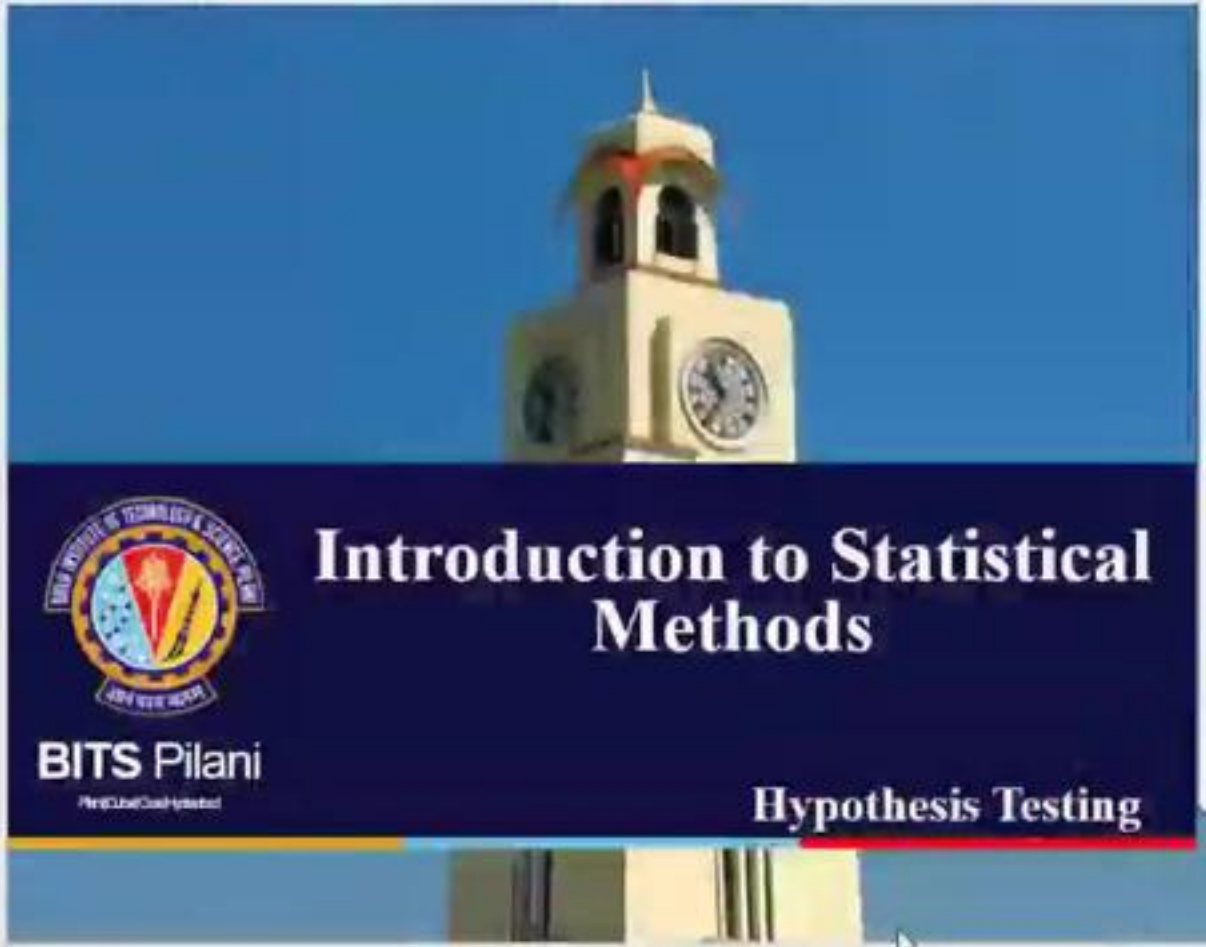
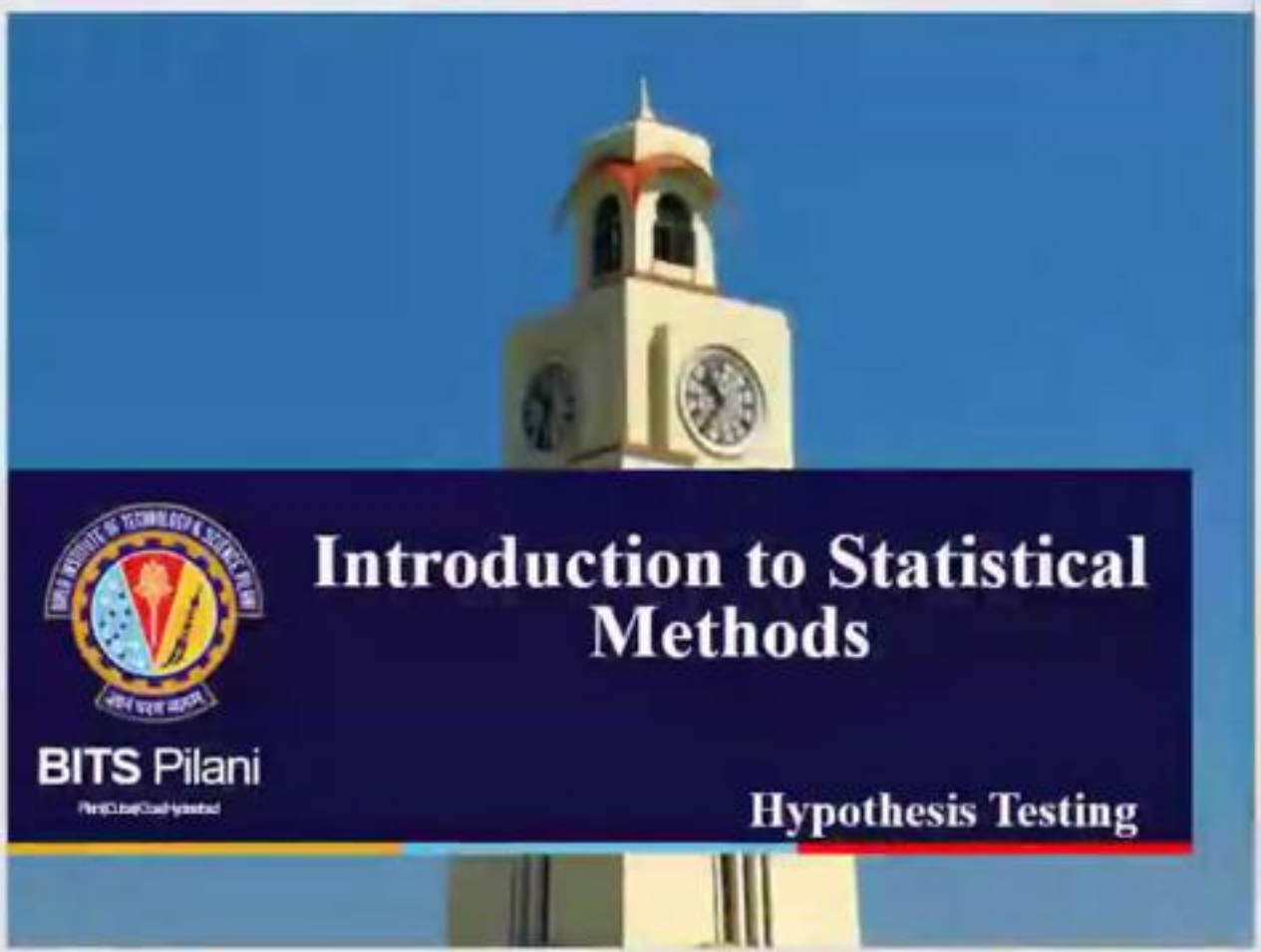

Introduction to Statistical Methods
BITS Pilani
Hypothesis Testing


Introduction to Statistical Methods
BITS Pilani
Hypothesis Testing

Webinar-3

(8th February 2022)

TESTING OF HYPOTHESIS

Problem

For the United States, the mean monthly Internet bill is \$32.79 per household. A sample of 50 households in a southern state showed a sample mean of \$30.63. Use a population standard deviation of \$5.60.

a. Formulate hypotheses for a test to determine whether the sample data support the conclusion that the mean monthly Internet bill in the southern state is less than the national mean of \$32.79.

b. What is the value of the test statistic?

c. What is the *p*-value?

d. At α .01, what is your conclusion?

