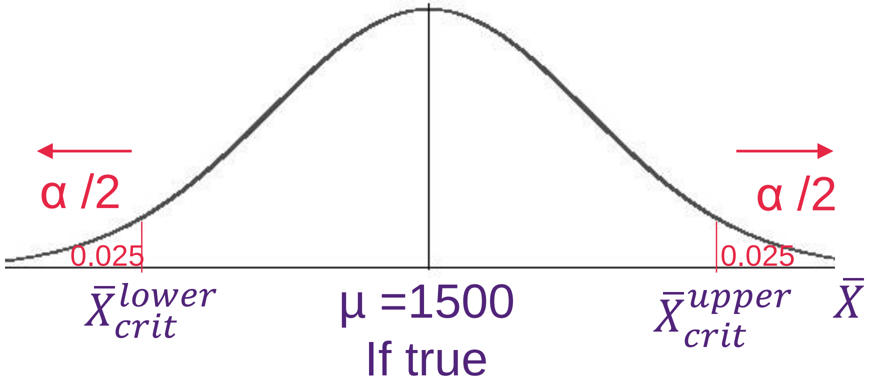
$$t_{calc} = \frac{\bar{X} - \mu}{s_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{1200 - 1500}{\frac{450}{\sqrt{9}}} = -2$$

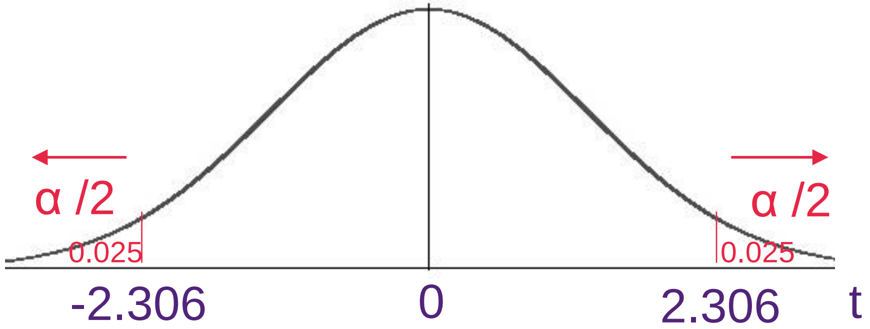
Step 4: Make a decision
$|t_{calc}| > t_{crit} \rightarrow |-2| > 2.306 \rightarrow$ Do not reject.

Step 5: Conclusion
There is insufficient evidence to suggest that average ad sales are not \$1500 at the 5% LOS.

Cannot refute it.

Rejection regions





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4. Make a decision (reject H_0 or do not reject H_0)
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26

Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

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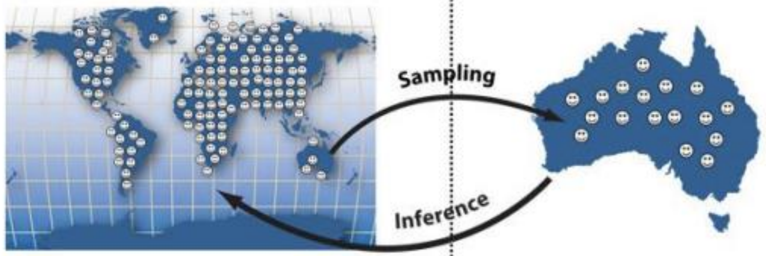
(Poll)

1. What symbol would you give to the value 920? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

Inferential Statistics drawing conclusions about a population based on a randomly selected sample.

POPULATION | Sample



PARAMETERS			Statistics		
POPULATION SIZE	=	N	sample size	=	n
POPULATION MEAN	=	μ	sample mean	=	$\bar{x}$
POPULATION STD. DEV.	=	σ	sample std. dev.	=	s
POPULATION VARIANCE	=	σ^2	sample variance	=	s^2
POPULATION PROPORTION	=	p	sample proportion	=	$\hat{p}$

2. What symbol would you give to the value 20? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

3. What symbol would you give to the value 35? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

4. What symbol would you give to the value 925? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

5. What symbol would you give to the value 5% level of significance? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

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1. What symbol would you give to the value 920? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

(Poll)

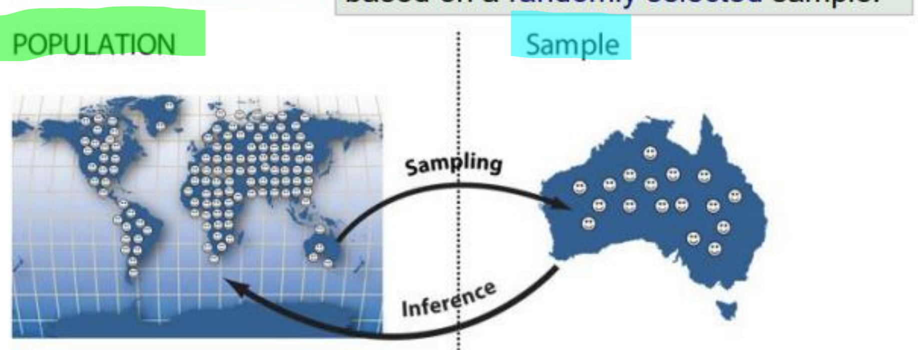
2. What symbol would you give to the value 20? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

3. What symbol would you give to the value 35? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

4. What symbol would you give to the value 925? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

5. What symbol would you give to the value 5% level of significance? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

Inferential Statistics: drawing conclusions about a population based on a randomly selected sample.



PARAMETERS			Statistics		
POPULATION SIZE	=	N	sample size	=	n
POPULATION MEAN	=	μ	sample mean	=	x̄
POPULATION STD. DEV.	=	σ	sample std. dev.	=	s
POPULATION VARIANCE	=	σ^2	sample variance	=	s^2
POPULATION PROPORTION	=	p	sample proportion	=	p̂

adm T09 Q1 Q2 Q3 Q4

$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\%$

Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

1. What type of problem is it? (Single Choice) *

- ◯ Population Mean (Seagull) (no sample)
- ◯ Population Mean (Pelican) (σ is known)
- ◯ Population Mean (Shag) (σ is unknown but s is known)
- ◯ Population Proportion (Freaky fish) (proportion)

2. What table will we use? (Single Choice) *

- ◯ Z table (standard normal distribution)
- ◯ t table (Student's t-distribution)

(Poll)

3. What is the value of α (alpha)? (Single Choice) *

- ◯ 0.01
- ◯ 0.02
- ◯ 0.03
- ◯ 0.04
- ◯ 0.05
- ◯ 0.1

4. What type of test is it? (Single Choice) *

- ◯ one tail test (upper tail >)
- ◯ one tail test (lower tail <)
- ◯ two tail test (=)

$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

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(Poll)

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- 0.01
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- 0.03
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- 0.1

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- one tail test (upper tail >)
- one tail test (lower tail <)
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Step 1: State H_0 and H_1

adm T09 Q1 Q2 Q3 Q4

$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

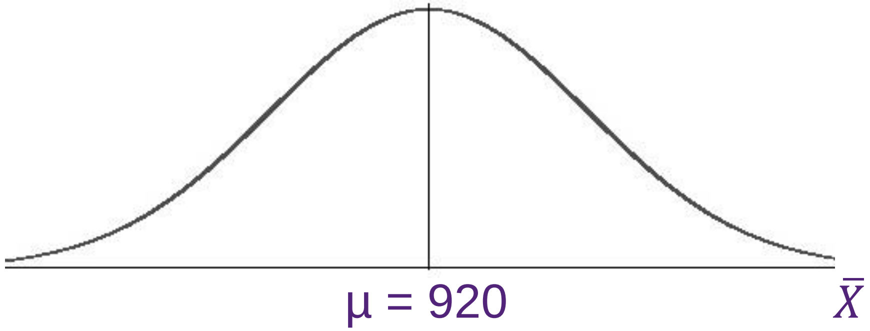
Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

Step 1: State H_0 and H_1

H_0: $\mu \leq 920$ or could be $\mu = 920$

H_1: $\mu > 920$

One tail test



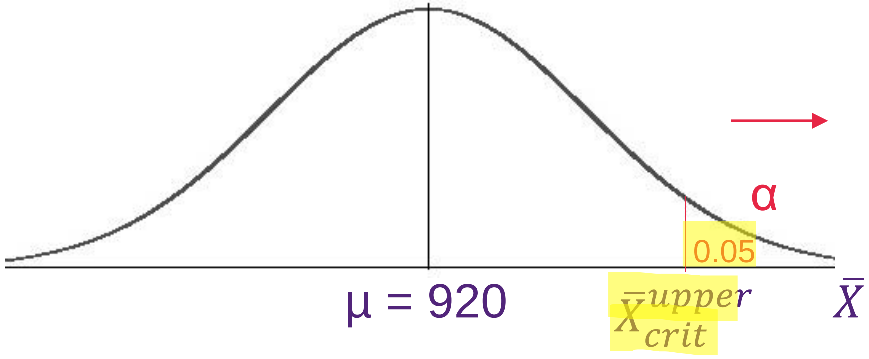
$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

Step 1: State H_0 and H_1
H_0: $\mu \le 920$
H_1: $\mu > 920$

One tail test

Rejection regions

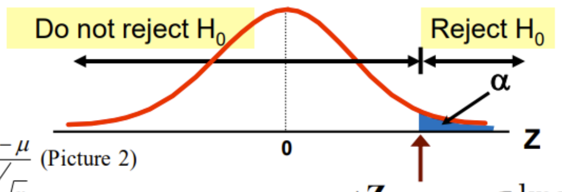


PICTURE 8

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0 : \mu \le 50$
$H_1 : \mu > 50$



$Z_{calc} = \dfrac{\bar{X} - \mu}{\sigma / \sqrt{n}}$ (Picture 2)

$t_{calc} = \dfrac{\bar{X} - \mu}{s / \sqrt{n}}$ (Picture 4)

$+Z_{critical} \rightarrow \sigma$ known
$+t_{critical} \rightarrow s$ known

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AUSTRALIA

$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

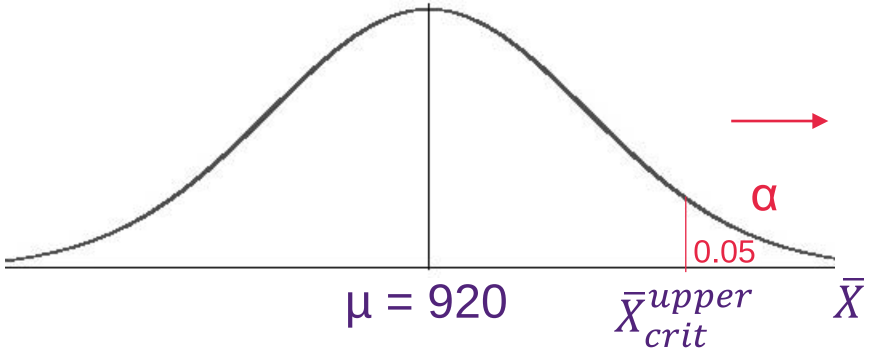
Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

Step 1: State H_0 and H_1

H_0: $\mu \le 920$

H_1: $\mu > 920$

Rejection regions



Step 2: Decision rule

Reject H_0 if

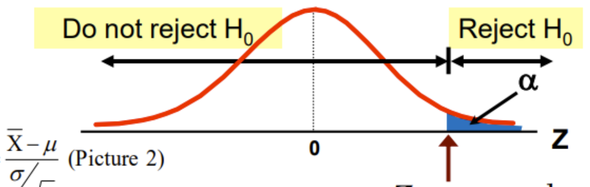
PICTURE 8

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0: \mu \le 50$

$H_1: \mu > 50$



$Z_{calc} = \dfrac{\bar{X} - \mu}{\sigma / \sqrt{n}}$ (Picture 2)

$t_{calc} = \dfrac{\bar{X} - \mu}{s / \sqrt{n}}$ (Picture 4)

$+Z_{critical} \rightarrow \sigma$ known

$+t_{critical} \rightarrow s$ known

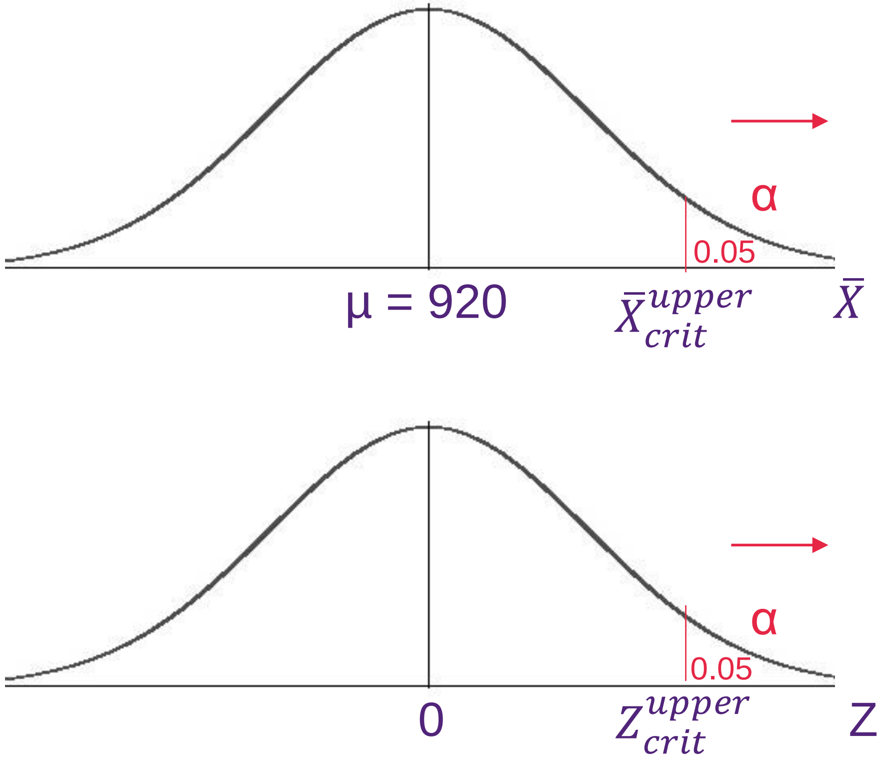
$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

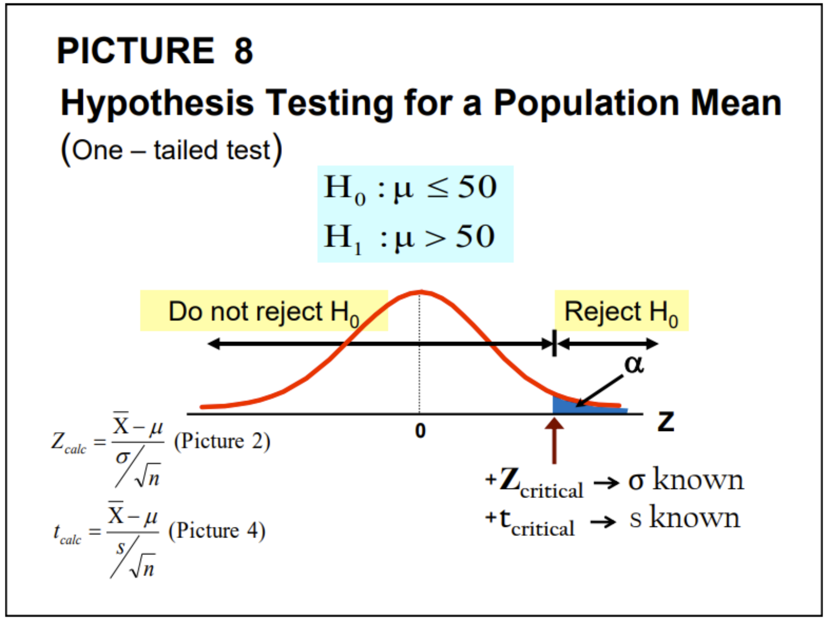
Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

Step 1: State H_0 and H_1
H_0: $\mu \leq 920$
H_1: $\mu > 920$

Step 2: Decision rule
Reject H_0 if $|Z_{calc}| > Z_{crit}$

Rejection regions





adm T09 Q1 Q2 Q3 Q4

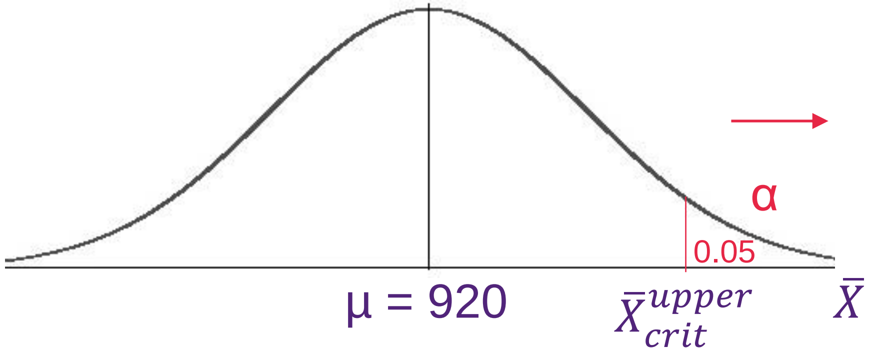
THE UNIVERSITY OF QUEENSLAND AUSTRALIA

$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

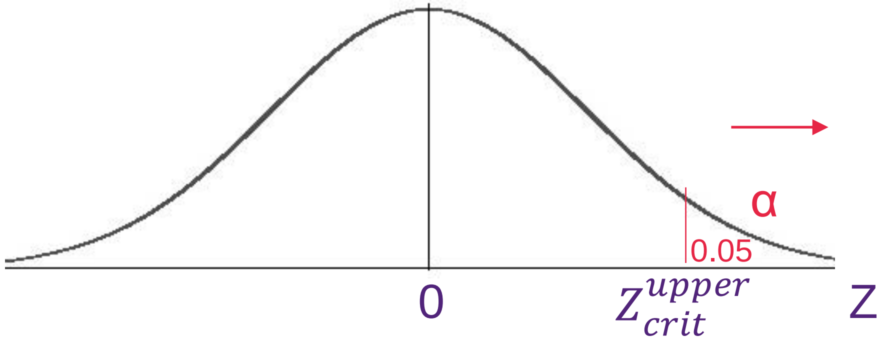
Step 1: State H_0 and H_1
H_0: $\mu \leq 920$
H_1: $\mu > 920$

