ECON1310 Introductory Statistics for Social Sciences

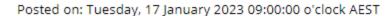
Tutorial 9: HYPOTHESIS TESTING I

Tutor: Francisco Tavares Garcia



LBRT #2 is open!

LBRT #2 (First Attempt) now available



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 (2nd) and 05 (1st)

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).
- 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



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.

Q1.



(Poll)

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?

	Single C	-	id you give to the value 9 different c	omputer ma	gazines:		
	σ (sig	ma)					
	s					2. What symbol would you give to the value \$1200? (Single Choice) *	4. What symbol would you give to the value 5% level of significance? (Single
	μ (mu)				σ (sigma)	Choice) *
)	ar)				○ s	o (sigma)
	Level	of Confide	nce (LOC)			Ο μ (mu)	○ s
	α (alp	ha)				◯ x̄ (x bar)	_ μ (mu)
(n					Level of Confidence (LOC)	○ x̄ (x bar)
Inferential Statistic	d	rawing	conclusions about a print a randomly selected	opulati	on	α (alpha)	Level of Confidence (LOC)
illierenda Stadsul	b	ased o	n a randomly selected	sampl	e.	\bigcirc n	α (alpha)
POPULATION			Sample				○ n
		Sam	ling			3. What symbol would you give to the value \$450? (Single Choice) * σ (sigma)	5. What symbol would you give to the value \$1500? (Single Choice) *
	2		8 8 8 8 8			○ s	σ (sigma)
			A. P. C.	4		Ο μ (mu)) s
		Infer	nce			x (x bar)	_ μ (mu)
A94 ==						Level of Confidence (LOC)	○ x̄ (x bar)
PARAMETERS			Statistics			α (alpha)	Level of Confidence (LOC)
POPULATION SIZE POPULATION MEAN	=	N	sample size	=	n —	○ n	
POPULATION MEAN POPULATION STD. DEV.	=	μ	sample mean	=	x		α (alpha)
	=	σ-2	sample std. dev. sample variance	=	s s ²		○ n
POPULATION VARIANCE	=	σ^2	sample proportion				
POPULATION PROPORTION	=	p	: sample proportion	=	p		

Q1.



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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?

		Choice) *	ia you give to the value 5 different e	omputer ma	gazines:		
	o (sig	gma)					
	s					2. What symbol would you give to the value \$1200? (Single Choice) *	4. What symbol would you give to the value 5% level of significance? (Single
	_ μ (mι	1)				o (sigma)	Choice) *
)	ar)				○ s	O σ (sigma)
	Leve	l of Confide	nce (LOC)			○ μ (mu)	○ s
	α (alp	oha)				x̄ (x bar)	_ μ (mu)
	O n					Level of Confidence (LOC)	○ x̄ (x bar)
Inferential Statistic	d	rawing	conclusions about a non a randomly selected	populati	on	α (alpha)	Level of Confidence (LOC)
interential Statistic	b	ased o	n a randomly selected	sampl	e.	○ n	α (alpha)
POPULATION			Sample				○ n
		Sam	ling			3. What symbol would you give to the value \$450? (Single Choice) * σ (sigma)	5. What symbol would you give to the value \$1500? (Single Choice) *
	E 2/		9 99 9			○ s	o (sigma)
	0.					_ μ (mu)	○ s
		Infer	ance v			x̄ (x bar)	<u>μ (mu)</u>
DADAMETERS			5			Level of Confidence (LOC)	○ x̄ (x bar)
PARAMETERS		NI.	Statistics sample size			α (alpha)	Level of Confidence (LOC)
POPULATION SIZE POPULATION MEAN	=	N μ	sample size	=	n x	○ n	α (alpha)
POPULATION STD. DEV.	=	σ	sample std. dev.	=	s		○ n
POPULATION VARIANCE	=	σ^2	sample variance	=	s ²		○ II
POPULATION PROPORTION	=	p	sample proportion	=	ĝ		



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)

1	Pol	
		-/

3.	What i	is the	value	of o	(alp	ha)?	(Single	Choice)	*

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

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

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

1. What	type of	test is	it?	(Single	Choice) *	b
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- one tail test (upper tail >)
- one tail test (lower tail <)
- two tail test (=)



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 $\alpha = 5\% = 0.05$

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

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Five Steps for Hypothesis Testing.

- 1. State H₀ and H₁
- 2. State the decision rule for the appropriate test statistic and sampling distribution
- 3. Calculate the test statistic
- 4. Make a decision (reject H₀ or do not reject H₀)
- 5. State a conclusion

Note:

steps 1 and 2 are prior to any sample information.



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 H_0 : $\mu = 1500 H_1 : $\mu \neq 1500



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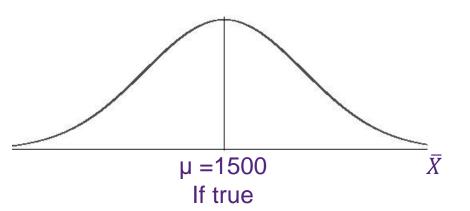
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Two tail test



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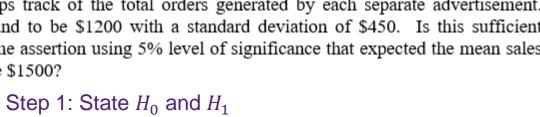
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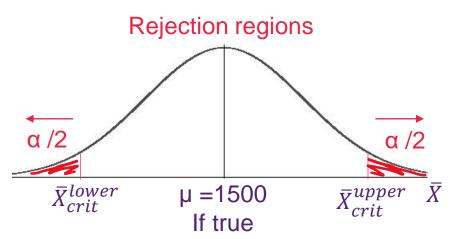
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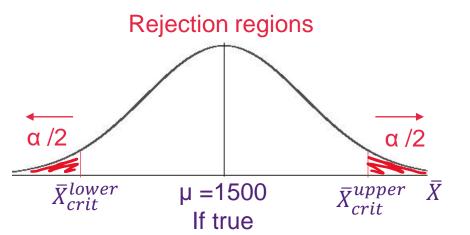
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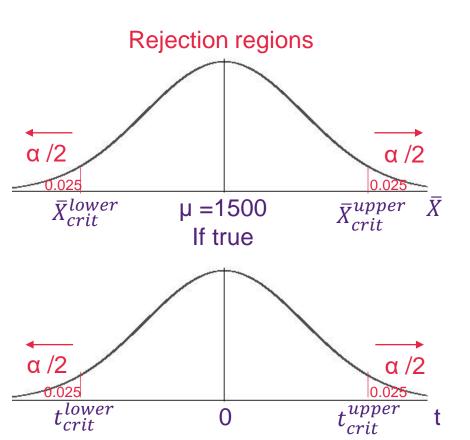
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Step 2: Decision rule

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



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- 2

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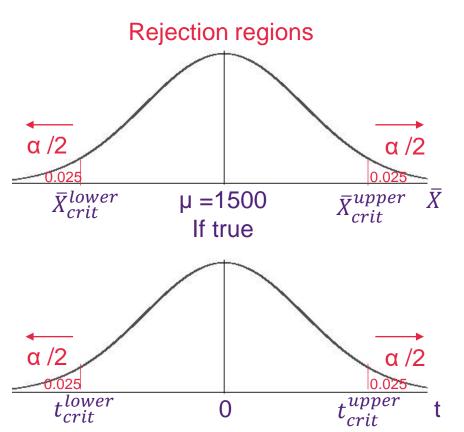


Step 1: State H_0 and H_1

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Step 2: Decision rule

Reject H_0 if $|t_{calc}| > t_{crit} = t_{\Omega/2,n-1} = t_{0.025,8} = ?$



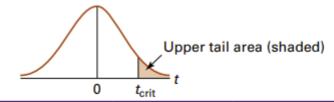
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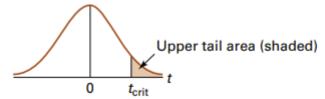




			Upper tail areas			
df	<i>t</i> _{.10}	t _{.05}	t _{.025}	<i>t</i> _{.01}	<i>t</i> .005	<i>t</i> _{.001}
1	3.078	6.314	12.706	31.821	63.657	318.309
2	1.886	2.920	4.303	6.965	9.925	22.327
3	1.638	2.353	3.182	4.541	5.841	10.215
4	1.533	2.132	2.776	3.747	4.604	7.173
5	1.476	2.015	2.571	3.365	4.032	5.893
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	<i>t</i> _{.10}	<i>t</i> .05	t _{.025}	<i>t</i> _{.01}	<i>t</i> .005	<i>t</i> _{.001}
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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
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
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 $t_{0.025,\,8}$

Q1.



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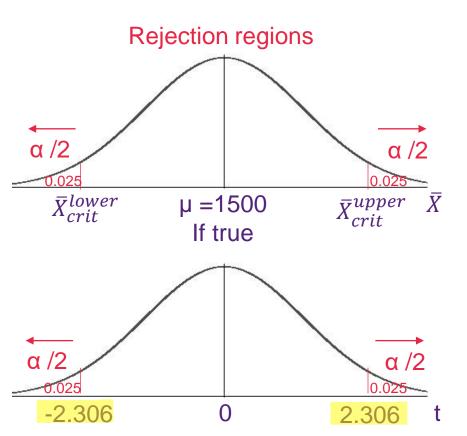


Step 1: State H_0 and H_1

 H_0 : $\mu = 1500 H_1 : $\mu \neq 1500

Step 2: Decision rule

Reject H_0 if $|t_{calc}| > t_{crit} = t_{\Omega/2, n-1} = t_{0.025, 8} = 2.306$



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- State H₀ and H₁
- 2. State the decision rule for the appropriate test statistic and sampling distribution
- 3. Calculate the test statistic
- Make a decision (reject H₀ or do not reject H₀)
- 5. State a conclusion

Note:

steps 1 and 2 are prior to any sample information.

