7.2: Null and Alternative Hypotheses

The actual test begins by considering two **hypotheses**. They are called the **null hypothesis** and the **alternative (or research) hypothesis**. These hypotheses contain opposing viewpoints.

- H_a: **The alternative (or research) hypothesis:** This is a claim about the predicted effect in a population. It is contradictory to H_0 and what we conclude when we reject H_0. For example, we might like to test whether the mean of men's salaries and the mean of women's salaries in a given occupation differ from each other.
- H_0: **The null hypothesis:** This is a statement of no difference (that is, zero difference) between a sample mean or proportion and a population mean or proportion. This is used in hypothesis testing since it allows us to set a clear baseline for comparison. For example, we can compare whether there is more than 0 difference between men's mean salaries and women's mean salaries in a given occupation. When conducting hypothesis testing, if you reject the null it suggests there is an effect.

Since the null hypothesis provides a fixed baseline for testing the alternative hypothesis, you must examine evidence to decide if you have enough evidence to reject the null hypothesis or not. The evidence is in the form of sample data.

After you have determined whether the sample data appear likely under the null hypothesis, you make a **decision.** There are two options for a decision, and you always make the decision about the null hypothesis. The two decision options are (1) "reject H_0" if the sample data seems unlikely to have occurred according to the null hypothesis; or (2) "do not reject H_0" or "decline to reject H_0" or "fail to reject H_0" if the sample information seems probable within the prediction made by the null hypothesis. These conclusions are all based upon a set level of probability, a significance level, that is chosen by the analyst. Typically, the selected probability level is 5% or 1%, but we'll discuss what helps decide the exact probability here later.

Table 7.2.1 presents possible forms of hypotheses in pairs. For example, if the null hypothesis is equal to some value, the alternative has to be not equal to that value.

Table 7.2.1

H_0	H_a
equal (=)	not equal ($\neq$)
greater than or equal to ($\geq$)	less than (<)
less than or equal to ($\leq$)	more than (>)

Note

As a mathematical convention H_0 always has a symbol with an equal in it. H_a never has a symbol with an equal in it. The choice of symbol depends on the wording of the hypothesis test.

Example 7.2.1

H_0: No more than 30% of the registered voters in Santa Clara County voted in the primary election. $P \leq .30$
H_a: More than 30% of the registered voters in Santa Clara County voted in the primary election. $P > .30$

Example 7.2.2

We want to test whether the mean GPA of students in American colleges is different from 3.0 (out of 4.0). The null and alternative hypotheses are:
$H_0 : \mu = 3.0$
$H_a : \mu \neq 3.0$

Example 7.2.3

We want to test if college students take less than five years to graduate from college, on average. The null and alternative hypotheses are:

$H_0 : \mu \geq 5$
$H_a : \mu < 5$
