Where We've Been...and Where We're Headed...

Descriptive Statistics: **graphs and statistics**

Inferential Statistics: **Use sample data to make an inference or conclusion about a population.**

...estimate a population parameter

...test a claim about a population parameter

Chaper 6 Hypothesis Testing

A Hypothesis is a claim or statement about a property of a population.

A Hypothesis Test is a procedure for testing the claim.

Examples of hypotheses that can be tested:

- **Genetics:** The Genetics Institute claims that its selection method allows couples to increase the probability of having a baby girl.

- **Business:** A newspaper headline makes the claim that less than 40% of workers get their jobs through networking.

- **Medicine:** Medical researchers claim that when people with colds are treated with echinacea the mean duration length is no different from doing nothing.

Overview

The Genetics Institute claims that its selection method allows couples to increase the probability of having a baby girl.

Null Hypothesis

Alternative Hypothesis

It's like a trial. Assume the null hypothesis is true.

We will use our sample data to see if there is evidence to show the new method does increase the chances of having a girl.

If probability is very small...

If probability is not small...

CONDUCTING A HYPOTHESIS TEST

Form the Null Hypothesis

- **The null hypothesis is a statement that the value of a population parameter (such as proportion or mean) is equal to (=, ≤, ≥) some claimed value.**

- **We test the null hypothesis directly.**

  Guiding rule for hypothesis testing:

  Assuming the null hypothesis is true, if the probability of observing our sample value is really small, we conclude that the null hypothesis is probably not correct.

- **Either reject H_0 or fail to reject H_0.**

Form the alternative hypothesis

The alternative hypothesis is the statement that the parameter has a value that differs from the null hypothesis.

The symbolic form of the alternative hypothesis must use one of these symbols:

$\neq$ **OR** $<$ **OR** $>$

Calculate the value of the test statistic.

This is where sample data is used.

We use the test statistic and probability to make a conclusion.

$$z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

Use the Standard Normal Distribution to see how likely for us to have observed such a sample...

How...

Calculate the P-value

Calculate the probability of getting the value of the test statistic at least as extreme as the one you calculated.

$$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$$

Case 1	Case 2	Case 3
$H_o : \mu \le \mu_o$	$H_o : \mu \ge \mu_o$	$H_o : \mu = \mu_o$
$H_1 : \mu > \mu_o$	$H_1 : \mu < \mu_o$	$H_1 : \mu \ne \mu_o$
P-value	P-value	P-value

Form a Conclusion Based on the Evidence from the Sample.

The conclusion will always be one of the following:

Reject the null hypothesis.

Fail to reject the null hypothesis.

- **Never say, "accept the null hypothesis."**
- **We can NEVER prove the null hypothesis is true.**
- **"Fail to reject" is more correct.**
- **There is not enough evidence to reject the null hypothesis.**

It is known that the mean cholesterol level for all Americans is 190 mg/dL. A scientist would like to determine if children have a mean cholesterol level greater than 190 mg/dL. A sample of 100 children yields a sample mean of 198 mg/dL and a standard deviation of 15 mg/dL.

Set up hypothesis statements.

Calculate the test statistic.

Calculate the P-value.

Form a conclusion.

The manufacturer of Coke lists 12 fl oz on the cans. Do cans of Coke have volumes with a mean different from 12 fl oz? A simple random sample of 36 cans of Coke has a mean volume of 12.05 oz and a standard deviation of 0.21 oz. Test the claim.

Set up hypothesis statements.

Calculate the test statistic.

Calculate the P-value.

Form a conclusion.

A manufacturer of synthetic fishing line believes the mean breaking strength is 8 kg. Action will be taken in the manufacturing process if the mean breaking strength is less than 8 kg. A simple random sample of 50 lines is taken. The sample mean breaking strength is 7.8 kg and the standard deviation is 0.5 kg.

$$H_o : \mu \geq 8$$

$$H_1 : \mu < 8$$

Calculate the test statistic.

Calculate the P-value.

Form a conclusion.

Section 6.2 More about the P-value

The P-value is

the probability we observed a sample as extreme or more extreme than we did

If the P-value is small....

we have evidence to say H_o is false

$\alpha = 0.05$

If the P-value is not small...

the sample offers support for H_o

How should you write the hypothesis statements?

Example: A new component will be used if it has a mean output greater than 24 units.

Example: A manufacturer has equipment set to fill soda cans with a mean of 12.2 fl oz. Recalibration will be needed if the mean fill volume is different from 12.2 fl oz.

Confidence Intervals and Two-Tailed Tests are related.

A confidence interval contains all the values that are plausible for the population mean to take on.

95% Confidence Interval, α=0.05

(low, high)

$H_o : \mu = \mu_o$

$H_1 : \mu \neq \mu_o$

So for example, using the Coke data from earlier, we have enough information to build a CI. Remember that:

Example: A simple random sample of 36 cans of Coke has a mean volume of 12.05 oz and a standard deviation of 0.11 oz. Test the claim that cans of Coke have volumes with a mean of 12 oz.