- 2

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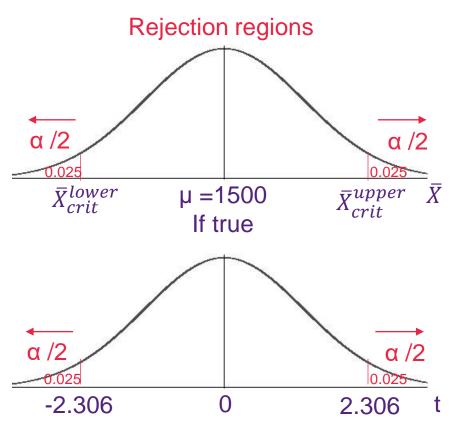
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Step 3: Calculate t_{calc}



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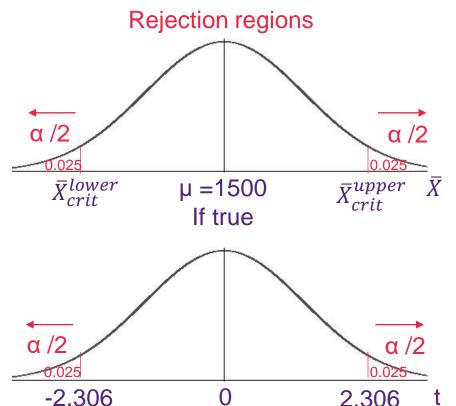
 H_1 : $\mu \neq 1500

Step 2: Decision rule

Reject
$$H_0$$
 if $|t_{calc}| > t_{crit} = t_{\Omega/2,n-1} = t_{0.025,8} = 2.306$

Step 3: Calculate t_{calc}

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



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 $\mu = 1500

-2.306

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

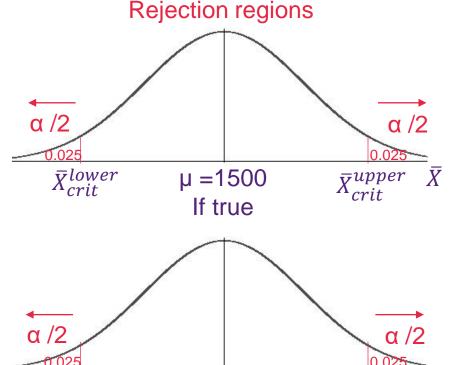
 H_1 : $\mu \neq 1500

Step 2: Decision rule

Reject H_0 if $|t_{calc}| > t_{crit} = t_{\Omega/2, n-1} = t_{0.025, 8} = 2.306$

Step 3: Calculate t_{calc}

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



2.306

Five Steps for Hypothesis Testing.

- State H₀ and H₁
- 2. State the decision rule for the appropriate test statistic and sampling distribution
- 3. Calculate the test statistic
- Make a decision (reject H₀ or do not reject H₀)
- 5. State a conclusion

Note:

steps 1 and 2 are prior to any sample information.

- 2

O1.



n = 9

 $\bar{X} = 1200

s = \$450

 $\alpha = 5\% = 0.05$

 $\mu = 1500

-2.306

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

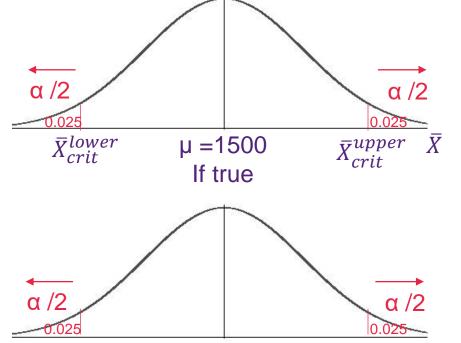
Reject H_0 if $|t_{calc}| > t_{crit} = t_{\Omega/2,n-1} = t_{0.025,8} = 2.306$

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

$$|t_{calc}| > t_{crit}$$



2.306

Rejection regions

Five Steps for Hypothesis Testing.

- 1. State H₀ and H₁
- 2. State the decision rule for the appropriate test statistic and sampling distribution
- 3. Calculate the test statistic
- 4. Make a decision (reject H₀ or do not reject H₀)
- 5. State a conclusion

Note:

steps 1 and 2 are prior to any sample information.

O1.



n = 9

 $\bar{X} = 1200

s = \$450

 $\alpha = 5\% = 0.05$

 $\mu = 1500

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 $|t_{calc}| > t_{crit} = t_{\Omega/2,n-1} = t_{0.025,8} = 2.306$

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

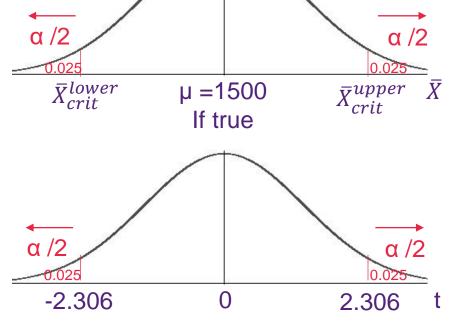
$$|t_{calc}| > t_{crit} \rightarrow |-2| > 2.306 \rightarrow Do \text{ not reject.}$$

Five Steps for Hypothesis Testing.

- State H₀ and H₁
- State the decision rule for the appropriate test statistic and sampling distribution
- Calculate the test statistic
- Make a decision (reject H_0 or do not reject H_0)
- State a conclusion

Note:

steps 1 and 2 are prior to any sample information.



Rejection regions

O1.



n = 9

 $\bar{X} = 1200

s = \$450

 $\alpha = 5\% = 0.05$

 $\mu = 1500

 $\alpha/2$

 \bar{X}_{crit}^{lower}

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 $|t_{calc}| > t_{crit} = t_{\Omega/2,n-1} = t_{0.025,8} = 2.306$

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

 $|t_{calc}| > t_{crit} \rightarrow |-2| > 2.306 \rightarrow Do \text{ not reject.}$

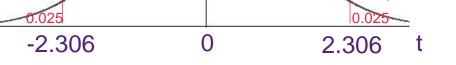
Five Steps for Hypothesis Testing.

- State H₀ and H₁
- 2. State the decision rule for the appropriate test statistic and sampling distribution
- 3. Calculate the test statistic
- 4. Make a decision (reject H₀ or do not reject H₀)
 - State a conclusion

Note:

steps 1 and 2 are prior to any sample information.

26



 \bar{X}_{crit}^{upper} \bar{X}

Rejection regions

 $\mu = 1500$

If true

O1.



n = 9

 $\alpha/2$

 \bar{X}_{crit}^{lower}

 $\bar{X} = 1200

s = \$450

 $\alpha = 5\% = 0.05$

 $\mu = 1500

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 $|t_{calc}| > t_{crit} = t_{\Omega/2,n-1} = t_{0.025,8} = 2.306$

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

 $|t_{calc}| > t_{crit} \rightarrow |-2| > 2.306 \rightarrow Do \text{ not reject.}$

Step 5: Conclusion

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

Cannot refute it.

Five Steps for Hypothesis Testing.

- State H₀ and H₁
- 2. State the decision rule for the appropriate test statistic and sampling distribution
- 3. Calculate the test statistic
- Make a decision (reject H₀ or do not reject H₀)
- 5. State a conclusion

Note:

steps 1 and 2 are prior to any sample information.

2

Tutorial 9 - HYPOTHESIS TESTING I

-2.306 0 2.306 t

Rejection regions

 $\mu = 1500$

If true



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.

σ (sigma)



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 1. What symbol would you give to the value 920? (Single Choice) the decision rule in terms of the sample mean.

s						
μ (mu)					2. What symbol would you give to the value 20? (Single Choice) *	4. What symbol would you give to the value 925? (Single Choice) *
\bar{x} (x bar)		/D	- 111		o (sigma)	o (sigma)
Level of Confidence (LOC)		(P	oll)		○ s	○ s
α (alpha)		•	,		_ μ (mu)	Ο μ (mu)
<u>n</u>					◯ x̄ (x bar)	◯ x̄ (x bar)
	drawing conclu	isions about a no	nulatio	n	Level of Confidence (LOC)	Level of Confidence (LOC)
Inferential Statistics	based on a ran	sions about a po domly selected s	sample		α (alpha)	α (alpha)
POPULATION	į Sa	mple		112	○ n	○ n
PARAMETERS POPULATION SIZE = POPULATION MEAN =	N sai μ sai	atistics mple size mple mean	= =	n x	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)	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)
POPULATION STD. DEV. =		mple std. dev. mple variance	=	s s ²		α (alpha)
POPULATION VARIANCE = POPULATION PROPORTION =		mple proportion	=	p	<i>∵</i>	\bigcirc n
countries and Supplied a state of agreement reading on the free free countries (SPEE) (1)	of the second	and the second of the second o			Tutorial 9 - HYPOTHESIS TESTING I	28



Q2. A university claims that the average tertiary entry (TE) score of applicants to its business the 5% level of significance, can we conclude that the university's claim is true? State

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 1. What symbol would you give to the value 920? (Single Choice) the decision rule in terms of the sample mean. σ (sigma) 2. What symbol would you give to the value 20? (Single Choice) * 4. What symbol would you give to the value 925? (Single Choice) * x (x bar)

			(llo ^c)
(alpha)			(-		
Inferential Statistic	s d	rawing o	conclusions about a a randomly selecte	populat d sampl	ion e.
POPULATION		i	Sample		
W00 00 W00 0	100	Sampl	A A A		
PARAMETERS		Inferer			
PARAMETERS POPULATION SIZE			Statistics		n
PARAMETERS POPULATION SIZE POPULATION MEAN		Inferer N	Statistics sample size	= =	n x
POPULATION SIZE	= = =	N	Statistics	= =	
POPULATION SIZE POPULATION MEAN		N µ	Statistics sample size sample mean	= = =	\bar{x}

σ (sigma)	σ (sigma)
○ s	○ s
_ μ (mu)	_ μ (mu)
\bigcirc \bar{x} (x bar)	○ x̄ (x bar)
Level of Confidence (LOC)	Level of Confidence (LOC)
α (alpha)	α (alpha)
\bigcirc n	○ n
3. What symbol would you give to the value 35? (Single Choice) *	5. What symbol would you give to the value 5% level of significance? (Single
3. What symbol would you give to the value 35? (Single Choice) * σ (sigma)	5. What symbol would you give to the value 5% level of significance? (Single Choice) $\mbox{\ensuremath{^{\bullet}}}$
_ σ (sigma)	Choice) *
σ (sigma) s	Choice) * σ (sigma)
σ (sigma) s μ (mu)	Choice) * σ (sigma) s
σ (sigma) s μ (mu) x̄ (x bar)	Choice) * σ (sigma) s μ (mu)
σ (sigma) s μ (mu) x̄ (x bar) Level of Confidence (LOC)	Choice) * σ (sigma) s μ (mu) x̄ (x bar)



 $\mu = 920$

 $\sigma = 20$

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.









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

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)

(Pol	I)
------	----

0.01		
0.02		
0.03		
0.04		
0.05		

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

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

0.1

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

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



 $\mu = 920$

 $\sigma = 20$

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.



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)

(Poll)

0.010.020.030.040.05

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

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

one tail test (upper tail >)

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

0.1

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

Z table (standard normal distribution)

t table (Student's t-distribution)



 $\mu = 920$ $\sigma = 20$ 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



Q2.



