Introduction

Welcome to the module on 'Hypothesis Testing'.

In the previous modules, you learnt exploratory data analysis and inferential statistics.

In this session

The statistical analyses learnt in Inferential Statistics enable you try to make inferences about population mean from the sample data when you have no idea of population mean. However, sometimes you have some starting assumption about the population mean and you want to confirm those assumptions using the sample data. It is here that **hypothesis testing** comes into the picture. We will cover the basic concepts of hypothesis testing in this session, which are as follows:

- Types of hypotheses
- Types of tests
- Decision criteria
- Critical value method of hypothesis testing

This session covers the **concepts of Hypothesis Testing from the theory perspective**, since that is very important while performing Hypothesis Testing in industry using tools like Python, Excel etc. The demonstration of Hypothesis Testing on Excel has been done in the last session of this module.

The in-video and in-content questions for this module are not graded. Note that graded questions are given on a separate page labelled 'Graded Questions' at the end of this session. The questions in this session will adhere to the following guidelines:

	First Attempt Marks	**Second Attempt Marks**
Question with 2 Attempts	10	5
Question with 1 Attempt	10	0

People you will hear from in this session

Subject Matter Expert

Tricha Anjali

Associate Professor, IIIT- B

The International Institute of Information Technology, Bangalore, commonly known as IIIT Bangalore, is a premier national graduate school in India. Founded in 1999, it offers Integrated M.Tech., M.Tech., M.S. (Research) and Ph.D. programs in the field of Information Technology.

Industry Expert

Ankit Jain

Head of Data Science & Analytics, Roadrunnr

Roadrunnr is a B2B platform with the aim of building India's largest fleet of on-demand

Rohit Sharma

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NEXT
Understanding Hypothesis Testing

Understanding Hypothesis Testing

In the last two modules, you learned about the following topics:

- Exploratory data analysis: Exploring data for insights and patterns
- Inferential statistics: Making inferences about the population using the sample data

Now, these methods help you formulate a basic idea or conclusion about the population. Such assumptions are called “hypotheses”. But how do you really confirm these conclusions or hypotheses? Let’s see.

Let's understand the **basic difference between inferential statistics and hypothesis testing**.

Inferential statistics is used to find some population parameter (mostly population mean) when you have no initial number to start with. So, you start with the sampling activity and find out the sample mean. Then, you estimate the population mean from the sample mean using the confidence interval.

Hypothesis testing is used to confirm your conclusion (or hypothesis) about the population parameter (which you know from EDA or your intuition). Through hypothesis testing, you can determine whether there is enough evidence to conclude if the hypothesis about the population parameter is true or not.

Both these modules have a few similar concepts, so don't confuse terminology used in hypothesis testing with inferential statistics.

Let's get started by understanding the basics of hypothesis testing.

Hypothesis Testing starts with the formulation of these two hypotheses:

- **Null hypothesis** (H_0): The status quo
- **Alternate hypothesis** (H_1): The challenge to the status quo

Question 1/2

Mandatory

Null and Alternate Hypotheses

In the Maggi Noodles example, if you **fail to reject the null hypothesis**, what can you conclude from this statement?

- Maggi Noodles contain excess lead — ✕ Incorrect

  Feedback:
  The null hypothesis in this example is that the average lead content is less than or equal to 2.5 ppm.

- Maggi Noodles do not contain excess lead — ✓ Correct

  Feedback:
  The null hypothesis is that the average lead content is less than or equal to 2.5 ppm. Since you fail to reject the null hypothesis, you can conclude that Maggi

Now, having got a brief idea about what hypothesis testing is, in the next page, we will look at its different aspects in detail, starting with the formulation of the null and alternate hypotheses.

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Null and Alternate Hypotheses

Hypothesis Testing starts with the formulation of these two hypotheses:

- **Null hypothesis** (H_0): The status quo
- **Alternate hypothesis** (H_1): The challenge to the status quo

Question 2/2

Mandatory

Types of Hypotheses

The null and alternative hypotheses divide all possibilities into:

- 2 sets that overlap
- 2 non-overlapping sets ✓ Correct

  Feedback:

  Both the null and alternate hypotheses can't be true at the same time. Only one of them will be true.

- 2 sets that may or may not overlap

Null and Alternate Hypotheses

The first step of hypothesis testing is the formulation of the null and alternate hypotheses for a given situation. Let's learn how to do this through different examples.

But in some instances, if your claim statement has words like “at least”, “at most”, “less than”, or “greater than”, **you cannot formulate the null hypothesis just from the claim statement** (because it’s not necessary that the **claim is always about the status quo**).

You can use the following rule to formulate the null and alternate hypotheses:

The null hypothesis always has the following signs: $=$ OR $\leq$ OR $\geq$

The alternate hypothesis always has the following signs: $\neq$ OR $>$ OR $<$

For example:

Situation 1: Flipkart claimed that its total valuation in December 2016 was at least $14 billion. Here, the claim contains $\geq$ sign (i.e. the at least sign), so **the null hypothesis is the original claim**.

The hypothesis in this case can be formulated as:

Figure 1 - Hypotheses for Situation 1

formulated as:

The hypothesis in this case can be formulated as:

Figure 2 - Hypotheses for Situation 2

Now, answer the following questions to consolidate your learning about the formulation of null and alternate hypotheses.

Question 1/2 Mandatory

Null and Alternate Hypotheses

The average commute time for an UpGrad employee to and from office is at least 35 minutes.

What will be the null and alternate hypotheses in this case if the average time is represented by μ?

- H_0: μ ≤ 35 minutes and H_1: μ > 35 minutes

Feedback:

The null hypothesis is always formulated by either = or ≤ or ≥ whereas the alternate hypothesis is formulated by ≠ or > or <. In this case, the average time taken was greater than or equal to 35 minutes. So, that becomes the null hypothesis. Less than 35 minutes becomes the alternate hypothesis.

- H_0: μ < 35 minutes and H_1: μ ≥ 35 minutes

Your answer is Correct. Attempt 1 of 2 Continue

To summarize this, you cannot decide the status quo or formulate the null hypotheses from the claim statement, you need to take care of signs in writing the null hypothesis. Null Hypothesis never contains ≠ or > or < signs. It always has to be formulated using = or ≤ or ≥ signs.

Before you go ahead and look at some more examples of formulating null and alternate hypothesis, let us hear from Ankit Jain about how he used hypothesis testing during his time at Facebook.

FREQUENTLY ASKED QUESTIONS (FAQ)

- My answer does not match with the given solution
- My video doesn't play properly
- My progress is stuck/ Unable to proceed to the next section

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Understanding Hypothesis Testing

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Making a Decision

formulated as:

The hypothesis in this case can be formulated as:

Figure 2 - Hypotheses for Situation 2

Now, answer the following questions to consolidate your learning about the formulation of null and alternate hypotheses.

Question 2/2 Mandatory

Null and Alternate Hypotheses

Goodyear claims that each of its tyres can travel more than 7500 miles on average before they need any replacement.

Assuming that the average travel distance is given by μ, what would be the null and the alternate hypothesis in this case?

- H_0: μ>7500 miles and H_1: μ ≤ 7500 miles

H_0: μ ≤ 7500 miles and H_1: μ > 7500 miles ✓ Correct

- Feedback:

  The null hypothesis is always formulated by either = or ≤ or ≥ whereas the alternate hypothesis is formulated by ≠ or > or <. If you check the claim statement, it has the > sign (i.e. μ> 7500 miles). Hence the null hypothesis would be the complement of the claim statement i.e. μ ≤ 7500 miles, and the alternate hypothesis would be the claim statement itself or μ > 7500 miles.

Your answer is Correct. Attempt 2 of 2 Continue

To summarize this, you cannot decide the status quo or formulate the null hypotheses from the claim statement, you need to take care of signs in writing the null hypothesis. Null Hypothesis never contains ≠ or > or < signs. It always has to be formulated using = or ≤ or ≥ signs.

Before you go ahead and look at some more examples of formulating null and alternate hypothesis, let us hear from Ankit Jain about how he used hypothesis testing during his time at Facebook.

Making a Decision

Once you have formulated the null and alternate hypotheses, let's turn our attention to the most important step of hypothesis testing — **making the decision to either reject or fail to reject the null hypothesis** — through an interesting example of a friend playing archery.

Question 1/1 Mandatory

Making a decision

If your sample mean lies in the acceptance region, then:

- You reject the null hypothesis — Incorrect

  Feedback:
  You reject the null hypothesis only if your sample mean lies in the critical region.

- You fail to reject the null hypothesis — Correct

  Feedback:
  If your sample mean lies in the acceptance region, you fail to reject the null hypothesis because it is not beyond the critical point and you can consider that sample mean is equal to the population mean statistically.

Your answer is Wrong. | Attempt 1 of 1 | Continue

Let's learn more about the critical region and understand how the position of the critical region changes with the different types of null and alternate hypotheses.

The formulation of the null and alternate hypotheses determines the type of the test and the position of the critical regions in the normal distribution.

You can tell the type of the test and the position of the critical region on the basis of the **'sign' in the alternate hypothesis.**

$\neq$ in H_1	$\rightarrow$	Two-tailed test	$\rightarrow$	Rejection region on **both sides** of distribution
$<$ in H_1	$\rightarrow$	Lower-tailed test	$\rightarrow$	Rejection region on **left side** of distribution
$>$ in H_1	$\rightarrow$	Upper-tailed test	$\rightarrow$	Rejection region on **right side** of distribution

Question 3/3 Mandatory

Question 1	Correct
Question 2	Correct

FREQUENTLY ASKED QUESTIONS (FAQ)

Does the claim statement directly give the null hypothesis?

Report an error

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Null and Alternate Hypotheses

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Critical Value Method

The formulation of the null and alternate hypotheses determines the type of the test and the position of the critical regions in the normal distribution.

You can tell the type of the test and the position of the critical region on the basis of the **'sign' in the alternate hypothesis.**

$\neq$ in H_1 → Two-tailed test → Rejection region on **both sides** of distribution
$<$ in H_1 → Lower-tailed test → Rejection region on **left side** of distribution
$>$ in H_1 → Upper-tailed test → Rejection region on **right side** of distribution

Question 1/3 Mandatory

Null and Alternate Hypotheses

Lower-tailed test, with the rejection region on the right side

Upper-tailed test, with the rejection region on the right side

Lower-tailed test, with the rejection region on the left side ✓ Correct

Feedback:

For this situation, the hypotheses would be formulated as H_0: $\mu \geq 35$ minutes and H_1: $\mu < 35$ minutes. As < sign is used in alternate hypothesis, it would be a lower-tailed test and the rejection region would be on the left side of the distribution.