Solution

$H_0 : \mu \geq 32.79$ ---- accordingly set

$H_a : \mu < 32.79$ ------ formulated as per situation

ANUJ KUMAR JOINED

Das Amiya Kumar
z test

Pavan Kumar M K
test statistic = -2.734

MANOJ K K JOINED

PRITHVI MOHAN JOINED

Das Amiya Kumar
as per the ask

NEERAJ SABHNANI JOINED

Pavan Kumar M K
H0 is rejected and accept H1

Manvi Bajpai
not condition is Ho

yes sir

AAKANSHA JAIN JOINED

Sending to everyone
Write Message

Problem

For the United States, the mean monthly Internet bill is $32.79 per household. A sample of 50 households in a southern state showed a sample mean of $30.63. Use a population standard deviation of $5.60.

a. Formulate hypotheses for a test to determine whether the sample data support the conclusion that the mean monthly Internet bill in the southern state is less than the national mean of $32.79.

b. What is the value of the test statistic?

c. What is the *p*-value?

d. At α .01, what is your conclusion?

→ mean monthly bill = 32.79

$n = 50$ ($n > 30$)

$\sigma = 5.60$ is known (Past data/ Historic data)

Problem

For the United States, the mean monthly Internet bill is $32.79 per household. A sample of 50 households in a southern state showed a sample mean of $30.63. Use a population standard deviation of $5.60.

a. Formulate hypotheses for a test to determine whether the sample data support the conclusion that the mean monthly Internet bill in the southern state is less than the national mean of $32.79.

b. What is the value of the test statistic?

c. What is the p-value?

d. At $\alpha = .01$, what is your conclusion?

→ mean monthly bill = 32.79

$n = 50$ ($n > 30$)

$\sigma = 5.60$ is known (Past data/ Historic data)

Solution

$H_0 : \mu \geq 32.79$ ..... accordingly set

$H_a : \mu < 32.79$ ..... formulated as per situation

$$Z = \frac{\mu - \mu_0}{\frac{\sigma}{\sqrt{n}}} = \frac{30.63 - 32.79}{\frac{5.6}{\sqrt{50}}} = -2.73$$

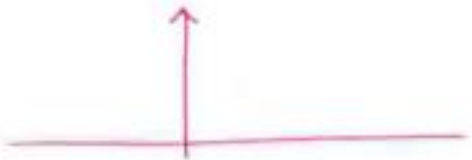
Solution

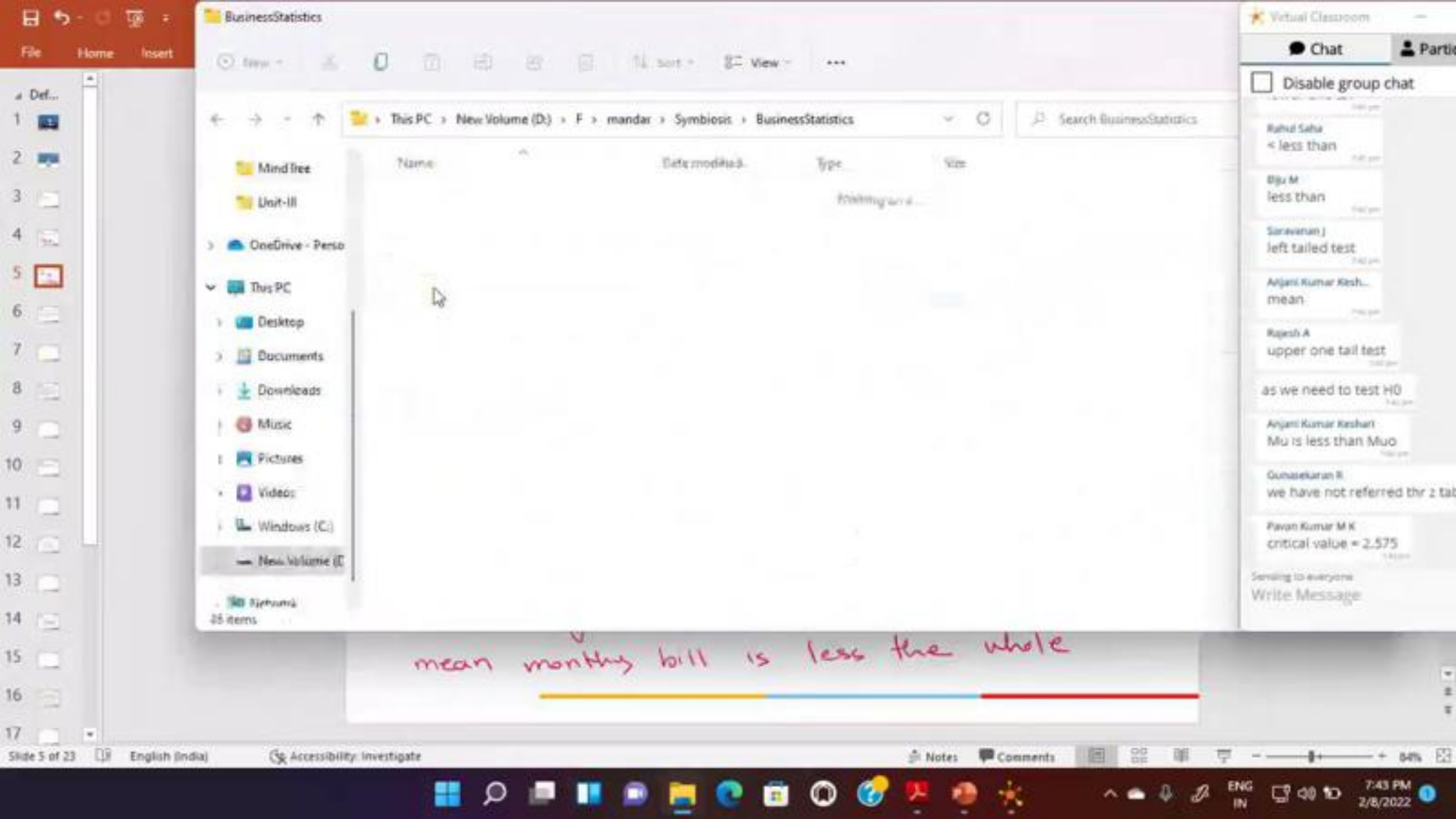
$H_0 : \mu \geq 32.79$ ---- accordingly set

$H_a : \mu < 32.79$ ------ formulated as per situation

$$Z = \frac{\mu - \mu_0}{\frac{\sigma}{\sqrt{n}}} = \frac{30.63 - 32.79}{\frac{5.6}{\sqrt{50}}} = -2.73$$

$\alpha = 0.01$

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Desktop
Documents
Downloads
Music
Pictures
Videos
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Virtual Classroom
Chat
Disable group chat
Rahul Saha
< less than
Biju M
less than
Saravanan J
left tailed test
Anjani Kumar Kesh...
mean
Rajesh A
upper one tail test
as we need to test H0
Anjani Kumar Keshari
Mu is less than Muo
Gunasekaran R
we have not referred thr z tab
Pavan Kumar M K
critical value = 2.575
Write Message
mean monthly bill is less the whole
Slide 5 of 23
English (India)
Accessibility: Investigate
Notes
Comments
ENG
IN
7:43 PM
2/8/2022

z-table.pdf - Adobe Reader

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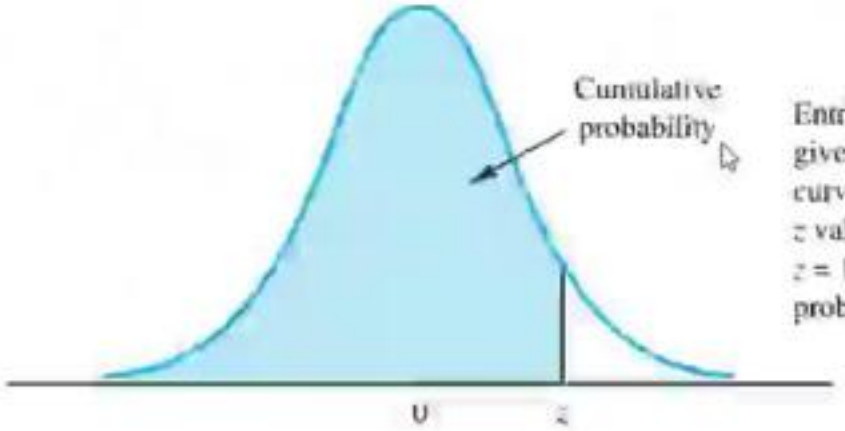
CUMULATIVE PROBABILITIES FOR THE STANDARD NORMAL DISTRIBU