Rejection regions



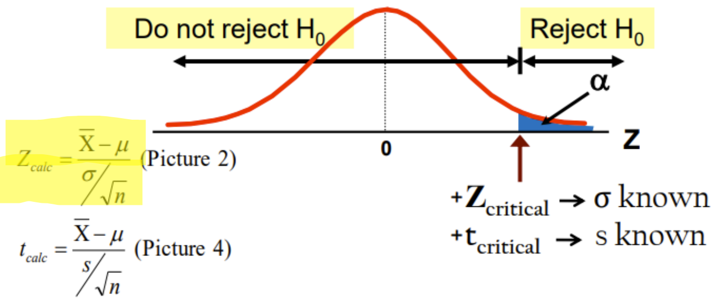
Step 2: Decision rule
Reject H_0 if $|Z_{calc}| > Z_{crit}$

$$Z_{crit} = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}} \rightarrow \bar{X} = \mu \pm Z_{crit} * \frac{\sigma}{\sqrt{n}}$$



PICTURE 8
Hypothesis Testing for a Population Mean
(One – tailed test)

$H_0: \mu \leq 50$
$H_1: \mu > 50$



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$\sigma = 20$
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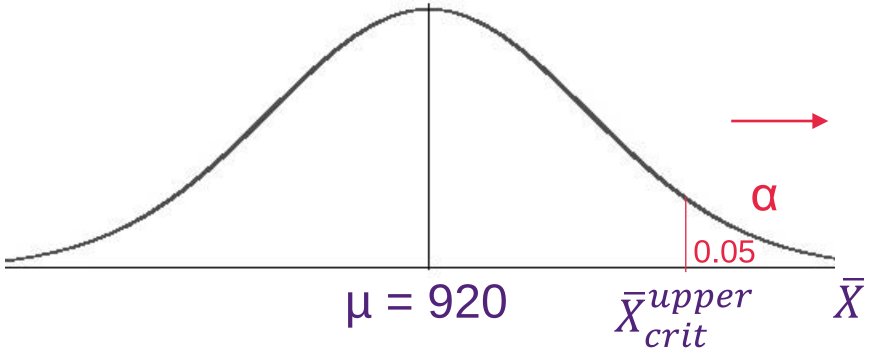
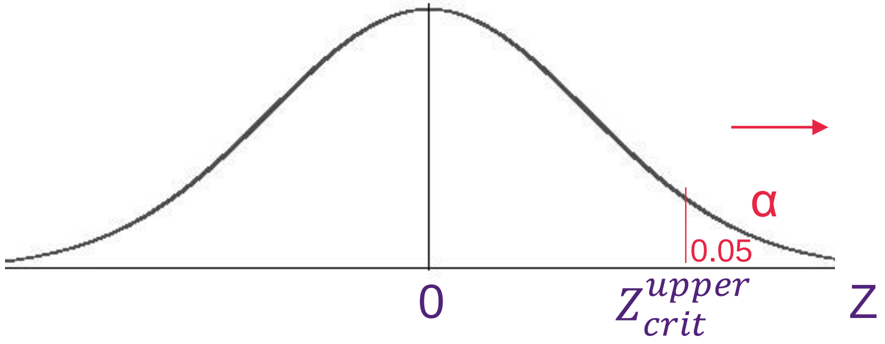
Step 1: State H_0 and H_1

H_0: $\mu \le 920$

H_1: $\mu > 920$

Rejection regions





Step 2: Decision rule

Reject H_0 if $|Z_{calc}| > Z_{crit}$

Sampling error

$$Z_{crit} = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}} \to \bar{X} = \mu \pm Z_{crit} * \frac{\sigma}{\sqrt{n}}$$

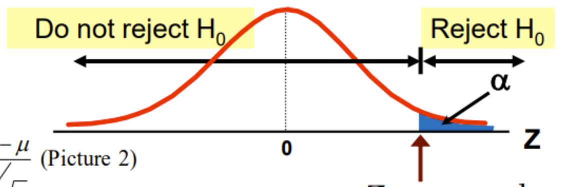
PICTURE 8

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0 : \mu \le 50$

$H_1 : \mu > 50$



$Z_{calc} = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}}$ (Picture 2)

$t_{calc} = \frac{\bar{X} - \mu}{s/\sqrt{n}}$ (Picture 4)

$+Z_{critical} \to \sigma$ known

$+t_{critical} \to s$ known

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

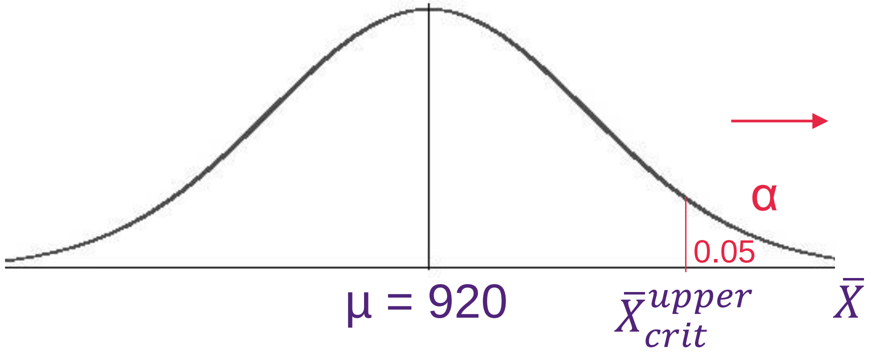
Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

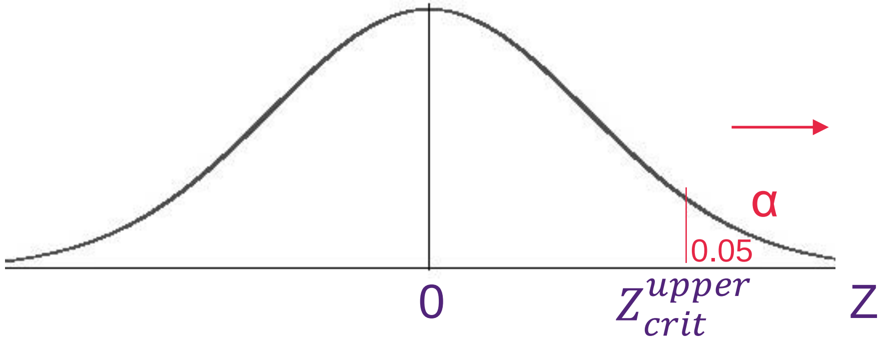
Step 1: State H_0 and H_1

H_0: $\mu \le 920$

H_1: $\mu > 920$

Rejection regions





Step 2: Decision rule

Reject H_0 if $|Z_{calc}| > Z_{crit}$

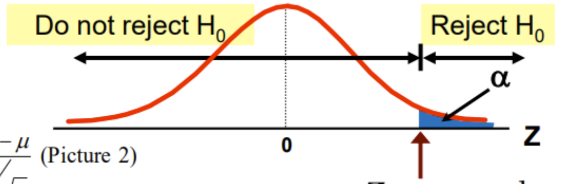
$$Z_{crit} = \frac{\bar{X}-\mu}{\sigma/\sqrt{n}} \rightarrow \bar{X}_{crit}^{upper} = \mu + Z_{crit} * \frac{\sigma}{\sqrt{n}}$$

PICTURE 8

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0 : \mu \le 50$
$H_1 : \mu > 50$



$Z_{calc} = \frac{\bar{X}-\mu}{\sigma/\sqrt{n}}$ (Picture 2)

$t_{calc} = \frac{\bar{X}-\mu}{s/\sqrt{n}}$ (Picture 4)

$+Z_{critical} \rightarrow \sigma$ known

$+t_{critical} \rightarrow s$ known

$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

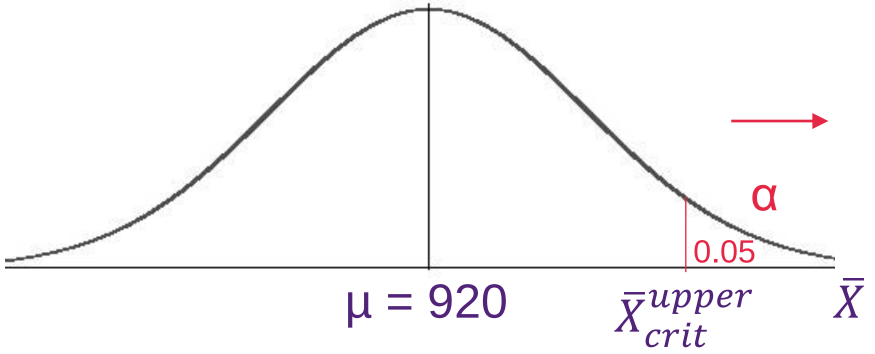
Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

Step 1: State H_0 and H_1

H_0: $\mu \leq 920$

H_1: $\mu > 920$

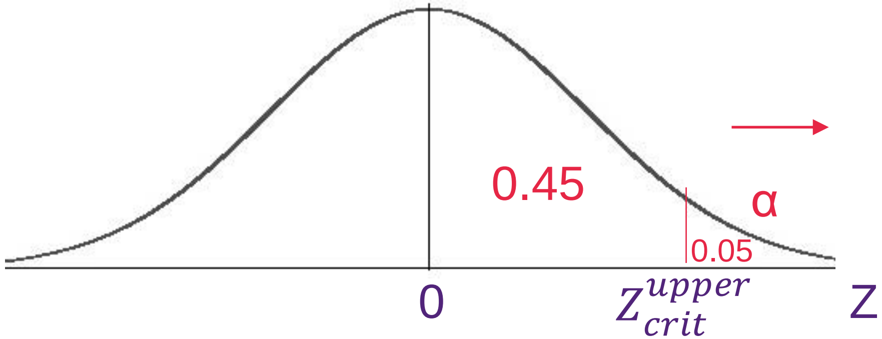
Rejection regions



Step 2: Decision rule

Reject H_0 if $|Z_{calc}| > Z_{crit}$

$$Z_{crit} = \frac{\bar{X}-\mu}{\sigma/\sqrt{n}} \rightarrow \bar{X}_{crit}^{upper} = \mu + Z_{crit} * \frac{\sigma}{\sqrt{n}}$$



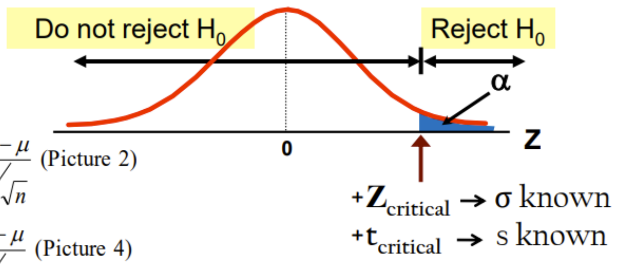
PICTURE 8

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0: \mu \leq 50$

$H_1: \mu > 50$

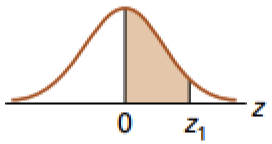


$Z_{calc} = \frac{\bar{X}-\mu}{\sigma/\sqrt{n}}$ (Picture 2)

$t_{calc} = \frac{\bar{X}-\mu}{s/\sqrt{n}}$ (Picture 4)

TABLE A.5 Areas of the standard normal distribution $\mu = 0, \sigma = 1$

The entries in this table are the probabilities that a standard normal random variable is between 0 and z_1 (the shaded area).



z_1	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767

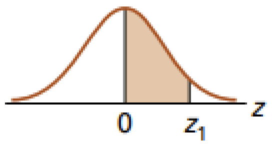
0.45

adm T09 Q1 Q2 Q3 Q4

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

TABLE A.5 Areas of the standard normal distribution $\mu = 0, \sigma = 1$

The entries in this table are the probabilities that a standard normal random variable is between 0 and z_1 (the shaded area).



1.645

0.45

z_1	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
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0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
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1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

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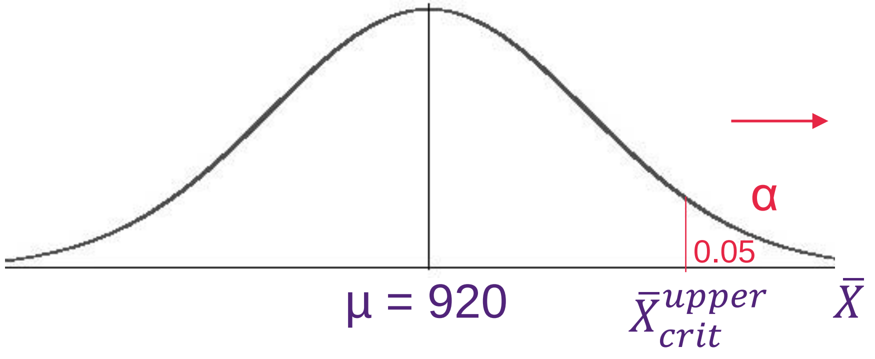
Step 1: State H_0 and H_1

H_0: $\mu \leq 920$

H_1: $\mu > 920$

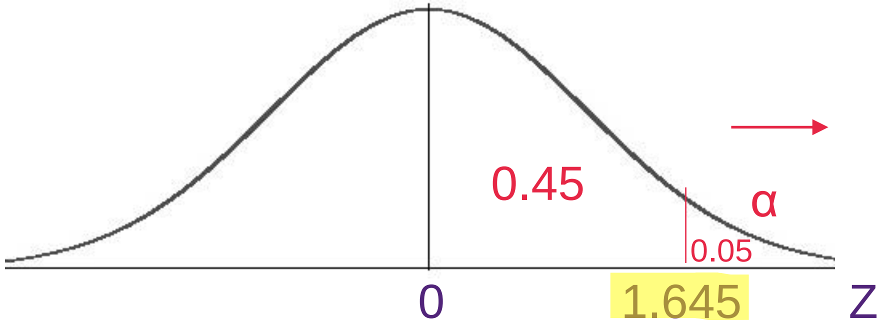
Rejection regions



Step 2: Decision rule

Reject H_0 if $|Z_{calc}| > Z_{crit}$

$$Z_{crit} = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}} \rightarrow \bar{X}^{upper}_{crit} = \mu + Z_{crit} * \frac{\sigma}{\sqrt{n}}$$

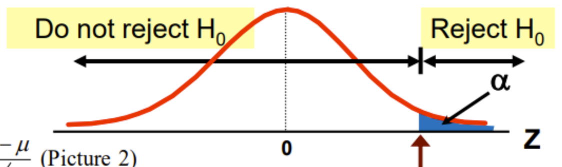


PICTURE 8

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0: \mu \leq 50$
$H_1: \mu > 50$



$Z_{calc} = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}}$ (Picture 2)

$t_{calc} = \frac{\bar{X} - \mu}{s/\sqrt{n}}$ (Picture 4)

$+Z_{critical} \rightarrow \sigma$ known

$+t_{critical} \rightarrow s$ known

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

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$\sigma = 20$
$n = 35$
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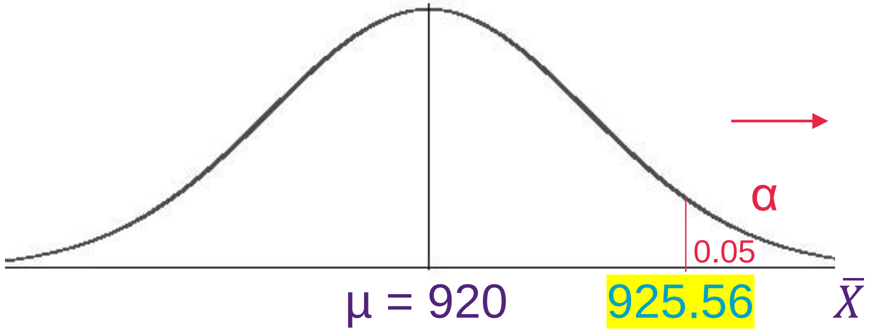
Step 1: State H_0 and H_1

H_0: $\mu \le 920$

H_1: $\mu > 920$

Rejection regions

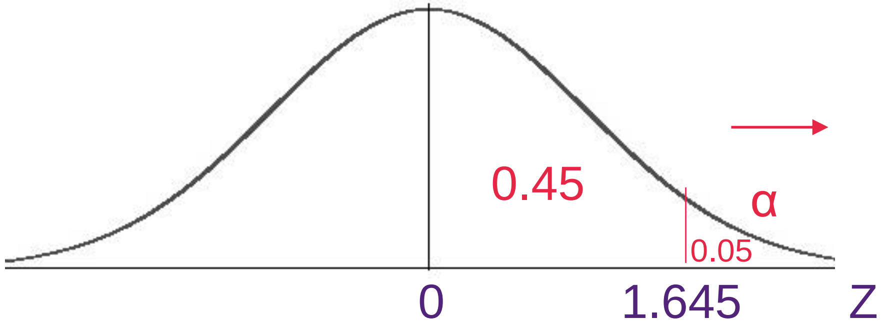


Step 2: Decision rule

Reject H_0 if $|Z_{calc}| > Z_{crit}$

$$Z_{crit} = \frac{\bar{X}-\mu}{\sigma/\sqrt{n}} \rightarrow \bar{X}^{upper}_{crit} = \mu + Z_{crit} * \frac{\sigma}{\sqrt{n}}$$

$$= 920 + 1.645 * 20/\sqrt{35} = 925.56$$



PICTURE 8

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0: \mu \le 50$

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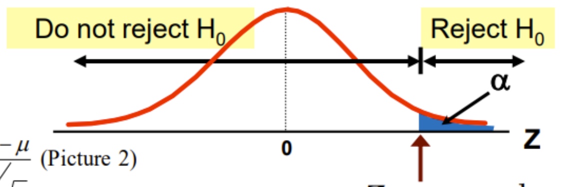

$Z_{calc} = \frac{\bar{X}-\mu}{\sigma/\sqrt{n}}$ (Picture 2)

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$+Z_{critical} \rightarrow \sigma$ known

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THE UNIVERSITY OF QUEENSLAND AUSTRALIA