Upper-tailed test, with the rejection region on the left side

Your answer is Correct. Attempt 1 of 2 Continue

FREQUENTLY ASKED QUESTIONS (FAQ)

Does the claim statement directly give the null hypothesis?

Report an error

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NEXT

The formulation of the null and alternate hypotheses determines the type of the test and the position of the critical regions in the normal distribution.

You can tell the type of the test and the position of the critical region on the basis of the **'sign' in the alternate hypothesis.**

$\neq$ in H_1 $\rightarrow$ Two-tailed test $\rightarrow$ Rejection region on **both sides** of distribution

$<$ in H_1 $\rightarrow$ Lower-tailed test $\rightarrow$ Rejection region on **left side** of distribution

$>$ in H_1 $\rightarrow$ Upper-tailed test $\rightarrow$ Rejection region on **right side** of distribution

Question 2/3 Mandatory

Null and Alternate Hypotheses

$H_0: \mu \neq 3; H_1: \mu = 3;\ \ Test: Two - tailed\ \ test$

$H_0: \mu = 3; H_1: \mu \neq 3;\ \ Test: Lower - tailed\ \ test$

$H_0: \mu = 3; H_1: \mu \neq 3;\ \ Test: Upper - tailed\ \ test$

$H_0: \mu = 3; H_1: \mu \neq 3;\ \ Test: Two - tailed\ \ test$ ✓ Correct

Feedback:
H0 always has an equal sign. And since H1 has an unequal sign, we need to test both the sides.

Your answer is Correct. Attempt 1 of 2 Continue

FREQUENTLY ASKED QUESTIONS (FAQ)

Does the claim statement directly give the null hypothesis?

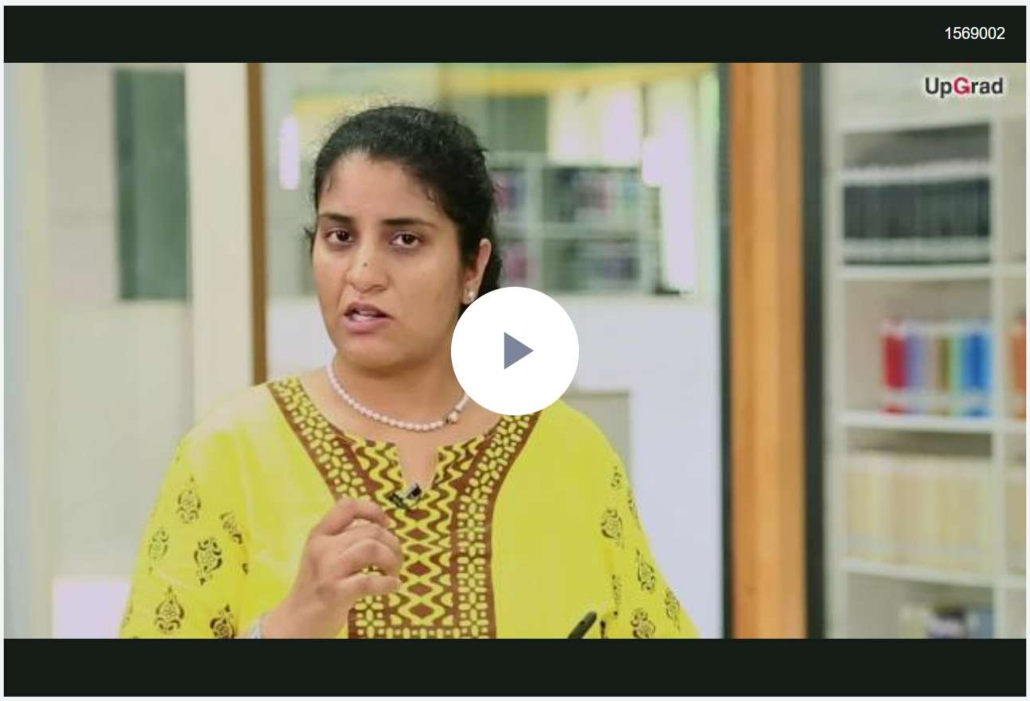
You fail to reject the null hypothesis ✓ Correct

Feedback:

If your sample mean lies in the acceptance region, you fail to reject the null hypothesis because it is not beyond the critical point and you can consider that sample mean is equal to the population mean statistically.

Your answer is Wrong. | Attempt 1 of 1 | Continue >

Let's learn more about the critical region and understand how the position of the critical region changes with the different types of null and alternate hypotheses.



The formulation of the null and alternate hypotheses determines the type of the test and the position of the critical regions in the normal distribution.

You can tell the type of the test and the position of the critical region on the basis of the **'sign' in the alternate hypothesis.**

$\neq$ in H_1 $\rightarrow$ Two-tailed test $\rightarrow$ Rejection region on **both sides** of distribution

$<$ in H_1 $\rightarrow$ Lower-tailed test $\rightarrow$ Rejection region on **left side** of distribution

$>$ in H_1 $\rightarrow$ Upper-tailed test $\rightarrow$ Rejection region on **right side** of distribution

< > **Question 3/3** Mandatory

Null and Alternate Hypotheses

A researcher claims that the weight of an average male Bengal tiger is less than 220 KG.

- (selected) $H_0 : \mu >= 220kg, H_1 : \mu < 220kg, \;\; Test : Upper - tailed \;\; test$ — ✕ Incorrect

  Feedback:
  Recall when to use an upper tailed and lower tailed test.

- $H_0 : \mu < 220kg, H_1 : \mu \geq 220kg, \;\; Test : Upper - tailed \;\; test$

- $H_0 : \mu > 220kg, H_1 : \mu \leq 220kg, \;\; Test : Lower - tailed \;\; test$

- None of the above — ✓ Correct

  Feedback:
  The correct formulation is as follows:

  $H_0 : \mu >= 220kg, H_1 : \mu < 220kg, \;\; Test : Lower - tailed \;\; test$

Your answer is Wrong. | Attempt 2 of 2 | Continue >

FREQUENTLY ASKED QUESTIONS (FAQ)

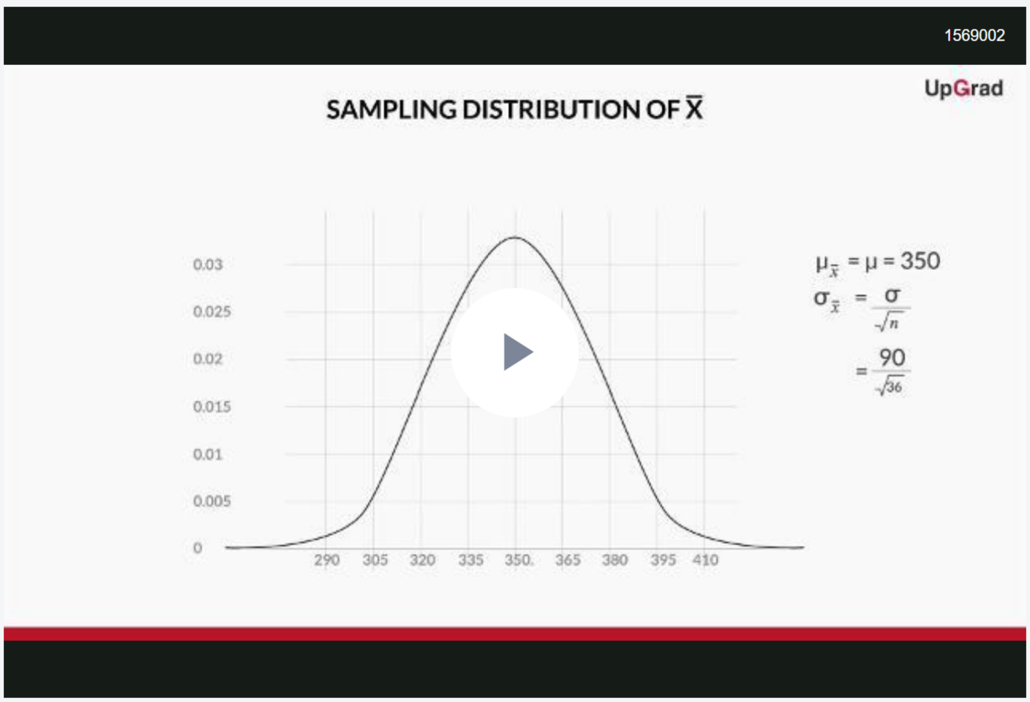
Does the claim statement directly give the null hypothesis?

Report an error

Critical Value Method

Now, let's learn how to find the critical values for the critical region in the distribution and make the final decision of rejecting or failing to reject the null hypothesis.

(**Note:** *In the video below, the graph showing the distribution of average sales data at 1:06 incorrectly displays 370.6 as the sample mean instead of 370.16. Also, it would be* $\sigma_{\bar{x}} = 15$ *instead of* $\sigma = 15$ *at 3:41*)



Before you proceed with finding the Zc and finally the critical values, let's revise the steps performed in this method till now.

1. First, you define a new quantity called α, which is also known as the significance level for the test. It refers to the proportion of the sample mean lying in the critical region. For this test, α is taken as 0.05 (or 5%).
2. Then, you calculate the cumulative probability of UCV from the value of α, which is further used to find the z-critical value (Zc) for UCV.

Attempt the following questions before you go ahead and learn the remaining steps in this method.