 $\mu = 920$

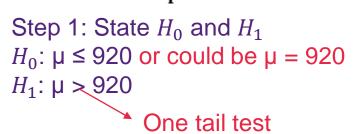
 $\sigma = 20$

n = 35

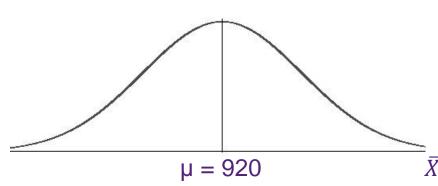
 $\bar{X} = 925$

 $\alpha = 5\% = 0.05$

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.**







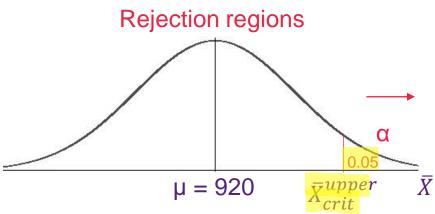
Q2.



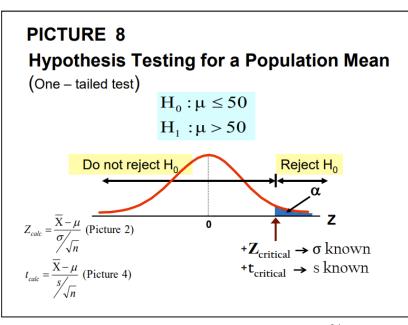
$$\mu = 920$$
 $\sigma = 20$
 $n = 35$
 $\bar{X} = 925$
 $\alpha = 5\% = 0.05$

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



Q2.



$$\mu = 920$$
 $\sigma = 20$

$$n = 35$$

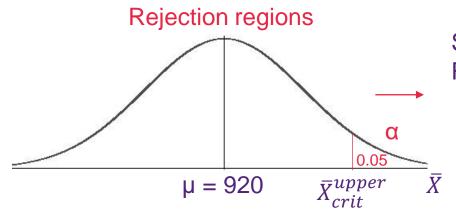
$$\bar{X} = 925$$

$$\alpha = 5\% = 0.05$$

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.**

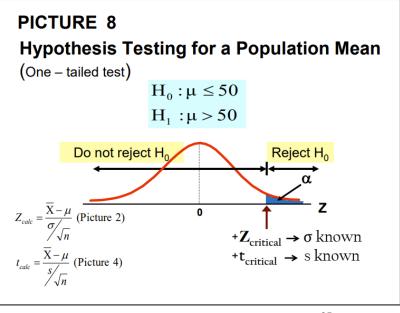
Step 1: State H_0 and H_1 H_0 : $\mu \le 920$

 H_1 : $\mu > 920$



Step 2: Decision rule Reject H_0 if





Q2.

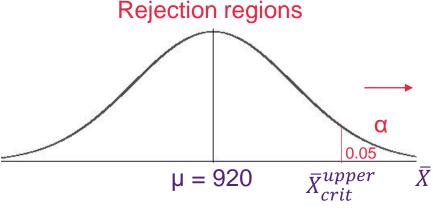


$$\mu = 920$$
 $\sigma = 20$
 $n = 35$
 $\bar{X} = 925$
 $\alpha = 5\% = 0.05$

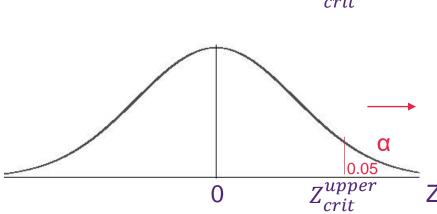
A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In 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 $|Z_{calc}| > Z_{crit}$



PICTURE 8

Hypothesis Testing for a Population Mean

(One – tailed test) $H_0: \mu \leq 50$ $H_1: \mu > 50$ Do not reject H_0 $Z_{calc} = \frac{\overline{X} - \mu}{\sigma / n}$ (Picture 2) $t_{calc} = \frac{\overline{X} - \mu}{s / n}$ (Picture 4) $t_{calc} = \frac{\overline{X} - \mu}{s / n}$ (Picture 4)

Q2.



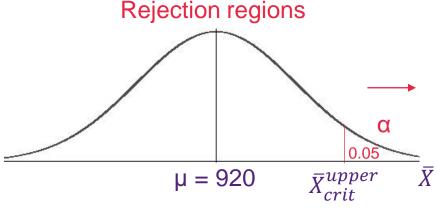
$$\mu = 920$$
 $\sigma = 20$
 $n = 35$
 $\bar{X} = 925$
 $\alpha = 5\% = 0.05$

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.

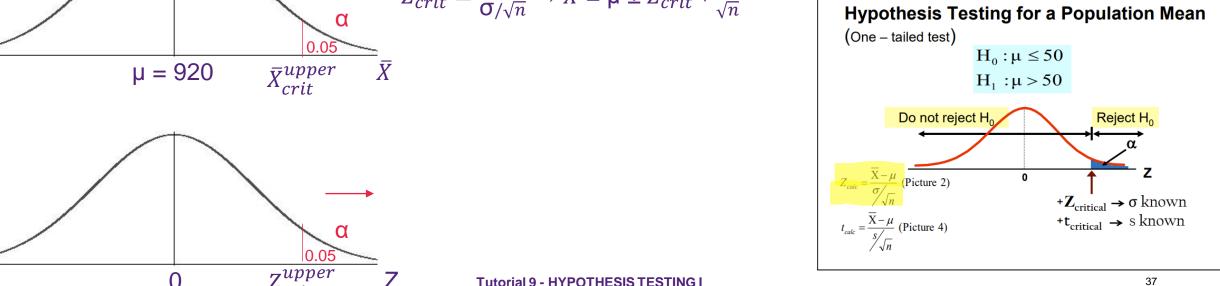


PICTURE 8

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



Step 2: Decision rule Reject H_0 if $|Z_{calc}| > Z_{crit}$ $Z_{crit} = \frac{\bar{X} - \mu}{\sigma / \sqrt{n}} \rightarrow \bar{X} = \mu \pm Z_{crit} * \frac{\sigma}{\sqrt{n}}$



Q2.



$$\mu = 920$$
 $\sigma = 20$

$$n = 35$$

$$\bar{X} = 925$$

$$\alpha = 5\% = 0.05$$

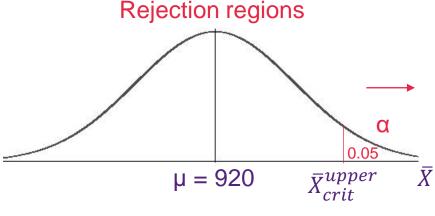
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Step 1: State H_0 and H_1

$$H_0$$
: µ ≤ 920

$$H_1$$
: $\mu > 920$

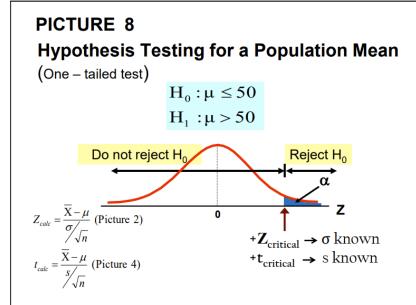


Step 2: Decision rule

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

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

Sampling error



Q2.



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

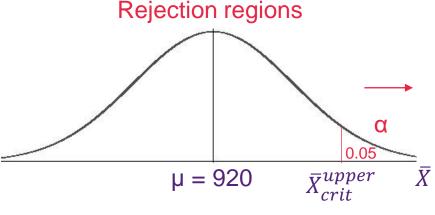
A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In 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.**



 $\alpha = 5\% = 0.05$

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

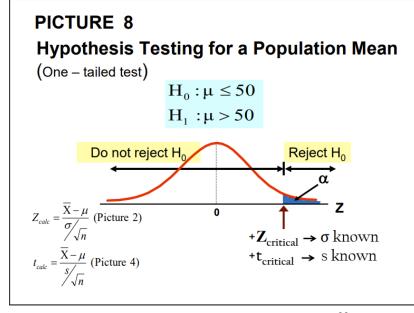
$$H_1$$
: $\mu > 920$

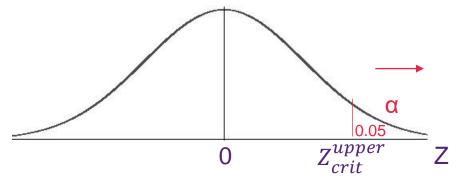


Step 2: Decision rule

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

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





Q2.

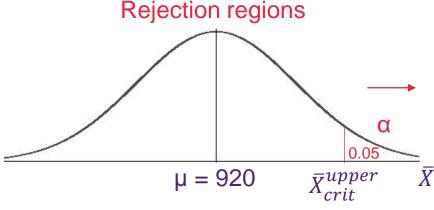


$$\mu = 920$$
 $\sigma = 20$
 $n = 35$
 $\bar{X} = 925$
 $\alpha = 5\% = 0.05$

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.**



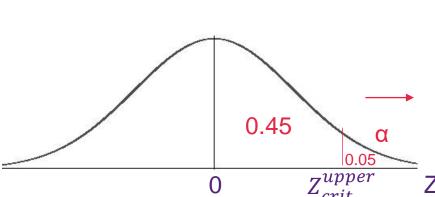
Step 1: State H_0 and H_1 H_0 : $\mu \le 920$ H_1 : $\mu > 920$



Step 2: Decision rule

Reject H_0 if $|Z_{calc}| > Z_{crit}$ $= \sqrt{x} - U = unner$

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

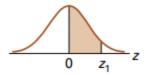


PICTURE 8 Hypothesis Testing for a Population Mean (One – tailed test) $H_0: \mu \leq 50$ $H_1: \mu > 50$ Do not reject H_0 $Z_{calc} = \frac{\overline{X} - \mu}{\sigma / \sqrt{n}}$ (Picture 2) $t_{calc} = \frac{\overline{X} - \mu}{s / \sqrt{n}}$ (Picture 4) $t_{calc} = \frac{\overline{X} - \mu}{s / \sqrt{n}}$ (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).



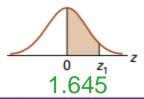
z ₁	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.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
8.0	.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



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).



