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6.1 - Type I and Type II Errors



When conducting a hypothesis test there are two possible decisions: reject the null hypothesis or fail to reject the null hypothesis. You should remember though, hypothesis testing uses data from a sample to make an inference about a population. When conducting a hypothesis test we do not know the population parameters. In most cases, we don't know if our inference is correct or incorrect.

When we reject the null hypothesis there are two possibilities. There could really be a difference in the population, in which case we made a correct decision. Or, it is possible that there is not a difference in the population (i.e., H_0 is true) but our sample was different from the hypothesized value due to random sampling variation. In that case we made an error. This is known as a Type I error.

When we fail to reject the null hypothesis there are also two possibilities. If the null hypothesis is really true, and there is not a difference in the population, then we made the correct decision. If there is a difference in the population, and we failed to reject it, then we made a Type II error.

Type I Error
Rejecting H_0 when H_0 is really true, denoted by α ("alpha") and commonly set at .05

$$\alpha = P(\text{Type I error})$$

Type II Error
Failing to reject H_0 when H_0 is really false, denoted by β ("beta")

$$\beta = P(\text{Type II error})$$

Decision	Reality	
	H_0 is true	H_0 is false
Reject H_0 , (conclude H_a)	Type I error	Correct decision
Fail to reject H_0	Correct decision	Type II error

Example: Trial

- A man goes to trial where he is being tried for the murder of his wife.
- We can put it in a hypothesis testing framework. The hypotheses being tested are:
- H_0 : Not Guilty
 - H_a : Guilty

Type I error is committed if we reject H_0 when it is true. In other words, did not kill his wife but was found guilty and is punished for a crime he did not really commit.

Type II error is committed if we fail to reject H_0 when it is false. In other words, if the man did kill his wife but was found not guilty and was not punished.



Example: Culinary Arts Study

A group of culinary arts students is comparing two methods for preparing asparagus: traditional steaming and a new frying method. They want to know if patrons of their school restaurant prefer their new frying method over the traditional steaming method. A sample of patrons are given asparagus prepared using each method and asked to select their preference. A statistical analysis is performed to determine if more than 50% of participants prefer the new frying method:



- $H_0 : p = .50$
- $H_a : p > .50$

Type I error occurs if they reject the null hypothesis and conclude that their new frying method is preferred when in reality it is not. This may occur if, by random sampling error, they happen to get a sample that prefers the new frying method more than the overall population does. If this does occur, the consequence is that the students will have an incorrect belief that their new method of frying asparagus is superior to the traditional method of steaming.

Type II error occurs if they fail to reject the null hypothesis and conclude that their new method is not superior when in reality it is. If this does occur, the consequence is that the students will have an incorrect belief that their new method is not superior to the traditional method when in reality it is.

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