Question 1/3 Mandatory

Area of rejection region

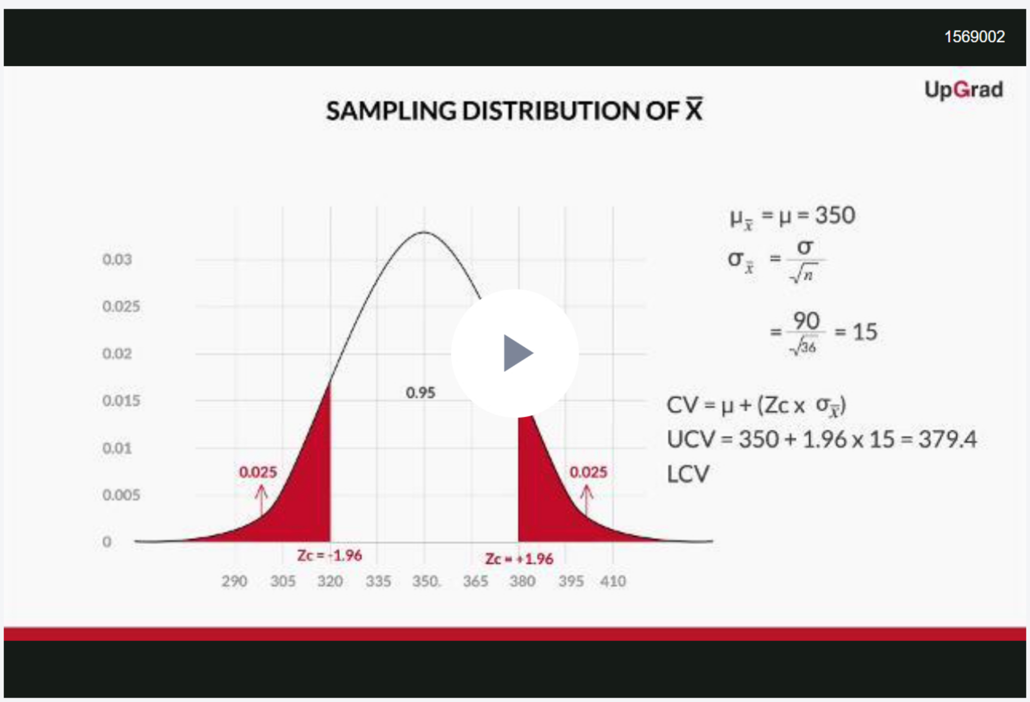
What will be the area of the critical region on the right-hand side of the distribution if the significance level (α) for a two-tailed test is 3%?

- 0.03
- 0.97
- 0.015 ✓ Correct

  Feedback:

  Here, value of α is 0.03 (of 3%), so the area of the rejection region would be 0.03 and the area of the acceptance region would be 0.97. In addition, since this is a two-tailed test, the area of the critical region on the right-hand side would be half of 0.03, i.e. 0.015.
- 0.985

Your answer is Correct. Attempt 1 of 2 Continue



After formulating the hypothesis, the steps you have to follow to **make a decision** using **the critical value method** are as follows:

1. Calculate the value of Zċ from the given value of α (significance level). Take it a 5% if not specified in the problem.
2. Calculate the critical values (UCV and LCV) from the value of Zċ.

3. Make the decision on the basis of the value of the sample mean x with respect to the critical values (UCV AND LCV).

You can download the z-table from the attachment below. It will be useful in the subsequent questions.

Z-table Download

Let's solve the following problem stepwise to consolidate your learning on how to make a decision about any hypothesis.

A manufacturer claims that the average life of its product is 36 months. An auditor selects a sample of 49 units of the product, and calculates the average life to be 34.5 months. The population standard deviation is 4 months. Test the manufacturer's claim at 3% significance level using the critical value method.

First, you need to **formulate the hypotheses** for this two-tailed test, which would be:

$$H_0: \mu = 36 \text{ months and } H_1: \mu \neq 36 \text{ months}$$

Now, you need to follow the three steps to **find the critical values and make a decision.**

Try out the three-step process by answering the following questions.

Question 3/3 Mandatory

Question 1	Incorrect	
Question 2	Correct	
Question 3	Correct	

1. First, you define a new quantity called α, which is also known as the significance level for the test. It refers to the proportion of the sample mean lying in the critical region. For this test, α is taken as 0.05 (or 5%).
2. Then, you calculate the cumulative probability of UCV from the value of α, which is further used to find the z-critical value (Zc) for UCV.

Attempt the following questions before you go ahead and learn the remaining steps in this method.

Question 2/3 Mandatory

Area of rejection region

What would be the area of the critical region on the right-hand side of the distribution if the significance level (α) for an upper-tailed test is 3%?

- 0.03 ✓ Correct

  Feedback:

  Here, the value of α is 0.03 (of 3%), so the area of the critical region would be 0.03 and the area of the acceptance region would be 0.97. Since this is an upper-tailed test, the critical region is only on the right-hand side of the distribution, and the area of the critical region would be 0.03.

- 0.97
- 0.015

0.03 and the area of the acceptance region would be 0.97. In this case, what would be the area of the critical region on the right-hand side if this is an upper-tailed test?

Your answer is Wrong. | Attempt 2 of 2 | Continue

After formulating the hypothesis, the steps you have to follow to **make a decision** using **the critical value method** are as follows:

1. Calculate the value of Zċ from the given value of α (significance level). Take it a 5% if not specified in the problem.
2. Calculate the critical values (UCV and LCV) from the value of Zċ.

1. First, you define a new quantity called α, which is also known as the significance level for the test. It refers to the proportion of the sample mean lying in the critical region. For this test, α is taken as 0.05 (or 5%).
2. Then, you calculate the cumulative probability of UCV from the value of α, which is further used to find the z-critical value (Zc) for UCV.

Attempt the following questions before you go ahead and learn the remaining steps in this method.

Question 3/3 Mandatory

Area of rejection region

What would be the value of the cumulative probability of UCV if the significance level (α) for an upper-tailed test is 3%?

- 0.03
- 0.97 ✓ Correct
  - Feedback:

    The area of the critical region in this case would be 0.03 (as calculated in the last question), which would be the area beyond the UCV point in the distribution. So, the area till the UCV point would be 1 - 0.03, i.e. 0.97. This would be the cumulative probability of that point, going by the definition of cumulative probability.

Standard Normal Probabilities

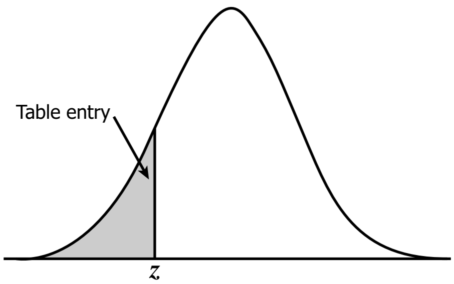


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

Standard Normal Probabilities

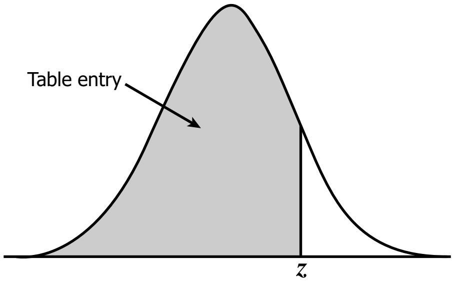


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.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
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Let's solve the following problem stepwise to consolidate your learning on how to make a decision about any hypothesis.

A manufacturer claims that the average life of its product is 36 months. An auditor selects a sample of 49 units of the product, and calculates the average life to be 34.5 months. The population standard deviation is 4 months. Test the manufacturer's claim at 3% significance level using the critical value method.

First, you need to **formulate the hypotheses** for this two-tailed test, which would be:

$$H_0: \mu = 36 \text{ months and } H_1: \mu \neq 36 \text{ months}$$

Now, you need to follow the three steps to **find the critical values and make a decision**.

Try out the three-step process by answering the following questions.

Question 1/3 Mandatory

Critical Value Method

1st step: Calculate the value of Zc from the given value of α (significance level).

Calculate the z-critical score for the two-tailed test at 3% significance level.

- 1.88
- 1.04 ✕ Incorrect
  - Feedback:
    For 3% significance level, you would have two critical regions on both sides with a total area of 0.03. So, the area of the critical region on the right side would be 0.015, which means that the area till UCV (cumulative probability of that point) would be 1 - 0.015 = 0.985. So, you need to find the z-score of 0.985.
- 2.965
- 2.17 ✓ Correct
  - Feedback:
    For 3% significance level, you would have two critical regions on both sides with a total area of 0.03. So, the area of the critical region on the right side would be 0.015, which means that the area till UCV (cumulative probability of that point) would be 1 - 0.015 = 0.985. So, you need to find the z-value of 0.985. The z-score for 0.9850 in the z-table is 2.17 (2.1 on the horizontal axis and 0.07 on the vertical axis).

Your answer is Wrong. Attempt 2 of 2 Continue

Let's solve the following problem stepwise to consolidate your learning on how to make a decision about any hypothesis.

A manufacturer claims that the average life of its product is 36 months. An auditor selects a sample of 49 units of the product, and calculates the average life to be 34.5 months. The population standard deviation is 4 months. Test the manufacturer's claim at 3% significance level using the critical value method.

First, you need to **formulate the hypotheses** for this two-tailed test, which would be:

H_0: μ = 36 months and H_1: $\mu \neq$ 36 months

Now, you need to follow the three steps to **find the critical values and make a decision**.

Try out the three-step process by answering the following questions.

Question 2/3

Mandatory

Critical Value Method

2nd step: Calculate the critical values (UCV and LCV) from the value of Zc.

Find out the UCV and LCV values for Zc = 2.17.

μ = 36 months σ = 4 months   n (Sample size) = 49

- (selected) UCV = 37.24 and LCV = 34.76 ✓ Correct

  Feedback:
  The critical values can be calculated from $\mu \pm Zc \times (\sigma/\sqrt{N})$ as $36 \pm 2.17(4/\sqrt{49}) = 36 \pm 1.24$ which comes out to be 37.24 and 34.76.

- UCV = 36.18 and LCV = 35.82
- UCV = 44.68 and LCV = 27.32
- UCV = 36.31 and LCV = 35.69

Your answer is Correct.   Attempt 2 of 2   Continue

Report an error

Let's solve the following problem stepwise to consolidate your learning on how to make a decision about any hypothesis.

A manufacturer claims that the average life of its product is 36 months. An auditor selects a sample of 49 units of the product, and calculates the average life to be 34.5 months. The population standard deviation is 4 months. Test the manufacturer's claim at 3% significance level using the critical value method.

First, you need to **formulate the hypotheses** for this two-tailed test, which would be:

$$H_0: \mu = 36 \text{ months and } H_1: \mu \neq 36 \text{ months}$$

Now, you need to follow the three steps to **find the critical values and make a decision**.