<i>z</i> 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
8.0	.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

Q2.



$$\mu = 920$$
 $\sigma = 20$

$$n = 35$$

$$\bar{X} = 925$$

$$\alpha = 5\% = 0.05$$

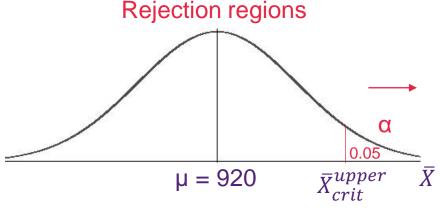
A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In 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

$$H_0$$
: µ ≤ 920

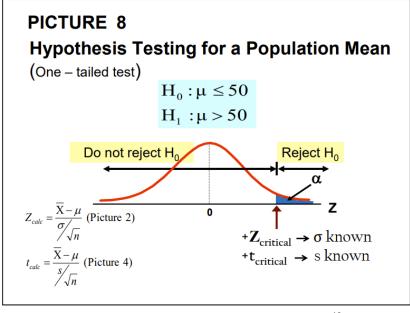
$$H_1$$
: $\mu > 920$

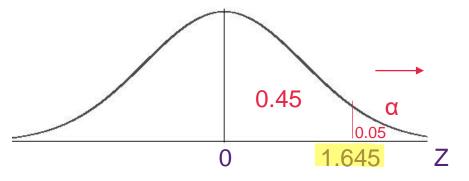


Step 2: Decision rule

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

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





Q2.



$$\mu = 920$$
 $\sigma = 20$
 $n = 35$

$$\bar{X} = 925$$

$$\alpha = 5\% = 0.05$$

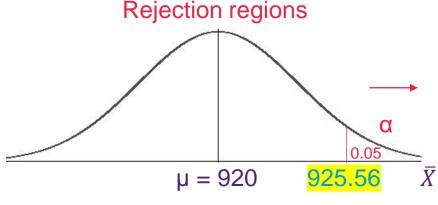
A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In 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

$$H_0$$
: µ ≤ 920

$$H_1$$
: $\mu > 920$

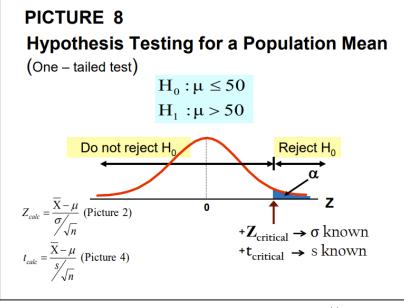


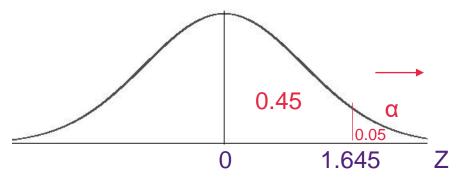
Step 2: Decision rule

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

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

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





Q2.



$$\mu = 920$$
 $\sigma = 20$

$$n = 35$$

$$\bar{X} = 925$$

$$\alpha = 5\% = 0.05$$

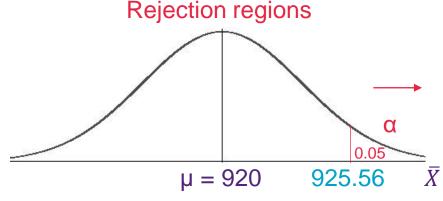
A university claims that the average tertiary entry (TE) score of applicants to its business studies program has increased during the past three years. Three years ago, the mean and standard deviation of TE scores of the university's business studies program applicants were 920 and 20 respectively. In 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

$$H_0$$
: µ ≤ 920

$$H_1$$
: $\mu > 920$

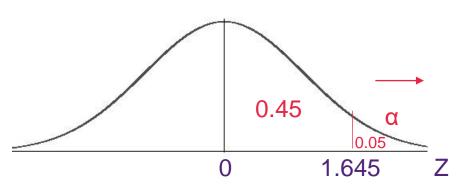


Step 2: Decision rule

Reject
$$H_0$$
 if $\bar{X} > \bar{X}_{crit} = 925.56$

Step 3: Calculate \bar{X}_{calc}

$$\bar{X} = 925 = \bar{X}_{calc}$$



PICTURE 8 Hypothesis Testing for a Population Mean (One – tailed test) $H_0: \mu \leq 50$ $H_1: \mu > 50$ Do not reject H_0 $Z_{calc} = \frac{\overline{X} - \mu}{\sigma / \sqrt{n}} \text{ (Picture 2)}$ $t_{calc} = \frac{\overline{X} - \mu}{s / \sqrt{n}} \text{ (Picture 4)}$ $t_{calc} = \frac{\overline{X} - \mu}{s / \sqrt{n}} \text{ (Picture 4)}$

Q2.



$$\mu = 920$$
 $\sigma = 20$

$$n = 35$$

$$\bar{X} = 925$$

$$\alpha = 5\% = 0.05$$

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

$$H_0$$
: µ ≤ 920

$$H_1$$
: $\mu > 920$





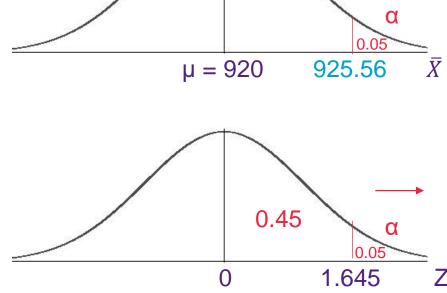
Reject
$$H_0$$
 if $\bar{X} > \bar{X}_{crit} = 925.56$

Step 3: Calculate \bar{X}_{calc}

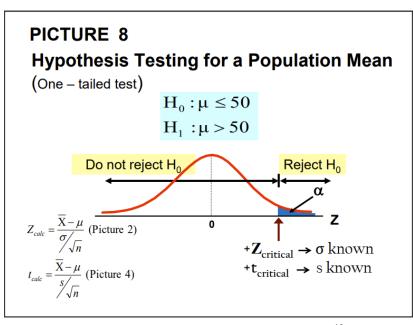
$$\bar{X} = 925 = \bar{X}_{calc}$$

Step 4: Make a decision

$$\bar{X} > \bar{X}_{crit}$$



Rejection regions



Q2.



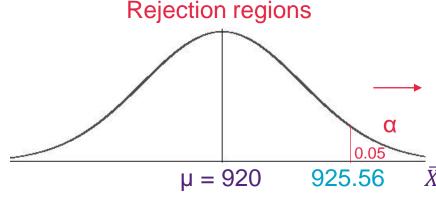
$$\mu = 920$$
 $\sigma = 20$
 $n = 35$
 $\bar{X} = 925$

 $\alpha = 5\% = 0.05$

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.**



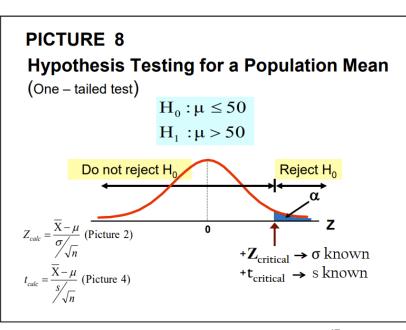
Step 1: State H_0 and H_1 H_0 : $\mu \le 920$ H_1 : $\mu > 920$



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 $\bar{X} > \bar{X}_{crit} \rightarrow 925 > 925.56$?



Q2.

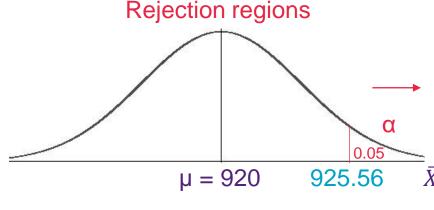


$$\mu = 920$$
 $\sigma = 20$
 $n = 35$
 $\bar{X} = 925$
 $\alpha = 5\% = 0.05$

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 : $\mu > 920$

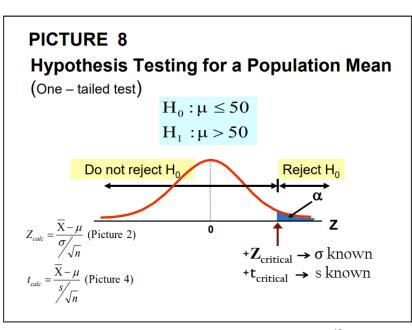


Step 2: Decision rule Reject H_0 if $\bar{X} > \bar{X}_{crit} = 925.56$

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

0.45 \quad \

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



Q2.



$$\mu = 920$$

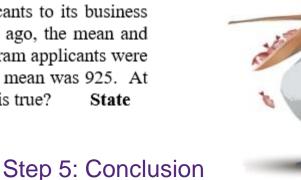
$$\sigma = 20$$

$$n = 35$$

$$\bar{X} = 925$$

$$\alpha = 5\% = 0.05$$

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

$$H_0$$
: $\mu \le 920$

$$H_1$$
: $\mu > 920$

 H_0 : µ ≤ 920



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

There is insufficient evidence to

amongst all applicants have

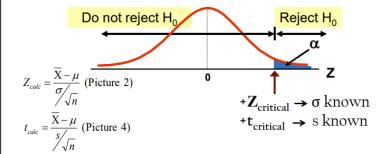
suggest that average entry scores

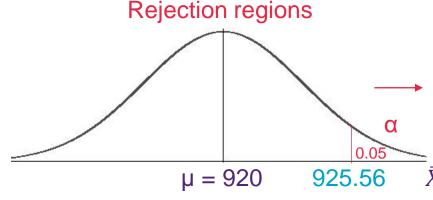
increased to 925 at the 5% LOS.

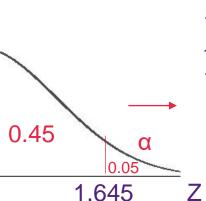
(One – tailed test)

$$H_0: \mu \leq 50$$

$$H_1: \mu > 50$$







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



- 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.
 - 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)?

Q3.



(Poll)

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

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.

