

## 9.1: Null and Alternative Hypotheses

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

- **$H_0$ : The null hypothesis:** It is a statement of no difference between a sample mean or proportion and a population mean or proportion. In other words, the difference equals 0. This can often be considered the status quo and as a result if you cannot accept the null it requires some action.
- **$H_a$ : The alternative hypothesis:** It is a claim about the population that is contradictory to  $H_0$  and what we conclude when we cannot accept  $H_0$ . The alternative hypothesis is the contender and must win with significant evidence to overthrow the status quo. This concept is sometimes referred to the tyranny of the status quo because as we will see later, to overthrow the null hypothesis takes usually 90 or greater confidence that this is the proper decision.

Since the null and alternative hypotheses are contradictory, 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 which hypothesis the sample supports, you make a **decision**. There are two options for a decision. They are "cannot accept  $H_0$ " if the sample information favors the alternative hypothesis or "do not reject  $H_0$ " or "decline to reject  $H_0$ " if the sample information is insufficient to reject the null hypothesis. These conclusions are all based upon a level of probability, a significance level, that is set by the analyst.

Table 9.1 presents the various hypotheses in the relevant pairs. For example, if the null hypothesis is equal to some value, the alternative has to be not equal to that value.

Table 9.1

$H_0$	$H_a$
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 9.1

$H_0$ : 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 9.2

We want to test whether the mean GPA of students in American colleges is different from 2.0 (out of 4.0). The null and alternative hypotheses are:

$H_0 : \mu = 2.0$   
 $H_a : \mu \neq 2.0$

### ? Example 9.3

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

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

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