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$\sigma = 20$
$n = 35$
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Step 1: State H_0 and H_1
H_0: $\mu \le 920$
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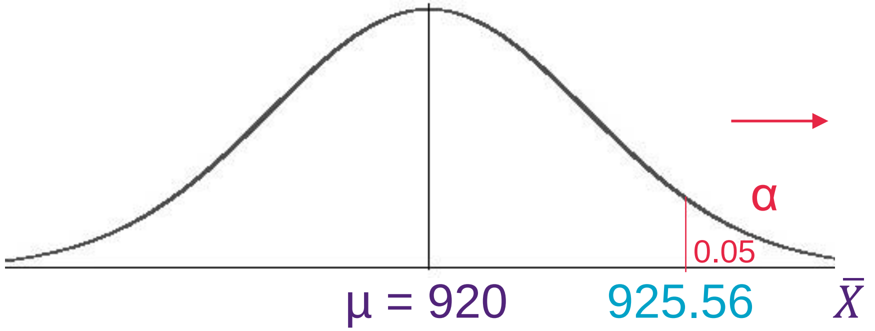
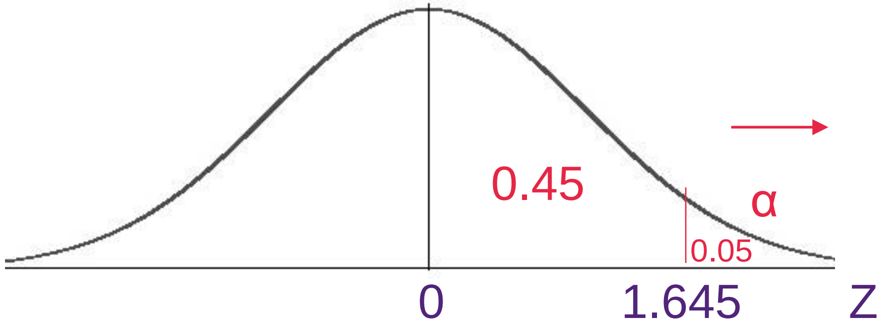
Rejection regions



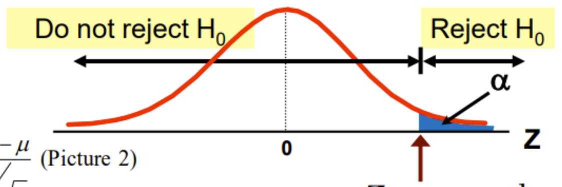
Step 2: Decision rule
Reject H_0 if $\bar{X} > \bar{X}_{crit} = 925.56$

Step 3: Calculate $\bar{X}_{calc}$
$\bar{X} = 925 = \bar{X}_{calc}$



PICTURE 8
Hypothesis Testing for a Population Mean
(One – tailed test)

$H_0: \mu \le 50$
$H_1: \mu > 50$



$Z_{calc} = \dfrac{\bar{X} - \mu}{\sigma / \sqrt{n}}$ (Picture 2)

$t_{calc} = \dfrac{\bar{X} - \mu}{s / \sqrt{n}}$ (Picture 4)

$+Z_{critical} \rightarrow \sigma$ known
$+t_{critical} \rightarrow s$ known

The University Of Queensland AUSTRALIA

$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

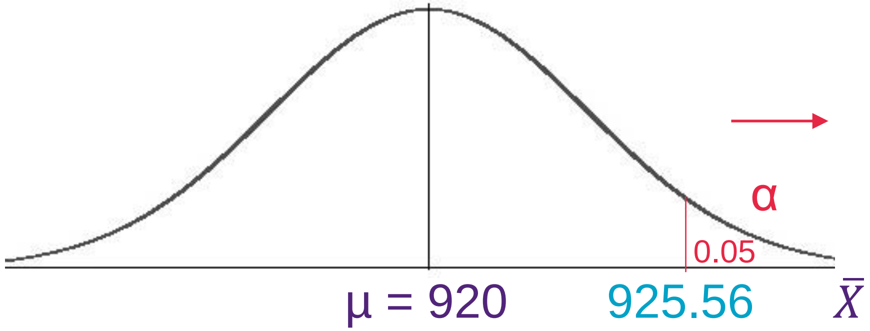
Step 1: State H_0 and H_1
H_0: $\mu \leq 920$
H_1: $\mu > 920$

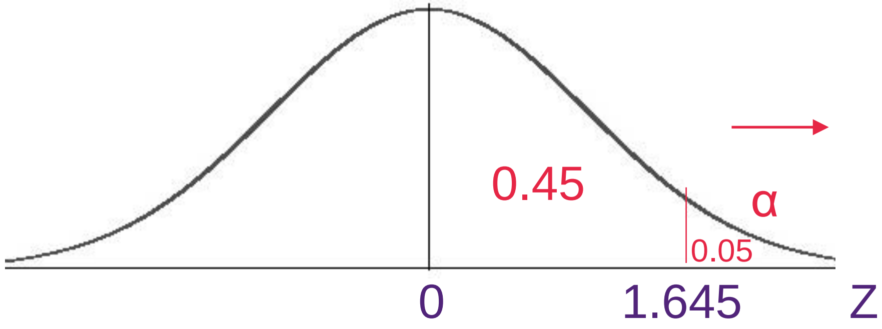
Step 2: Decision rule
Reject H_0 if $\bar{X} > \bar{X}_{crit} = 925.56$

Step 3: Calculate $\bar{X}_{calc}$
$\bar{X} = 925 = \bar{X}_{calc}$

Step 4: Make a decision
$\bar{X} > \bar{X}_{crit}$

Rejection regions





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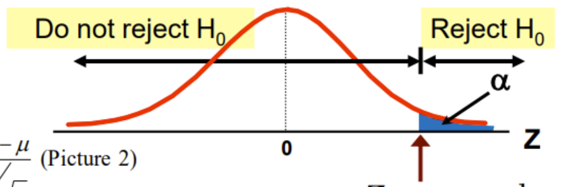


$Z_{calc} = \frac{\bar{X} - \mu}{\sigma / \sqrt{n}}$ (Picture 2)

$t_{calc} = \frac{\bar{X} - \mu}{s / \sqrt{n}}$ (Picture 4)

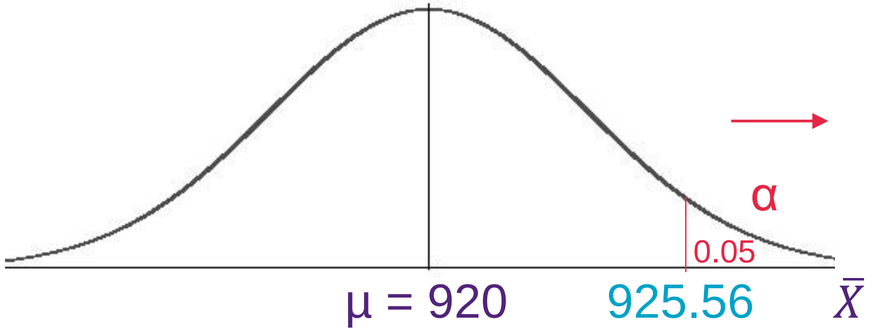
$+Z_{critical} \rightarrow \sigma$ known
$+t_{critical} \rightarrow s$ known

μ = 920
σ = 20
n = 35
$\bar{X}$ = 925
α = 5% = 0.05

Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

Step 1: State H_0 and H_1
H_0: $\mu \le 920$
H_1: $\mu > 920$

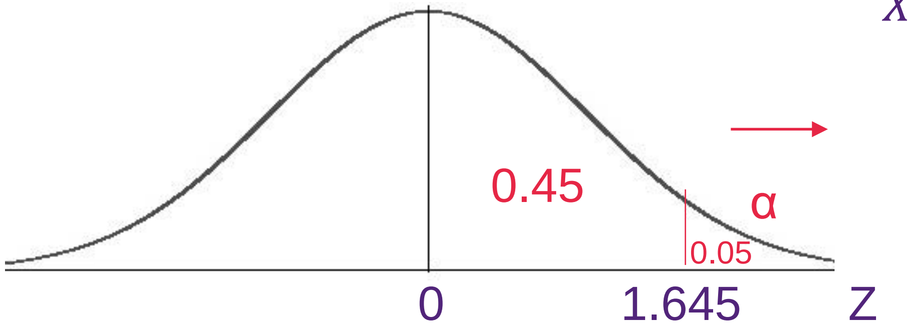
Rejection regions



Step 2: Decision rule
Reject H_0 if $\bar{X} > \bar{X}_{crit}$ = 925.56

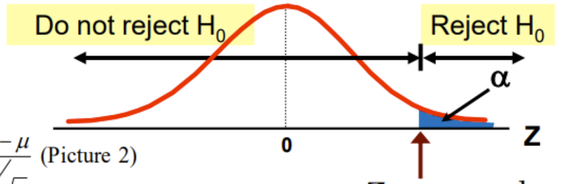
Step 3: Calculate $\bar{X}_{calc}$
$\bar{X} = 925 = \bar{X}_{calc}$

Step 4: Make a decision
$\bar{X} > \bar{X}_{crit} \rightarrow 925 > 925.56$?



PICTURE 8
Hypothesis Testing for a Population Mean
(One – tailed test)

$H_0 : \mu \le 50$
$H_1 : \mu > 50$



$Z_{calc} = \dfrac{\bar{X}-\mu}{\sigma/\sqrt{n}}$ (Picture 2)

$t_{calc} = \dfrac{\bar{X}-\mu}{s/\sqrt{n}}$ (Picture 4)

$+Z_{critical} \rightarrow \sigma$ known
$+t_{critical} \rightarrow s$ known

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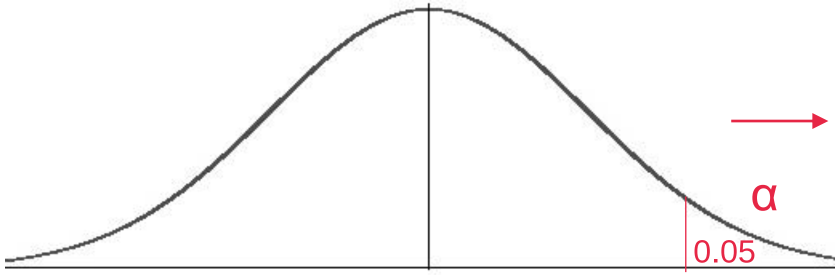
$\mu = 920$
$\sigma = 20$
$n = 35$
$\bar{X} = 925$
$\alpha = 5\% = 0.05$

Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

Step 1: State H_0 and H_1
H_0: $\mu \leq 920$
H_1: $\mu > 920$

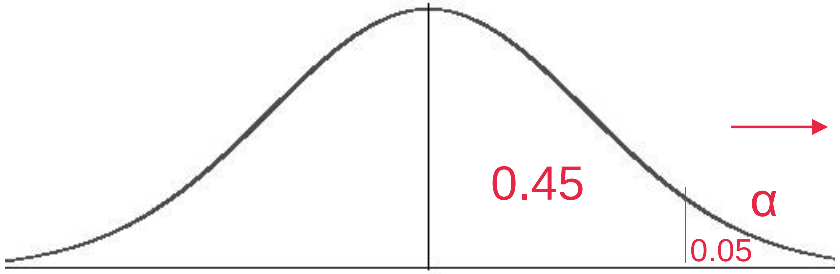
Rejection regions



Step 2: Decision rule
Reject H_0 if $\bar{X} > \bar{X}_{crit} = 925.56$

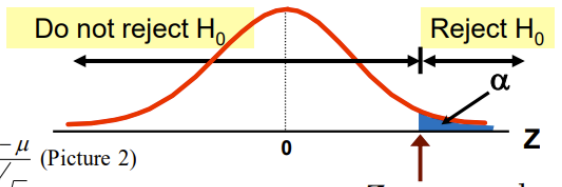
Step 3: Calculate $\bar{X}_{calc}$
$\bar{X} = 925 = \bar{X}_{calc}$

Step 4: Make a decision
$\bar{X} > \bar{X}_{crit} \rightarrow 925 > 925.56$
$\rightarrow$ Do not reject H_0.



PICTURE 8
Hypothesis Testing for a Population Mean
(One – tailed test)

$H_0: \mu \leq 50$
$H_1: \mu > 50$



$Z_{calc} = \frac{\bar{X} - \mu}{\sigma / \sqrt{n}}$ (Picture 2)

$t_{calc} = \frac{\bar{X} - \mu}{s / \sqrt{n}}$ (Picture 4)

$+Z_{critical} \rightarrow \sigma$ known
$+t_{critical} \rightarrow s$ known

μ = 920
σ = 20
n = 35
$\bar{X}$ = 925
α = 5% = 0.05

Q2. A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In a sample of 35 of this year's applicants the mean was 925. At the 5% level of significance, can we conclude that the university's claim is true? **State the decision rule in terms of the sample mean.**

Step 1: State H_0 and H_1
H_0: $\mu \le 920$
H_1: $\mu > 920$

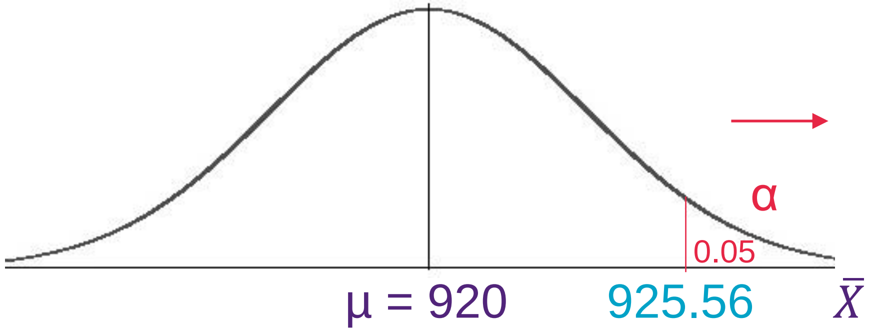
Step 2: Decision rule
Reject H_0 if $\bar{X} > \bar{X}_{crit}$ = 925.56

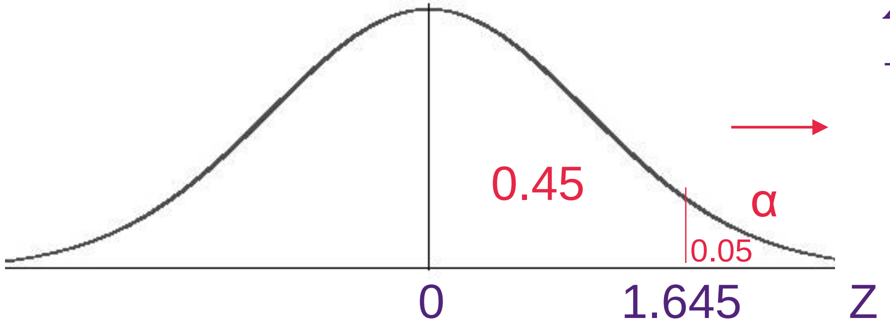
Step 3: Calculate $\bar{X}_{calc}$
$\bar{X} = 925 = \bar{X}_{calc}$

Step 4: Make a decision
$\bar{X} > \bar{X}_{crit} \rightarrow 925 > 925.56$
$\rightarrow$ Do not reject H_0.

Step 5: Conclusion
There is insufficient evidence to suggest that average entry scores amongst all applicants have increased to 925 at the 5% LOS.

Rejection regions



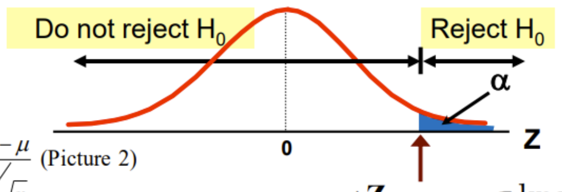


PICTURE 8

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0: \mu \le 50$
$H_1: \mu > 50$



$Z_{calc} = \dfrac{\bar{X}-\mu}{\sigma/\sqrt{n}}$ (Picture 2)

$t_{calc} = \dfrac{\bar{X}-\mu}{s/\sqrt{n}}$ (Picture 4)

$+Z_{critical} \rightarrow \sigma$ known
$+t_{critical} \rightarrow$ s known

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Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

i) If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.

ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?

adm T09 Q1 Q2 Q3 Q4

(Poll)

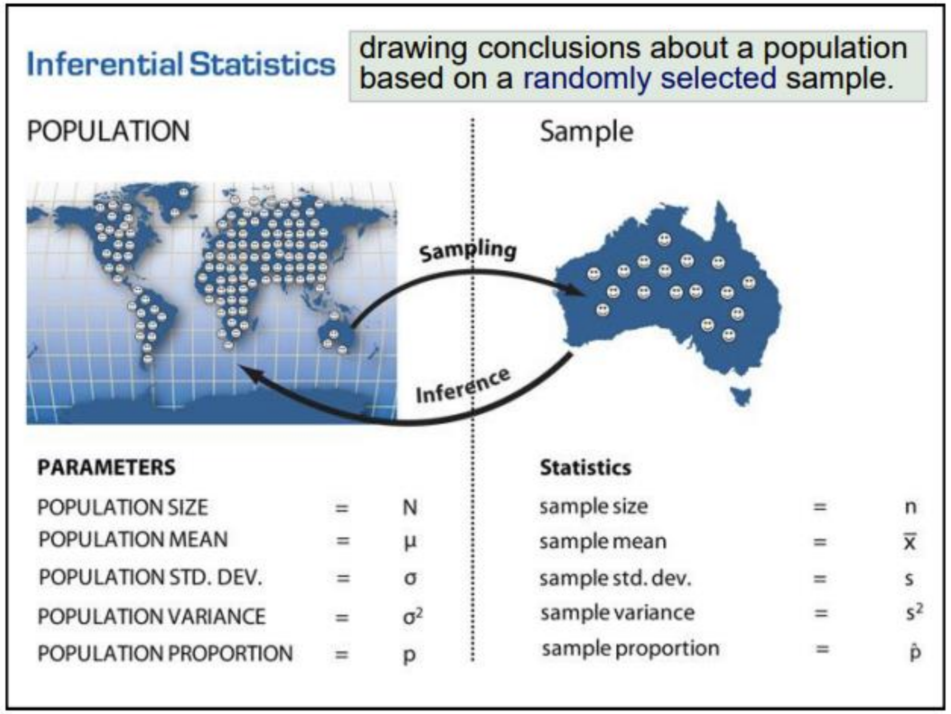
Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.

If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?

1. What symbol would you give to the value 14g? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n



2. What symbol would you give to the value 0.3g? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

3. What symbol would you give to the value 42 items? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

4. What symbol would you give to the value 13.87g? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

5. What symbol would you give to the value 0.02 level of significance? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

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AUSTRALIA

(Poll)

Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

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If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?