σ (sigma)					-	e of 42 items gives a mean of 13.87g, test to see	if the filling process
s			has alte	ered at	the 0	.02 level of significance.	
μ (mu)			TC //	~ 1			
x̄ (x bar)						tent delivered by the mechanism to containers is r	eally 14g, what error
Level of Confidence (LOC) α (alpha)			(if any)	has be	en ma	ade in the test in part i)? 2. What symbol would you give to the value 0.3g? (Single Choice) *	4. What symbol would you give to the value 13.87g? (Single Choice) *
						o (sigma)	σ (sigma)
) n						○ s	○ s
Inferential Statistics	di	rawing c	conclusions about a p	opulati	on	_ μ (mu)	_ μ (mu)
Interential Statistics	b	ased on	a randomly selected	sample	e.	○ x̄ (x bar)	◯ x̄ (x bar)
POPULATION		1	Sample			Level of Confidence (LOC)	Level of Confidence (LOC)
	11					α (alpha)	α (alpha)
		Sampli	e e e e			○ n	○ n
						3. What symbol would you give to the value 42 items? (Single Choice) *	5. What symbol would you give to the value 0.02 level of significance? (Single
thurtur.		Inferen	*			O σ (sigma)	Choice) *
PARAMETERS			Statistics			○ s	o (sigma)
POPULATION SIZE =	_	N	sample size	=	n	_ μ (mu)	○ s
	=	μ	sample mean	=	₹	◯ x̄ (x bar)	_ μ (mu)
POPULATION STD. DEV.	=	σ	sample std. dev.	=	s	Level of Confidence (LOC)	○ x̄ (x bar)
POPULATION VARIANCE =	=	σ^2	sample variance	=	s ²	(alpha)	Level of Confidence (LOC)
POPULATION PROPORTION =	=	р	sample proportion	=	ĝ	○ n	α (alpha)
						Tutorial 9 - HYPOTHESIS TESTING I	○ n 51

Q3.



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

(Poll)

σ (sigma)

μ (mu)

x (x bar)

Level of Confidence (LOC)

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

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)?

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

nferential Statistic	s ba	rawing or ased or	conclusions about a a randomly selected	populat d samp	ion le.
POPULATION		-	Sample		
	7	Samp	ing ** **		
		Infere			
PARAMETERS		Infere	Statistics		
PARAMETERS POPULATION SIZE	=	Inferé		=	n
	==		Statistics	= =	n x
POPULATION SIZE	= = =	N	Statistics sample size	= = =	
POPULATION SIZE POPULATION MEAN		N µ	Statistics sample size sample mean	= = =	$\overline{\mathbf{x}}$

σ (sigma)	σ (sigma)
s	○ s
) μ (mu)	_ μ (mu)
x̄ (x bar)	x̄ (x bar)
Level of Confidence (LOC)	Level of Confidence (LOC)
α (alpha)	α (alpha)
○ n	○ n
3. What symbol would you give to the value 42 items? (Single Choice) *	5. What symbol would you give to the value 0.02 level of significance? (Single
3. What symbol would you give to the value 42 items? (Single Choice) * σ (sigma)	5. What symbol would you give to the value 0.02 level of significance? (Single Choice) *
σ (sigma)	Choice) *
σ (sigma)	Choice) * σ (sigma)
σ (sigma) s μ (mu)	Choice) * σ (sigma) s
σ (sigma) s μ (mu) x̄ (x bar)	Choice) * σ (sigma) s μ (mu)
σ (sigma) s μ (mu) x̄ (x bar) Level of Confidence (LOC)	Choice) * σ (sigma) s μ (mu) x̄ (x bar)



 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

- 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.
 - 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)?



Z table (standard normal distribution)

t table (Student's t-distribution)







one tail test (lower tail <)

two tail test (=)

. What type of problem is it? (Single Choice) *		3. What is the value of α (alpha)? (Single Choice
		O.01
¥ 3 4 #		0.02
	(Poll)	0.03
Population Mean (Seagull) (no sample)	(1 011)	0.04
Population Mean (Pelican) (σ is known)		0.05
Population Mean (Shag) (σ is unknown but s is known)		O.1
Population Proportion (Freaky fish) (proportion)		
		4. What type of test is it? (Single Choice) *
?. What table will we use? (Single Choice) *		one tail test (upper tail >)

Tutorial 9 - HYPOTHESIS TESTING I



 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

- 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.
 - 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) *		3. What is the value of α (alpha)? (Single Choice) *
		0.01
→ → →		0.02
	(Poll)	0.03
Population Mean (Seagull) (no sample)	(1 011)	0.04
Population Mean (Pelican) (σ is known)		0.05
Population Mean (Shag) (σ is unknown but s is known)		O.1
O Population Proportion (Freaky fish) (proportion)		
		4. What type of test is it? (Single Choice) *
2. What table will we use? (Single Choice) *		one tail test (upper tail >)
Z table (standard normal distribution)		one tail test (lower tail <)
t table (Student's t-distribution)	Tutorial 9 - HYPOTHESIS TESTING I	two tail test (=)



 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

- 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.
 - 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)?

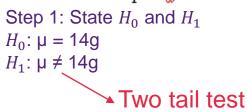
Step 1: State H_0 and H_1





 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

- 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.
 - 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)?

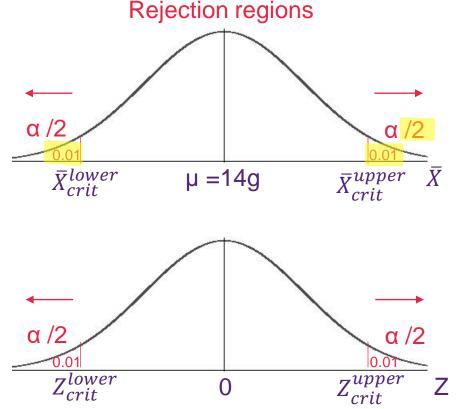


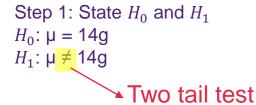


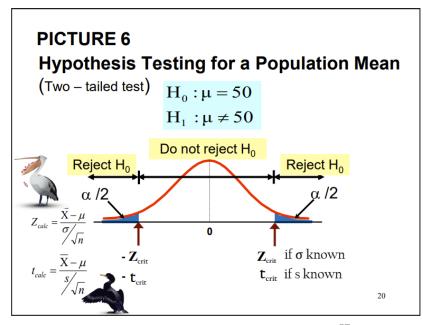


 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

- 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.
 - 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)?







Q3.

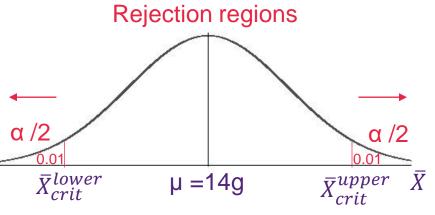


 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

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.

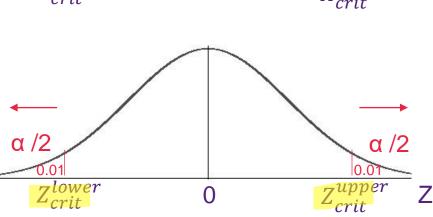
- If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.
 - at error

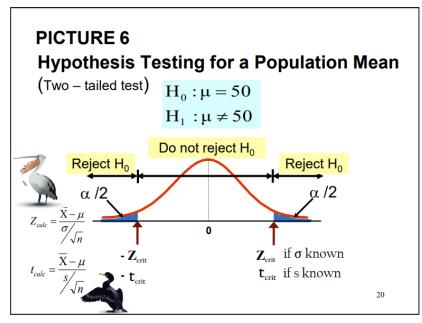
ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?



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

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







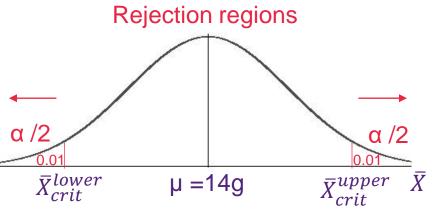
 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

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.

- 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)?



PICTURE 6



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

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

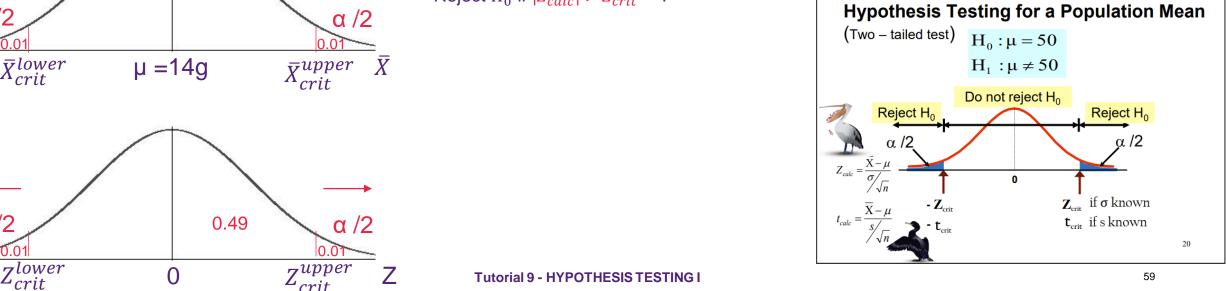
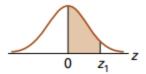




TABLE A.5 Areas of the standard normal distribution $\mu = 0$, $\sigma = 1$

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



<i>z</i> 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									

0.49

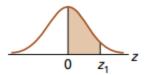
6.0

.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).



<i>z</i> 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

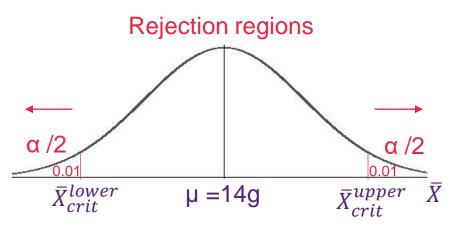


 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

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.

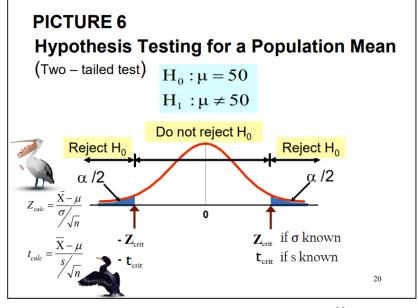
- i) If a random sample of 42 items gives a mean of 13.87g, test to see if the filling process has altered at the 0.02 level of significance.
- ii) If the mean fill content delivered by the mechanism to containers is really 14g, what error (if any) has been made in the test in part i)?





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

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

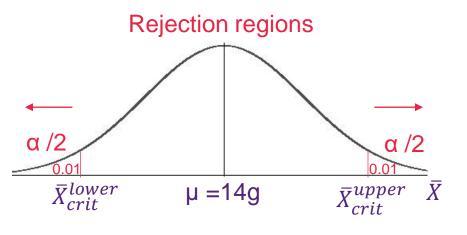




$$\mu = 14g$$
 $\sigma = 0.3g$
 $n = 42$
 $\bar{X} = 13.87g$
 $\alpha = 0.02$

- 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.
 - 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.
- To the second se

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)?