Try out the three-step process by answering the following questions.

Question 3/3

Mandatory

Critical Value Method

3rd step: Make the decision on the basis of the value of the sample mean $\bar{x}$ with respect to the critical values (UCV AND LCV).

What would be the result of this hypothesis test?

UCV = 37.24 months LCV = 34.76 months Sample mean ($\bar{x}$) = 34.5 months

- Fail to reject the null hypothesis
- Reject the null hypothesis ✓ Correct

Feedback:

The UCV and LCV values for this test are 37.24 and 34.76. The sample mean in this case is 34.5 months, which is less than LCV. So, this implies that the sample mean lies in the critical region and you can reject the null hypothesis.

- Can't say

Your answer is Correct.

Attempt 2 of 2

Continue

Report an error

Critical Value Method - Examples

You have learnt how to perform the three steps of the critical value method with the help of the AC sales problem as well as the above product lifecycle comprehension problem, which was a two-tailed test. But what would happen if it were a one-tailed test? Let's watch the video below to understand.

subsequent questions.

Z-table Download

Question 1/3 Mandatory

Critical Value Method

Consider this problem — H_0: $\mu \leq 350$ and H_1: $\mu > 350$

In case of a two-tailed test, you find the z-score of 0.975 in the z-table, since 0.975 was cumulative probability of UCV in that case. In this problem, what would be the cumulative probability of critical point in this example for the same significance level of 5%?

- 0.975
- 0.025
- 0.950 ✓ Correct

  Feedback:
  In this problem, the area of the critical region beyond the only critical point, which is on the right side, is 0.05 (in the last problem, it was 0.025). So, the cumulative probability of the critical point (the total area till that point) would be 0.950.
- 0.050

Comprehension

Government regulatory bodies have specified that the maximum permissible amount of lead in any food product is 2.5 parts per million or 2.5 ppm. Let's say you are an analyst working at the food regulatory body of India FSSAI. Suppose you take 100 random samples of Sunshine from the market and have them tested for the amount of lead. The mean lead content turns out to be 2.6 ppm with a standard deviation of 0.6.

One thing you can notice here is that the standard deviation of the sample is given as 0.6, instead of the population's standard deviation. In such a case, you can approximate the

against Sunshine or not, at 3% significance level.

Question 4/4

Mandatory

Question 1	Correct
Question 2	Correct
Question 3	Correct
Question 4	Incorrect

You can look at the solution of this comprehension from this video .

(**Note**: At 2:06, the sample size would be n instead of m while calculating critical value)

FREQUENTLY ASKED QUESTIONS (FAQ)

What exactly is the value of σ/√n?

Report an error

PREVIOUS
Critical Value Method

NEXT
Summary

Standard Normal Probabilities

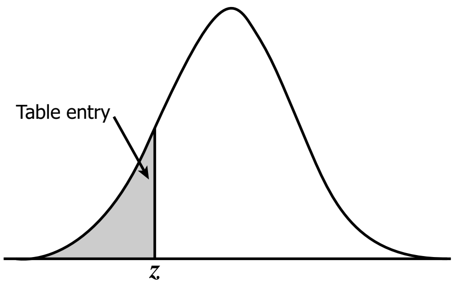


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
–3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
–3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
–3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
–3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
–3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
–2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
–2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
–2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
–2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
–2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
–2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
–2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
–2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
–2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
–2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
–1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
–1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
–1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
–1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
–1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
–1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
–1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
–1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
–1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
–1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
–0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
–0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
–0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
–0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
–0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
–0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
–0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
–0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
–0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
–0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

Standard Normal Probabilities

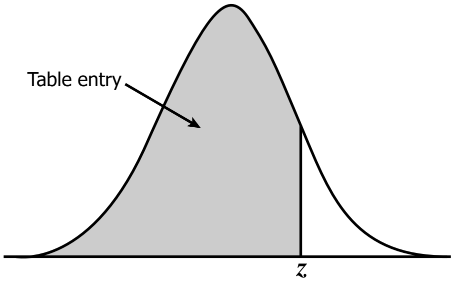


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.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
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

subsequent questions.

Z-table Download

Question 2/3 Mandatory

Critical Value Method

Consider this problem — H_0: $\mu \le 350$ and H_1: $\mu > 350$

The next step would be to find the Zc, which would basically be the z-score for the value of 0.950. Look at the z-table and find the value of Zc.

- 1.64
- 1.645 ✓ Correct

  Feedback:

  0.950 is not there in the z-table. So, look for the numbers nearest to 0.950. You can see that the z-score for 0.9495 is 1.64 (1.6 on the horizontal bar and 0.04 on the vertical bar), and the z-score for 0.9505 is 1.65. So, taking the average of these two, the z-score for 0.9500 is 1.645.
- 1.65
- 1.96

Continue

subsequent questions.

Z-table Download

Question 3/3 Mandatory

Critical Value Method

Consider this problem, H_0: μ ≤ 350 and H_1: μ > 350

So, the Zc comes out to be 1.645. Now, find the critical value for the given Zc and make the decision to accept or reject the null hypothesis.

μ = 350 σ = 90 N (Sample size) = 36 $\bar{x}$= 370.16

- Critical value = 374.67 and Decision = Reject the null hypothesis
- Critical value = 326.25 and Decision = Reject the null hypothesis
- Critical value = 374.67 and Decision = Fail to reject the null hypothesis ✓ Correct

  Feedback:

  The critical value can be calculated from μ + Zc x (σ/$\sqrt{N}$). 350 + 1.645(90/$\sqrt{36}$) = 374.67. Since 370.16 ($\bar{x}$) is less than 374.67, $\bar{x}$ lies in the acceptance region and you fail to reject the null hypothesis.
- Critical value = 326.25 and Decision = Fail to reject the null hypothesis

against Sunshine or not, at 3% significance level.

Question 1/4

Mandatory

Critical Value Method

Select the correct null and alternate hypotheses in this case.

- H_0: Average lead content ≤ 2.6 ppm and H_1: Average lead content > 2.6 ppm

- H_0: Average lead content ≤ 2.5 ppm and H_1: Average lead content > 2.5 ppm ✓ Correct
  - Feedback:
    The null hypothesis is your assumption about the population — it is based on the status quo. It always makes an argument about the population using the equality sign. The null hypothesis in this case would be that the average lead content in the food material is less than or equal to 2.5 ppm. And the alternate hypothesis is that the average lead content is greater than 2.5 ppm.

- H_0: Average lead content ≥ 2.6 ppm and H_1: Average lead content < 2.6 ppm

- H_0: Average lead content ≥ 2.5 ppm and H_1: Average lead content < 2.5 ppm

Continue

against Sunshine or not, at 3% significance level.

Question 2/4 Mandatory

Critical Value Method

Calculate the z-critical score for this test at 3% significance level.

- 1.88 ✓ Correct
  - Feedback:
    This is a one-tailed test. So, for 3% significance level, you would have only one critical region on the right side with a total area of 0.03. This means that the area till the critical point (the cumulative probability of that point) would be 1 - 0.030 = 0.970. So, you need to find the z-value of 0.970. The z-score for 0.9699 (~0.970) in the z-table is 1.88.
- 1.555
- 2.965
- 2.17

Your answer is Correct. Attempt 2 of 2 Continue

against Sunshine or not, at 3% significance level.

Question 3/4 Mandatory

Critical Value Method

Now, you need to find out the critical values and make a decision on whether to raise a regulatory alarm against Sunshine or not. Select the correct option.

- Critical value = 2.61 ppm and Decision: Raise a regulatory alarm
- Critical value = 2.63 ppm and Decision: Raise a regulatory alarm
- Critical value = 2.61 ppm and Decision: Don't raise a regulatory alarm ✓ Correct
  - Feedback:
    The critical value can be calculated from μ + Zc x (σ/$\sqrt{N}$), as 2.5 + 1.88(0.6 /$\sqrt{100}$) = 2.61 ppm . You need to use the + sign since the critical value is on the right-hand side (upper-tailed test). Since the sample mean 2.6 ppm is less than the critical value (2.61 ppm), you fail to reject the null hypothesis and don't raise a regulatory alarm against Sunshine.
- Critical value = 2.63 ppm and Decision: Don't a raise a regulatory alarm

Your answer is Correct. Attempt 2 of 2 Continue

subsequent questions.

Z-table Download

Question 3/3 Mandatory

Critical Value Method

Consider this problem, H_0: μ ≤ 350 and H_1: μ > 350

So, the Zc comes out to be 1.645. Now, find the critical value for the given Zc and make the decision to accept or reject the null hypothesis.

μ = 350 σ = 90 N (Sample size) = 36 $\bar{x}$= 370.16

- Critical value = 374.67 and Decision = Reject the null hypothesis
- Critical value = 326.25 and Decision = Reject the null hypothesis
- Critical value = 374.67 and Decision = Fail to reject the null hypothesis ✓ Correct

  Feedback:

  The critical value can be calculated from μ + Zc x (σ/$\sqrt{N}$). 350 + 1.645(90/$\sqrt{36}$) = 374.67. Since 370.16 ($\bar{x}$) is less than 374.67, $\bar{x}$ lies in the acceptance region and you fail to reject the null hypothesis.
- Critical value = 326.25 and Decision = Fail to reject the null hypothesis

Summary

So what did you learn in this session?

1. Hypothesis — a claim or an assumption that you make about one or more population parameters
2. Types of hypothesis:
    1. **Null hypothesis** (H_0) - Makes an assumption about the status quo
       - Always contains the symbols '=', '≤' or '≥'
    2. **Alternate hypothesis** (H_1) - Challenges and complements the null hypothesis
       - Always contains the symbols '≠', '<' or '>'
3. Types of tests:
    1. **Two-tailed test** - The critical region lies on both sides of the distribution
       - The alternate hypothesis contains the ≠ sign
    2. **Lower-tailed test** - The critical region lies on the left side of the distribution
       - The alternate hypothesis contains the < sign
    3. **Upper-tailed test** - The critical region lies on the right side of the distribution
       - The alternate hypothesis contains the > sign
4. Making a decision - Critical value method:
    1. Calculate the value of Zc from the given value of α (significance level)

to the critical values (UCV AND LCV)

Report an error

PREVIOUS
Critical Value Method - Examples

NEXT
Graded Questions

Graded Questions

Question 1/3 Mandatory

Types of hypotheses

The null and alternative hypotheses are statements about:

- Population parameters ✓ Correct

  Feedback:
  The hypothesis is always made about the population parameters. The sample parameters are only used as evidence to test the hypothesis.

