


**Type I and Type II Errors**

Because we are basing our conclusion in a significance test on sample data, there is always a chance that our conclusions will be in error. It turns out that there are two types of errors that can be committed in a significance test:

- If we reject  $H_0$  when  $H_0$  is true, it is called a **Type I Error**
- If we fail to reject  $H_0$  when  $H_0$  is false, it is called a **Type II Error**

Memory aid: Type II error occurs when we fail to reject the null hypothesis when we really should.

	$H_0$ TRUE	$H_0$ FALSE ( $H_A$ TRUE)
REJECT $H_0$	TYPE I	CORRECT
FAIL TO REJECT $H_0$	CORRECT	TYPE II



**Example** - The manager of a fast-food restaurant wants to reduce the proportion of drive-through customers who have to wait for more than 2 minutes to receive their food once their order is placed. Based on store records, the proportion of customers who had to wait at least 2 minutes was  $p = 0.63$ . To reduce this proportion, the manager will collect a random sample of drive-through times and test the following hypotheses:

$H_0: p = 0.63$   
 $H_A: p < 0.63$

TYPE I - REJECT  $p = 0.63$  WHEN THAT IS TRUE  
 TYPE II - FAIL TO REJECT  $p = 0.63$  WHEN  $p < 0.63$

Where  $p$  is the true proportion of drive-through customers who have to wait more than 2 minutes after their order is placed to receive their food. Describe a Type I and a Type II error in this setting and explain the consequences of each.

Which is worse?

- I: TRUE PROPORTION OF CUSTOMERS HAS BEEN REDUCED WHEN IT REALLY HAS NOT BEEN. HE WOULD NOT HAVE ADD'L EMPLOYEES ON DUTY.  
 MGR DID NOT DECIDE
- II: TRUE PROPORTION OF CUSTOMERS HAS ~~BEEN~~ BEEN REDUCED WHEN IN FACT IT HAS. MGR WOULD HAVE PEOPLE ON DUTY UNNECESSARILY.

**Application** - In the United States court system, defendants are "presumed innocent" and to be proven guilty, it must be done "beyond a shadow of a doubt."

In this situation, what constitutes a Type I error?  
 FINDING GUILTY WHEN INNOCENT.

What constitutes a Type II error?  
 FINDING INNOCENT WHEN GUILTY

Which error is worse?

(DISCUSS)

	INNOCENT	GUILTY
REJECT INNOCENT	TYPE I	✓
FAIL TO REJECT INNOCENT	✓	TYPE II

$H_0$ : PRESUMED INNOCENT  
 $H_1$ : GUILTY.