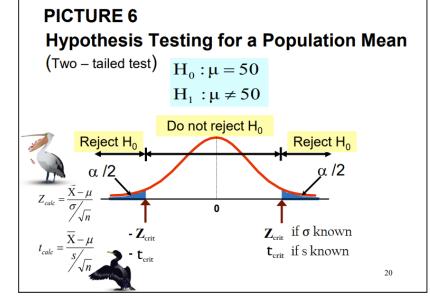


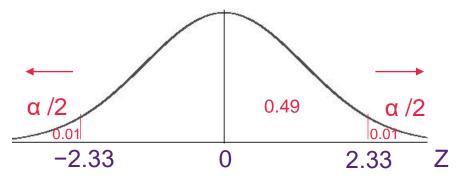
Step 1: State H_0 and H_1

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

Step 3: Calculate
$$Z_{calc}$$

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



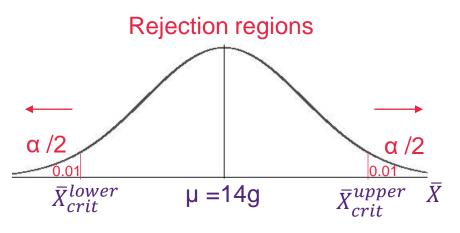




$$\mu = 14g$$
 $\sigma = 0.3g$
 $n = 42$
 $\bar{X} = 13.87g$
 $\alpha = 0.02$

- 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.
 - 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.
- To the second se

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)?



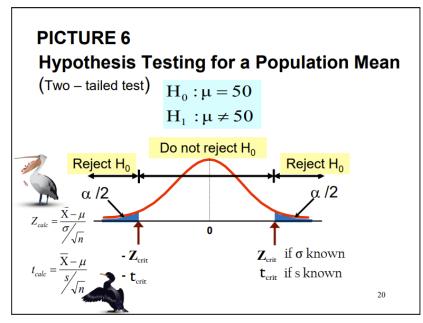


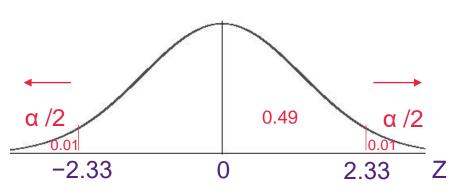
Step 2: Decision rule
Reject
$$H_0$$
 if $|Z_{calc}| > Z_{crit} = 2.33$

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
$$|Z_{calc}| > Z_{crit} \rightarrow |-2.808| > 2.33$$
 ?



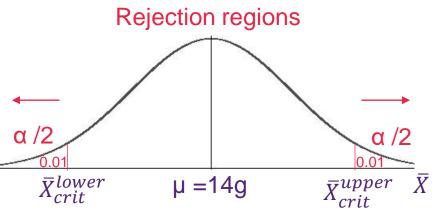


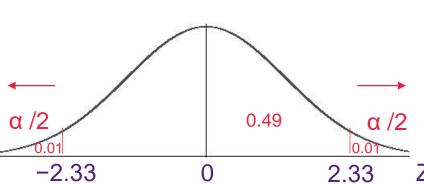


$$\mu = 14g$$
 $\sigma = 0.3g$
 $n = 42$
 $\bar{X} = 13.87g$
 $\alpha = 0.02$

- 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.
 - 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.
- To the second se

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)?



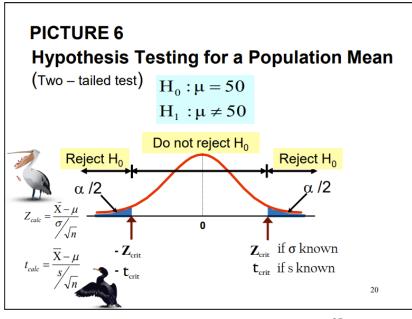


Step 1: State H_0 and H_1 H_0 : $\mu = 14g$ H_1 : $\mu \neq 14g$

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

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

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

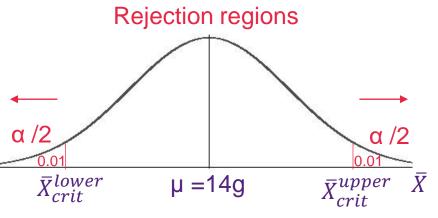


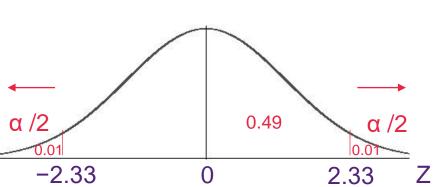


$$\mu = 14g$$
 $\sigma = 0.3g$
 $n = 42$
 $\bar{X} = 13.87g$
 $\alpha = 0.02$

- 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.
 - 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)?





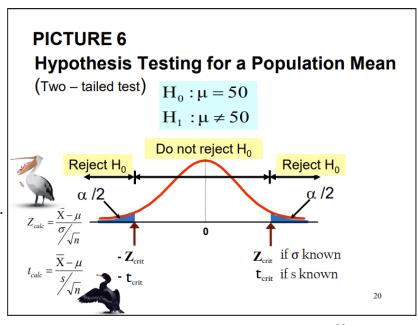
Step 1: State H_0 and H_1 H_0 : $\mu = 14g$ H_1 : $\mu \neq 14g$

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

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

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

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





 $\mu = 14q$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

When in correct adjustment, a filling mechanism is set to fill containers with a mean content Q3. 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



Rejection regions $ar{X}_{crit}^{upper}$ $ar{X}$ \bar{X}_{crit}^{lower} $\mu = 14g$

0.49 $\alpha/2$ -2.332.33

Step 1: State H_0 and H_1 H_0 : $\mu = 14q$

 H_1 : $\mu \neq 14g$

(if any) has been made in the test in part i)?

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

$$|Z_{calc}| > Z_{crit} \rightarrow |-2.808| > 2.33 \rightarrow \text{Reject } H_0.$$

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	✓

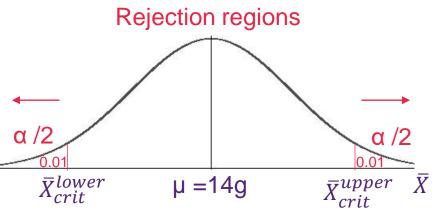


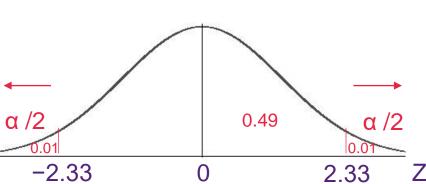
 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

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.

- 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 : $\mu = 14g$ H_1 : $\mu \neq 14g$

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

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

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

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	✓

18



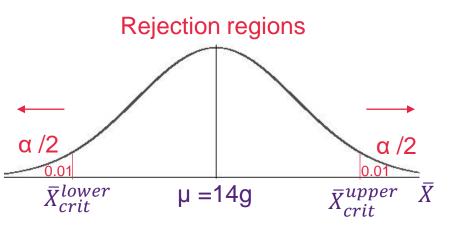
 $\mu = 14g$ $\sigma = 0.3g$ n = 42 $\bar{X} = 13.87g$ $\alpha = 0.02$

-2.33

- 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.



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 | Error



0.49

 $\alpha/2$

2.33



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
$$|Z_{calc}| > Z_{crit} \rightarrow |-2.808| > 2.33 \rightarrow \text{Reject } H_0.$$

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	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?

Q4.



(Poll)

1. What symbol would you give to the value 19 seconds? (Single Cho

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.

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

(x bar)						2. What symbol would you give to the value 8 seconds? (Single Choice) *	4. What symbol would you give to the value 17.6 seconds? (Single	le Choice)
evel of Confidence (LOC)						σ (sigma)	σ (sigma)	
(alpha)				○ s	○ s			
				110000000		Γ μ (mu)	_ μ (mu)	
Inferential Statistics drawing conclusions about a population based on a randomly selected sample.					on	○ x̄ (x bar)	◯ x̄ (x bar)	
				•	Level of Confidence (LOC)	Level of Confidence (LOC)		
POPULATION			Sample			(alpha)	α (alpha)	
		Samp	ling			○ n	\bigcirc n	
Inference						3. What symbol would you give to the value 60 calls? (Single Choice) * σ (sigma)	5. What symbol would you give to the value 4% level of signific Choice) *	ance? (Sir
			•			○ s	σ (sigma)	
PARAMETERS Statistics						μ (mu)	○ s	
POPULATION SIZE	=	N	sample size	=	n		_ μ (mu)	
POPULATION MEAN	=	μ	sample mean	=	$\overline{\mathbf{x}}$	○ x̄ (x bar)		
POPULATION STD. DEV.	=	σ	sample std. dev.	=	s	Level of Confidence (LOC)	x̄ (x bar)	
POPULATION VARIANCE	=	σ^2	sample variance	=	s²	O α (alpha)	Level of Confidence (LOC)	
POPULATION PROPORTION = p		р	sample proportion	=	ĝ		α (alpha)	
						Tutorial 9 - HYPOTHESIS TESTING I	O n 71	1

Q4.



(Poll)

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.

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

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?

can the fire department conclude about the effectiveness of the new switchboard?							
x̄ (x bar)	2. What symbol would you give to the value 8 seconds? (Single Choice) *	4. What symbol would you give to the value 17.6 seconds? (Single Choice) *					
Level of Confidence (LOC)	σ (sigma)	ο (sigma)					
α (alpha)	s	○ s					
n	μ (mu)	μ (mu)					
Inferential Statistics drawing conclusions about a population based on a randomly selected sample.	$\tilde{\mathbf{x}}$ (x bar)	\circ \bar{x} (x bar)					
	Level of Confidence (LOC)	Level of Confidence (LOC)					
POPULATION Sample	α (alpha)	α (alpha)					
Sampling	\bigcirc n	n5. What symbol would you give to the value 4% level of significance? (Sing Choice) *					
PARAMETERS Statistics	○ s	σ (sigma)					
	_ μ (mu)	○ s					
POPULATION SIZE = N sample size = n POPULATION MEAN = μ sample mean = $\overline{\chi}$	◯ x̄ (x bar)	Ο μ (mu)					
POPULATION STD. DEV. = σ sample std. dev. = s	Level of Confidence (LOC)	○ x̄ (x bar)					
POPULATION VARIANCE = σ^2 sample variance = s^2	α (alpha)	Level of Confidence (LOC)					
POPULATION PROPORTION = p sample proportion = p	Tutorial 9 - HYPOTHESIS TESTING I	α (alpha) 72					

t table (Student's t-distribution)



 $\mu = 19$ seconds

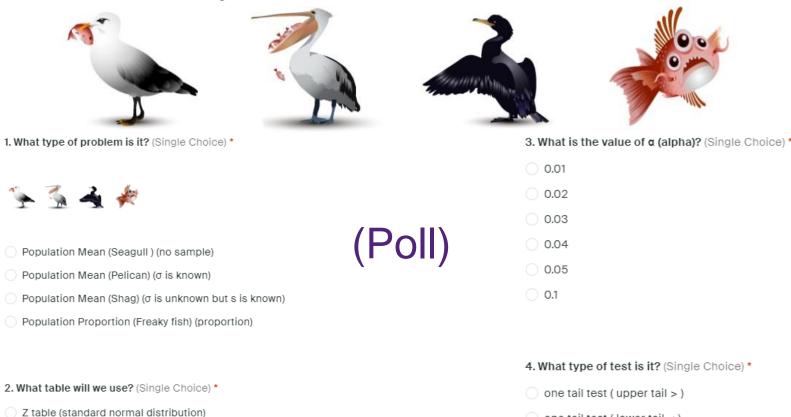
 $\sigma = 8$ seconds

n = 60

 \bar{X} = 17.6 seconds

 $\alpha = 4\%$

- 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?



