Hypothesis Testing

by Sophia Tutorial

WHAT'S COVERED

This tutorial will cover the basics of hypothesis testing. Our discussion breaks down as follows:

1. Hypothesis Testing
2. Null and Alternative Hypotheses
3. Reject to Fail or Fail to Reject the Null Hypotheses

1. Hypothesis Testing

Hypothesis testing is the standard procedure in statistics for testing a**hypothesis**, or claim, about population parameters.

IN CONTEXT

Suppose a Liter O'Cola company has a new Diet Liter O'Cola, which they claim is indistinguishable from Classic Liter O'Cola. They obtain 120 individuals to do a taste test.

If their claim is true, some people will be able to identify the diet soda just by guessing correctly. What percent of people will do that? You'd think it would probably be around 60 people, which is 50% --50% would guess correctly and 50% would guess incorrectly, simply based on guessing, even if the Diet Cola was indistinguishable from the Classic Cola.

Now, suppose that you didn't get an exact 50/50 split. Suppose 61 people correctly identified the diet Cola. Would that be evidence against the company's claim? Well, it's more than half, but it's not that much more than half. We would say no. Sixty-one isn't that different from 60. Therefore, it's not really evidenced that more than half of people can correctly identify the diet soda

Suppose that 102 people of the group were able to identify the diet cola correctly. Is that evidence against the company's claim? In this case, 102 is significantly more than half. We would say that this would be evidence that at least some of the people could taste the difference. Even if some of those 102 were guessing, it's evidence that at least *some* of those 102 can taste the difference.

Now, the question posed to us with the 102 is if the people were guessing randomly just by chance,

what would be the probability that we would get 102 correct answers or more? Isn't it possible that 102 out of 120 could correctly pick the diet cola just by chance? Anything is possible.

However, if this was a low probability, then the evidence doesn't really support the hypothesis of guessing. In fact, it would appear that some people *can* taste the difference.

TERMS TO KNOW

Hypothesis Testing
The standard procedure in statistics for testing claims about population parameters.

Hypothesis
A claim about a population parameter.

2. Null and Alternative Hypothesis

With hypothesis testing, there are two hypotheses that are pitted against each other.

- **Null Hypothesis**: A claim about a particular value of a population parameter that serves as the starting assumption for a hypothesis test.
- **Alternative Hypothesis**: A claim that a population parameter differs from the value claimed in the null hypothesis.

The null hypothesis is a default hypothesis that is temporarily accepted as true.

EXAMPLE Refer back to the competing hypotheses from above. The null hypothesis will be that "Liter O'Cola claims that 50% of people will correctly select the diet cola. We will state the null hypothesis as the true proportion of people who can correctly identify the diet soda, p, is equal to 1/2.

Null Hypothesis
H_0: $p = 0.5$

The suspicion is that perhaps over 50% of people will select the diet cola--some of those by chance, and some of those because they can actually taste the difference. This is called the alternative hypothesis, which in essence is a "something is going on here" type of assumption.

Alternative Hypothesis
H_a: $p > 0.50$

HINT

The notation is H subscript 0 for the null hypothesis (H_0), and H subscript a for the alternative hypothesis (H_a).

Null hypothesis is always an equality, and the alternative hypothesis can be expressed many ways, depending on the problem. It's either a "less than" symbol, a "greater than" symbol, or a strictly "not equal to" symbol.

TERMS TO KNOW

Null Hypothesis

A claim about a particular value of a population parameter that serves as the starting assumption for a hypothesis test.

Alternative Hypothesis
A claim that a population parameter differs from the value claimed in the null hypothesis.

3. Reject to Fail or Fail to Reject the Null Hypotheses

In this example, if significantly more than half of the cola drinkers in our sample of 120 can correctly select the diet soda, we would reject the null hypothesis where Liter O'Cola claims that 50% of people will correctly select diet cola by chance.

If we reject the null hypothesis, then we are saying that we are in favor of the alternative hypothesis, which states that there is convincing evidence that more than half of people will correctly identify the diet cola.

Now, significantly more than half is a loose term. How many is that? It was decided that 102 was probably significant, while 61 probably wasn't that significant. We'll leave that definition for another time. On the other hand, if *not* significantly more than half of the participants select the diet soda, then you would fail to reject the null hypothesis. For instance, the 61 is not significantly more than half of the participants, and so you'd fail to reject the null hypothesis.

HINT

Notice you don't say the word "accept" the null hypothesis. Why not? Why do you fail to reject the null hypothesis and not accept it? There's a very good reason for that.

When you do an experiment like this, you already believe the null hypothesis and try to provide evidence against it. If there isn't enough legitimate evidence against it or strong enough evidence to reject it, then all you can do is not reject it. You haven't proven that the null hypothesis is true, you just haven't presented strong enough evidence to prove it false.

SUMMARY

You learned about the hypotheses in the hypothesis test: the null and alternative hypotheses. You pit those against each other and calculate probabilities in order to make a decision about the population. Hypothesis testing involves a lot of things. You start by stating your assumption about the population, which is the null hypothesis denoted H subscript null. You determine if the evidence gathered contradicts the assumption, leading you to reject the null hypothesis in favor of the alternative hypothesis, H sub a. You can calculate conditional probabilities by questioning the probability that you would obtain statistics at least as extreme as these from a sample if the null hypothesis were, in fact, true.

Good luck!

Source: Adapted from Sophia tutorial by Jonathan Osters.

TERMS TO KNOW

Alternative Hypothesis
A claim that a population parameter differs from the value claimed in the null hypothesis.

Hypothesis
A claim about a population parameter.

Hypothesis Testing
The standard procedure in statistics for testing claims about population parameters.

Null Hypothesis
A claim about a particular value of a population parameter that serves as the starting assumption for a hypothesis test.