1. What symbol would you give to the value 14g? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

2. What symbol would you give to the value 0.3g? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

3. What symbol would you give to the value 42 items? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

4. What symbol would you give to the value 13.87g? (Single Choice) *

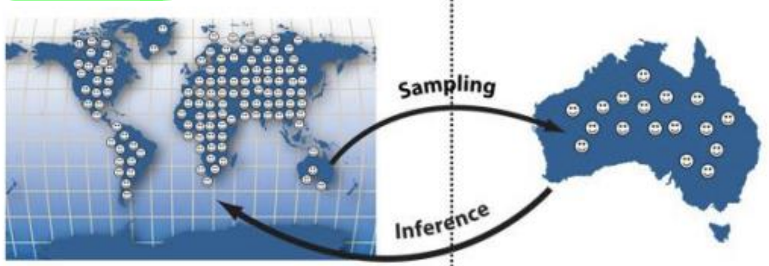
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

5. What symbol would you give to the value 0.02 level of significance? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

Inferential Statistics drawing conclusions about a population based on a randomly selected sample.

POPULATION | Sample



PARAMETERS			Statistics		
POPULATION SIZE	=	N	sample size	=	n
POPULATION MEAN	=	μ	sample mean	=	$\bar{x}$
POPULATION STD. DEV.	=	σ	sample std. dev.	=	s
POPULATION VARIANCE	=	σ^2	sample variance	=	s^2
POPULATION PROPORTION	=	p	sample proportion	=	$\hat{p}$

μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
α = 0.02

Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

i) If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.

ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?




1. What type of problem is it? (Single Choice) *

- Population Mean (Seagull) (no sample)
- Population Mean (Pelican) (σ is known)
- Population Mean (Shag) (σ is unknown but s is known)
- Population Proportion (Freaky fish) (proportion)

2. What table will we use? (Single Choice) *

- Z table (standard normal distribution)
- t table (Student's t-distribution)

(Poll)

3. What is the value of α (alpha)? (Single Choice) *

- 0.01
- 0.02
- 0.03
- 0.04
- 0.05
- 0.1

4. What type of test is it? (Single Choice) *

- one tail test (upper tail >)
- one tail test (lower tail <)
- two tail test (=)

μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
α = 0.02

Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

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(Poll)

1. What type of problem is it? (Single Choice) *

- Population Mean (Seagull) (no sample)
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ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?

Step 1: State H_0 and H_1

μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
α = 0.02

Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

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ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?

Step 1: State H_0 and H_1
H_0: μ = 14g
H_1: μ ≠ 14g

Two tail test

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μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
α = 0.02

Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

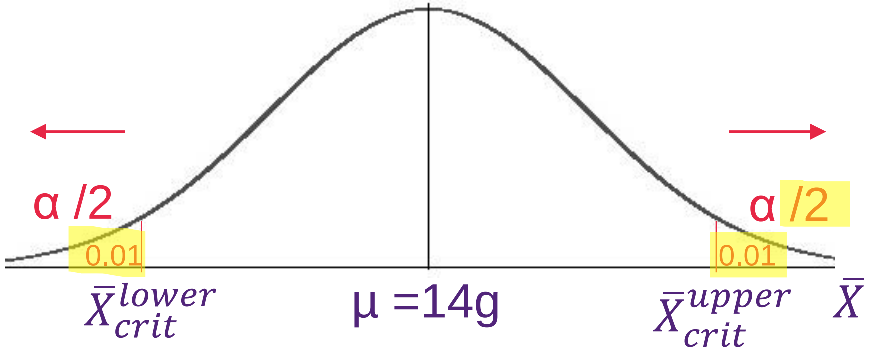
i) If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.

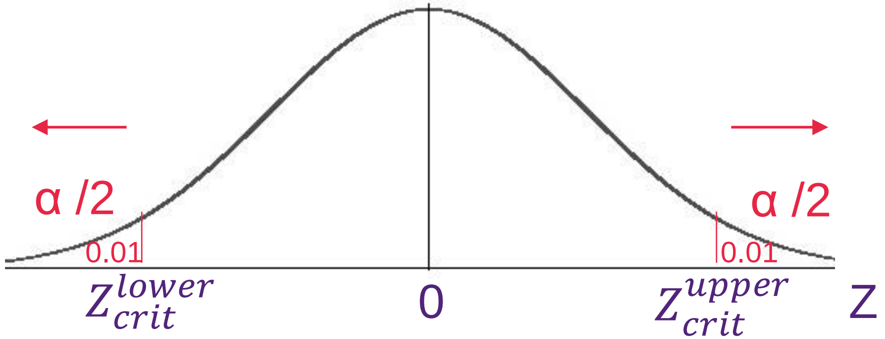
ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?

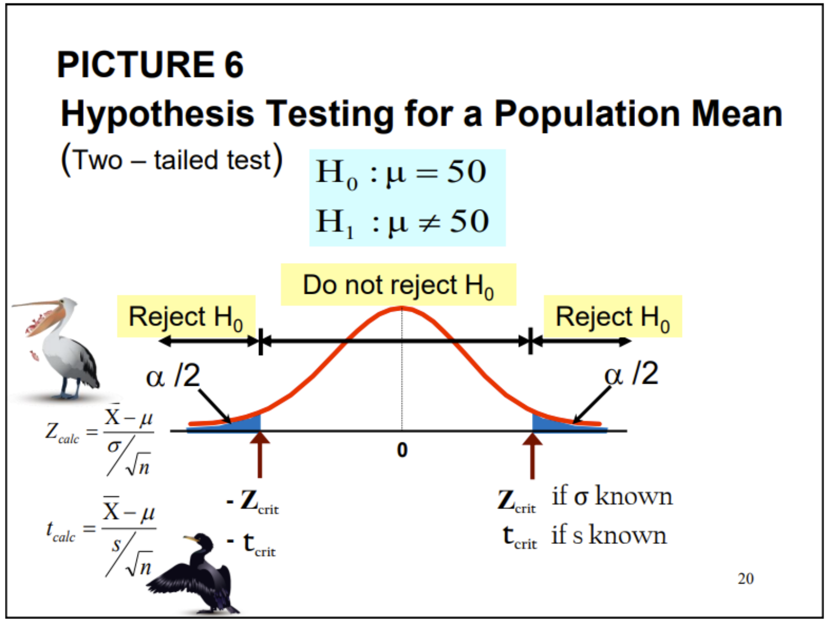
Step 1: State H_0 and H_1
H_0: μ = 14g
H_1: $\mu \neq$ 14g

Two tail test

Rejection regions







μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
α = 0.02

Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

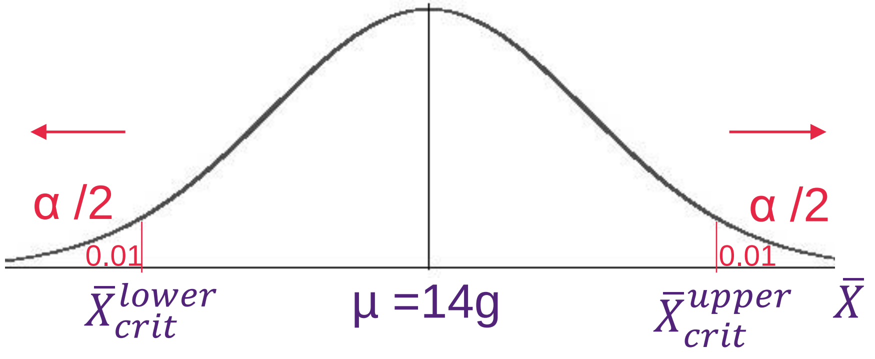
i) If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.

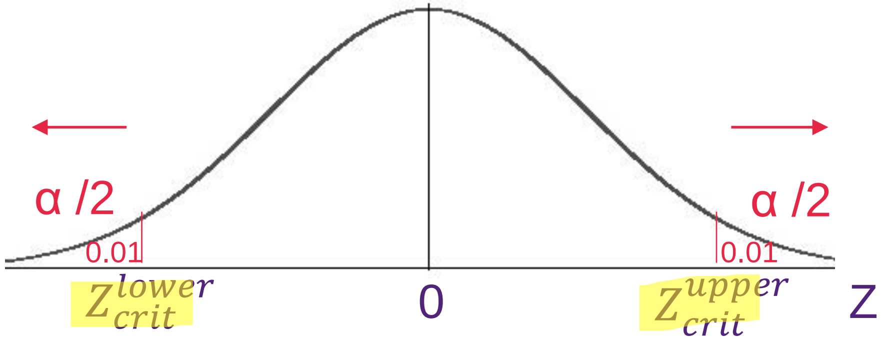
ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?

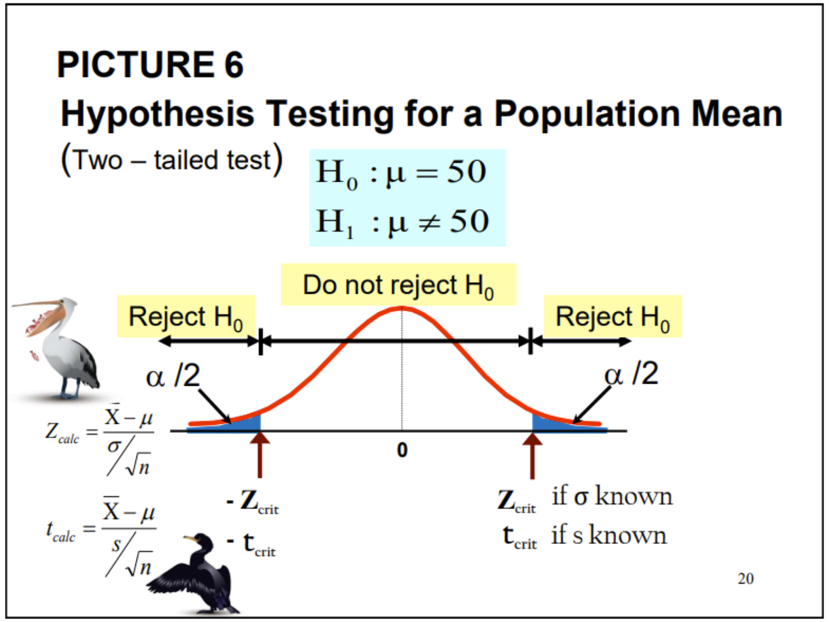
Step 1: State H_0 and H_1
H_0: μ = 14g
H_1: μ ≠ 14g

Step 2: Decision rule
Reject H_0 if $|Z_{calc}| > Z_{crit}$

Rejection regions







μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
α = 0.02

Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

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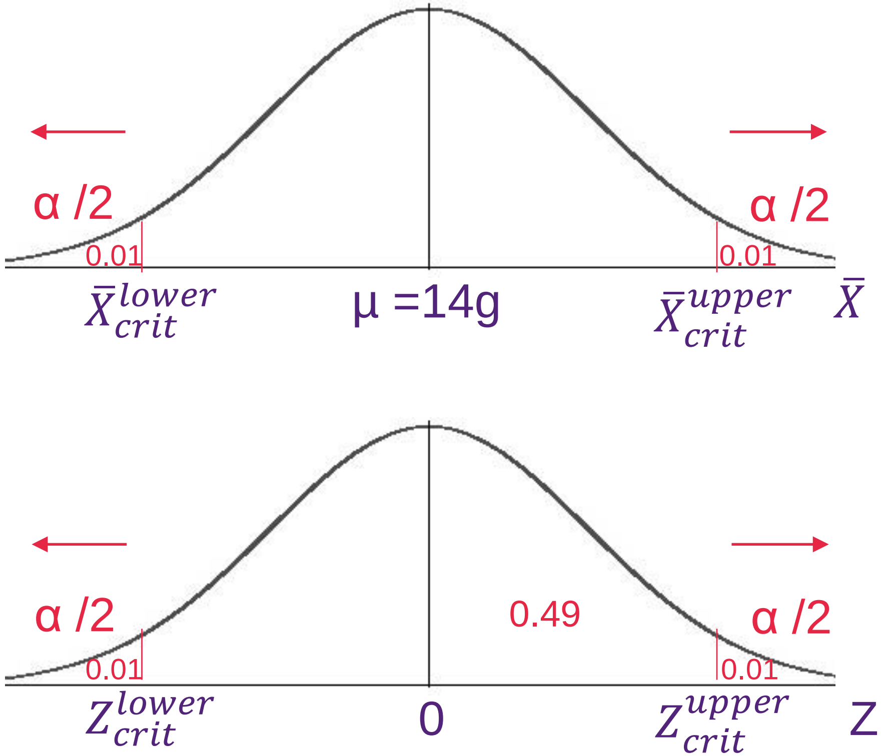
ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?

Rejection regions



Step 1: State H_0 and H_1
H_0: μ = 14g
H_1: μ ≠ 14g

Step 2: Decision rule
Reject H_0 if $|Z_{calc}| > Z_{crit}$ = ?

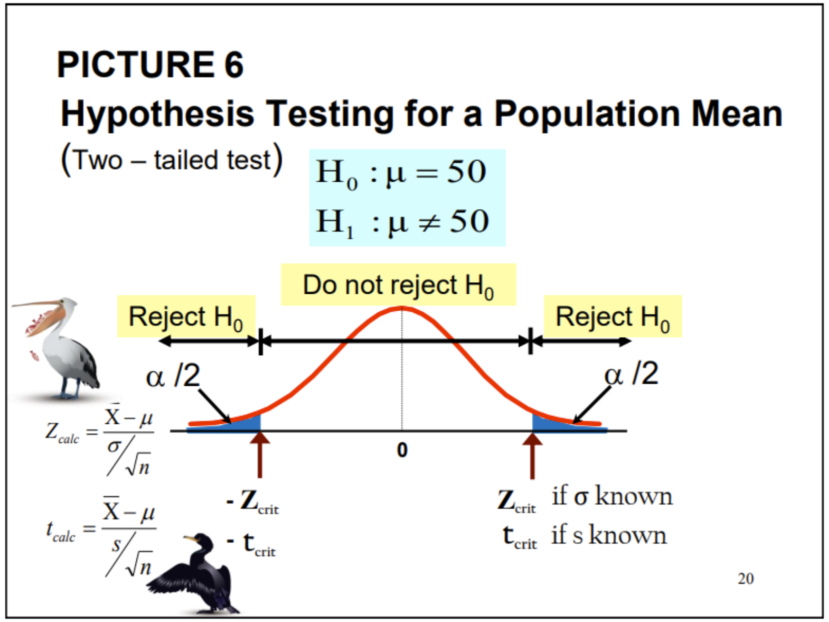
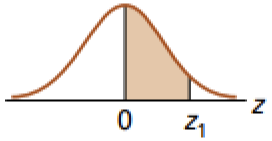


TABLE A.5 Areas of the standard normal distribution $\mu = 0, \sigma = 1$

The entries in this table are the probabilities that a standard normal random variable is between 0 and z_1 (the shaded area).

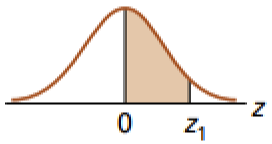


0.49

z_1	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998									
4.0	.49997									
4.5	.499997									
5.0	.4999997									
6.0	.499999999									

TABLE A.5 Areas of the standard normal distribution $\mu = 0, \sigma = 1$

The entries in this table are the probabilities that a standard normal random variable is between 0 and z_1 (the shaded area).



z_1	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998									
4.0	.49997									
4.5	.499997									
5.0	.4999997									
6.0	.499999999									

0.49

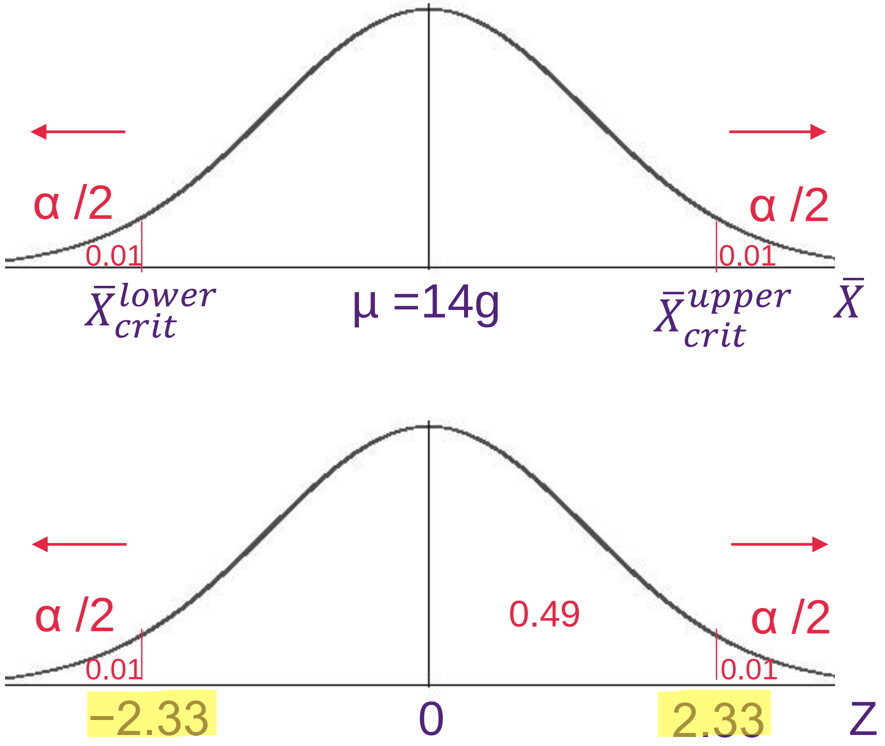
μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
α = 0.02

Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

i) If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.

ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?