- Sample parameters
- Population parameters or sample parameters

Your answer is Correct. Attempt 1 of 2 Continue

Graded Questions

Question 2/3 Mandatory

Null and Alternate Hypotheses

A house owner claims that the current market value of his house is at least Rs.40,00,000. 60 real estate agents are asked independently to estimate the house's value. The hypothesis test that is conducted ends with the decision of "reject H_0". Which of the following statements accurately states the conclusion?

- The house owner is right, the house is worth Rs. 40,00,000
- The house owner is right, the house is worth less than Rs. 40,00,000
- The house owner is wrong, the house is worth less than Rs. 40,00,000 ✓ Correct

Feedback:

Rejection of the null hypothesis means rejection of the status quo or the earlier assumption of the house owner that his house is worth at least Rs. 40,00,000. As the null hypothesis is H_0: House market value ≥ 40,00,000, the alternate hypothesis would be opposite of that.

Graded Questions

Question 3/3 Mandatory

Null and Alternate Hypotheses

Which of the following options hold true for null hypothesis?

More than one option may be correct.

- [ ] The claim with only the “less than” sign

- [ ] The claim with the “less than or equal to” sign ✓ Correct

  Feedback:
  The null hypothesis is always written with the “equal to” or “less than or equal to” or “more than or equal to” sign.

- [ ] The claim with the “equal to” sign ✓ Correct

  Feedback:
  The null hypothesis is always written with the “equal to” or “less than or equal to” or “more than or equal to” sign.

Graded Questions

Question 3/3

Mandatory

Null and Alternate Hypotheses

Which of the following options hold true for null hypothesis?

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- [ ] The claim with only the “less than” sign

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- [ ] The claim with the “equal to” sign ✓ Correct

  Feedback:
  The null hypothesis is always written with the “equal to” or “less than or equal to” or “more than or equal to” sign.

Cadbury states that the average weight of one of its chocolate products 'Dairy Milk Silk' is 60 g. As an analyst on the internal Quality Assurance team, you would like to test whether, at the 2% significance level, the average weight is 60 g or not. A sample of 100 chocolates is collected and the sample mean size is calculated to be 62.6 g. The sample standard deviation, as calculated from the sample, is 10.7 g.

Answer the following questions in order to draw a conclusion from the test.

Question 1/2 Mandatory

Critical Value Method

What would be the Zc for the critical point/s in this case?

2.33 ✓ Correct

- Feedback:
  For a 2% significance level, you would have two critical regions on both sides with a total area of 0.02 (because you want to test if the average weight of the chocolate is greater than or less than 60 g). So, the area of the critical region on the right side would be 0.01, which means that the area till UCV (cumulative probability of that point) would be 1 - 0.01 = 0.99. So, you need to find the z-value of 0.99. The z-score for 0.9901 in the z-table is 2.33 (2.3 on the horizontal axis

3.30

3.10

Your answer is Correct.

Attempt 1 of 2

Continue

The water purifier company Kent claims that the total hardness of the water after being treated and filtered by its product Kent RO is less than 300 ppm on an average. To test the claim, a water inspector takes a sample of 400 purifiers and calculates the mean total hardness of water being filtered out, which comes out to be 296 ppm, with a standard deviation of 25 ppm. The hypothesis test is to be conducted at a significance level of 3%.

Now answer the following questions.

Question 3/3

Mandatory

Question 1	Incorrect
Question 2	Correct
Question 3	Incorrect

Question 1	Correct	
Question 2	Correct	

Report an error

PREVIOUS
Summary

FINISH SESSION
Graded Questions

Graded Questions

Question 3/3 Mandatory

Null and Alternate Hypotheses

Which of the following options hold true for null hypothesis?

More than one option may be correct.

- [ ] The claim with only the “less than” sign
- [x] The claim with the “less than or equal to” sign ✓ Correct

  Feedback:
  The null hypothesis is always written with the “equal to” or “less than or equal to” or “more than or equal to” sign.

- [x] The claim with the “equal to” sign ✓ Correct

  Feedback:
  The null hypothesis is always written with the “equal to” or “less than or equal to” or “more than or equal to” sign.

- [ ] The claim with the “not equal to” sign

Your answer is Correct. Attempt 1 of 2 Continue

Cadbury states that the average weight of one of its chocolate products ‘Dairy Milk Silk’ is 60 g. As an analyst on the internal Quality Assurance team, you would like to test whether, at the 2% significance level, the average weight is 60 g or not. A sample of 100 chocolates is collected and the sample mean size is calculated to be 62.6 g. The sample standard deviation, as calculated from the sample, is 10.7 g.

Answer the following questions in order to draw a conclusion from the test.

Question 2/2 Mandatory

Critical Value Method

Find out the critical values for this test and conclude whether the QA team can safely pass this test or not.

- UCV = 62.49 g, LCV = 57.51 g and Result = Pass the test
- UCV = 62.49 g, LCV = 57.51 g and Result = Don't pass the test ✓ Correct

  Feedback:
  The critical values can be calculated from μ ± Zc x $(\sigma/\sqrt{N})$ as 60g ± 2.33(10.7 / $\sqrt{100}$) = 60g ± 2.49g which comes out to be 62.49 g and 57.51 g. Since 62.6 g is greater than the UVC of 62.49, which means the sample mean lies outside the range of the critical values, you reject the null hypothesis that the average weight of the chocolate is 60 g. So, the QA would not pass this test.
- UCV = 62.18 g, LCV = 57.82 g and Result = Pass the test
- UCV = 62.18 g, LCV = 57.82 g and Result = Don't pass the test ✗ Incorrect

  Feedback:
  The critical values can be calculated from μ ± Zc x $(\sigma/\sqrt{N})$. If 62.6 g lies between the critical values, you can safely pass this test; otherwise, you cannot.

Your answer is Wrong. | Attempt 2 of 2 | Continue >

The water purifier company Kent claims that the total hardness of the water after being treated and filtered by its product Kent RO is less than 300 ppm on an average. To test the claim, a water inspector takes a sample of 400 purifiers and calculates the mean total hardness of water being filtered out, which comes out to be 296 ppm, with a standard deviation of 25 ppm. The hypothesis test is to be conducted at a significance level of 3%.

Now answer the following questions.

Question 3/3 Mandatory

Question 1	Incorrect
Question 2	Correct
Question 3	Incorrect

Question 2/2 Mandatory

Question 1	Correct
Question 2	Correct

Question 1/3 Mandatory

Hypothesis Definition and Critical Region

What would be the null/alternate hypotheses in this case and where would the critical region lie?

H_0: $\mu \geq 300$ ppm and H_1: $\mu < 300$ ppm; Critical region lies on the left side of the tail ✓ Correct

Feedback:

Observe that the claim statement has a less than sign associated with it. Thus the null hypothesis would be the complement of it. And the alternate hypothesis would be the claim statement itself. Once you formulate the null and alternate hypothesis,i.e. H_0: $\mu \geq 300$ ppm and H_1: $\mu < 300$ ppm, it is easy to see that the critical region would lie on the left side of the tail since the alternate hypothesis has a $<$ sign associated with it.

H_0: $\mu < 300$ ppm and H_1: $\mu \geq 300$ ppm; Critical region lies on the left side of the tail ✗ Incorrect

Feedback:

First, you need to observe the sign associated with the claim statement and decide what would be the null and the alternate hypothesis. Then, you need to check the sign associated with the alternate hypothesis to decide the position of the critical region.

Question 2/3

Mandatory

Critical Value and Final Decision

What would be the Zc for this case?

- -1.65
- -1.96
- -1.88 ✓ Correct

  Feedback:
  From the significance level = 3 % we get the area of the critical region to be 0.03. Now this region would lie on the left side of the tail. Thus we have P(Z<Zc)= 0.03. From the table, we get the value of Zc = -1.88

- 1.88

Your answer is Correct. Attempt 2 of 2 Continue

Question 3/3 Mandatory

Critical Value and Final Decision

What would be the critical value and the final decision to be made here?

- 292.33; Reject the null hypothesis

- 297.65; Reject the null hypothesis ✓ Correct

  Feedback:

  You need to calculate the critical value from the Zc calculated in the previous question. Here you get the value of Zc as -1.88. Now critical value is 300 - 1.88*1.25 = 297.65 runs. Observe that 296 falls in the critical region. Hence you need to reject the null hypothesis in this case.

- 298.75; Fail to reject the null hypothesis

- 301.22; Fail to reject the null hypothesis ✗ Incorrect

  Feedback:

  You need to calculate the critical value from the Zc calculated in the previous question. Here you get the value of Zc as -1.88. So what would be the critical value in this case? Does the given sample mean lie in the critical region or not?

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Question 1/2 Mandatory

Null and Alternate Hypotheses

A weather forecast agency predicts that the average rainfall this year will be more than 800mm. Determine the null and alternate hypotheses along with the type of test.

$H_0 : Average\ rainfall = 800mm, H_1 : Average\ rainfall \neq 800mm$
$Test\ type : Two - tailed\ \ test$

$H_0 : Average\ rainfall \leq 800mm, H_1 : Average\ rainfall \geq 800mm$
$Test\ type : Lower - tailed\ \ test$

$H_0 : Average\ rainfall \geq 800mm, H_1 : Average\ rainfall < 800mm$
$Test\ type : Two - tailed\ \ test$

$H_0 : Average\ rainfall \leq 800mm, H_1 : Average\ rainfall > 800mm$
$Test\ type : Upper - tailed\ \ test$

✓ Correct

Feedback:
Since the critical region lies on the right side, the test type will be the upper-tailed test. The null and alternate hypotheses are self-explanatory.

Your answer is Correct.

Attempt 2 of 2

Continue

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Question 2/2 Mandatory

Null and Alternate Hypotheses

Suppose the average weight of a sedan is 1300 kgs. A researcher claims that SUVs are, on average, more than 200 kgs heavier than sedans. What is the null hypothesis, and what kind of test is this?