Entries in the table give the area under the curve to the left of the z value. For example, for $z = 1.25$, the cumulative probability is .8944.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09

Virtual Classroom

Chat Partic

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Rahul Saha
< less than

Biju M
less than

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left tailed test

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Sending to everyone
Write Message

ENG IN 7:44 PM 2/8/2022

z-table.pdf - Adobe Reader

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.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.53	
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.57	
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857

Virtual Classroom

Chat Partic

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< less than

Biju M
less than

Saravanan J
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Anjani Kumar Kesh...
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Pavan Kumar M K
critical value = 2.575

SENTHIL T K JOINED

Sending to everyone
Write Message

ENG IN 7:44 PM 2/8/2022

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2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.98
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.98
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.98
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934
2.5	.9938	9940	.9941	9943	.9945	.9946	.9948	.9949	.9951
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973
2.8	.9974	9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986
3.0	.9987	9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990

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ENG IN 7:44 PM 2/8/2022

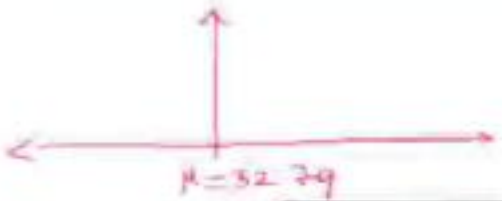
Solution

→ $H_0 : \mu \geq 32.79$ ... accordingly set

$H_a : \mu < 32.79$ ... formulated as per situation

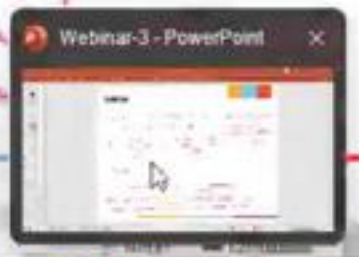
$$Z = \frac{\mu - \mu_0}{\frac{\sigma}{\sqrt{n}}} = \frac{30.63 - 32.79}{\frac{5.6}{\sqrt{50}}} = -2.73$$

$\alpha = 0.01$



We will reject H_0 ... conclu...

mean monthly bill is les...



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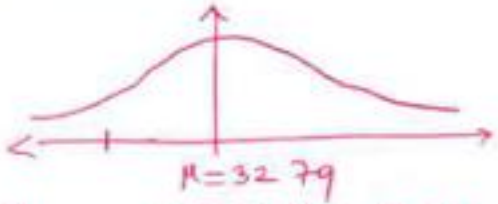
$\alpha = 0.01$



We will reject H_0 : conclude that the mean monthly bill is less the whole

Solution

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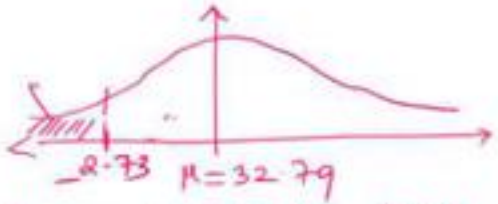
$\alpha = 0.01$



1.0000
0.9968
0.0032

We will reject H_0 : conclude that the mean monthly bill is less the whole

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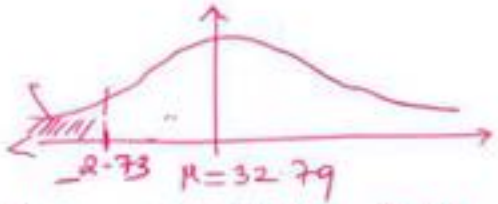
1.0000
0.9968
0.0032

$\alpha = 0.01$

$\alpha = 5\%$



We will reject H_0 : conclude that the mean monthly bill is less the whole nation

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Solution

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$H_a : \mu < 32.79$ ------ formulated as per situation

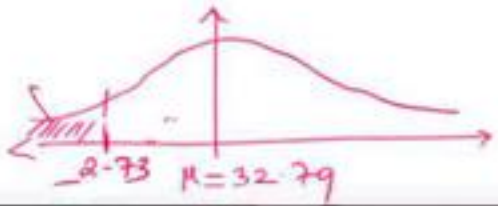
$$Z = \frac{\mu - \mu_0}{\frac{\sigma}{\sqrt{n}}} = \frac{30.63 - 32.79}{\frac{5.6}{\sqrt{50}}} = -2.73$$

1.0000
0.9968
0.0032

$\alpha = 0.01$

$\alpha = 5\%$

=



We will ...

mean ...

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2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990

Virtual Classroom

Chat

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SAIARUNRAJA M JOINED

Z table also should be -ve refe

Rajesh A

YES

Rajesh A

We accept H0

ENG IN

7:46 PM 2/8/2022

Solution

→ $H_0 : \mu \geq 32.79$ ---- accordingly set

$H_a : \mu < 32.79$ ---- formulated as per situation

$$Z = \frac{\mu - \mu_0}{\frac{\sigma}{\sqrt{n}}} = \frac{30.63 - 32.79}{\frac{5.6}{\sqrt{50}}} = -2.73$$

1 - 0.00
0.9968
0.0032

$\alpha = 0.01$

$\alpha = 5\%$

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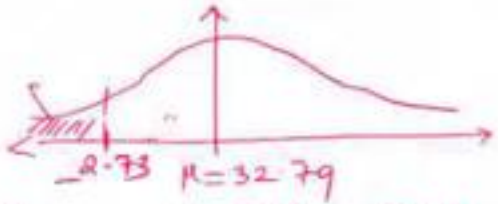

We will reject H_0 : conclude that the mean monthly bill is less the whole nation

Problem

AOL Time Warner Inc.'s CNN has been the longtime ratings leader of cable television news. Nielsen Media Research indicated that the mean CNN viewing audience was 600,000 viewers per day during 2002. Assume that for a sample of 40 days during the first half of 2003, the daily audience was 612,000 viewers with a sample standard deviation of 65,000 viewers.

a. What are the hypotheses if CNN management would like information on any change in the CNN viewing audience?

b. What is the *p*-value?

c. Select your own level of significance. What is your conclusion? $\alpha = 0.05$ $1-\alpha = 0.95$

d. What recommendation would you make to CNN management in this application?

$H_0 : \mu = 600000$

$H_a : \mu \neq 600000$

$s = 65000$

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Open 2 / 3 139% Tools

TABLE 2 *t* DISTRIBUTION (*Continued*)

Degrees of Freedom	Area in Upper Tail					
	.20	.10	.05	.025	.01	.005
35	.852	1.306	1.690	2.030	2.438	2.724
36	.852	1.306	1.688	2.028	2.434	2.719
37	.851	1.305	1.687	2.026	2.431	2.715
38	.851	1.304	1.686	2.024	2.429	2.712
39	.851	1.304	1.685	2.023	2.426	2.708
40	.851	1.303	1.684	2.021	2.423	2.704
41	.850	1.303	1.683	2.020	2.421	2.701
42	.850	1.302	1.682	2.018	2.418	2.698
43	.850	1.302	1.681	2.017	2.416	2.695
44	.850	1.301	1.680	2.015	2.414	2.692
45	.850	1.301	1.679	2.014	2.412	2.690
46	.850	1.300	1.679	2.013	2.410	2.687
53	.848	1.298	1.674	2.006	2.399	2.672

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Virtual Classroom

Chat

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from Two different popu
sample and that's why t
difference ? What is the
conclusion if we reject t
hypothesis or accept it

Dattaraya Udapiran Kulkarni
2 different populations

Rajesh A
but student t test is mo
and post comparision n

Pavan Kumar M K
accept H0

Gunaseelan R
t table to be referred

SONAR ADITI DEEPAK

V R Lou
2.030

Dattaraya Udapira...
2.023

ENG IN 8:00 PM 2/8/2022

Problem

AOL Time Warner Inc.'s CNN has been the longtime ratings leader of cable television news. Nielsen Media Research indicated that the mean CNN viewing audience was 600,000 viewers per day during 2002. Assume that for a sample of 40 days during the first half of 2003, the daily audience was 612,000 viewers with a sample standard deviation of 65,000 viewers.

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$H_0 : \mu = 600000$

$H_a : \mu \neq 600000$

$s = 65000$

$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$ $\quad n-1 = 39$

$= 1.17$

$\alpha = 0.05$

H_0 accepted

Virtual Classroom

Chat | Participant

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Dattatraya Udapinar Kulkarni: no difference in viewership

Bhimsen Joshi: sorry can u explain why t test?