Tutorial 9 - HYPOTHESIS TESTING I

one tail test (lower tail <)

two tail test (=)



 $\mu = 19$ seconds

 σ = 8 seconds

n = 60

 \bar{X} = 17.6 seconds

 $\alpha = 4\% = 0.04$

- 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) *		3. What is the value of α (alpha)? (Single Choice) * $$
		O.01
4 3 4 #		0.02
	(- 11)	0.03
Population Mean (Seagull) (no sample)	(Poll)	0.04
Population Mean (Pelican) (σ is known)	(1 011)	0.05
Population Mean (Shag) (σ is unknown but s is known	1)	O.1
O Population Proportion (Freaky fish) (proportion)		
		4. What type of test is it? (Single Choice) *
2. What table will we use? (Single Choice) *		one tail test (upper tail >)
Z table (standard normal distribution)		one tail test (lower tail <)
t table (Student's t-distribution)	Tutorial 9 - HYPOTHESIS TESTING I	two tail test (=)



 $\mu = 19$ seconds

 σ = 8 seconds

n = 60

 \bar{X} = 17.6 seconds

 $\alpha = 4\% = 0.04$

- 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

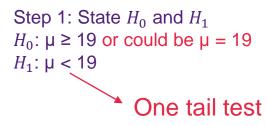




 μ = 19 seconds σ = 8 seconds n = 60 \overline{X} = 17.6 seconds

 $\alpha = 4\% = 0.04$

- 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?





Q4.



 $\mu = 19$ seconds

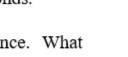
 $\sigma = 8$ seconds

n = 60

 \bar{X} = 17.6 seconds

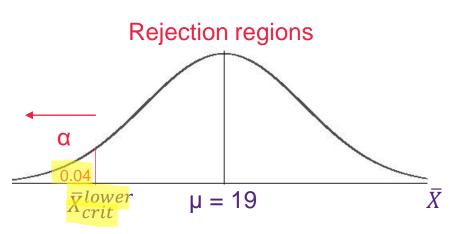
 $\alpha = 4\% = 0.04$

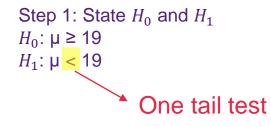
A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the 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.

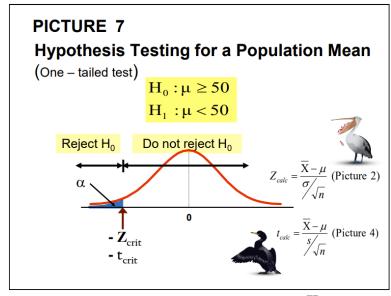




a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?







Q4.



 $\mu = 19$ seconds

 $\sigma = 8$ seconds

n = 60

 \bar{X} = 17.6 seconds

 $\alpha = 4\% = 0.04$

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.

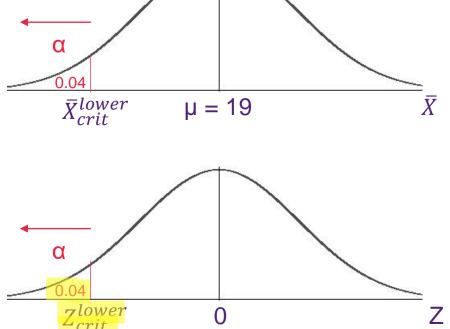


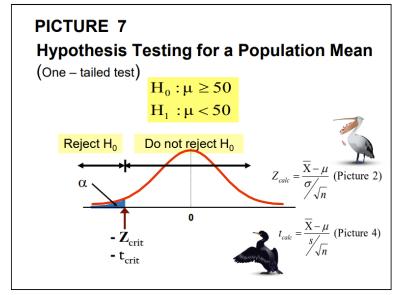
a) Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?



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







Q4.



 $\mu = 19$ seconds

 $\sigma = 8$ seconds

n = 60

 \bar{X} = 17.6 seconds

 $\alpha = 4\% = 0.04$

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.



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

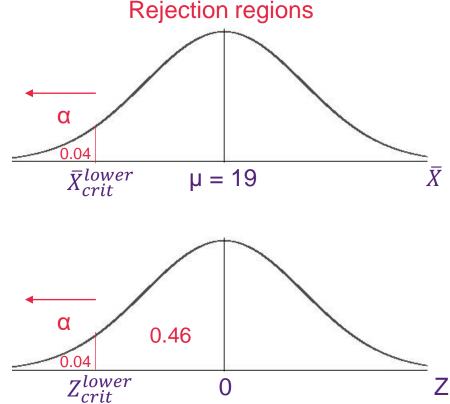
 H_0 : µ ≥ 19

 H_1 : $\mu < 19$



Step 2: Decision rule

Reject H_0 if $Z_{calc} < Z_{crit} = ?$



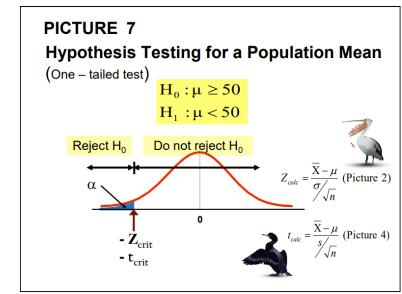
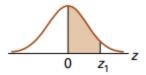




TABLE A.5 Areas of the standard normal distribution $\mu = 0$, $\sigma = 1$

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



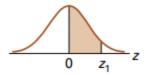
<i>z</i> ₁	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.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
8.0	.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

0.46



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).



<i>z</i> 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
8.0	.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

0.46

Q4.



 $\mu = 19$ seconds

 $\sigma = 8$ seconds

n = 60

 \bar{X} = 17.6 seconds

 $\alpha = 4\% = 0.04$

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?

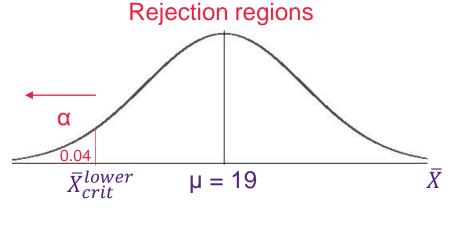


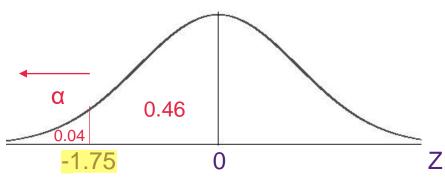
 $H_0: \mu \ge 19$

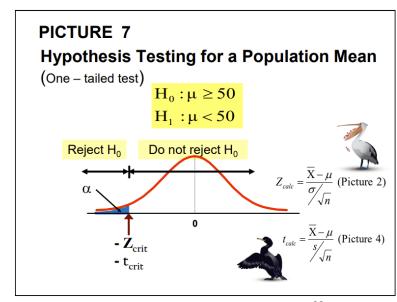
 H_1 : μ < 19

Step 2: Decision rule

Reject H_0 if $Z_{calc} < Z_{crit} = -1.75$







Q4.



 $\mu = 19$ seconds

 σ = 8 seconds

n = 60

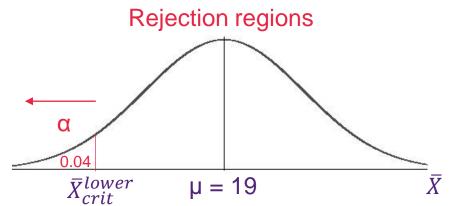
 \bar{X} = 17.6 seconds

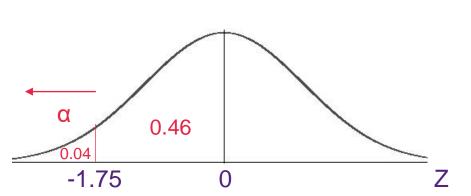
 $\alpha = 4\% = 0.04$

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?

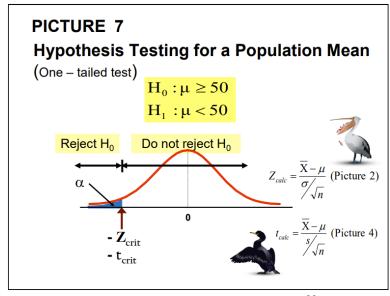




Step 1: State H_0 and H_1 H_0 : $\mu \ge 19$ H_1 : $\mu < 19$

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

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



Q4.



 $\mu = 19$ seconds

 σ = 8 seconds

n = 60

 \bar{X} = 17.6 seconds

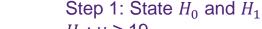
 $\alpha = 4\% = 0.04$

 \bar{X}_{crit}^{lower}

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?



 H_0 : µ ≥ 19

 H_1 : μ < 19



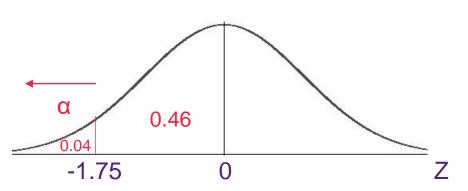
Step 2: Decision rule

Reject H_0 if $Z_{calc} < Z_{crit} = -1.75$

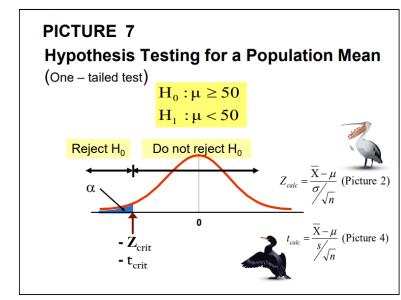
Step

Step 3: Calculate Z_{calc}

$$Z_{calc} = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{2}}} = \frac{17.6 - 19}{\frac{8}{\sqrt{60}}} = -1.36$$



 $\mu = 19$



Q4.