- $H_0 : \mu <= 1500$. This is a lower-tailed test.
- $H_0 : \mu <= 1500$. This is an upper-tailed test. ✓ Correct

  Feedback:

  The researcher claims that SUVs are more than 200 kgs heavier than sedans. In other words, he claims that SUVs are weigh more than 1500 kgs. Therefore, the alternate hypothesis becomes $H_1 : \mu > 1500$. Hence, this becomes an upper-tailed test. And, the null hypothesis is $H_0 : \mu <= 1500$.
- $H_0 : \mu <= 1300$. This is an upper-tailed test.
- $H_0 : \mu > 1500$. This is an upper-tailed test.

Your answer is Correct. Attempt 1 of 2 Continue

The p-Value Method

Let’s get started with the p-value method of making a decision.

Prof. Tricha has defined **p-value** as the **probability that the null hypothesis** will not be rejected. This statement is not the technical (or formal) definition of p-value; it is used for better understanding of the p-value.

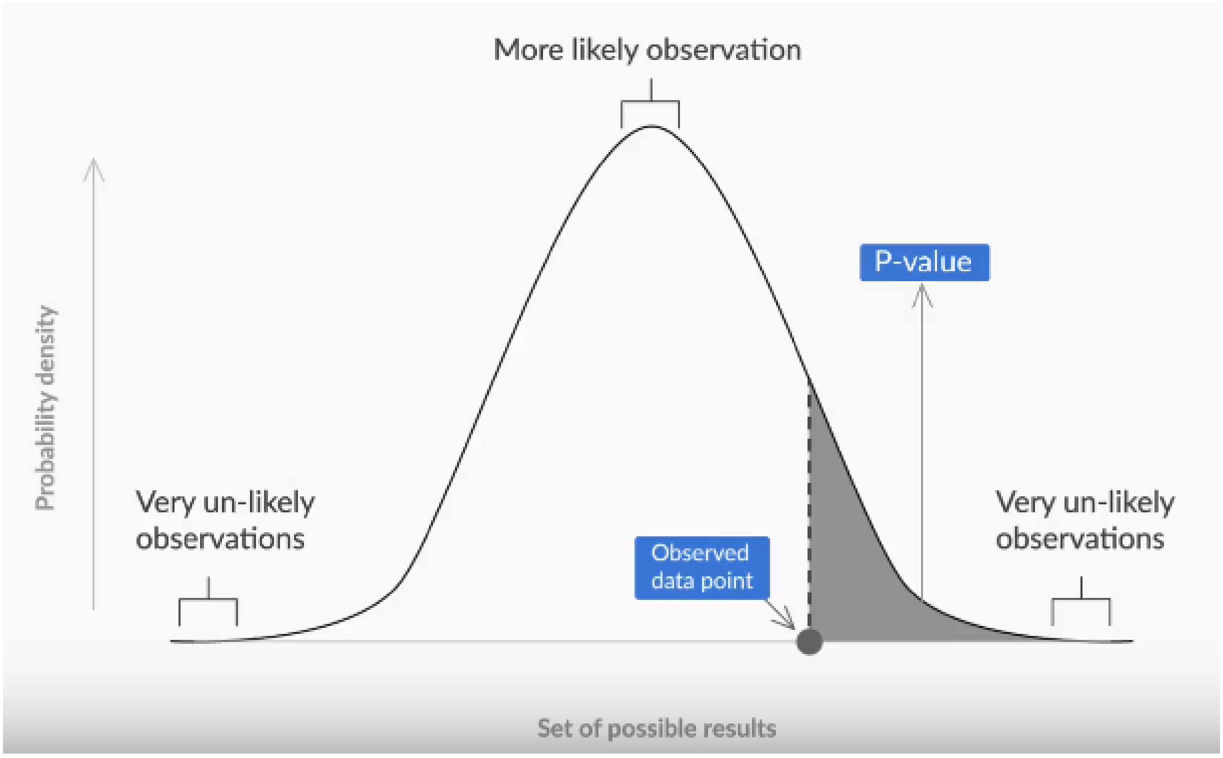

Figure 1 -Interpretation of p-value

After formulating the null and alternate hypotheses, the steps to follow in order to **make a decision** using the **p-value method** are as follows:

1. Calculate the value of the z-score for the sample mean point on the distribution.
2. Calculate the p-value from the cumulative probability for the given z-score using the z-table.
3. Make a decision on the basis of the p-value (multiply it by 2 for a two-tailed test) with respect to the given value of α (significance value).

To find the correct p-value from the z-score, find the **cumulative probability** first, by simply looking at the z-table, which gives you the area under the curve till that point.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
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
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Figure 2 - z-table for positive z-scores

Cumulative probability of the sample point = 0.9987

For a one-tailed test: p = 1 - 0.9987 = 0.0013

For a two-tailed test: p = 2 (1 - 0.9987) = 2 * 0.0013 = 0.0026

Situation 2: The sample mean is on the left side of the distribution mean (the z-score is negative).

Example: The z-score for the sample point = -3.02

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026

Figure 3 - z-table for negative z-scores

You can download the z-table from the attachment below. It will be useful in the subsequent questions.

Z-table Download

Let's solve the following problem stepwise to consolidate your learning on how to make a decision about any hypothesis using the p-value method.

You are working as a data analyst at an auditing firm. A manufacturer claims that the average life of its product is 36 months. An auditor selects a sample of 49 units of the product and calculates the average life to be 34.5 months. The population standard deviation is 4 months. Test the manufacturer's claim at a 3% significance level using the p-value method.

First, **formulate the hypotheses** for this two-tailed test, which would be:

$$H_0: \mu = 36 \text{ months and } H_1: \mu \neq 36 \text{ months}$$

Now, you need to follow the three steps to **find the p-value and make a decision**.

Try out the three-step process by answering the following questions.

Question 1		Incorrect	>
Question 2		Incorrect	>
Question 3	✓	Correct	>

You learnt how to perform the three steps of the p-value method through the AC sales problem as well as the product life cycle comprehension problem given above.

FREQUENTLY ASKED QUESTIONS (FAQ)

- Does p-value signify a probability for the null hypothesis?
- I am confused about how to calculate the standard deviation in the case where the sample's standard deviation is already given.

Report an error

NEXT
The p-Value Method: Examples

The p-Value Method

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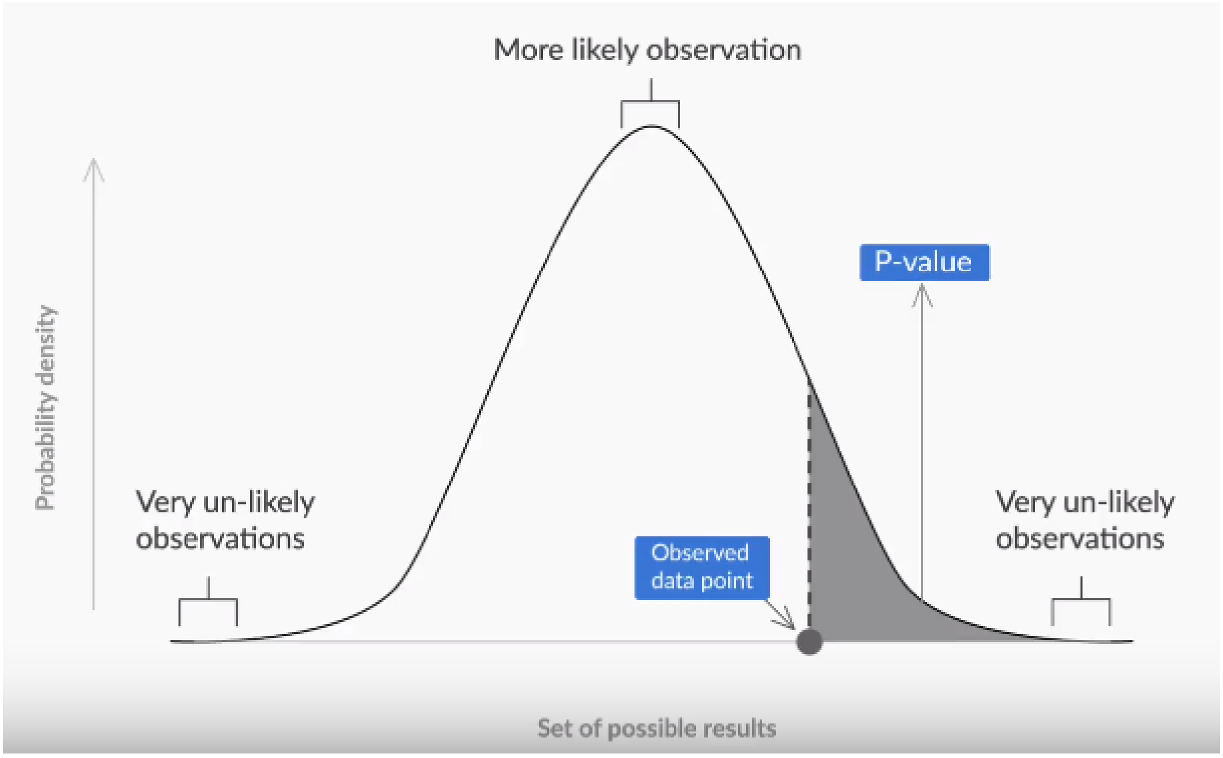

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3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

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Example: The z-score for the sample point = -3.02

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
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Question 1	Incorrect	
Question 2	Incorrect	
Question 3	Correct	

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I am confused about how to calculate the standard deviation in the case where the sample's standard deviation is already given.

