

CHAPTER OVERVIEW

Unit 4B: Inference for Relationships

CO-4: Distinguish among different measurement scales, choose the appropriate descriptive and inferential statistical methods based on these distinctions, and interpret the results.

Learning Objectives

LO 4.20: Classify a data analysis situation involving two variables according to the “role-type classification.”

Learning Objectives

LO 4.35: For a data analysis situation involving two variables, choose the appropriate inferential method for examining the relationship between the variables and justify the choice.

Learning Objectives

LO 4.36: For a data analysis situation involving two variables, carry out the appropriate inferential method for examining relationships between the variables and draw the correct conclusions in context.

REVIEW: Unit 1 [Role-Type Classification](#) before continuing.

Video

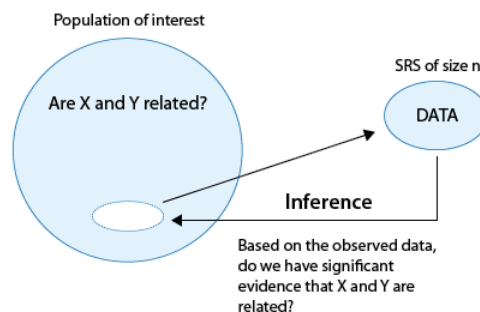
Video: [Unit 4B: Inference for Relationships](#) (5:15)

In the previous unit, we learned to perform inference for a **single** categorical or quantitative **variable** in the form of **point estimation**, **confidence intervals** or **hypothesis testing**.

The inference was actually

- about the **population proportion** (when the variable of interest was **categorical**) and
- about the **population mean** (when the variable of interest was **quantitative**).

Our next (and final) goal for this course is to perform **inference** about **relationships** between **two variables** in a population, based on an observed relationship between variables in a sample. Here is what the process looks like:



We are interested in studying whether a **relationship** exists **between** the **variables** X and Y **in a population of interest**. We choose a random sample and collect data on both variables from the subjects.

Our goal is to determine whether these data provide strong enough evidence for us to **generalize** the **observed relationship** in the **sample** and **conclude** (with some acceptable and agreed-upon level of uncertainty) that a **relationship** between X and Y **exists** in the entire **population**.

The primary form of inference that we will use in this unit is **hypothesis testing** but we will discuss **confidence intervals** both to estimate unknown parameters of interest involving two variables and as an alternative way of determining the conclusion to our hypothesis test.

Conceptually, across all the inferential methods that we will learn, we'll test some form of:

Ho: There is no relationship between X and Y

Ha: There is a relationship between X and Y

(We will also discuss point and interval estimation, but our discussion about these forms of inference will be framed around the test.)

Recall that when we discussed examining the relationship between two variables in the **Exploratory Data Analysis** unit, our discussion was framed around the **role-type classification**. This part of the course will be structured exactly in the same way.

In other words, we will look at hypothesis testing in the 3 sections corresponding to cases $C \rightarrow Q$, $C \rightarrow C$, and $Q \rightarrow Q$ in the table below.

		Response	
		Categorical	Quantitative
Explanatory	Categorical	$C \rightarrow C$	$C \rightarrow Q$
	Quantitative	$Q \rightarrow C$	$Q \rightarrow Q$

Recall that case $Q \rightarrow C$ is not specifically addressed in this course other than that we may investigate the association between these variables using the same methods as case $C \rightarrow Q$.

It is also important to remember what we learned about lurking variables and causation.

- If our explanatory variable was part of a **well-designed experiment** then it may be **possible** for us to claim a **causal effect**
- But if it was based upon an **observational study**, we must be **cautious** to **imply only** a **relationship** or **association** between the two variables, **not** a direct **causal link** between the explanatory and response variable.

Unlike the previous part of the course on Inference for One Variable, where we discussed in some detail the theory behind the machinery of the test (such as the null distribution of the test statistic, under which the p-values are calculated), in the inferential procedures that we will introduce in Inference for Relationships, we will discuss much less of that kind of detail.

The principles are the same, but the details behind the null distribution of the test statistic (under which the p-value is calculated) become more complicated and require knowledge of theoretical results that are beyond the scope of this course.

Instead, **within each of the inferential methods we will focus on:**

- When the inferential method is appropriate for use.
- Under what conditions the procedure can safely be used.
- The conceptual idea behind the test (as it is usually captured by the test statistic).
- How to use software to carry out the procedure in order to get the p-value of the test.
- Interpreting the results in the context of the problem.
- Also, we will continue to introduce each test according to the four-step process of hypothesis testing.

Two-Sided Tests

From this point forward, we will generally focus on

- **TWO-SIDED tests** and
- **Supplement** with **confidence intervals** for the **effect of interest** to give further information

Using two-sided tests is **standard practice in clinical research** EVEN when there is a direction of interest for the research hypothesis, such as the desire to prove a new treatment is better than the current treatment.

Here are a few comments:

- Although fewer participants are required for one-sided tests, we are **unable to draw appropriate conclusions** if the study demonstrates the new treatment is worse. (See [Defending the Rationale for the Two-Tailed Test in Clinical Research](#) for a detailed discussion of this and other issues.)
- Using a one-sided test for the purpose of gaining statistical significance is **NOT A VALID APPROACH**. (See [What are the differences between one-tailed and two-tailed tests?](#) for more on this as well as a general overview of both types of tests.)

We are now ready to start with Case $C \rightarrow Q$.

Topic hierarchy

[Case \$C \rightarrow C\$](#)

[Case \$C \rightarrow Q\$](#)

[Case \$Q \rightarrow Q\$](#)

[Wrap-Up \(Inference for Relationships\)](#)

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