Rejection regions



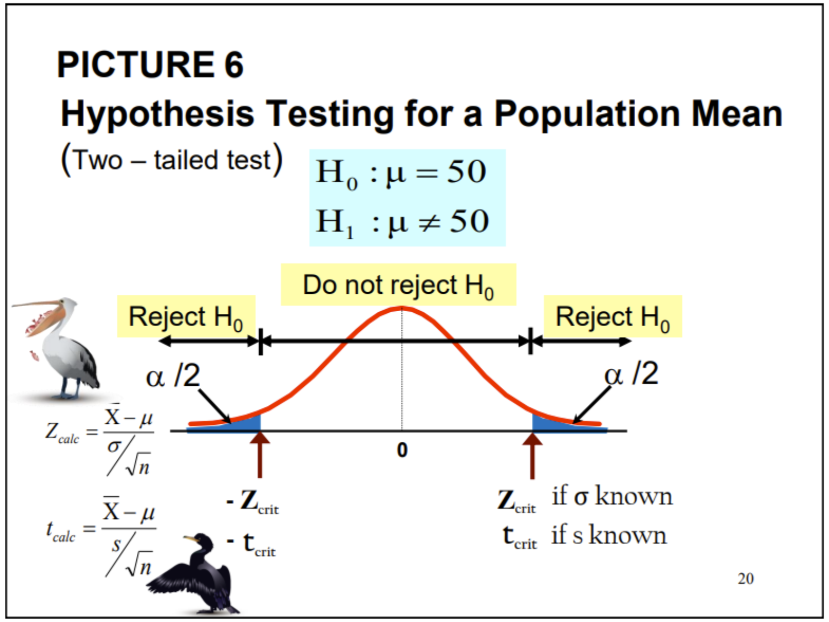
Step 1: State H_0 and H_1

H_0: μ = 14g

H_1: $\mu \neq$ 14g

Step 2: Decision rule

Reject H_0 if $|Z_{calc}| > Z_{crit}$ = 2.33



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n = 42
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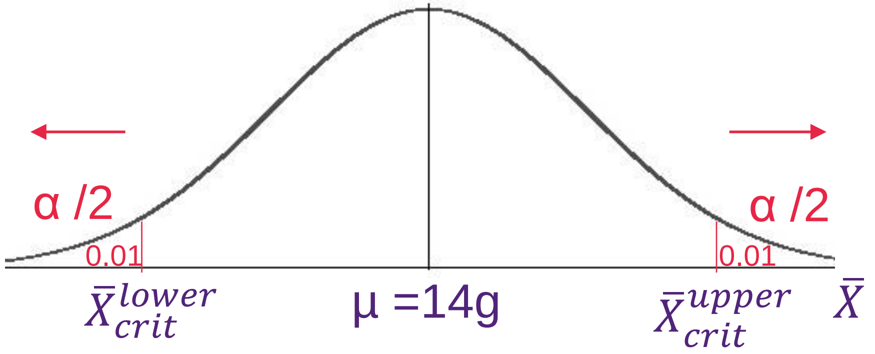
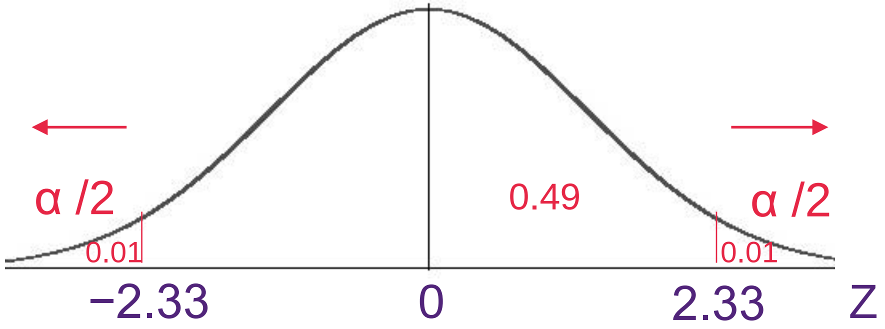
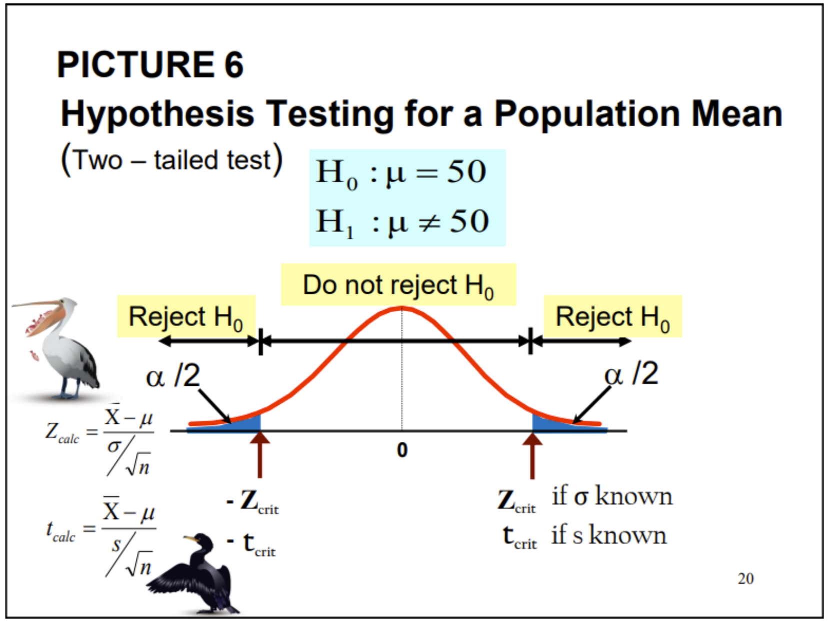




Step 1: State H_0 and H_1
H_0: μ = 14g
H_1: μ ≠ 14g

Step 2: Decision rule
Reject H_0 if $|Z_{calc}| > Z_{crit}$ = 2.33

Step 3: Calculate Z_{calc}
$$Z_{calc} = \frac{\bar{X} - \mu}{\sigma_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = ?$$



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i) If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.

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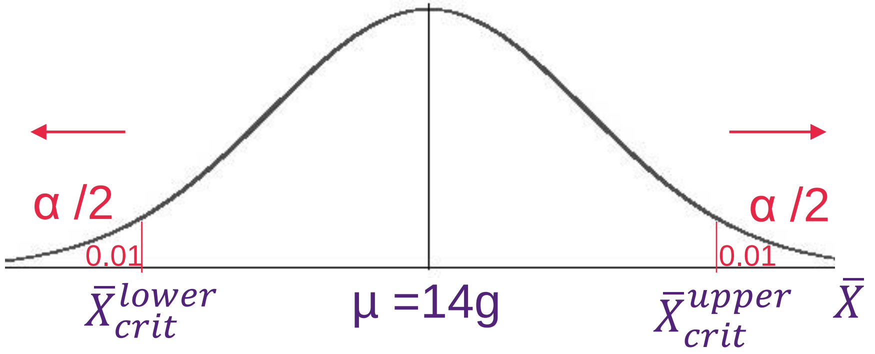
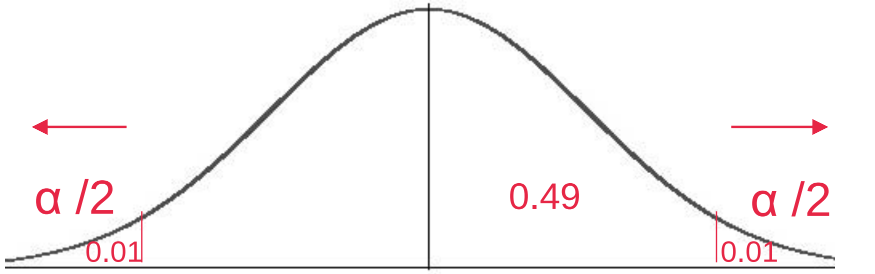
Rejection regions





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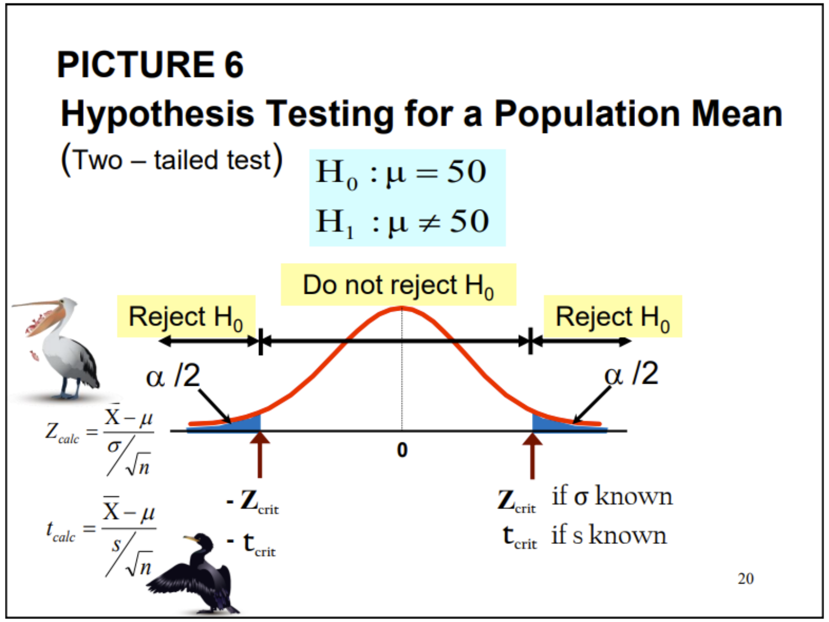
Step 2: Decision rule
Reject H_0 if $|Z_{calc}| > Z_{crit}$ = 2.33

Step 3: Calculate Z_{calc}
$$Z_{calc} = \frac{\bar{X}-\mu}{\sigma_{\bar{X}}} = \frac{\bar{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{13.87-14}{\frac{0.3}{\sqrt{42}}} = -2.808$$

Step 4: Make a decision
$|Z_{calc}| > Z_{crit} \rightarrow |-2.808| > 2.33$?



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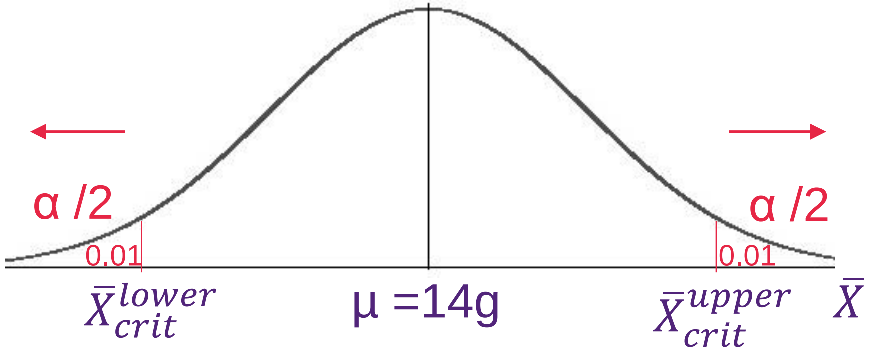

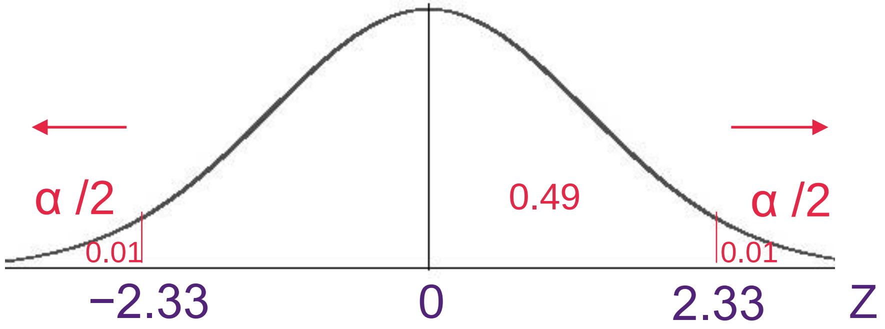

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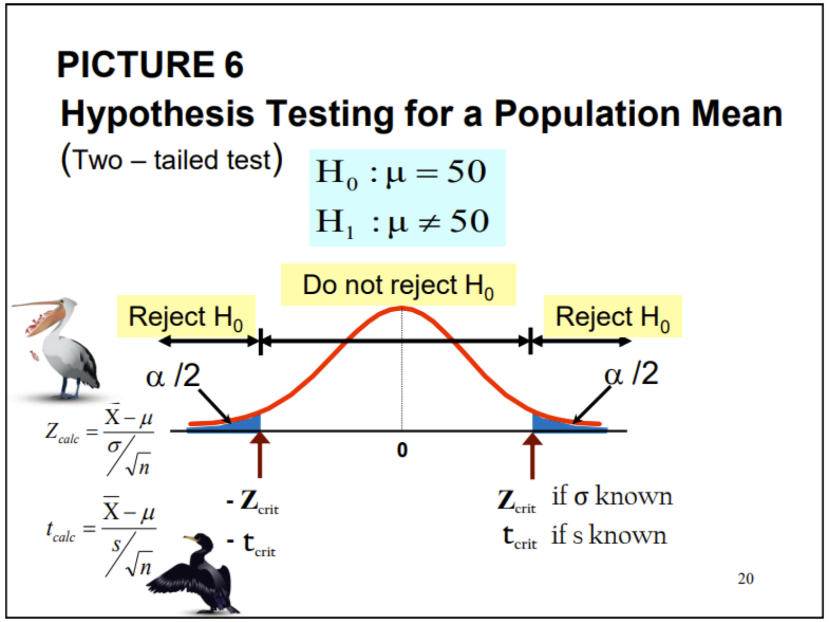

adm T09 Q1 Q2 Q3 Q4

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μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
α = 0.02

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i) If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.

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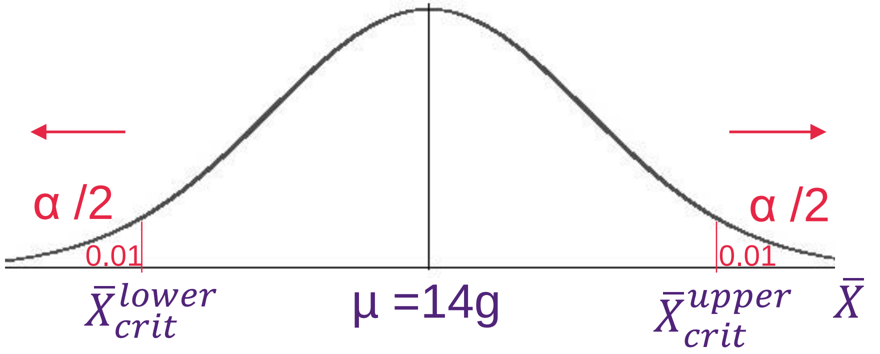

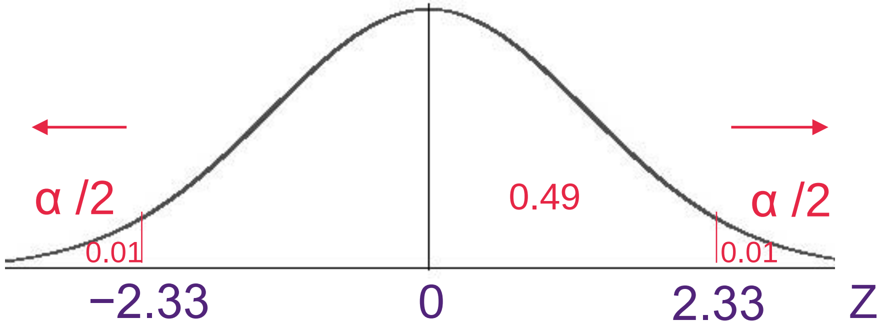

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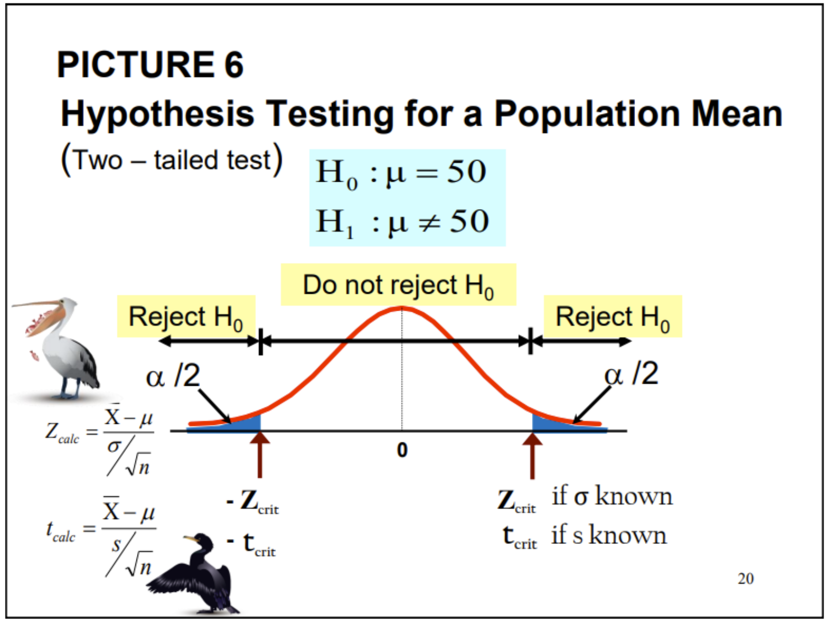
Step 4: Make a decision
$|Z_{calc}| > Z_{crit} \rightarrow |-2.808| > 2.33 \rightarrow$ Reject H_0.

Step 5: Conclusion
There is sufficient evidence to suggest that the fill amounts are not 14g at the 2% LOS.



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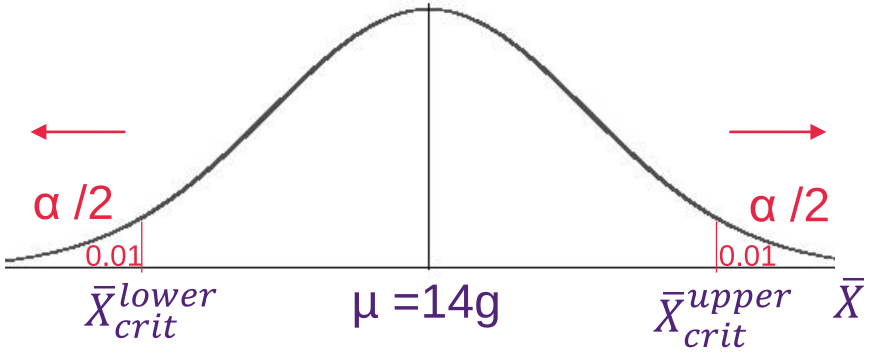

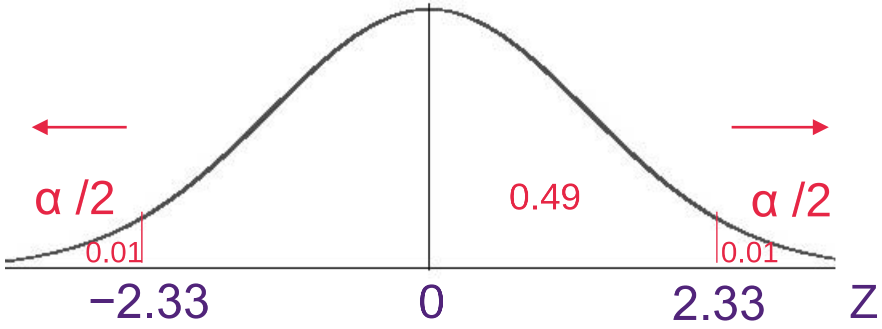

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Step 4: Make a decision
$|Z_{calc}| > Z_{crit} \rightarrow |-2.808| > 2.33 \rightarrow$ Reject H_0.

