Conditions for Inference in Practice

Any confidence interval or significance test can be trusted only under specific conditions.

Where did the data come from?
When you use statistical inference, you are acting as if your data are a random sample or come from a randomized comparative experiment.
- *If your data don't come from a random sample or randomized comparative experiment, your conclusions may be challenged.*
- *Practical problems such as nonresponse or dropouts from an experiment can hinder inference.*
- *Different methods are needed for different designs.*
- *There is no cure for fundamental flaws like voluntary response.*

What is the shape of the population distribution?
Many of the basic methods of inference are designed for Normal populations.
- *Any inference procedure based on sample statistics like the sample mean that are not resistant to outliers can be strongly influenced by a few extreme observations.*

Cautions About Confidence Intervals

A sampling distribution shows how a statistic varies in repeated random sampling.

This variation causes random sampling error because the statistic misses the true parameter by a random amount.

No other source of variation or bias in the sample data influences the sampling distribution.

The margin of error in a confidence interval covers only random sampling errors. Practical difficulties such as undercoverage and nonresponse are often more serious than random sampling error. The margin of error does not take such difficulties into account.

Sample Size for Confidence Intervals

A wise user of statistics never plans a sample or an experiment without also planning the inference. The number of observations is a critical part of planning the study.

The margin of error *ME* of the confidence interval for the population mean *μ* is:

$$z^* \cdot \frac{\sigma}{\sqrt{n}}$$

The *z* confidence interval for the mean of a Normal population will have a specified margin of error *m* when the sample size is:

$$n = \left(\frac{z^* \sigma}{m} \right)^2$$

Sample Size for Confidence Intervals

Researchers would like to estimate the mean cholesterol level μ of a particular variety of monkey that is often used in laboratory experiments. They would like their estimate to be within 1 milligram per deciliter (mg/dl) of the true value of μ at a 95% confidence level. A previous study involving this variety of monkey suggests that the standard deviation of cholesterol level is about 5 mg/dl.

✓ The critical value for 95% confidence is $z^* = 1.96$.

✓ We will use $\sigma = 5$ as our best guess for the standard deviation.

$$n = \left(\frac{z^*\sigma}{m}\right)^2$$

$$= \left(\frac{1.96 * 5}{1}\right)^2$$

$$= 96.04$$

We round up to 97 monkeys to ensure the margin of error is no more than 1 mg/dl at 95% confidence.

- Ex 16.22 **Sampling at the mall.** A market researcher chooses at random from women entering a large suburban shopping mall. One outcome of the study is a 95% confidence interval for the mean of "the highest price you would pay for a pair of jeans."

- (a) Explain why this confidence interval does not give useful information about the population of all women.

- The sample described is a random sample, but women shopping at a suburban shopping mall don't represent the population of all women.

- (b) Explain why it may give useful information about the population of women who shop at large suburban malls.

- Because the sample is random, the sample is likely represent the population of all women that shop at suburban malls.

- Ex 16.25 **An outlier strikes.** You have data on an SRS of recent graduates from your college that shows how long each student took to complete a bachelor's degree. The data contain one high outlier. Will this outlier have a greater effect on a confidence interval for mean completion time if your sample is small or if it is large? Why?

- The effect is greater if the sample is small. With a larger sample, the impact of any one value is small.

- Ex 16.6 **Is your food safe?** "Do you feel confident or not confident that the food available at most grocery stores is safe to eat?" When a Gallup Poll asked this question, 82% of the sample said they were confident.3 Gallup announced the poll's margin of error for 95% confidence as ±3 percentage points. Which of the following sources of error are included in this margin of error?

- (a) Gallup dialed landline telephone numbers at random and so missed all people without landline phones, including people whose only phone is a cell phone.

- (b) Some people whose numbers were chosen never answered the phone in several calls or answered but refused to participate in the poll.

- (c) There is chance variation in the random selection of telephone numbers.

- The margin error only addresses chance variation in the random selection of a sample. Thus, the answer is (c). Sources of bias described in (a) and (b) are not accounted for in the margin of error, and are difficult to assess.

Sample Size for Conf. Intervals

We want to estimate the true pH of a test tube of solution. The pH meter is known to have a standard deviation of 0.025. The margin of error for the pH of the solution must be no larger than .05, with 99% confidence. How many times should the pH be measured?

a) $(1.96 \times .025/.05)^2$

b) **$(2.58 \times .025/.05)^2$**

c) $(2.58 \times .05/.025)^2$

d) $(1.96 \times .05/.025)^2$