AP Statistics
Type I and Type II Errors

Truth about the population

Decision based on sample		H_o true	H_a true
	Reject H_o	Type I error	Correct Decision
	Accept H_o	Correct Decision	Type II error

Ramifications: A Type I error is made when the null hypothesis H_o is actually true but the alternative hypothesis H_a is chosen.

A Type II error is made when the alternative hypothesis H_a is actually true but the conservative step of accepting the null hypothesis H_o is actually made.

Example 1: Conjecture: The defendant is guilty of the crime.

H_o: The defendant is not guilty

H_a: The defendant is guilty

Because we are seeking evidence for guilt, it becomes the alternative hypothesis. The trial is the process whereby information (sample data) is obtained. The jury then deliberates about the evidence (the data analysis). Finally, the jury either convicts the defendant (rejects the null hypothesis) or declares the defendant not guilty (fails to reject the null hypothesis). The two correct decisions are to conclude that an innocent man is not guilty or conclude that a guilty person is guilty. The two incorrect decisions are to convict an innocent person or to let a guilty man free.

Truth about the defendant

Decision based on evidence		H_o true (defendant did not commit the crime)	H_a true (defendant committed the crime)
	Reject H_o	**Type I error – come to the conclusion that the defendant is guilty when he is not**	Correct Decision
	Accept H_o	Correct Decision	**Type II error – come to the conclusion that the defendant is not guilty when he really is guilty.**

Which is worse?

If you want to reduce the possibility of a type I error, you must lower your alpha value - you want to be as sure as possible that a person did it. Circumstantial evidence is not enough. We don't have an innocent person punished. But if we do that, there are certainly going to be more people who get away with crimes because in that process of being crystal sure of the person's guilt, we will be letting more people go for whom we have strong suspicion but not positive proof. That means we are increasing the possibility of a type II error.

If we want to reduce the possibility of a type II error, (we don't want criminals getting away with it), we need to take anyone we strongly have suspicions about crimes and punish them. But if we do that, there are bound to be people who get caught by the circumstantial evidence against them and possibility gets punished for crimes when they didn't do it. Hence more type I errors.
Ramifications:

Type I error – punishing a person who is truly innocent and putting them wrongly in jail.

Type II error – criminals gets away with crimes and perhaps thinks he always can. Later in life, this can lead to larger or continued crimes.

Problem: The USDA limit for salmonella contamination for chicken is 20%. A meat inspector reports that the chicken produced by a company exceeds the USDA limit. You perform a hypothesis test to determine whether the meat inspector's claim is true.

a) What are the null and alternative hypotheses?
b) Make the table like the one above to show what and where your type I and type II errors are.
c) Describe your type I error in context.
d) Describe your type II error in context.
e) Describe the consequences and which error is more serious.

H_o : H_a :

		H_o true	H_a true
Decision based on sample	Reject H_o	Type I error	Correct Decision
	Accept H_o	Correct Decision	Type II error

Type I and Type I Errors Practice

1. A clean air standard requires that vehicle exhaust emissions not exceed specified limits for various pollutants. Many states require cars be tested annually to be sure they meet these standards. Suppose state regulators double check a random sample of cars that a suspect repair shop has certified as okay. They will revoke the shop's license if they find significant evidence that the shop is certifying vehicles that do not meet standards.
a) What are the null and alternative hypotheses?
b) In this context, what is a Type I error?
c) In this context, what is a Type II error?
d) Which type of error would the shop's owner consider more serious? Why?
e) Which type of error might environmentalists consider more serious? Why?

2. Captain Ben flies small passenger jets. These jets carry 50 passengers, plus their luggage. On a full flight, these jets will perform properly as long as the total weight of passengers' checked baggage does not exceed 5000 pounds. Ben is concerned that passengers on a particular flight have brought unusually heavy bags. He selects a random sample of 10 passengers and weighs their checked baggage. Based on the results from this sample, he must decide whether it is safe to take off.

a) Ben wants to perform a test to determine whether the mean weight μ of passengers' luggage on this flight is too heavy. State the appropriate null and alternative hypotheses.
b) Describe the two types of errors that you might make. Identify which is a Type I error and which is a Type II error.
c) Explain the consequences of each type of error. Which is the most serious?
d) If you had to choose one of the "standard" significance levels for your significance test, would you choose α = 0.01, 0.05, or 0.10? Justify your choice.
e) Discuss any concerns you have about how the data were produced.

3. A school administrator claims that students whose first language learned is not English score worse on the verbal portion of the SAT exam than students whose first language is English. The mean SAT verbal score of students whose first language is English is 515 with a population standard deviation of 112, on the basis of data obtained from the College Board. SAT verbal scores are normally distributed. In a random sample of 20 students whose first language learned were not English results in a sample mean SAT Verbal Score of 458.
a) Is there significant evidence in the administrator's claim that the SAT Verbal Score will be lower than those students whose first language is English? Provide statistical evidence to support your answer. Base it on the 5% level of significance and the 1% level of significance.
b) Based on the work done, what are the Type I and Type I errors? What are the consequences of each and which is more serious? If the administrator wants to start a new program to assist these types of students in improving their SAT Verbal score, what should he do based on the errors?