Step 5: Conclusion
There is sufficient evidence to suggest that the fill amounts are not 14g at the 2% LOS.

Error Table Associated with Hypothesis Testing Decisions.

Possible Outcomes from Decisions

	Actual (reality) Situation	
Statistical Decision	H_0 True	H_0 False
Do Not Reject H_0	✓	Type II Error
Reject H_0	Type I Error	✓

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adm T09 Q1 Q2 Q3 Q4

μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
α = 0.02

Q3. When in correct adjustment, a filling mechanism is set to fill containers with a mean content of 14g. Variability in the fill per container is given by a standard deviation of 0.3g. The manufacturer is equally concerned in finding if the mean fill amount per container has shifted in either direction.

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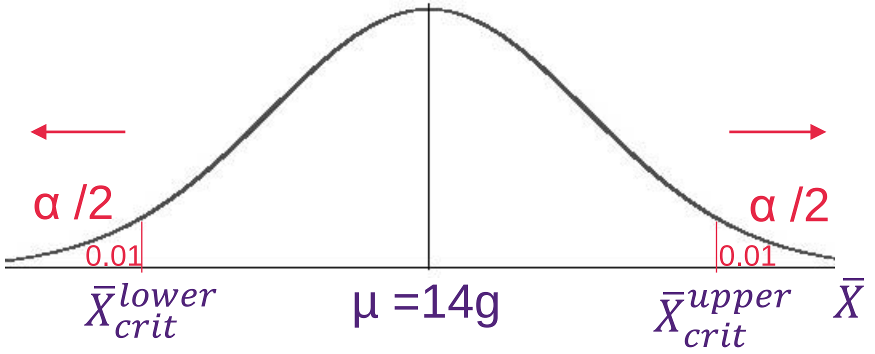

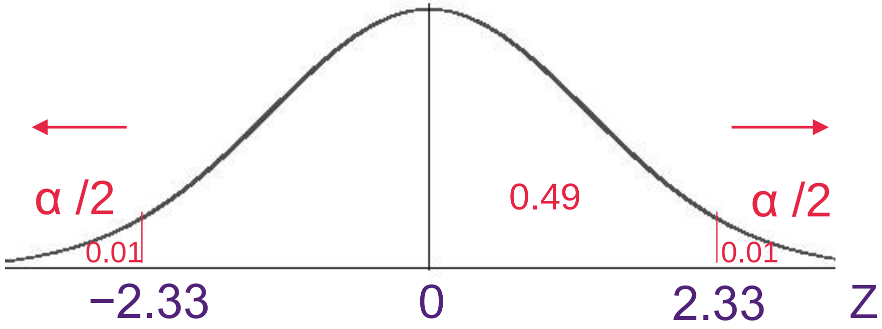

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Step 4: Make a decision
$|Z_{calc}| > Z_{crit} \rightarrow |-2.808| > 2.33 \rightarrow$ Reject H_0.

Step 5: Conclusion
There is sufficient evidence to suggest that the fill amounts are not 14g at the 2% LOS.

Error Table Associated with Hypothesis Testing Decisions.

Possible Outcomes from Decisions

Statistical Decision	Actual (reality) Situation: H_0 True	Actual (reality) Situation: H_0 False
Do Not Reject H_0	✓	**Type II Error**
Reject H_0	**Type I Error**	✓

18

adm T09 Q1 Q2 Q3 Q4

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μ = 14g
σ = 0.3g
n = 42
$\bar{X}$ = 13.87g
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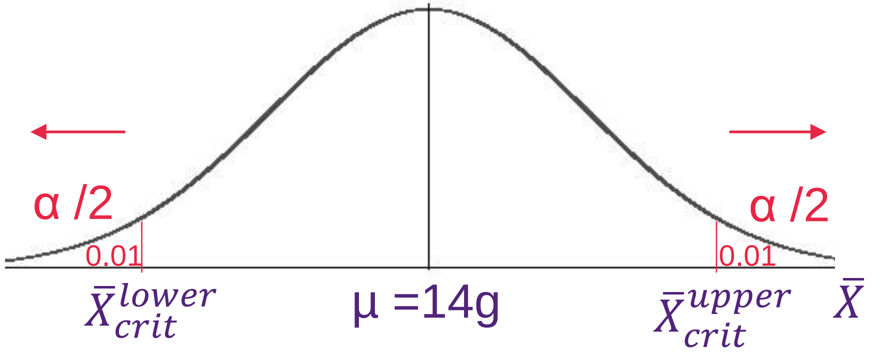
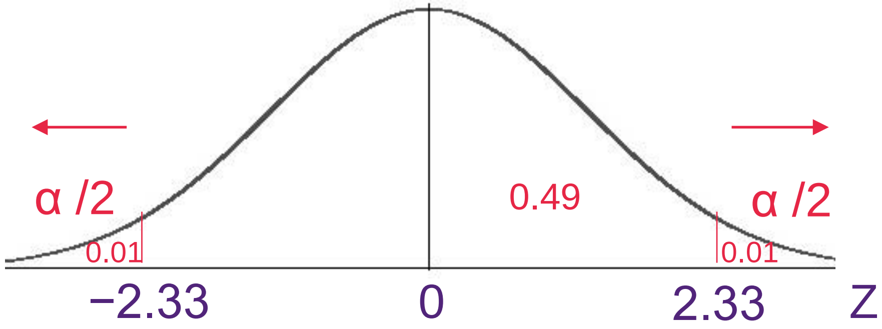
ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)? Type I Error

Rejection regions





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Step 4: Make a decision
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Step 5: Conclusion
There is sufficient evidence to suggest that the fill amounts are not 14g at the 2% LOS.

Error Table Associated with Hypothesis Testing Decisions.

Possible Outcomes from Decisions

	Actual (reality) Situation	
Statistical Decision	H_0 True	H_0 False
Do Not Reject H_0	✓	Type II Error
Reject H_0	Type I Error	✓

18

Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

b) Describe the Type I and Type II errors that are possible.

c) If the mean waiting time with the new switchboard is really 20 seconds, what error if any has been made?

adm T09 Q1 Q2 Q3 Q4

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AUSTRALIA

(Poll)

Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

1. What symbol would you give to the value 19 seconds? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

2. What symbol would you give to the value 8 seconds? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

3. What symbol would you give to the value 60 calls? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

4. What symbol would you give to the value 17.6 seconds? (Single Choice) *

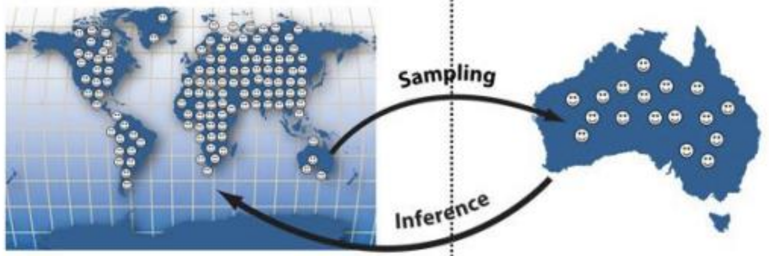
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

5. What symbol would you give to the value 4% level of significance? (Single Choice) *

- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

Inferential Statistics — drawing conclusions about a population based on a randomly selected sample.

POPULATION | Sample



PARAMETERS			Statistics		
POPULATION SIZE	=	N	sample size	=	n
POPULATION MEAN	=	μ	sample mean	=	$\bar{x}$
POPULATION STD. DEV.	=	σ	sample std. dev.	=	s
POPULATION VARIANCE	=	σ^2	sample variance	=	s^2
POPULATION PROPORTION	=	p	sample proportion	=	$\hat{p}$

adm T09 Q1 Q2 Q3 Q4

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(Poll)

Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

1. What symbol would you give to the value 19 seconds? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

2. What symbol would you give to the value 8 seconds? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

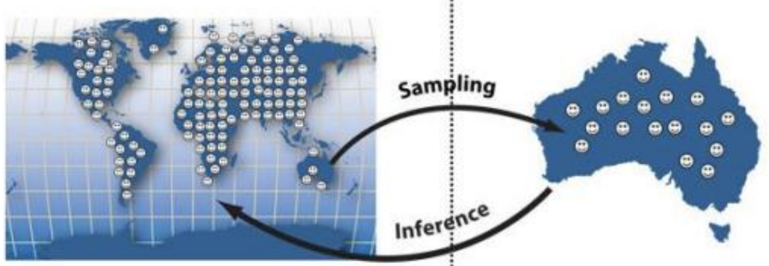
3. What symbol would you give to the value 60 calls? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

4. What symbol would you give to the value 17.6 seconds? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

5. What symbol would you give to the value 4% level of significance? (Single Choice) *
- σ (sigma)
- s
- μ (mu)
- x̄ (x bar)
- Level of Confidence (LOC)
- α (alpha)
- n

Inferential Statistics drawing conclusions about a population based on a randomly selected sample.

POPULATION | Sample



PARAMETERS			Statistics		
POPULATION SIZE	=	N	sample size	=	n
POPULATION MEAN	=	μ	sample mean	=	x̄
POPULATION STD. DEV.	=	σ	sample std. dev.	=	s
POPULATION VARIANCE	=	σ^2	sample variance	=	s^2
POPULATION PROPORTION	=	p	sample proportion	=	p̂

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μ = 19 seconds
σ = 8 seconds
n = 60
$\bar{X}$ = 17.6 seconds
α = 4%

Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

1. What type of problem is it? (Single Choice) *

- Population Mean (Seagull) (no sample)
- Population Mean (Pelican) (σ is known)
- Population Mean (Shag) (σ is unknown but s is known)
- Population Proportion (Freaky fish) (proportion)

2. What table will we use? (Single Choice) *

- Z table (standard normal distribution)
- t table (Student's t-distribution)

(Poll)

3. What is the value of α (alpha)? (Single Choice) *

- 0.01
- 0.02
- 0.03
- 0.04
- 0.05
- 0.1

4. What type of test is it? (Single Choice) *

- one tail test (upper tail >)
- one tail test (lower tail <)
- two tail test (=)

adm T09 Q1 Q2 Q3 Q4

μ = 19 seconds
σ = 8 seconds
n = 60
$\bar{X}$ = 17.6 seconds
α = 4% = 0.04

Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

1. What type of problem is it? (Single Choice) *

- Population Mean (Seagull) (no sample)
- Population Mean (Pelican) (σ is known)
- Population Mean (Shag) (σ is unknown but s is known)
- Population Proportion (Freaky fish) (proportion)

2. What table will we use? (Single Choice) *

- Z table (standard normal distribution)
- t table (Student's t-distribution)

(Poll)

3. What is the value of α (alpha)? (Single Choice) *

- 0.01
- 0.02
- 0.03
- 0.04
- 0.05
- 0.1

4. What type of test is it? (Single Choice) *

- one tail test (upper tail >)
- one tail test (lower tail <)
- two tail test (=)

adm T09 Q1 Q2 Q3 Q4

μ = 19 seconds
σ = 8 seconds
n = 60
$\bar{X}$ = 17.6 seconds
α = 4% = 0.04

Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

Step 1: State H_0 and H_1

μ = 19 seconds
σ = 8 seconds
n = 60
$\bar{X}$ = 17.6 seconds
α = 4% = 0.04

Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

Step 1: State H_0 and H_1
H_0: $\mu \geq 19$ or could be $\mu = 19$
H_1: $\mu < 19$

One tail test

adm T09 Q1 Q2 Q3 Q4

μ = 19 seconds
σ = 8 seconds
n = 60
$\bar{X}$ = 17.6 seconds
α = 4% = 0.04

Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

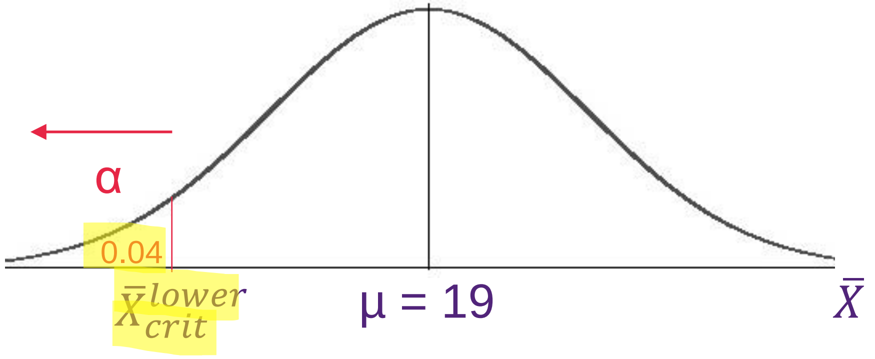
Step 1: State H_0 and H_1

H_0: $\mu \geq 19$

H_1: $\mu < 19$

One tail test

Rejection regions



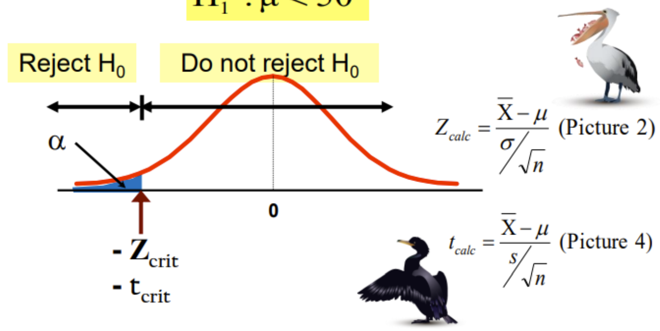
PICTURE 7

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0 : \mu \geq 50$

$H_1 : \mu < 50$



$Z_{calc} = \frac{\bar{X}-\mu}{\sigma/\sqrt{n}}$ (Picture 2)

$t_{calc} = \frac{\bar{X}-\mu}{s/\sqrt{n}}$ (Picture 4)

μ = 19 seconds
σ = 8 seconds
n = 60
$\bar{X}$ = 17.6 seconds
α = 4% = 0.04

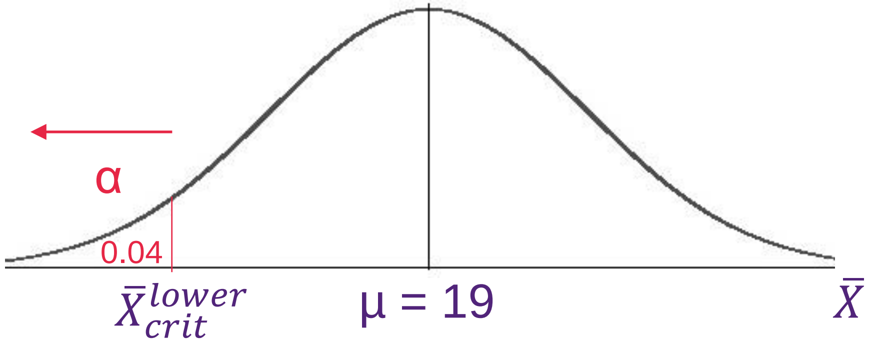
Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

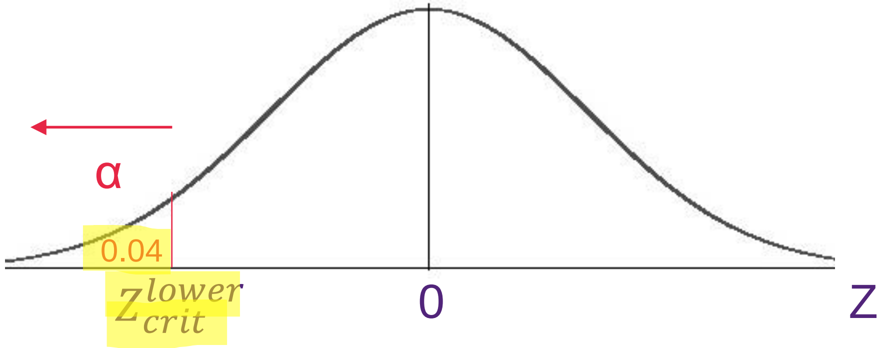
a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

Step 1: State H_0 and H_1
H_0: $\mu \geq 19$
H_1: $\mu < 19$

Step 2: Decision rule
Reject H_0 if $Z_{calc} < Z_{crit}$

Rejection regions



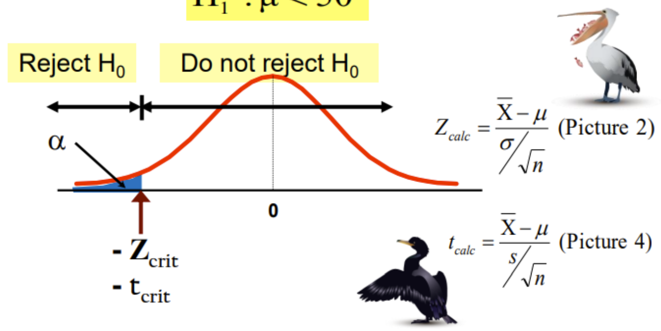


PICTURE 7

Hypothesis Testing for a Population Mean

(One – tailed test)

$H_0: \mu \geq 50$
$H_1: \mu < 50$

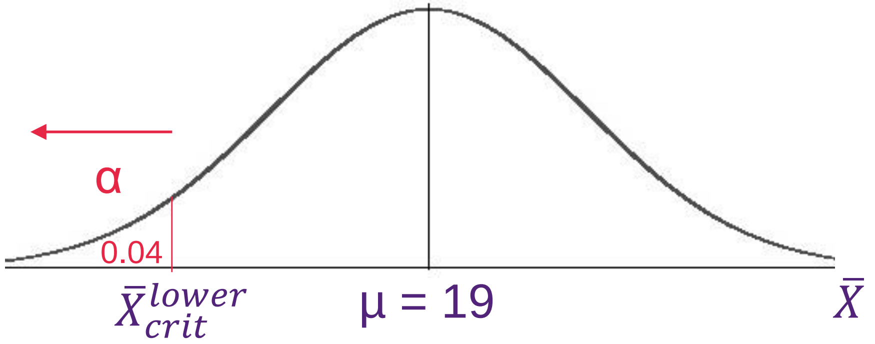


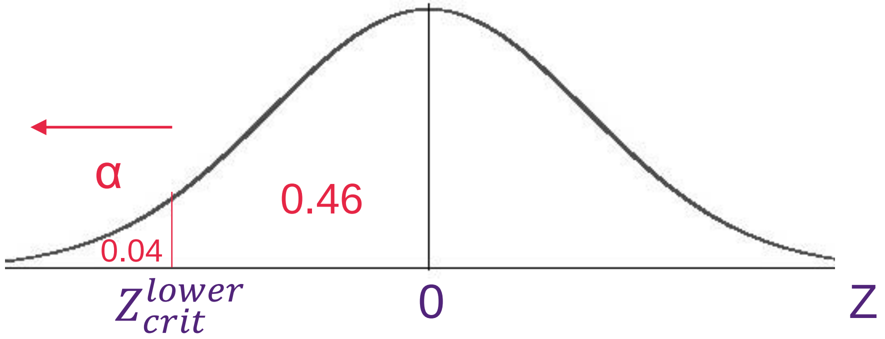
μ = 19 seconds
σ = 8 seconds
n = 60
$\bar{X}$ = 17.6 seconds
α = 4% = 0.04

Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

Rejection regions





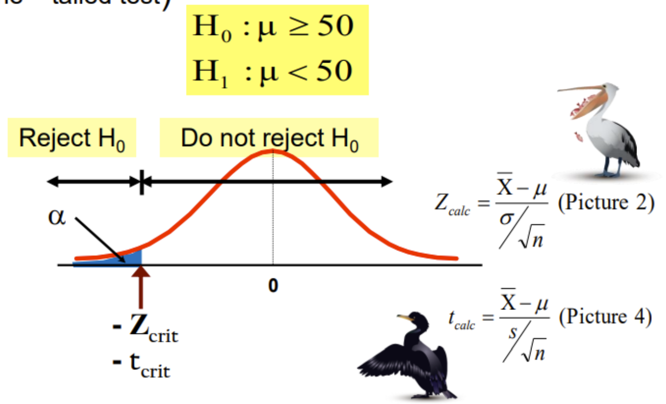
Step 1: State H_0 and H_1
H_0: μ ≥ 19
H_1: μ < 19

Step 2: Decision rule
Reject H_0 if $Z_{calc} < Z_{crit}$ = ?

