9.2 Types of Errors in Hypothesis testing

Mistakes we could make

- As I mentioned, when we take a sample we won't be 100% sure of something because we do not take a census (we only look at information on a subset of the full population).

Mistakes we could make

- Since we don't look at the full 100% of the population, could we make a mistake (or error) in our final conclusion?
  - Yes, it's possible, but we try to keep the probability of making a mistake at a low level.
  - We try to keep the 'error rate' low.

What type of mistake could we make?

- We have only two possible outcomes to a hypothesis test…
  - 1) Reject the null (H_0)
    - This occurs when our data provides some support for the alternative hypothesis.
  - 2) Do not reject the null
    - This occurs when our data did not give strong evidence against the null.

Mistakes we could make:

- We could Reject the Null when it was actually true (bad thing).
  - We thought we found something interesting, but it was just a 'false positive'.
- We could Fail to Reject the Null when it was actually false (bad thing)
  - We thought there wasn't anything interesting , BUT THERE WAS !!! That's a 'false negative'.

Two types of errors

- A false positive
- A false negative

Table 9.2 Decision Table for H_0 and H_a

		Reality	
		H_0 true	**H_a true**
Our decision	**Reject H_0**	False positive	Correct decision
	Do not reject H_0	Correct decision	False negative

What if we Reject the Null when it was actually true (bad thing).

- We found evidence in our data in favor of the alternative, but it was a false finding.
- This error is sometimes called a false positive.
  - You thought you found something interesting, but there really wasn't anything there.
- This error is called a type I error.

Rejecting the Null when it was actually true (bad thing).

- The type I error:
  - We tend to see this as a very bad mistake.
  - When you reject the null in favor of the alternative, there are often follow-ups with large impact:
    - A jury who mistakenly convicts an innocent person will send an innocent person to jail.
    - A manufacturing plant who mistakenly thinks they found a much better product will make costly changes to their manufacturing line thinking the new product is better and worth the extra cost.

Rejecting the Null when it was actually true (bad thing).

- It turns out that the probability of making a type I error **is** the **significance level**!

- When $\alpha=0.05$ (i.e. significance level is 0.05), there is a 5% chance of mistakenly reject H_0 when it was actually true.

Section 9.2, Problem 51

- The null and alternative hypotheses are

  H_0: *The patient is free of a particular disease.*

  H_a: *The patient has the disease.*

- What is a type I error in the context of the problem?

Section 9.2, Problem 51

- Making a type I error means we mistakenly reject the null…

H_0: *The patient is free of a particular disease.*

- So, the patient truly does NOT have the disease, but we said they did. They may then be subjected to further procedures or medications that are not needed (and may be risky).

What if we Fail to Reject the Null when it was actually false (bad thing).

- Even though the null was false, the data unfortunately did not give strong support for the alternative, so we accepted H_0.
- This error is sometimes called a false negative.
  - There was something interesting there, but you MISSED IT!!!
- This error is called a type II error.

What if we Fail to Reject the Null when it was actually false (bad thing).

- The type II error rate is related to the Power of a hypothesis test (the probability that you find something interesting if it's there).
- A small type II error rate coincides with high power (which is good).
- The type II error does not coincide with the significance level of the test.

Section 9.2, Problem 51

- The null and alternative hypotheses are

  H_0: *The patient is free of a particular disease.*

  H_a: *The patient has the disease.*

- What is a type II error in the context of the problem?

Section 9.2, Problem 51

- Making a type II error means we mistakenly accepted the null (did not reject it)…

H_0: *The patient is free of a particular disease.*

- So, the patient truly DOES have the disease, but we said they didn't. The patient will not receive any further procedures or medications that may have actually helped them improve.

Two types of errors: Type I and Type II errors
(We like to have low error rates)

- An error in which H_0 is *wrongly rejected*, is called a **type I error**.

- An error in which we *wrongly fail to reject* H_0, is called a **type II error**.

Table 9.2 Decision Table for H_0 and H_a

		Reality	
		H_0 true	**H_a true**
Decision	**Reject H_0**	Type I error	Correct decision
	Do not reject H_0	Correct decision	Type II error