

Test of Significance

Data Science | CCDATSCl

Statistical Inference

Confidence intervals are one of the two most common types of statistical inference.

Researchers use a confidence interval when their goal is to **estimate a population parameter**.

The second common type of inference, called a **test of significance**, has a different goal:

To assess the evidence provided by data about some claim concerning a population.

Test of Significance

A test of significance is a formal procedure for comparing observed data with a claim (**also called a hypothesis**), the truth of which is being assessed.

The first step in conducting a test of statistical significance is to **state the hypothesis**.

Hypothesis Testing

In today's data-driven world, decisions are based on data all the time

Hypothesis plays a crucial role in that process, whether it may be making business decisions, in the health sector, academia, or in quality improvement.

Without hypothesis and hypothesis tests, you risk drawing the **wrong conclusions** and **making bad decisions**.

Hypothesis Testing **puts our assumptions about a population parameter to the test**.

It is used to estimate the relationship between two statistical variables. Real life examples include:

- A teacher assumes that 60% of his college's students come from lower-middle-class families.
- A doctor believes that 3D (Diet, Dose, and Discipline) is 90% effective for diabetic patients.

How Hypothesis Testing Works?

Measurements and analyses are conducted on a **random sample** of the population to test a theory. In hypothesis testing, a decision between two alternatives must be made.

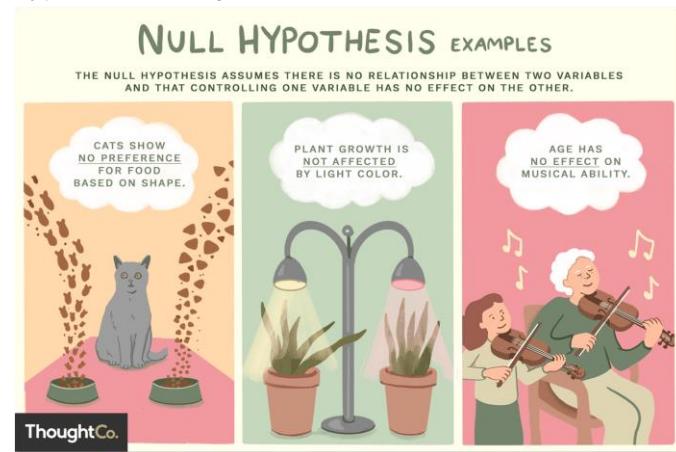
One of which is called the **null hypothesis** and the other the **alternative hypothesis**

Null Hypothesis

The **null hypothesis** is a form of hypothesis that is deemed "true" until proven wrong based on experimental data.

It is defined as the **commonly accepted fact (such as the sky is blue)** and the **researcher's aim is to reject or nullify this fact**.

The notation that is typically used for the null hypothesis is H_0

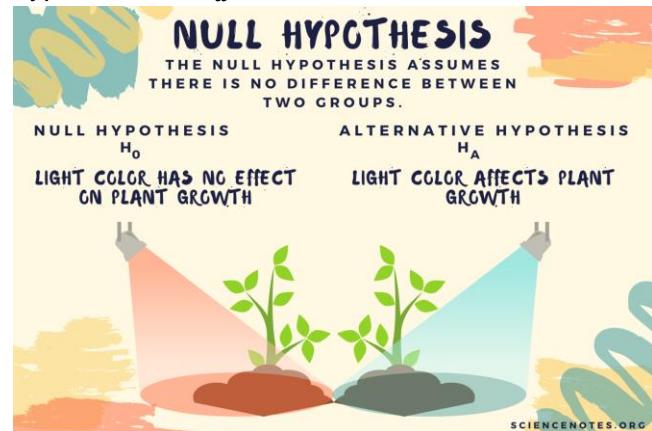


Alternative Hypothesis

The opposite of a null hypothesis is called the **alternative hypothesis**.

The alternative hypothesis is the **claim that researchers are actually trying to prove is true**.

The notation that is typically used for the alternative hypothesis is H_a



Court Trial Example

The process of testing hypotheses can be compared to court trials. A person comes into court charged with a crime.



A jury must decide whether the person is **not guilty (null hypothesis)** or **guilty (alternative hypothesis)**.



Even though the person is charged with the crime, at the beginning of the trial (and until the jury declares otherwise) the accused is assumed to be **not guilty** of the crime.

Only if overwhelming evidence of the person's guilt can be shown is the jury expected to declare the person **guilty**, otherwise the person is considered **not guilty**.

Hand Sanitizer Example

A sanitizer manufacturer claims that its product **kills 95 percent of germs on average**.

To put this company's claim to the test, create a **null and alternate hypothesis**.

Null Hypothesis H_0 : Average is 95%.

Alternative Hypothesis H_a : The average is less than 95%.

Test of Significance

When conducting a significance test, the goal is to **provide evidence to reject the null hypothesis**. If the evidence is strong enough to reject the **null hypothesis**, then the **alternative hypothesis** can automatically be accepted.

However, if the evidence is not strong enough, researchers fail to reject the **null hypothesis**.

Steps of Hypothesis Testing

In the Philippines, the average height of males is **5'4" or 64.8 inches** with a **standard deviation of 2**.

We conducted a study to determine if this is true so we gather a sample of **100 males** and determine that their average height is **5'5" or 66 inches**.

Step 1: Specify your Null and Alternate Hypothesis

- Null Hypothesis H_0 : The average height of males is 5'4"
- Alternative Hypothesis H_a : The average height of males is greater than 5'4"

Step 2: Gather your data

- After specifying our null and alternate hypothesis, we must gather data.
- In a real world setting, sampling must be done **randomly**.
- This refers to recording the height of 100 males from **different parts of the country**.

Step 3: Conduct a statistical test

- To determine whether a discovery or relationship is statistically significant, hypothesis testing uses a **t-test**.
- It usually checks to see if the two means, the **population mean** and the **sample mean**, are the same.
- **Note:** Only when the population **standard deviation is known** and the **sample size is 30 data points or more**, can a t-test be applied.

$$z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

Where:

\bar{x} is the **Population mean height**
 σ is the **Population standard deviation**
 μ is the **sample mean**
 n is the **sample size**

$\bar{x} = 66$ inches

$\sigma = 2$

$\mu = 64.8$ inches

$n = 100$

$$z = \frac{66 - 64.8}{\sqrt{\frac{2}{100}}}$$

$$z = 6.00$$

Step 4: Determine Rejection Of Your Null Hypothesis

- A **p-value** is used in hypothesis testing to help you **support** or **reject** the **null hypothesis**.
- The **p-value** is the evidence against a null hypothesis. **The smaller the p-value**, the stronger the evidence that you should **reject the null hypothesis**.
- p-values are expressed as decimals although it may be easier to understand what they are if you convert them to a percentage. For example, a p value of **0.0254** is **2.54%**.
- A **small p (≤ 0.05)**, reject the **null hypothesis**. This is strong evidence that the null hypothesis is invalid.
- A **large p (> 0.05)** means the **alternate hypothesis** is weak, so you do not reject the null hypothesis.

Step 5: Present your Results

- We will reject the **null hypothesis** as the **p-value of is less than 0.0001**
- and conclude that there is evidence to suggest that the average height of men in the Philippines is greater than **5'4"**.