PICTURE 7

Hypothesis Testing for a Population Mean

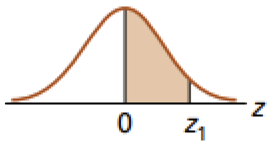
(One – tailed test)



adm T09 Q1 Q2 Q3 Q4

TABLE A.5 Areas of the standard normal distribution $\mu = 0, \sigma = 1$

The entries in this table are the probabilities that a standard normal random variable is between 0 and z_1 (the shaded area).

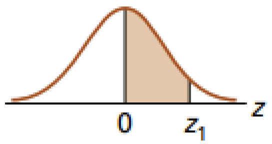


0.46

z_1	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767

TABLE A.5 Areas of the standard normal distribution $\mu = 0, \sigma = 1$

The entries in this table are the probabilities that a standard normal random variable is between 0 and z_1 (the shaded area).



0.46

z_1	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
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0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
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1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767

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μ = 19 seconds
σ = 8 seconds
n = 60
$\bar{X}$ = 17.6 seconds
α = 4% = 0.04

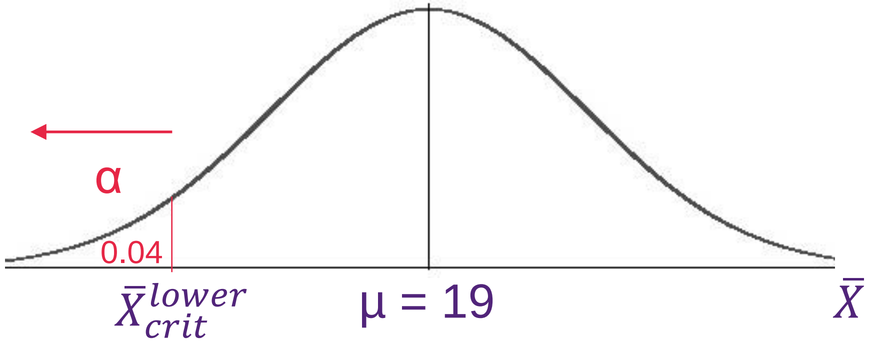
Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

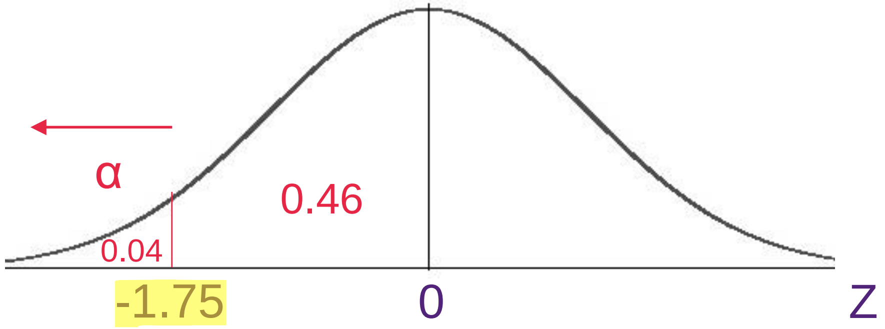
a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

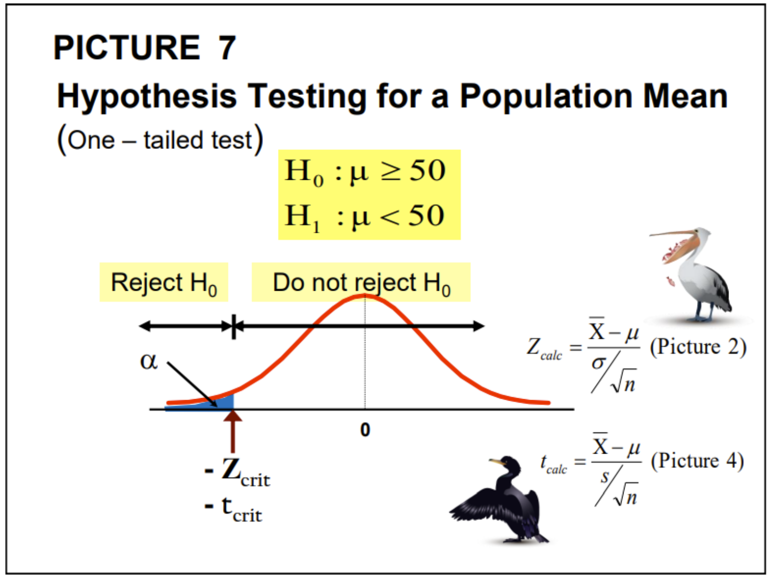
Step 1: State H_0 and H_1
H_0: μ ≥ 19
H_1: μ < 19

Step 2: Decision rule
Reject H_0 if $Z_{calc} < Z_{crit}$ = -1.75

Rejection regions







adm T09 Q1 Q2 Q3 Q4

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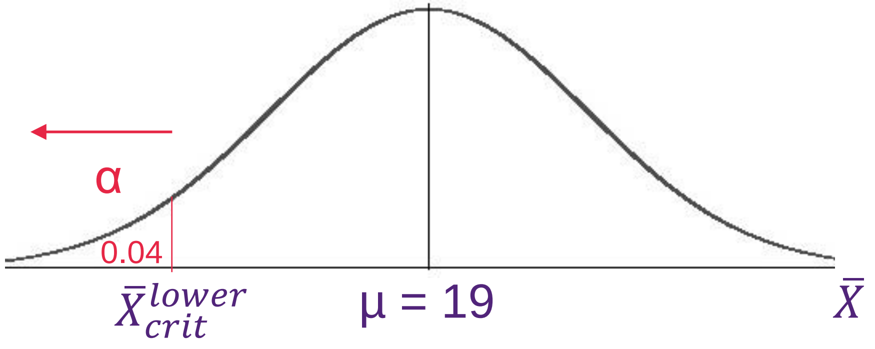
H_0: $\mu \geq 19$
H_1: $\mu < 19$

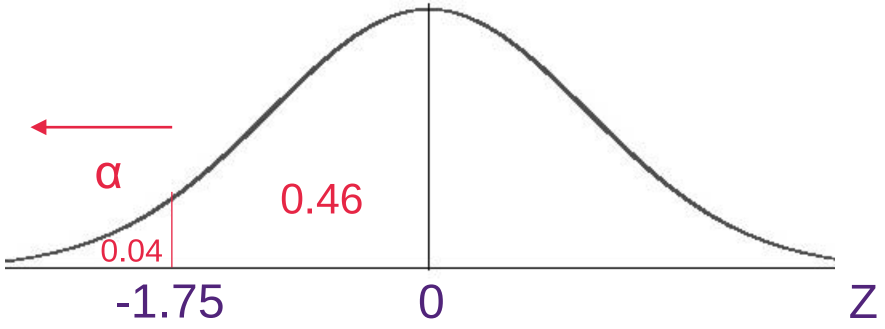
Step 2: Decision rule
Reject H_0 if $Z_{calc} < Z_{crit}$ = -1.75

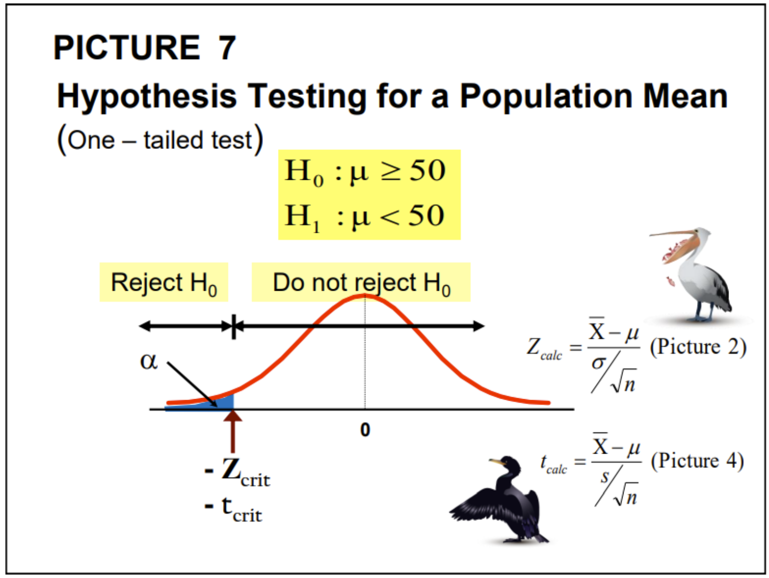
Step 3: Calculate Z_{calc}

$$Z_{calc} = \frac{\bar{X} - \mu}{\sigma_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = ?$$

Rejection regions







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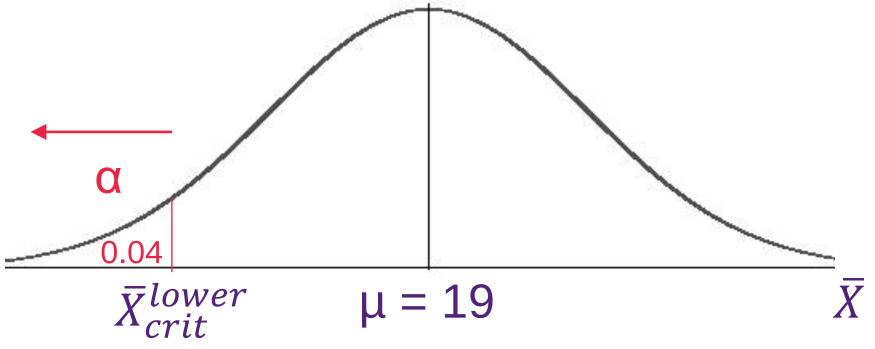
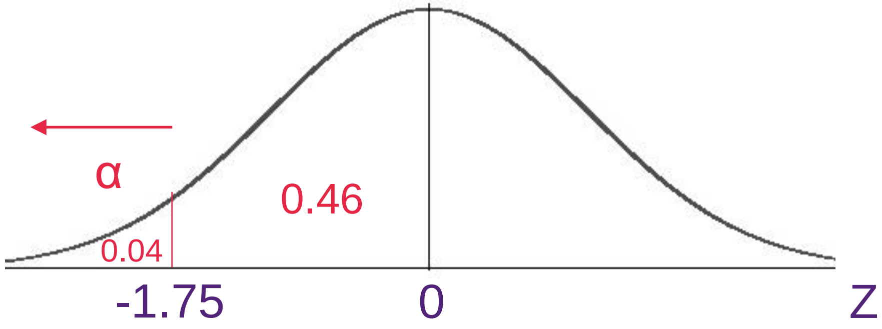


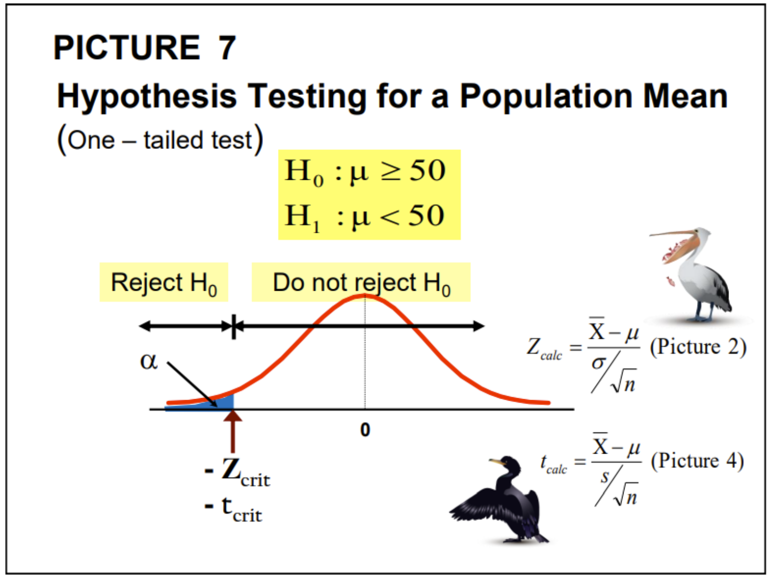


Step 1: State H_0 and H_1
H_0: μ ≥ 19
H_1: μ < 19

Step 2: Decision rule
Reject H_0 if $Z_{calc} < Z_{crit}$ = -1.75

Step 3: Calculate Z_{calc}

$$Z_{calc} = \frac{\bar{X} - \mu}{\sigma_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{17.6 - 19}{\frac{8}{\sqrt{60}}} = -1.36$$



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AUSTRALIA

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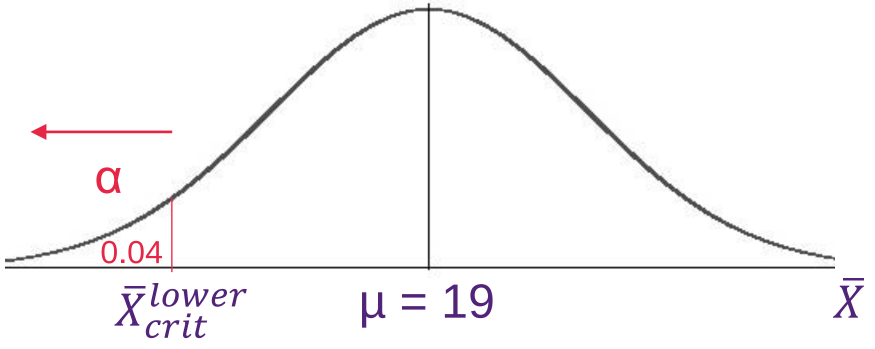
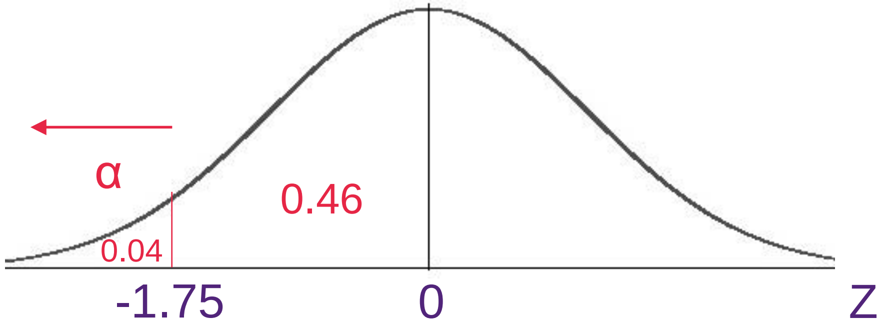
Rejection regions



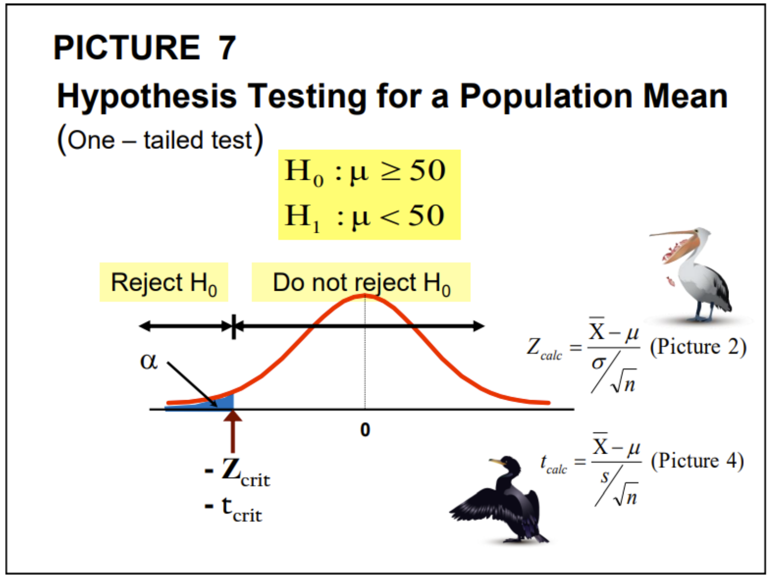


Step 1: State H_0 and H_1
H_0: μ ≥ 19
H_1: μ < 19

Step 2: Decision rule
Reject H_0 if $Z_{calc} < Z_{crit}$ = -1.75

Step 3: Calculate Z_{calc}
$$Z_{calc} = \frac{\bar{X} - \mu}{\sigma_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{17.6 - 19}{\frac{8}{\sqrt{60}}} = -1.36$$