Gunasekaran R: a. i dont understand the question

B C HEMANTH KUMAR JOINED

Bhimsen Joshi: ok

I thought sample > 30 is only criteria

Bipin Manoj Madhavan: So here recommendation is - CNN content need to be changed/improved to increase number of viewers. is this right?

Rajesh A: but there is no mention of any change between 2002 and 2003

Sending to everyone

Write Message

ENG IN 8:02 PM 2/8/2022

Problem

AOL Time Warner Inc.'s CNN has been the longtime ratings leader of cable television news. Nielsen Media Research indicated that the mean CNN viewing audience was 600,000 viewers per day during 2002. Assume that for a sample of 40 days during the first half of 2003, the daily audience was 612,000 viewers with a sample standard deviation of 65,000 viewers.

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$H_a : \mu \neq 600000$

$s = 65000$

$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$ $n-1 = 39$

$= 1.17$

$\alpha = 0.05$

H_0 accepted

Virtual Classroom

Chat Participant

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Bhimsen Joshi
ok

I thought sample > 30 is only criteria

Birje Manoj Madhukar
So here recommendation is - CNN content need to be changed/improved to increase number of viewers. is this right?

Rajesh A
but there is no mention of any change between 2002 and 2003

SHIBU K PAUL JOINED

Varsha Jetley
what is criteria of selecting alpha?

Birje Manoj Madhukar
Alpha selection is typical values

Bhimsen Joshi
Hi

Sending to everyone
Write Message

Notes

Problem

AOL Time Warner Inc.'s CNN has been the longtime ratings leader of cable television news. Nielsen Media Research indicated that the mean CNN viewing audience was 600,000 viewers per day during 2002. Assume that for a sample of 40 days during the first half of 2003, the daily audience was 612,000 viewers with a sample standard deviation of 65,000 viewers.

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$H_0 : \mu = 600000$

$H_a : \mu \neq 600000$

$s = 65000$

$t = \dfrac{\bar{x} - \mu}{s/\sqrt{n}} = 1.17$ $\quad n-1 = 39$

$\alpha = 0.05$

H_0 accepted

TABLE 2 t DISTRIBUTION (*Continued*)

Degrees of Freedom	Area in Upper Tail					
	.20	.10	.05	.025	.01	
35	.852	1.306	1.690	2.030	2.438	
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38	.851	1.304	1.686	2.024	2.429	
39	.851	1.304	1.685	2.023	2.426	
40	.851	1.303	1.684	2.021	2.423	
41	.850	1.303	1.683	2.020	2.421	
42	.850	1.302	1.682	2.018	2.418	
43	.850	1.302	1.681	2.017	2.416	
44	.850	1.301	1.680	2.015	2.414	
45	.850	1.301	1.679	2.014	2.412	
46	.850	1.300	1.679	2.013	2.410	
47	.849	1.300	1.678	2.012	2.408	
48	.849	1.299	1.677	2.011	2.407	
49	.849	1.299	1.677	2.010	2.405	2.680
50	.849	1.299	1.676	2.009	2.403	2.678
51	.849	1.298	1.675	2.008	2.402	2.676
52	.849	1.298	1.675	2.007	2.400	2.674
53	.848	1.298	1.674	2.006	2.399	2.672

TABLE 2 t DISTRIBUTION (*Continued*)

Degrees of Freedom	Area in Upper Tail					
	.20	.10	.05	.025	.01	.005
35	.852	1.306	1.690	2.030	2.438	2.724
36	.852	1.306	1.688	2.028	2.434	2.719
37	.851	1.305	1.687	2.026	2.431	2.715
38	.851	1.304	1.686	2.024	2.429	2.712
39	.851	1.304	1.685	2.023	2.426	2.708
40	.851	1.303	1.684	2.021	2.423	2.704
41	.850	1.303	1.683	2.020	2.421	2.701
42	.850	1.302	1.682	2.018	2.418	2.698
43	.850	1.302	1.681	2.017	2.416	2.695
44	.850	1.301	1.680	2.015	2.414	2.692
45	.850	1.301	1.679	2.014	2.412	2.690
46	.850	1.300	1.679	2.013	2.410	2.687
47	.849	1.300	1.678	2.012	2.408	2.685
48	.849	1.299	1.677	2.011	2.407	2.682
49	.849	1.299	1.677	2.010	2.405	2.680
50	.849	1.299	1.676	2.009	2.403	2.678
51	.849	1.298	1.675	2.008	2.402	2.676
52	.849	1.298	1.675	2.007	2.400	2.674
53	.848	1.298	1.674	2.006	2.399	2.672

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TABLE 2 *t* DISTRIBUTION (*Continued*)

Degrees of Freedom	Area in Upper Tail				
	.20	.10	.05	.025	.01
35	.852	1.306	1.690	2.030	2.438
36	.852	1.306	1.688	2.028	2.434
37	.851	1.305	1.687	2.026	2.431
38	.851	1.304	1.686	2.024	2.429
39	.851	1.304	1.685	2.023	2.426
40	.851	1.303	1.684	2.021	2.423
41	.850	1.303	1.683	2.020	2.421
42	.850	1.302	1.682	2.018	2.418
43	.850	1.302	1.681	2.017	2.416
44	.850	1.301	1.680	2.015	2.414
45	.850	1.301	1.679	2.014	2.412
46	.850	1.300	1.679	2.013	2.410
53	.848	1.298	1.674	2.006	2.399

Chat Participant

Disable group chat

Varsha Jettley
ok

please show impact of different alpha

K MOHAMMED NAYAZUDDIN JOINED

Birje Manoj Madhukar
yes, impact of Alpha to be checked

Varsha Jettley
ok

Das Amiya Kumar
accept

V R Lyju
Reject

Birje Manoj Madhu...
Still same

Varsha Jettley
ok

pdfcoffee.com_statistics-for-b... | Statistics for Business and Ec... | z-table.pdf - Adobe Reader | t-table.pdf - Adobe Reader

ENG IN 8:06 PM 2/8/2022

Problem

AOL Time Warner Inc.'s CNN has been the longtime ratings leader of cable television news. Nielsen Media Research indicated that the mean CNN viewing audience was 600,000 viewers per day during 2002. Assume that for a sample of 40 days during the first half of 2003, the daily audience was 612,000 viewers with a sample standard deviation of 65,000 viewers.

a. What are the hypotheses if CNN management would like information on any change in the CNN viewing audience?

b. What is the *p*-value?

c. Select your own level of significance. What is your conclusion? $\alpha = 0.05$ $1-\alpha = 0.95$

d. What recommendation would you make to CNN management in this application?

$H_0 : \mu = 600000$

$H_a : \mu \neq 600000$

$s = 65000$

$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$ $\quad n-1 = 39$

$= 1.17$

$\alpha = 0.05$

$\alpha = 0.1$ $\quad \alpha_0 = 0.05$ $\quad H_0$ accepted

Virtual Classroom

Chat | Participant

Disable group chat

K MOHAMMED NAYAZUDDIN JOINED

Birja Manoj Madhukar: yes, impact of Alpha to be checked

Varsha jettley: ok

Das Amiya Kumar: accept

V R Lyju: Reject

Birja Manoj Madhu...: Still same

Varsha jettley: ok

0.2 is very high value -- mostly not taken ?

GEETANJALI RAI JOINED

yes sir

Sending to everyone

Write Message

ENG IN 8:06 PM 2/8/2022

Problem

A study by *Consumer Reports* showed that 64% of supermarket shoppers believe supermarket brands to be as good as national name brands. To investigate whether this result applies to its own product, the manufacturer of a national name-brand ketchup asked a sample of shoppers whether they believed that supermarket ketchup was as good as the national brand ketchup.

a. Formulate the hypotheses that could be used to determine whether the percentage of supermarket shoppers who believe that the supermarket ketchup was as good as the national brand ketchup differed from 64%.

b. If a sample of 100 shoppers showed 52 stating that the supermarket brand was as good as the national brand, what is the p-value?

c. At α .05, what is your conclusion?

d. Should the national brand ketchup manufacturer be pleased with this conclusion? Explain.

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c. At α .05, what is your conclusion?

d. Should the national brand ketchup manufacturer be pleased with this conclusion? Explain.