 $\mu = 19$ seconds

 σ = 8 seconds

n = 60

 \bar{X} = 17.6 seconds

 $\alpha = 4\% = 0.04$

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?



 H_0 : µ ≥ 19

 H_1 : μ < 19

Step 2: Decision rule

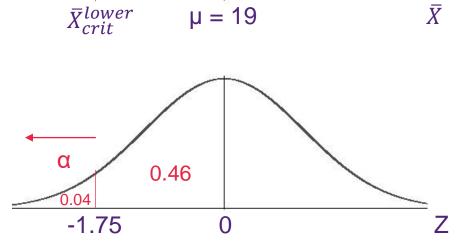
Reject H_0 if $Z_{calc} < Z_{crit} = -1.75$

Step 3: Calculate Z_{calc}

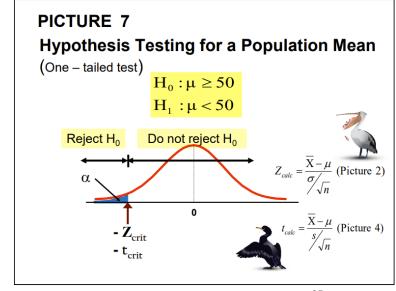
$$Z_{calc} = \frac{\bar{X} - \mu}{\sigma_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{17.6 - 19}{\frac{8}{\sqrt{60}}} = -1.36$$

Step 4: Make a decision

$$Z_{calc} < Z_{crit} \rightarrow -1.36 < -1.75$$
?



Rejection regions



Q4.



 $\mu = 19$ seconds

 $\sigma = 8$ seconds

n = 60

 \bar{X} = 17.6 seconds

 $\alpha = 4\% = 0.04$

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?



 H_0 : µ ≥ 19

 H_1 : μ < 19



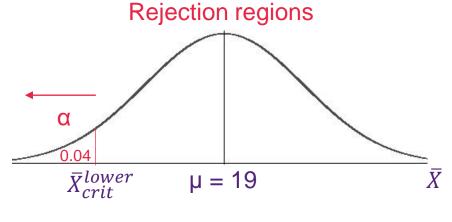
Reject H_0 if $Z_{calc} < Z_{crit} = -1.75$

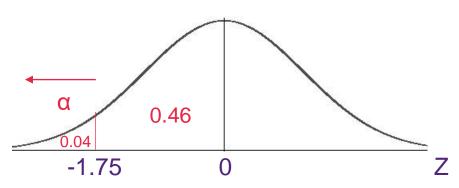
Step 3: Calculate Z_{calc}

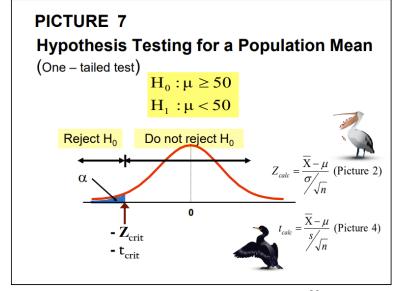
$$Z_{calc} = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{17.6 - 19}{\frac{8}{\sqrt{60}}} = -1.36$$

Step 4: Make a decision

 $Z_{calc} < Z_{crit} \rightarrow -1.36 < -1.75 \rightarrow Do not reject H_0$.







Q4.



 $\mu = 19$ seconds

 σ = 8 seconds

n = 60

 \bar{X} = 17.6 seconds

 $\alpha = 4\% = 0.04$

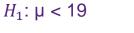
A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the 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



Step 2: Decision rule

Reject H_0 if $Z_{calc} < Z_{crit} = -1.75$

Step 3: Calculate Z_{calc}

$$Z_{calc} = \frac{\bar{X} - \mu}{\sigma_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{2}}} = \frac{17.6 - 19}{\frac{8}{\sqrt{60}}} = -1.36$$

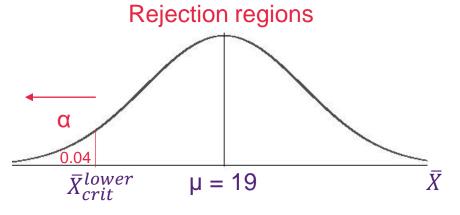
Step 4: Make a decision

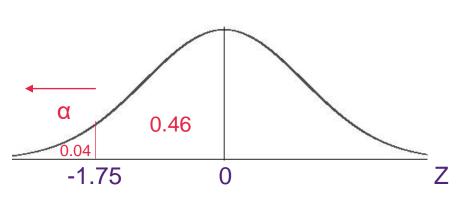
 $Z_{calc} < Z_{crit} \rightarrow -1.36 < -1.75 \rightarrow Do not reject H_0.$

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.

PICTURE 7 Hypothesis Testing for a Population Mean (One – tailed test) $H_0: \mu \geq 50$ $H_1: \mu < 50$ Reject H_0 Do not reject H_0 $Z_{calc} = \frac{\overline{X} - \mu}{\sigma / n}$ (Picture 2) $C_{crit} = \frac{\overline{X} - \mu}{\sigma / n}$ (Picture 4)





Q4.



 $\mu = 19$ seconds

 σ = 8 seconds

n = 60

 \bar{X} = 17.6 seconds

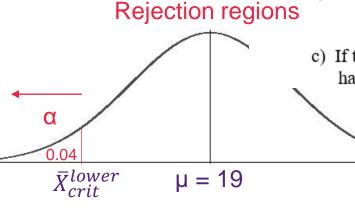
 $\alpha = 4\% = 0.04$

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.



0.46

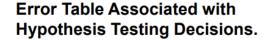
-1.75

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

Step 1: State H_0 and H_1

 H_0 : µ ≥ 19

 H_1 : $\mu < 19$



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.



 $\mu = 19$ seconds

 $\sigma = 8$ seconds

n = 60

 $\bar{X} = 17.6$ seconds

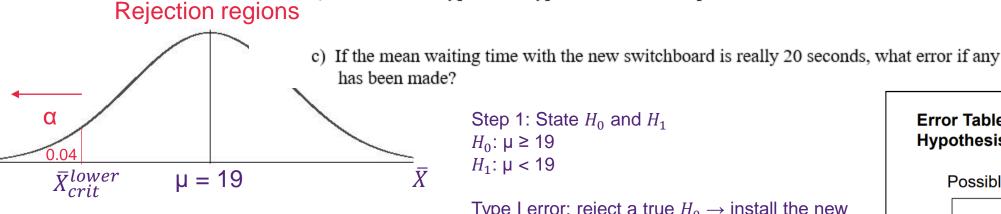
 $\alpha = 4\% = 0.04$

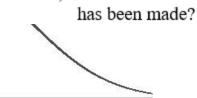
A local fire department is concerned about the waiting time from the moment a person telephones until they are connected with a service controller. In the past the mean waiting time has been 19 seconds with a standard deviation of 8 seconds. A new switchboard is being trialed to see if it reduces the 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.

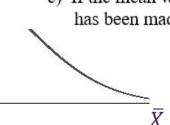


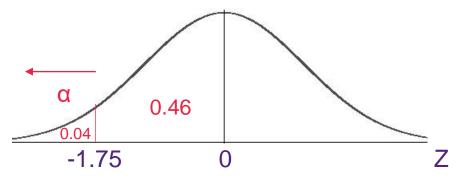
Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

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









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

 H_1 : $\mu < 19$

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

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

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	✓	

Q4.



 $\mu = 19$ seconds

 $\sigma = 8$ seconds

n = 60

 $\bar{X} = 17.6$ seconds

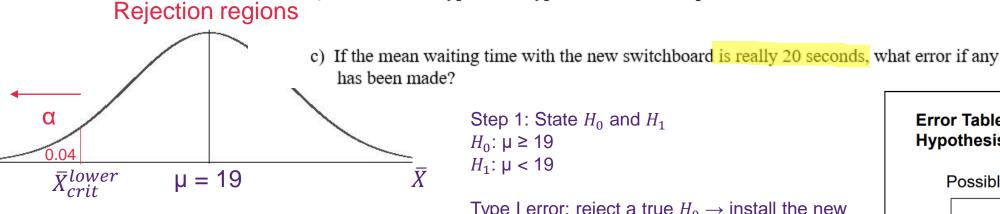
 $\alpha = 4\% = 0.04$

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.



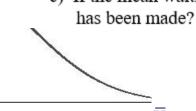
Test to see if the waiting time has been reduced at the 4% level of significance. What can the fire department conclude about the effectiveness of the new switchboard?

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



0.46

-1.75



Step 1: State H_0 and H_1

 H_0 : µ ≥ 19 H_1 : $\mu < 19$

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

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

Error Table Associated with Hypothesis Testing Decisions.

Possible Outcomes from Decisions

	Actual (reality) Situation			
Statistical Decision	H ₀ True	H₀ False		
Do Not Reject H ₀	✓	Type II Error		
Reject H ₀	Type I Error	✓		

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Tutorial 9 - HYPOTHESIS TESTING

Q4.



 $\mu = 19$ seconds

 $\sigma = 8$ seconds

n = 60

 $\bar{X} = 17.6$ seconds

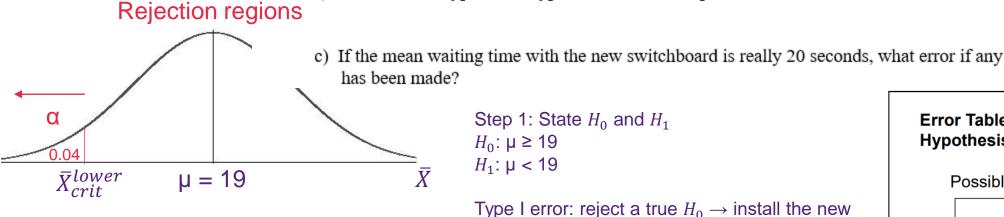
 $\alpha = 4\% = 0.04$

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.



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.



0.46

-1.75



 H_0 : µ ≥ 19

 H_1 : $\mu < 19$

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

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

No error was made: we did not reject H_0 .

Hypothesis Testing Decisions.

Error Table Associated with

Possible Outcomes from Decisions

	Actual (reality) Situation			
Statistical Decision	H ₀ True	H ₀ False		
Do Not Reject	√	Type II Error		
H₀				
Reject H ₀	Type I Error	✓		



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.



Thank you

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tavaresgarcia.github.io

Reference

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

CRICOS code 00025B