Step 4: Make a decision
$Z_{calc} < Z_{crit}$ → -1.36 < -1.75 ?



adm T09 Q1 Q2 Q3 Q4

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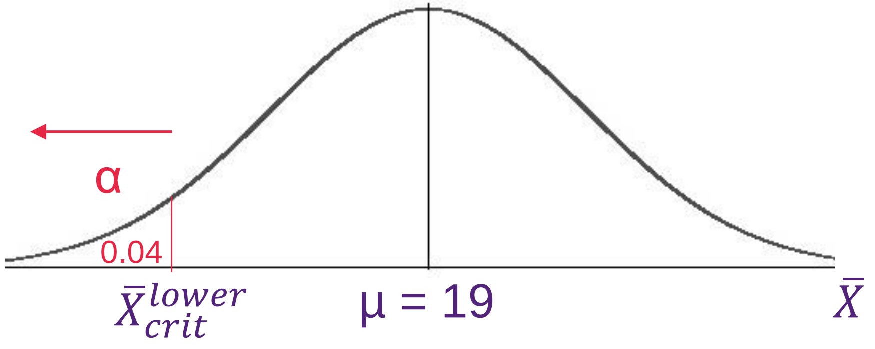

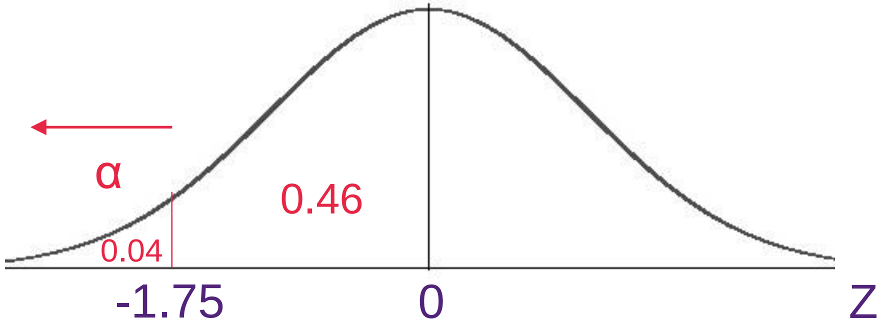

Step 1: State H_0 and H_1
H_0: $\mu \geq 19$
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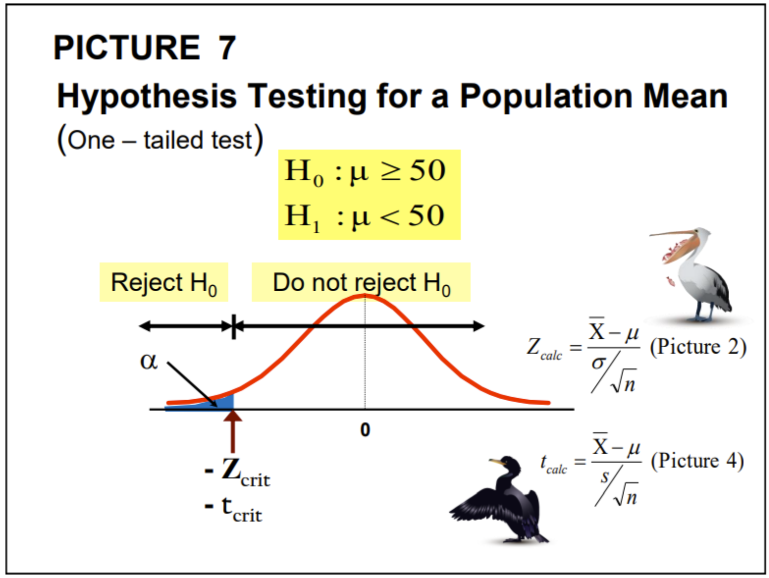
Step 2: Decision rule
Reject H_0 if $Z_{calc} < Z_{crit}$ = -1.75

Step 3: Calculate Z_{calc}

$$Z_{calc} = \frac{\bar{X}-\mu}{\sigma_{\bar{X}}} = \frac{\bar{X}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{17.6-19}{\frac{8}{\sqrt{60}}} = -1.36$$

Step 4: Make a decision
$Z_{calc} < Z_{crit} \rightarrow -1.36 < -1.75 \rightarrow$ Do not reject H_0.



adm T09 Q1 Q2 Q3 Q4

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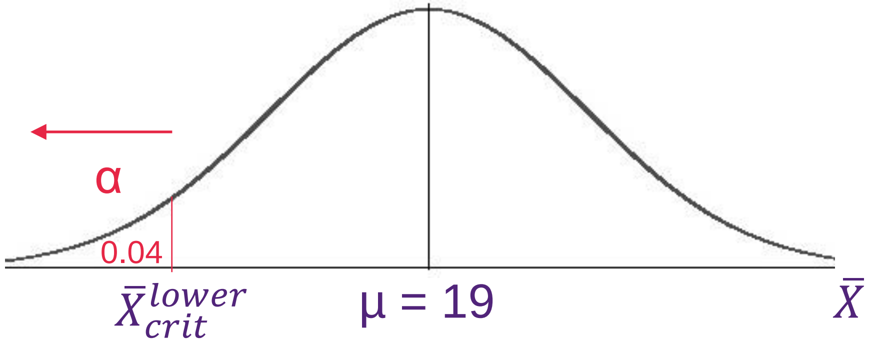
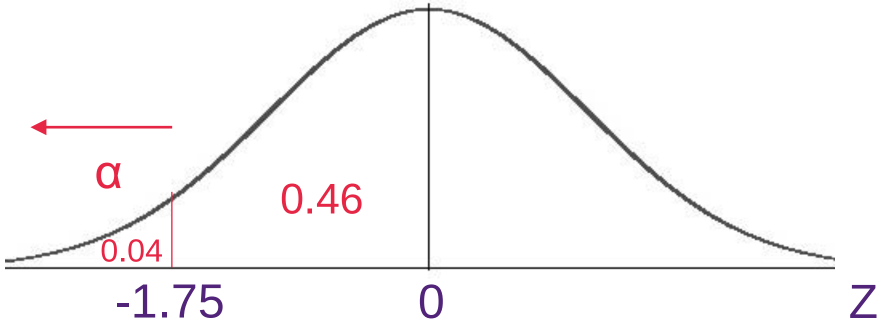
Q4. A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the mean waiting time. The department wishes to sample calls under the new conditions to see whether the new switchboard should replace the old one. A random sample of 60 calls found that the mean waiting time was 17.6 seconds.

a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

Rejection regions





Step 1: State H_0 and H_1
H_0: μ ≥ 19
H_1: μ < 19

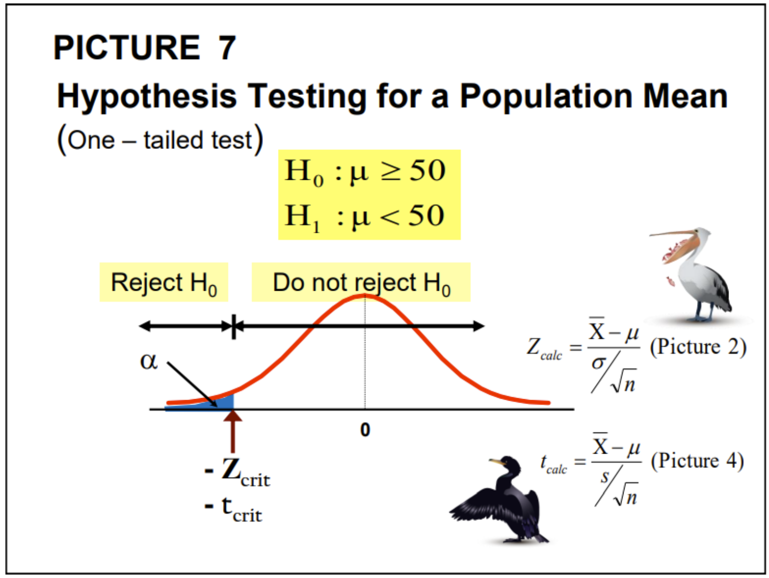
Step 2: Decision rule
Reject H_0 if $Z_{calc} < Z_{crit}$ = -1.75

Step 3: Calculate Z_{calc}

$$Z_{calc} = \frac{\bar{X} - \mu}{\sigma_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{17.6 - 19}{\frac{8}{\sqrt{60}}} = -1.36$$

Step 4: Make a decision
$Z_{calc} < Z_{crit}$ → -1.36 < -1.75 → Do not reject H_0.

Step 5: Conclusion
There is insufficient evidence to suggest that the new switchboard has, on average, lower waiting times than the old one at the 2% LOS.



μ = 19 seconds
σ = 8 seconds
n = 60
$\bar{X}$ = 17.6 seconds
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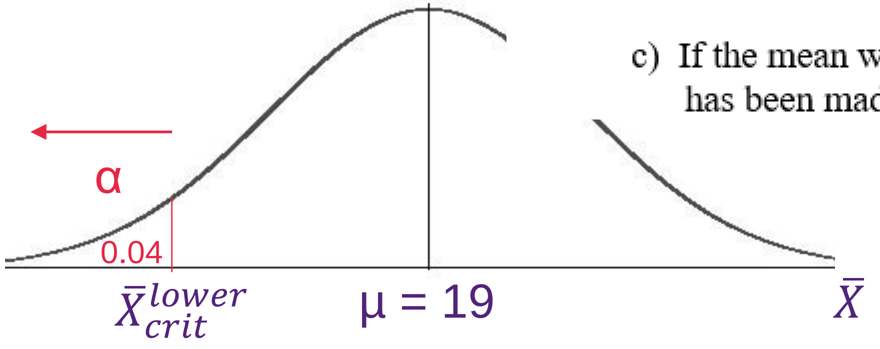
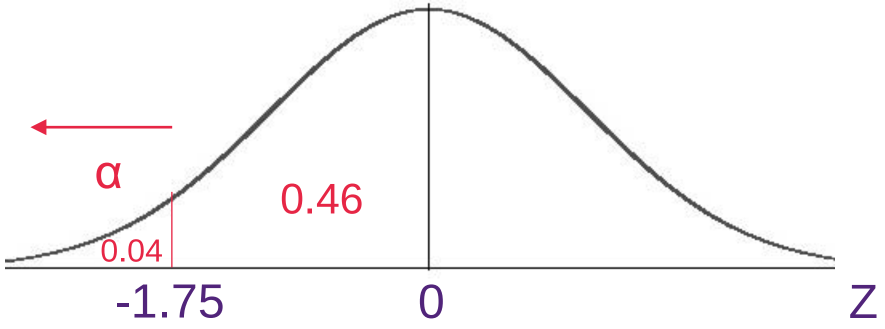
a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

b) Describe the Type I and Type II errors that are possible.

c) If the mean waiting time with the new switchboard is really 20 seconds, what error if any has been made?

Rejection regions





Step 1: State H_0 and H_1
H_0: $\mu \geq 19$
H_1: $\mu < 19$

Error Table Associated with Hypothesis Testing Decisions.

Possible Outcomes from Decisions

Statistical Decision	Actual (reality) Situation: H_0 True	Actual (reality) Situation: H_0 False
Do Not Reject H_0	✓	**Type II Error**
Reject H_0	**Type I Error**	✓

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μ = 19 seconds
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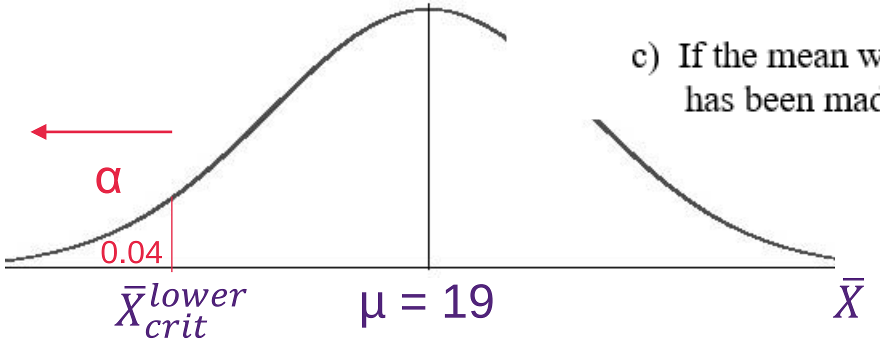

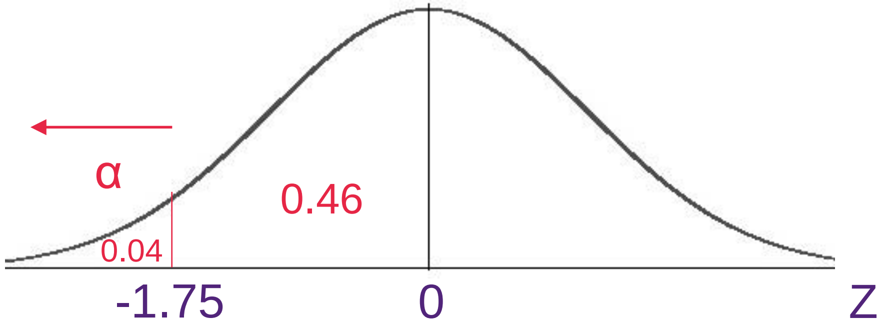

Step 1: State H_0 and H_1
H_0: μ ≥ 19
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Type I error: reject a true H_0 → install the new switchboard when it shouldn't

Type II error: fail to reject a false H_0 → not install new switchboard when it should.

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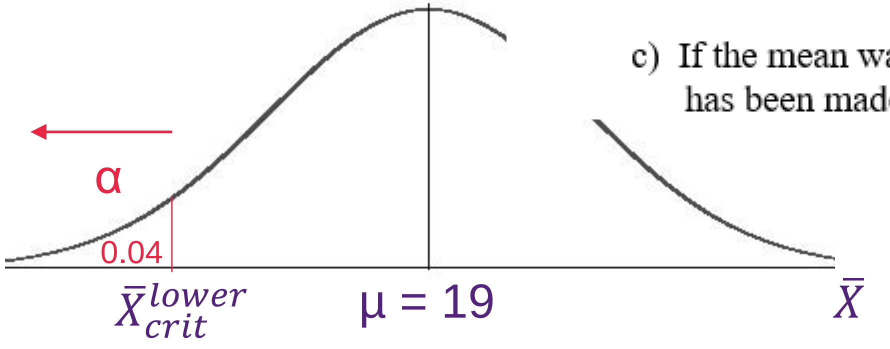

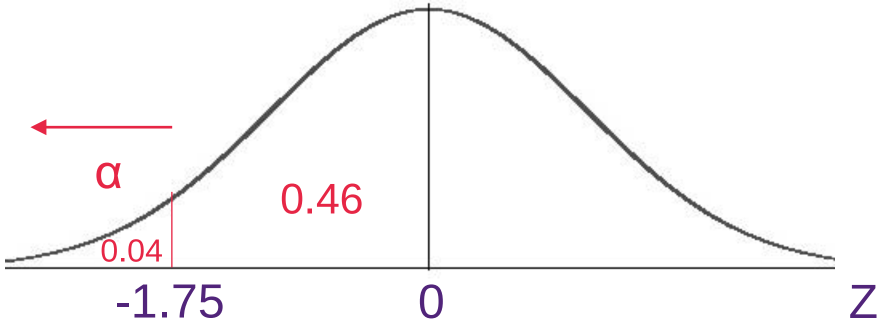

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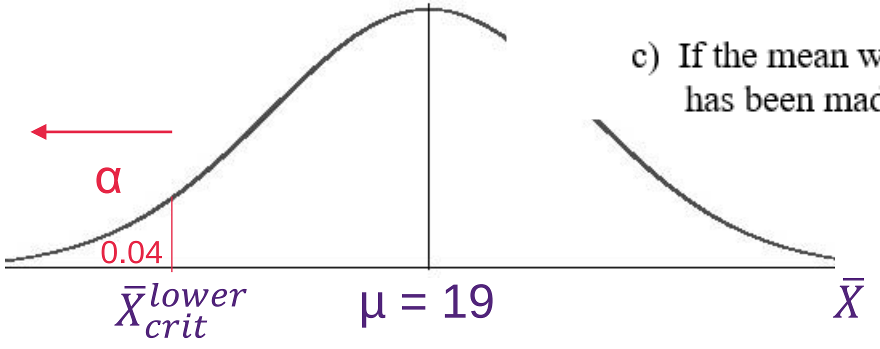

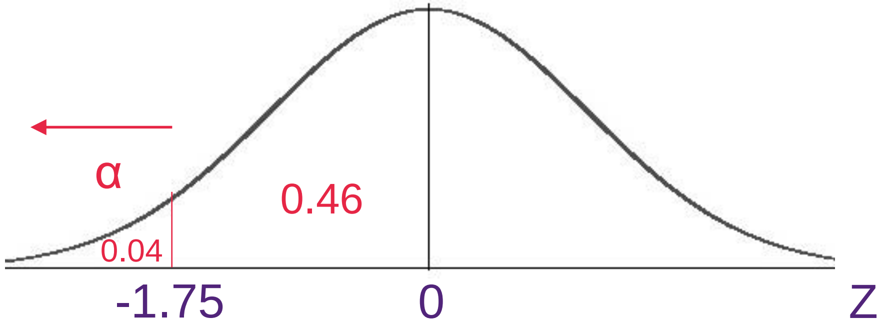

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Type I error: reject a true H_0 → install the new switchboard when it shouldn't

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No error was made: we did not reject H_0.

Error Table Associated with Hypothesis Testing Decisions.

Possible Outcomes from Decisions

Statistical Decision	Actual (reality) Situation: H_0 True	H_0 False
Do Not Reject H_0	✓	**Type II Error**
Reject H_0	**Type I Error**	✓

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ECON1310

Tutorial 9 – Week 10

HYPOTHESIS TESTING I

At the end of this tutorial you should be able to

- Formulate a hypothesis as a two-tail test or a one-tail test
- Determine whether it is appropriate to use a Z statistic or a *t* statistic
- Carry out one-tail and two-tail hypothesis tests using the 5-step method
- Describe Type I and Type II errors.

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Thank you

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tavaresgarcia.github.io

Reference

Black et al. (2016), Australasian Business Statistics, 4th Edition, Wiley Australia.