$H_a: p \neq 0.64$ $H_0: P = 0.64$

Solution

H_0 : $p = 0.64$

H_a : $p \neq 0.64$

Solution

$H_0 : p = 0.64$

$H_a : p \neq 0.64$

$n = 100$

$\bar{p} = \frac{52}{100} = 0.52$

$\alpha = 0.05$

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

.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986

.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.813
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.838
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.862
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.883
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.901
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.917
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.931
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.944
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.954
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.963
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.970
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.976
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.981
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.985
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.989
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.991
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.993
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986

.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986

.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9923	.9925	.9927	.9929	.9931	.9932	.9934	.9936

.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
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1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
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2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986

.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890

.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
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2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990

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1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.85	
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2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.99	
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.99	
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990

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Problem

A study by *Consumer Reports* showed that 64% of supermarket shoppers believe supermarket brands to be as good as national name brands. To investigate whether this result applies to its own product, the manufacturer of a national name-brand ketchup asked a sample of shoppers whether they believed that supermarket ketchup was as good as the national brand ketchup.

a. Formulate the hypotheses that could be used to determine whether the percentage of supermarket shoppers who believe that the supermarket ketchup was as good as the national brand ketchup differed from 64%.

b. If a sample of 100 shoppers showed 52 saying that the supermarket brand was as good as the national brand, what is the *p*-value?

c. At $\alpha = .05$, what is your conclusion?

d. Should the national brand ketchup manufacturer be pleased with this conclusion? Explain.

$H_a: p \neq 0.64$ $H_0: p = 0.64$

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Problem

Young Adult magazine states the following hypotheses about the mean age of its subscribers. If H0: $\mu = 28$, Ha : $\mu \neq 28$

If the manager conducting the test will permit a 0.15 probability of making a Type II error when the true mean age is 29, what sample size should be selected? Assume $\sigma = 6$ and a 0.05 level of significance.

Type -II error

Problem

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If the manager conducting the test will permit a 0.15 probability of making a Type II error when the true mean age is 29, what sample size should be selected? Assume $\sigma = 6$ and a 0.05 level of significance.

Type -II error Accept Ho when it is false

Applications

30. A *BusinessWeek*/Harris survey asked senior executives at large corporations their opinions about the economic outlook for the future. One question was, "Do you think that there will be an increase in the number of full-time employees at your company over the next 12 months?" In the current survey, 220 of 400 executives answered yes, while in a previous year survey, 192 of 400 executives had answered yes. Provide a 95% confidence interval estimate for the difference between the proportions at the two points in time. What is your interpretation of the interval estimate?

31. The Professional Golf Association (PGA) measured the putting accuracy of professional golfers playing on the PGA Tour and the best amateur golfers playing in the World Amateur Championship (*Golf Magazine*, January 2007). A sample of 1075 6-foot putts by professional golfers found 688 made puts. A sample of 1200 6-foot putts by amateur golfers fo

a. t putts by professional golfers. Estimate the amateur golfers. Which group had a better

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    a. Estimate the proportion of made 6-foot putts by professional golfers. Estimate the proportion of made 6-foot putts by amateur golfers. Which group had a better putting accuracy?
    b. What is the point estimate of the difference between the proportions of the two populations? What does this estimate tell you about the percentage of putts made by the two

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WEB file
Mutual

Arch Small Cap Equity	14.57	Berger One Hundred	1
Bartlett Cap Basic	17.73	Columbia International Stock	1
Calvert World International	10.31	Dodge & Cox Balanced	1
Colonial Fund A	16.23	Evergreen Fund	1

a. Formulate H_0 and H_a such that rejection of H_0 leads to the conclusion that the load mutual funds have a higher mean annual return over the five-year period.

b. Use the 60 mutual funds in the file set Mutual to conduct the hypothesis test. What is the p-value? At $\alpha = .05$, what is your conclusion?

41. The National Association of Home Builders provided data on the cost of the most popular home remodeling projects. Sample data on cost in thousands of dollars for two types of remodeling projects are as follows.

Kitchen	Master Bedroom	Kitchen	Master Bedroom
25.2	18.0	23.0	17.8
17.4	32.9	19.7	24.6
22.8	26.4	16.9	21.0
21.9	24.8	21.8	
19.7	26.9	23.6	

d. What is the probability of making a Type II error when the population mean i
is 70 minutes?

e. Sketch the power curve for this problem.

75. A federal funding program is available to low-income neighborhoods. To qualify for the funding, a neighborhood must have a mean household income of less than $15,000 per year. Neighborhoods with mean annual household income of $15,000 or more do not qualify. Funding decisions are based on a sample of residents in the neighborhood. A hypothesis test with a .02 level of significance is conducted. If the funding guidelines call for a maximum probability of .05 of not funding a neighborhood with a mean annual household income of $14,000, what sample size should be used in the funding decision study? Use $\sigma = \$4000$ as a planning value.

76. H_0: $\mu = 120$ and H_a: $\mu \neq 120$ are used to test whether a bath soap production process is meeting the standard output of 120 bars per batch. Use a .05 level of significance for the test and a planning value of 5 for the standard deviation.

a. If the mean output drops to 117 bars per batch, the firm wants to have a 98% chance of concluding that the standard production output is not being met. How large a sample should be selected?

b. With your sample size from part (a), what is the probability of concluding that the process is operating satisfactorily for each of the following actual mean outputs: 117, 118, 119, 121, 122, and 123 bars per batch? That is, what is the probability of a Type II error in each case?

the sample size were provided in Sections 9.3 and 9.4. In the case of hypothesis tes a population proportion, the hypothesis testing procedure uses a test statistic base standard normal distribution.

In all cases, the value of the test statistic can be used to compute a p-value for the test. A p-value is a probability used to determine whether the null hypothesis should be rejected. If the p-value is less than or equal to the level of significance α, the null hypothesis can be rejected.

Hypothesis testing conclusions can also be made by comparing the value of the test statistic to a critical value. For lower tail tests, the null hypothesis is rejected if the value of the test statistic is less than or equal to the critical value. For upper tail tests, the null hypothesis is rejected if the value of the test statistic is greater than or equal to the critical value. Two-tailed tests consist of two critical values: one in the lower tail of the sampling distribution and one in the upper tail. In this case, the null hypothesis is rejected if the value of the test statistic is less than or equal to the critical value in the lower tail or greater than or equal to the critical value in the upper tail.

Extensions of hypothesis testing procedures to include an analysis of the Type II error were also presented. In Section 9.7 we showed how to compute the probability of making a Type II error. In Section 9.8 we showed how to determine a sample size that will control for the probability of making both a Type I error and a Type II error.

1. Once two of the three values are known, the other can be computed.
2. For a given level of significance α, increasing the sample size will reduce β.
3. For a given sample size, decreasing α will increase β, whereas increasing α will decrease β.

The third observation should be kept in mind when the probability of a Type II error is not being controlled. It suggests that one should not choose unnecessarily small values for the level of significance α. For a given sample size, choosing a smaller level of significance means more exposure to a Type II error. Inexperienced users of hypothesis testing often think that smaller values of α are always better. They are better if we are concerned only about making a Type I error. However, smaller values of α have the disadvantage of increasing the probability of making a Type II error.

Exercises

Methods

SELF test

54. Consider the following hypothesis test.

$$H_0: \mu \geq 10$$
$$H_a: \mu < 10$$

The sample size is 120 and the population standard deviation is 5. Use $\alpha = .05$. If the ac-

35. Consider the following hypothesis test:

$$H_0: p = .20$$
$$H_a: p \neq .20$$

A sample of 400 provided a sample proportion $\bar{p} = .175$.

a. Compute the value of the test statistic.
b. What is the p-value?
c. At $\alpha = .05$, what is your conclusion?
d. What is the rejection rule using the critical value? What is your conclusion?

SELF test

36. Consider the following hypothesis test:

$$H_0: p \geq .75$$
$$H_a: p < .75$$

A sample of 300 items was selected. Compute the p-value and state your conclusion for each of the following sample results. Use $\alpha = .05$.

a. $\bar{p} = .68$
b. $\bar{p} = .72$
c. $\bar{p} = .70$
d. $\bar{p} = .77$

$$297.6 \pm 3.3$$

or

294.3 to 300.9

This finding enables the quality control manager to conclude with 95% confidence that the mean distance for the population of golf balls is between 294.3 and 300.9 yards. Because the hypothesized value for the population mean, $\mu_0 = 295$, is in this interval, the hypothesis testing conclusion is that the null hypothesis, H_0: $\mu = 295$, cannot be rejected.