Report an error

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The p-Value Method: Examples

The p-Value Method

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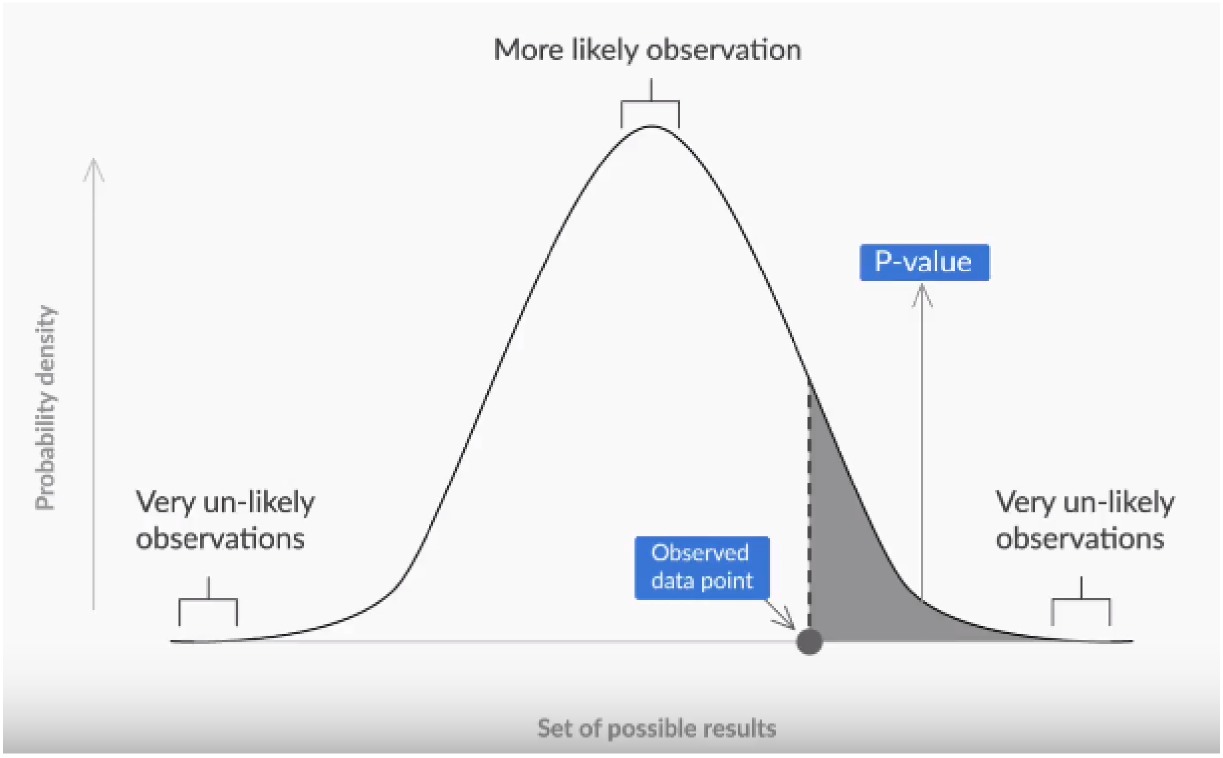

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3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

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Cumulative probability of the sample point = 0.9987

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For a two-tailed test: p = 2 (1 - 0.9987) = 2 * 0.0013 = 0.0026

Situation 2: The sample mean is on the left side of the distribution mean (the z-score is negative).

Example: The z-score for the sample point = -3.02

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026

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You are working as a data analyst at an auditing firm. A manufacturer claims that the average life of its product is 36 months. An auditor selects a sample of 49 units of the product and calculates the average life to be 34.5 months. The population standard deviation is 4 months. Test the manufacturer's claim at a 3% significance level using the p-value method.

First, **formulate the hypotheses** for this two-tailed test, which would be:

H_0: μ = 36 months and H_1: $\mu \neq$ 36 months

Now, you need to follow the three steps to **find the p-value and make a decision**.

Try out the three-step process by answering the following questions.

The p-Value Method

Step 1: Calculate the value of the z-score for the sample mean point of the distribution. Calculate the z-score for the sample mean ($\bar{x}$) = 34.5 months.

0.86

-0.86 ✕ Incorrect

Feedback:
Calculate the z-score using the formula: z-score = ($\bar{x}$ - μ)/(σ/$\sqrt{n}$).

2.62

-2.62 ✓ Correct

Feedback:
You can calculate the z-score for the sample mean of 34.5 months using the formula: ($\bar{x}$ - μ)/(σ/$\sqrt{n}$). This gives you (34.5 - 36)/(4/$\sqrt{49}$) = (-1.5) * 7/4 = -2.62. Notice that since the sample mean lies on the left side of the hypothesised mean of 36 months, the z-score comes out to be negative.

Your answer is Wrong. Attempt 2 of 2 Continue

FREQUENTLY ASKED QUESTIONS (FAQ)

Does p-value signify a probability for the null hypothesis?

I am confused about how to calculate the standard deviation in the case where the sample's standard deviation is already given.

Report an error

NEXT
The p-Value Method: Examples

The p-Value Method

Step 2: Calculate the p-value from the cumulative probability for the given z-score using the z-table.

Find out the p-value for a z-score of -2.62 (corresponding to the sample mean of 34.5 months).

Hint: The sample mean is on the left side of the distribution, and it is a two-tailed test.

0.0044 ✕ Incorrect

Feedback:

Check out the value in the z-table corresponding to -2.6 on the vertical axis and 0.02 on the horizontal axis. This would give you the cumulative area until the sample mean point. As the sample mean is on the left-hand side, don't subtract it from 1. If it is a two-tailed test, double the cumulative value to get the p-value.

0.9956

0.0088 ✓ Correct

Feedback:

The value in the z-table corresponding to -2.6 on the vertical axis and 0.02 on the horizontal axis is 0.0044. Since the sample mean is on the left side of the distribution and this is a two-tailed test, the p-value would be 2 * 0.0044 = 0.0088.

1.9912

The p-Value Method

Step 3: Make the decision on the basis of the p-value with respect to the given value of α (significance value).

What would the result of this hypothesis test be?

- Fail to reject the null hypothesis
- Reject the null hypothesis ✓ Correct

Feedback:

Here, the p-value comes out to be 2 * 0.0044 = 0.0088. Since the p-value is less than the significance level (0.0088 < 0.03), you reject the null hypothesis that the average lifespan of the manufacturer's product is 36 months.

Your answer is Correct. Attempt 1 of 1 Continue

You learnt how to perform the three steps of the p-value method through the AC sales problem as well as the product life cycle comprehension problem given above.

FREQUENTLY ASKED QUESTIONS (FAQ)

- Does p-value signify a probability for the null hypothesis?
- I am confused about how to calculate the standard deviation in the case where the sample's standard deviation is already given.

Solve the following questions in order to find the answers to the questions stated above.

One thing you can notice here is that the standard deviation of the sample of 900 is given as 110 instead of the population standard deviation. In such a case, you can **assume the population standard deviation to be the same as the sample standard deviation, which is 110 in this case**.

Question 2/3 Mandatory

The p-Value Method

Find out the p-value for the Z-score of 2.73 (corresponding to the sample mean of 510 mg).

- 0.0032
- 0.0064 ✓ Correct

  - Feedback:
    The value in the Z-table corresponding to 2.7 on the vertical axis and 0.03 on the horizontal axis is 0.9968. Since the sample mean is on the right side of the distribution and this is a two-tailed test (because we want to test whether the value of the paracetamol is too low or too high), the p-value would be 2 * (1 - 0.9968) = 2 * 0.0032 = 0.0064.

Solve the following questions in order to find the answers to the questions stated above.

One thing you can notice here is that the standard deviation of the sample of 900 is given as 110 instead of the population standard deviation. In such a case, you can **assume the population standard deviation to be the same as the sample standard deviation, which is 110 in this case**.

Question 3/3 Mandatory

The p-Value Method

Based on this hypothesis test, what decision would you make about the manufacturing process?

- The manufacturing process is completely fine and need not be changed.
- The manufacturing process is not fine, and changes need to be made. ✓ Correct
  - Feedback:
    Here, the p-value comes out to be 0.0064. Here, the p-value is less than the significance level (0.0064 < 0.05) and a smaller p-value gives you greater evidence against the null hypothesis. So, you reject the null hypothesis that the

Here's another exercise set to consolidate your learning.

A nationwide survey claimed that the unemployment rate of a country is at least 8%. However, the government claimed that the survey was wrong and the unemployment rate is less than that. The government asked about 36 people, and the unemployment rate came out to be 7%. The population standard deviation is 3%.

Question 1/4

Mandatory

Null and Alternative Hypotheses

What are the null and alternative hypotheses in this case?

- $H_0 : \mu \geq 8\% \; and \; H_1 : \mu < 8\%$ ✓ Correct
- $H_0 : \mu \leq 8\% \; and \; H_1 : \mu > 8\%$
- $H_0 : \mu > 8\% \; and \; H_1 : \mu \leq 8\%$

Here's another exercise set to consolidate your learning.

A nationwide survey claimed that the unemployment rate of a country is at least 8%. However, the government claimed that the survey was wrong and the unemployment rate is less than that. The government asked about 36 people, and the unemployment rate came out to be 7%. The population standard deviation is 3%.

Question 2/4

Mandatory

Z-Score of the Sample Mean

Based on the information above, conduct a hypothesis test at a 5% significance level using the p-value method. What is the Z-score of the sample mean point $\bar{x}$ = 7%?

- -0.2
- 2.0
- -2.0 ✓ Correct

Feedback:

Here's another exercise set to consolidate your learning.

A nationwide survey claimed that the unemployment rate of a country is at least 8%. However, the government claimed that the survey was wrong and the unemployment rate is less than that. The government asked about 36 people, and the unemployment rate came out to be 7%. The population standard deviation is 3%.

Question 3/4 Mandatory

p-Value of the Z-Score

Calculate the p-value from the cumulative probability for the given Z-score using the Z-table. In other words, find out the p-value for the Z-score of -2.0 (corresponding to the sample mean of 7%).

- 0.9772
- 0.0228 ✓ Correct

Feedback:
The p-value corresponding to a Z-score of -2.0 is 0.0228.

Here's another exercise set to consolidate your learning.

A nationwide survey claimed that the unemployment rate of a country is at least 8%. However, the government claimed that the survey was wrong and the unemployment rate is less than that. The government asked about 36 people, and the unemployment rate came out to be 7%. The population standard deviation is 3%.

Question 4/4 Mandatory

Making a Decision

Make the decision on the basis of the p-value with respect to the given value of α (significance value).

- You reject the null hypothesis because the p-value is less than 0.05. ✓ Correct

  Feedback:
  Since the p-value of the Z-score of the sample mean is less than the given p-value of 0.05, we reject the null hypothesis $H_0 : \mu \geq 8\%$.

- You fail to reject the null hypothesis because the p-value is less than 0.05.

Types of Errors

While doing hypothesis testing, there is always a possibility of making the wrong decision about your hypothesis; such instances are referred to as 'errors'. Let's learn about the different types of errors in hypothesis testing.