Note that this discussion and example pertain to two-tailed hypothesis tests about a population mean. However, the same confidence interval and two-tailed hypothesis testing relationship exists for other population parameters. The relationship can also be extended to one-tailed tests about population parameters. Doing so, however, requires the development of one-sided confidence intervals, which are rarely used in practice.

NOTES AND COMMENTS

We have shown how to use p-values. The smaller the p-value the greater the evidence against H_0 and the more the evidence in favor of H_a. Here are some guidelines statisticians suggest for interpreting small p-values.

- Less than .01—Overwhelming evidence to conclude H_a is true.
- Between .01 and .05—Strong evidence to conclude H_a is true.
- Between .05 and .10—Weak evidence to conclude H_a is true.
- Greater than .10—Insufficient evidence to conclude H_a is true.

We can generalize the rejection rule for the critical value approach to handle any level of significance. The rejection rule for a lower tail test follows.

REJECTION RULE FOR A LOWER TAIL TEST: CRITICAL VALUE APPROACH

Reject H_0 if $z \leq -z_\alpha$

where $-z_\alpha$ is the critical value; that is, the z value that provides an area of α in the lower tail of the standard normal distribution.

The p-value approach to hypothesis testing and the critical value approach will always lead to the same rejection decision; that is, whenever the p-value is less than or equal to α, the value of the test statistic will be less than or equal to the critical value. The advantage of the p-value approach is that the p-value tells us *how* significant the results are (the ob-

TABLE 8.7 SALES DATA FOR GULF REAL ESTATE PROPERTIES

Gulf View Condominiums			No Gulf View Condominiums		
List Price	Sale Price	Days to Sell	List Price	Sale Price	Days to Sell
495.0	475.0	130	217.0	217.0	182
379.0	350.0	71	148.0	135.5	338
529.0	519.0	85	186.5	179.0	122
552.5	534.5	95	239.0	230.0	150
334.9	334.9	119	279.0	267.5	169
550.0	505.0	92	215.0	214.0	58
169.9	165.0	197	279.0	259.0	110
210.0	210.0	56	179.9	176.5	130
975.0	945.0	73	149.9	144.9	149
314.0	314.0	126	235.0	230.0	114
315.0	305.0	88	199.8	192.0	120
885.0	800.0	282	210.0	195.0	61
975.0	975.0	100	226.0	212.0	146
469.0	445.0	56	149.9	146.5	137

WEB file
GulfProp

p-value does not provide much support for the null hypothesis, but is it small enough to cause us to reject H_0? The answer depends upon the level of significance for the test.

As noted previously, the director of the FTC's testing program selected a value of .01 for the level of significance. The selection of $\alpha = .01$ means that the director is willing to tolerate a probability of .01 of rejecting the null hypothesis when it is true as an equality ($\mu_0 = 31$). The sample of 36 coffee cans in the Hilltop Coffee study resulted in a p-value = .0038, which means that the probability of obtaining a value of $\bar{x} = 2.92$ or less when the null hypothesis is true as an equality is .0038. Because .0038 is less than or equal to $\alpha = .01$, we reject H_0. Therefore, we find sufficient statistical evidence to reject the null hypothesis at the .01 level of significance.

We can now state the general rule for determining whether the null hypothesis can be rejected when using the p-value approach. For a level of significance α, the rejection rule using the p-value approach is as follows:

REJECTION RULE USING p-VALUE

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

If the sample data are consistent with the null hypothesis H_0, we will follow the practice of concluding "do not reject H_0." This conclusion is preferred over "accept H_0," because the conclusion to accept H_0 puts us at risk of making a Type II error.

if we decide to accept H_0, we cannot determine how confident we can be with that d
Because of the uncertainty associated with making a Type II error when conducting
cance tests, statisticians usually recommend that we use the statement "do not rej
instead of "accept H_0." Using the statement "do not reject H_0" carries the recommendation to withhold both judgment and action. In effect, by not directly accepting H_0, the statistician avoids the risk of making a Type II error. Whenever the probability of making a Type II error has not been determined and controlled, we will not make the statement "accept H_0." In such cases, only two conclusions are possible: *do not reject H_0* or *reject H_0*.

Although controlling for a Type II error in hypothesis testing is not common, it can be done. In Sections 9.7 and 9.8 we will illustrate procedures for determining and controlling the probability of making a Type II error. If proper controls have been established for this error, action based on the "accept H_0" conclusion can be appropriate.

NOTES AND COMMENTS

Walter Williams, syndicated columnist and professor of economics at George Mason University, points out that the possibility of making a Type I or a Type II error is always present in decision making (*The Cincinnati Enquirer*, August 14, 2005). He notes that the Food and Drug Administration runs the risk of making these errors in their drug approval process. With a Type I error, the FDA fails to approve a drug that is safe and effective. A Type II error means the FDA approves a drug that has unanticipated dangerous side effects. Regardless of the decision made, the possibility of making a costly error cannot be eliminated.

TABLE 9.1 ERRORS AND CORRECT CONCLUSIONS IN HYPOTHESIS TESTING

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

rejection of H_0 when H_a is true. Unfortunately, the correct conclusions are not always possible. Because hypothesis tests are based on sample information, we must allow for the possibility of errors. Table 9.1 illustrates the two kinds of errors that can be made in hypothesis testing.

The first row of Table 9.1 shows what can happen if the conclusion is to accept H_0. If H_0 is true, this conclusion is correct. However, if H_0 is true, we make a **Type II error**; that

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2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7										
2.8										
2.9										
3.0										

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z-table.pdf - Adobe Reader

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1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.862
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.883
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.901
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.917
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.931
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.944
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.954
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.963
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.970
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.976
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.981
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.985
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.989
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.991
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.993
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.995
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.996
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.997
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990

Virtual Classroom

Chat

Disable group chat

but accept H0 when fals
or Type II?

Rajesh A
Type1: Reject Null hypo
it is true

TypeII:Not rejecting Ho
false

Bhimsen Joshi
search matrix

yes

ok

Birje Manoj Madhukar
Type 2 - False Positive

Bhimsen Joshi
ok thank you

Birje Manoj Madhukar
Type 1 = False Negative

Sending to everyone
Write Message

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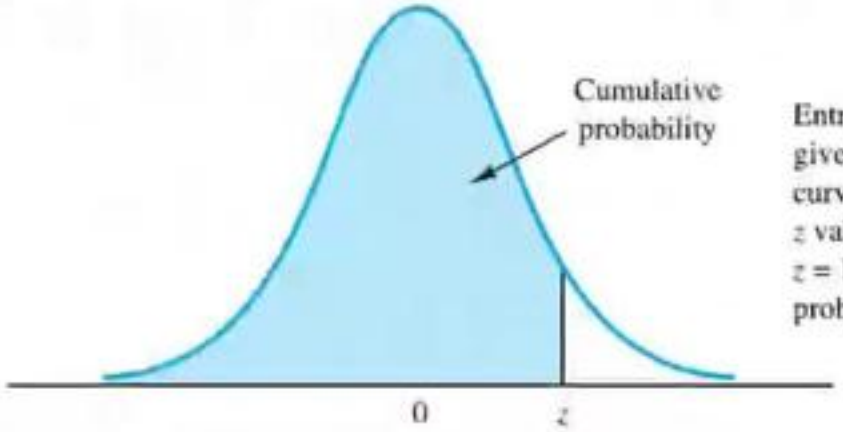
CUMULATIVE PROBABILITIES FOR THE STANDARD NORMAL DISTRIBUTION



Entries in the table give the area under the curve to the left of the z value. For example, for $z = 1.25$, the cumulative probability is .8944.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879

probability is .8944.

z	.00	.01	.02	.03	.04	.05	.06	.07	.
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8
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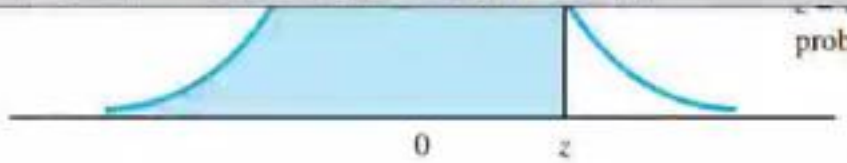
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441

Solution

probability is .8944.



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
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.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441

Problem

Young Adult magazine states the following hypotheses about the mean age of its subscribers. If H0: $\mu = 28$, Ha : $\mu \neq 28$

If the manager conducting the test will permit a 0.15 probability of making a Type II error when the true mean age is 29, what sample size should be selected? Assume $\sigma = 6$ and a 0.05 level of significance.