There are two types of errors that you might make in the hypothesis testing process: type-I error and type-II error.

	is true	is false
We decide to reject the null hypothesis	Type I error (rejecting a true null hypothesis) α	Correct decision
We fail to reject the null hypothesis	Correct decision	Type II error (failing to reject a false null hypothesis) β

Figure 1 - Types of errors

A **type I-error**, represented by α, occurs when you reject a true null hypothesis.

A **type-II error**, represented by β, occurs when you fail to reject a false null hypothesis.

The power of any hypothesis test is defined by $1 - \beta$. The power of the test or the calculation of β is beyond the scope of this course. You can study more about the power of a test at this link.

If you go back to the analogy of the **criminal trial example**, you would find that the probability of making a type-I error is more if the jury convicts the accused even on less substantial evidence. The probability of a type-I error can be reduced if the jury follows more stringent criteria to convict an accused party.

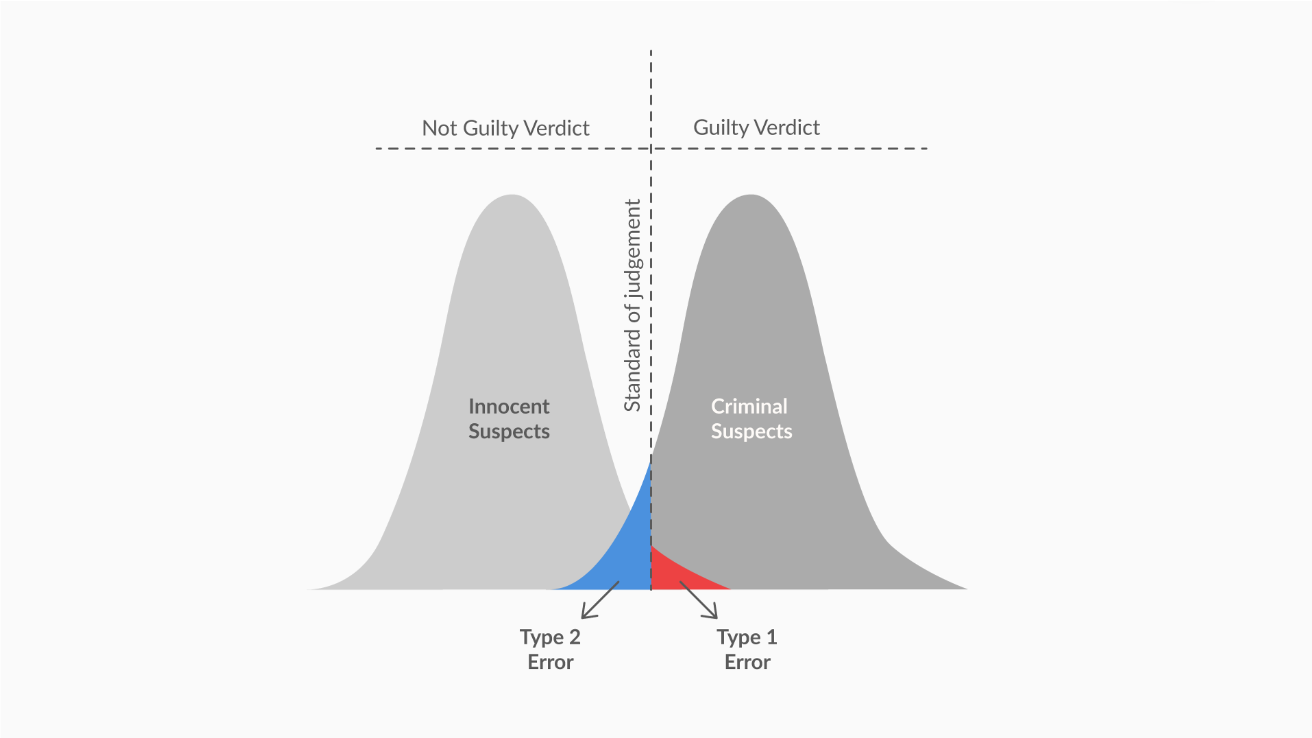

Figure 2 -Two types of errors in criminal trial example

Question 1/2 Mandatory

Errors in Hypothesis Testing

Mark all the correct options below.

- [ ] A type-I error occurs when a true null hypothesis is rejected. ✓ Correct

  Feedback:

  A type-I error occurs when the null hypothesis is true (i.e., the sample mean lies in the acceptance region) but you incorrectly reject it.

fact, correct.

A type II error occurs when the null hypothesis is not rejected when it is, in fact, incorrect. ✓ Correct

Feedback:

A type-II error occurs when the null hypothesis is not true (i.e., the sample mean lies in the critical region) but you incorrectly fail to reject it.

Your answer is Correct. Attempt 1 of 2 Continue

Report an error

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beyond the scope of this course. You can study more about the power of a test at this link.

If you go back to the analogy of the **criminal trial example**, you would find that the probability of making a type-I error is more if the jury convicts the accused even on less substantial evidence. The probability of a type-I error can be reduced if the jury follows more stringent criteria to convict an accused party.

However, reducing the probability of a type-I error may increase the probability of making a type-II error. If the jury becomes very liberal in acquitting people on trial, there is a higher probability of an actual criminal walking free.

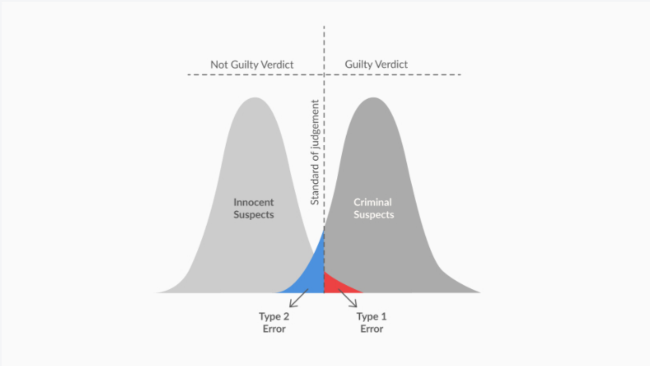

Figure 2 -Two types of errors in criminal trial example

Question 2/2 Mandatory

Types of Errors

Suppose the null hypothesis is that a particular new process is as good as or better than the old one. A type-I error would conclude that ___.

- The old process is as good as or better than the new one when, in fact, it is not.
- The old process is better than the new one when it really is so.
- The old process is better than the new one when, in fact, it is not. ✓ Correct

  Feedback:
  A type-I error refers to incorrectly rejecting a true null hypothesis. So, a type-1 error means that the null hypothesis is true, i.e., the new process is as good as or better than the old one, but you reject it, i.e., you conclude that the old process is better.

- The new process is as good as or better than the new one when it really is so.

Your answer is Correct. Attempt 2 of 2 Continue

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Summary

So, what did you learn in this session?

1. Making a decision using the p-value method, which involves the following steps:

- Calculate the value of the Z-score for the sample mean point of the distribution.
- Calculate the p-value from the cumulative probability of the given Z-score using the Z-table.
- Make a decision on the basis of the p-value with respect to the given value of α (significance level).

2. Types of errors:

- **Type-I error:** This occurs when you reject a true null hypothesis. Its probability is represented by α.
- **Type-II error:** This occurs when you fail to reject a false null hypothesis. Its probability is represented by β.

Let's quickly recap the first two sessions in this video.

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Question 1/1 Mandatory

The p-Value Method

Suppose you are conducting a hypothesis test where the sample size is 49. Now, you want to conduct another hypothesis test on a different sample, where the sample size is 121. The p-value calculated in the first case comes out to be 0.0512. What will happen to the p-value in the second case if you observe the same values for the sample mean and the sample standard deviation for both the cases?

- It will increase.
- It will decrease. ✓ Correct
  - Feedback:
    With an increase in the sample size, the denominator of the Z-score decreases, and thus, the absolute value of Z-score increases, which means that the sample mean would move away from the central tendency towards the tails. This means that the p-value would actually decrease. Conceptually, increasing the sample size will make the distribution of the sample means narrower, and chances of the sample mean falling in the critical region increase. So, the p-value will decrease.
- It will stay the same.

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Your answer is Correct. Attempt 2 of 2 Continue

Question 2/2

Mandatory

Question 1	Correct
Question 2	Correct

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Question 1/1 Mandatory

Question 1 Correct

Question 1/2 Mandatory

Types of Errors

Consider the null hypothesis that a process produces no more than the maximum permissible rate of defective items. In this situation, a type-II error would be ___.

- To conclude that the process does not produce more than the maximum permissible rate of defective items when it actually does not.
- To conclude that the process produces more than the maximum permissible rate of defective items when it actually does.
- To conclude that the process produces more than the maximum

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the maximum permissible rate of defective items when it actually does.

- Feedback:

  A type-II error refers to not rejecting an incorrect null hypothesis. So, a type-II error would signify that the null hypothesis is actually incorrect, i.e., the process actually produces more than the maximum permissible rate of defective items, but you fail to reject it. In other words, you think that it does not produce more than the maximum permissible rate of defective items.

Your answer is Correct. Attempt 2 of 2 Continue

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Question 1/1 Mandatory

Question 1 Correct

Question 2/2 Mandatory

Types of Errors

A screening test for a serious but curable disease is similar to hypothesis testing. In this instance, the null hypothesis would be that the person does not have the disease, and the alternative hypothesis would be that the person has the disease. If the null hypothesis is rejected, it means that the disease is detected and treatment will be provided to the particular patient. Otherwise, it will not. Assuming that the treatment does not have serious side effects, in this scenario, it is better to increase the probability of ___.

- Making a type-I error, i.e., not provide treatment when it is needed.
- Making a type-I error, i.e., provide treatment when it is not needed. ✓ Correct
  - Feedback:
    Here, a type-I error would be providing treatment on false detection of the disease, when, in fact, the person does not have the disease. And a type-II error would be not providing treatment upon failing to detect the disease, when, in fact, the person has the disease. Since the treatment has no serious side effects, a type-I error poses a lower health risk than a type-II error, as not providing treatment to a person who actually has the disease would increase his/her health risk.
- Making a type-II error, i.e., not provide treatment when it is needed.
- Making a type-II error, i.e., provide treatment when it is not needed.

Your answer is Correct. Attempt 1 of 2 Continue

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