Type - II error Accept H_0 when it is false

H_0 $\mu_0 = 28$ H_1 $\mu \neq 28$

$\alpha = 0.05$ $Z_{\alpha/2} = Z_{0.025} = 1.96$

$Z_{0.15} = 1.04$

$$n = \frac{(Z_{\alpha/2} + Z_\beta)^2 \sigma^2}{(\mu_0 - \mu_1)^2}$$

Problem

During the 2003 season, Major League Baseball took steps to speed up the play of baseball games in order to maintain fan interest (CNN Headline News, September 30, 2003). The following results come from a sample of 60 games played during the summer of 2002 and a sample of 50 games played during the summer of 2003. The sample mean shows the mean duration of the games included in each sample.

2002 Season	2003 Season
$n_1 = 60$	$n_2 = 50$
$\bar{x}_1 = 2$ hours, 52 minutes	$\bar{x}_2 = 2$ hours, 46 minutes

a. A research hypothesis was that the steps taken during the 2003 season would reduce the population mean duration of baseball games. Formulate the null and alternative hypotheses.

b. What is the point estimate of the reduction in the mean duration of games during the 2003 season?

c. Historical data indicate a population standard deviation of 12 minutes is a reasonable assumption for both years. Conduct the hypothesis test and report the p-value. At a .05 level of significance, what is your conclusion?

d. Provide a 95% confidence interval estimate of the reduction in the mean duration of games during the 2003 season.

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2002 Season	2003 Season
$n_1 = 60$	$n_2 = 50$
$\bar{x}_1 = 2$ hours 52 minutes	$\bar{x}_2 = 2$ hours, 46 minutes
$= 172$ min	$= 161$ min

a. A research hypothesis was that the steps taken during the 2003 season would reduce the population mean duration of baseball games. Formulate the null and alternative hypotheses.

b. What is the point estimate of the reduction in the mean duration of games during the 2003 season?

c. Historical data indicate a population standard deviation of 12 minutes is a reasonable assumption for both years. Conduct the hypothesis test and report the p-value. At a .05 level of significance, what is your conclusion?

d. Provide a 95% confidence interval estimate of the reduction in the mean duration of games during the 2003 season.

Virtual Classroom

Chat | Participants (56)

Disable group chat

without sd?

Birje Manoj Madhukar: We will move towards more accurate data with increase in sample size

Bhimsen Joshi: H0 is mean didnot change

Birje Manoj Madhu...: ok sir

yes sir

K GIRISH GOPINATHAN JOINED

Bhimsen Joshi: H1 mean < 2 52

ok.. x1 - x2 > 0 we can take

Dattatraya Udapirao Kul...: difference > 0 is fine

RAHUL KUMAR KAUSHIK JOINED

Sending to everyone

Write Message

ENG IN 8:35 PM 2/8/2022

Problem

During the 2003 season, Major League Baseball took steps to speed up the play of baseball games in order to maintain fan interest (CNN Headline News, September 30, 2003). The following results come from a sample of 60 games played during the summer of 2002 and a sample of 50 games played during the summer of 2003. The sample mean shows the mean duration of the games included in each sample.

2002 Season	2003 Season
$n_1 = 60$	$n_2 = 50$
$\bar{x}_1$ = 2 hours, 52 minutes = 172 min	$\bar{x}_2$ = 2 hours, 46 minutes = 166 min

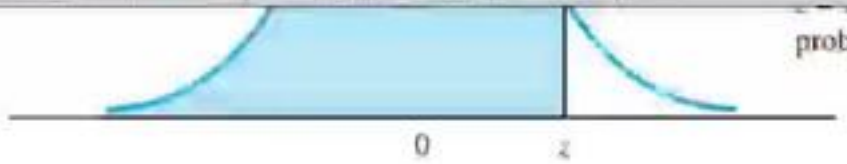
a. A research hypothesis was that the steps taken during the 2003 season would reduce the population mean duration of baseball games. Formulate the null and alternative hypotheses.

b. What is the point estimate of the reduction in the mean duration of games during the 2003 season?

c. Historical data indicate a population standard deviation of 12 minutes is a reasonable assumption for both years. Conduct the hypothesis test and report the *p*-value. At a .05 level of significance, what is your conclusion?

d. Provide a 95% confidence interval estimate of the reduction in the mean duration of games during the 2003 season.

probability is .8944.



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
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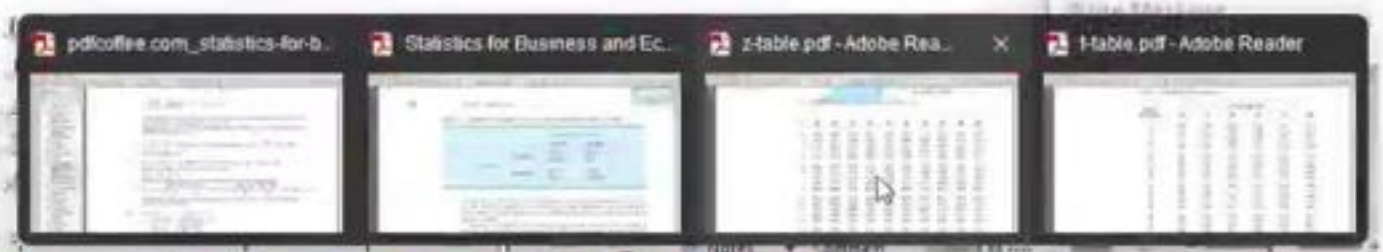
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389



Problem

Are nursing salaries in Tampa, Florida, lower than those in Dallas, Texas? Salary data show staff nurses in Tampa earn less than staff nurses in Dallas (*The Tampa Tribune*, January 15, 2007). Suppose that in a follow-up study of 40 staff nurses in Tampa and 50 staff nurses in Dallas you obtain the following results.

	Tampa	Dallas
	$n_1 = 40$	$n_2 = 50$
	$x_1 = 56100$	$x_2 = 59400$
	$s_1 = 6000$	$s_2 = 7000$

a. Formulate hypothesis so that, if the null hypothesis is rejected, we can conclude that salaries for staff nurses in Tampa are significantly lower than for those in Dallas. Use $\alpha = .05$.

b. What is the value of the test statistic?

c. What is the p-value?

d. What is your conclusion?

Solution

Here $n_1 = 40$, $n_2 = 50$

$\bar{x}_1 = 561.00$, $\bar{x}_2 = 594.00$

$s_1 = 6000$ $s_2 = 7000$

Problem

Bank of America's Consumer Spending Survey collected data on annual credit card charges in seven different categories of expenditures: transportation, groceries, dining out, household expenses, home furnishings, apparel, and entertainment (*US Airways Attaché*, December 2003). Using data from a sample of 42 credit card accounts, assume that each account was used to identify the annual credit card charges for groceries (population 1) and the annual credit card charges for dining out (population 2). Using the difference data, the sample mean difference was $\bar{d} = \$850$, and the sample standard deviation was $s_d = \$1123$.

a. Formulate the null and alternative hypotheses to test for no difference between the population mean credit card charges for groceries and the population mean credit card charges for dining out.

b. Use a .05 level of significance. Can you conclude that the population means differ? What is the *p*-value?

c. Which category, groceries or dining out, has a higher population mean annual credit card charge? What is the point estimate of the difference between the population means? What is the 95% confidence interval estimate of the differences between the population means?

TABLE 2 t DISTRIBUTION (*Continued*)

Degrees of Freedom	Area in Upper Tail					
	.20	.10	.05	.025	.01	.005
35	.852	1.306	1.690	2.030	2.438	2.724
36	.852	1.306	1.688	2.028	2.434	2.719
37	.851	1.305	1.687	2.026	2.431	2.715
38	.851	1.304	1.686	2.024	2.429	2.712
39	.851	1.304	1.685	2.023	2.426	2.708
40	.851	1.303	1.684	2.021	2.423	2.704
41	.850	1.303	1.683	2.020	2.421	2.701
42	.850	1.302	1.682	2.018	2.418	2.698
43	.850	1.302	1.681	2.017	2.416	2.695
44	.850	1.301	1.680	2.015	2.414	2.692
45	.850	1.301	1.679	2.014	2.412	2.690
46	.850	1.300	1.679	2.013	2.410	2.687
47	.849	1.300	1.678	2.012	2.408	2.685
48	.849	1.299	1.677	2.011	2.407	2.682
49	.849	1.299	1.677	2.010	2.405	2.680
50	.849	1.299	1.676	2.009	2.403	2.678
51	.849	1.298	1.675	2.008	2.402	2.676
52	.849	1.298	1.675	2.007	2.400	2.674
53	.848	1.298	1.674	2.006	2.399	2.672

Solution

let μ_1 = Population mean grocery

μ_2 = Population mean dining out

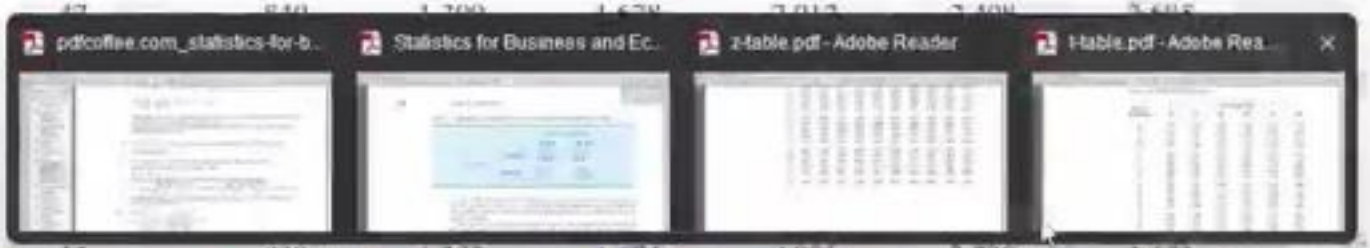
$H_0 : \mu_d = 0$ $\quad$ $H_a : \mu_d \neq 0$

$$t = \frac{\bar{d} - \mu_0}{s_d/\sqrt{n}} = \frac{850 - 0}{1123/\sqrt{42}} = 4.91$$

$df = 42 - 1 = 41$

TABLE 2 *t* DISTRIBUTION (*Continued*)

Degrees of Freedom	Area in Upper Tail					
	.20	.10	.05	.025	.01	.005
35	.852	1.306	1.690	2.030	2.438	2.724
36	.852	1.306	1.688	2.028	2.434	2.719
37	.851	1.305	1.687	2.026	2.431	2.715
38	.851	1.304	1.686	2.024	2.429	2.712
39	.851	1.304	1.685	2.023	2.426	2.708
40	.851	1.303	1.684	2.021	2.423	2.704
41	.850	1.303	1.683	2.020	2.421	2.701
42	.850	1.302	1.682	2.018	2.418	2.698
43	.850	1.302	1.681	2.017	2.416	2.695
44	.850	1.301	1.680	2.015	2.414	2.692
45	.850	1.301	1.679	2.014	2.412	2.690
46	.850	1.300	1.679	2.013	2.410	2.687



Solution

let μ_1 = Population mean grocery

μ_2 = Population mean dining out

$H_0 : \mu_d = 0$ $\quad H_a : \mu_d \neq 0$

$$t = \frac{\bar{d} - \mu_0}{s_d/\sqrt{n}} = \frac{850 - 0}{1123/\sqrt{42}} = 4.91$$

$d.f. = 42 - 1 = 41$ $\quad \alpha = 0.05$

$t_\alpha = 2.020$

$$\bar{d} \pm t_{0.025} \frac{s_d}{\sqrt{n}} = 850 \pm$$

Reject H_0.

Solution

let μ_1 = Population mean grocery

μ_2 = Population mean dining out

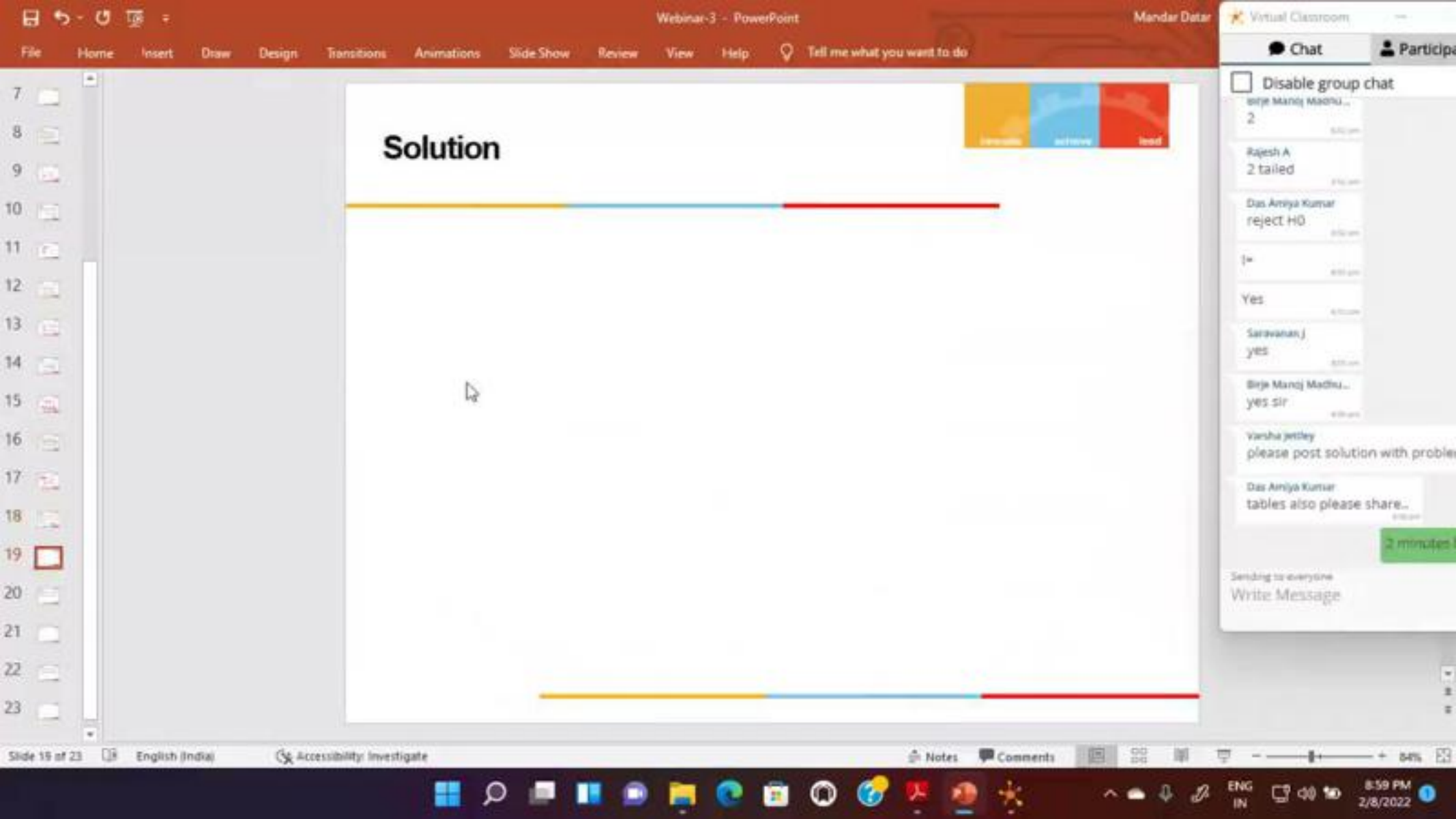
$H_0 : \mu_d = 0$ $\quad$ $H_a : \mu_d \neq 0$

$$t = \frac{\bar{d} - \mu_0}{s_d/\sqrt{n}} = \frac{850 - 0}{1123/\sqrt{42}} = 4.91$$

d.f $= 42 - 1 = 41$ $\quad$ $\alpha = 0.05$

$t_\alpha = 2.020$

Reject H_0.


Webinar-3 - PowerPoint
Mandar Datar
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Home
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Transitions
Animations
Slide Show
Review
View
Help
Tell me what you want to do
Solution
Virtual Classroom
Chat
Disable group chat
2
Rajesh A
2 tailed
Das Amiya Kumar
reject H0
!=
Yes
Saravanan J
yes
Birje Manoj Madhu...
yes sir
Vansha Jetley
please post solution with proble
Das Amiya Kumar
tables also please share..
2 minutes
Sending to everyone
Write Message
Slide 19 of 23
English (India)
Accessibility: Investigate
Notes
Comments
84%
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IN
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2/8/2022

Solution

$\bar{P}_1 - \bar{P}_2 = 0.64 - 0.58 = 0.06$

Professional golfers make 6% putts more than amature

$P_1 - P_2 +$

1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990