

Data Basics

Colby Community College

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| 1 | 7500 | 7.34 | 36 | A | MD | 70000 | rent |
| 2 | 25000 | 9.43 | 60 | B | OH | 254000 | mortgage |
| 3 | 14500 | 6.08 | 36 | A | MO | 80000 | mortgage |
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Each column is called a **variable**.

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It is very important to provide descriptions of all the variables in a data matrix. Be sure to include the units of measurement.

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Data Set

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| variable | description |
|---------------|---|
| loan_amount | Amount of the load received, in US dollars. |
| interest_rate | Interest rate on the loan, in an annual percentage. |
| term | The length of the loan, which is always a whole number of months. |
| grade | Loan grade, which takes values A through G and represents the quality of the loan and its likelihood of being repaid. |
| state | US state where the borrower resides. |
| total_income | Borrower's total income, including any second income, in US dollars. |
| homeownership | Indicates whether the person owns, owns but has a mortgage, or rents. |

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The names and labels in categorical data are sometimes coded with numbers. When a number is used as a name it is **not** numerical data.

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Identification numbers 1, 2, 3, ..., 25 are assigned randomly to 25 subjects in a clinical trial. The identification numbers are?

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The numbers in Example 4 don't actually measure or count anything.

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Example 6

Casino employees plan to roll a fair die until the number 5 is rolled, and they count the number of rolls required to get a 5. (It is possible, but unlikely, that a 5 could never be rolled.)

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A grade school teacher measures the heights of his students.

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Example 11

For an item on a survey, respondents are given a choice of possible answers, and they are coded as follows:

1 is coded as “I agree”

2 is coded as “I disagree”

3 is coded as “I don’t care”

4 is coded as “I refuse to answer”

The numbers 1,2,3, and 4 don’t count or measure anything.

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Example 12

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Example 13

A survey asks people what they felt their blood pressure was. The possible answers are “Low”, “Normal”, “High.” These responses can be arranged in a meaningful order, but the differences between “Low” and “High” doesn’t make sense.

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Body temperatures of 98.2°F and 98.9°F are examples of data at this interval level of measurement. The values are ordered, and we can calculate their difference. There is no natural starting point. (The value 0°F is an arbitrary choice and doesn't represent the complete absence of heat.)

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Example 15

The years 1492 and 1776 can be arranged in order, and the difference of 284 years is meaningful. But, time doesn't not have a natural starting point that represents "no time."

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Data are at the **ratio level of measurement** if they can be arranged in order, differences can be found and are meaningful, and there is a natural starting point which indicates that none of the quantity is present.

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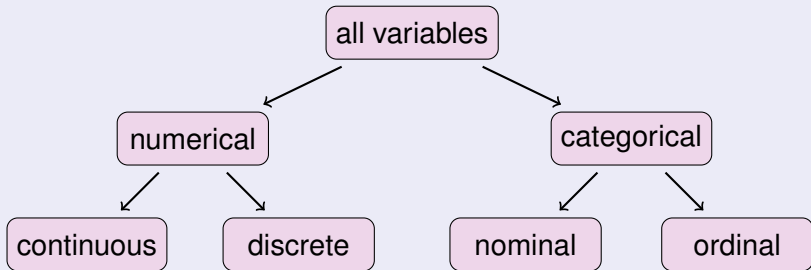
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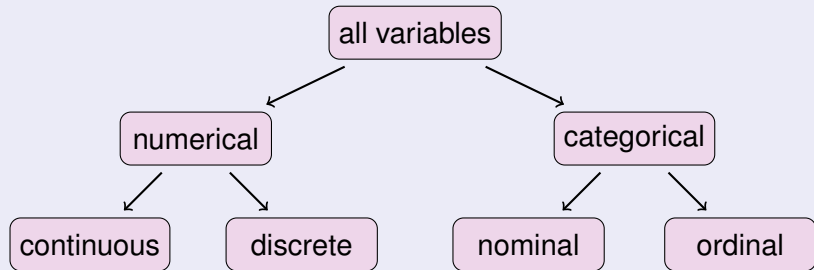
Example 17

The times of 50 minutes and 100 minutes for a math class are at the ratio level of measurement. (The starting point is 0 minutes and 100 minutes is twice as long as 50 minutes.)

Classification of Variables



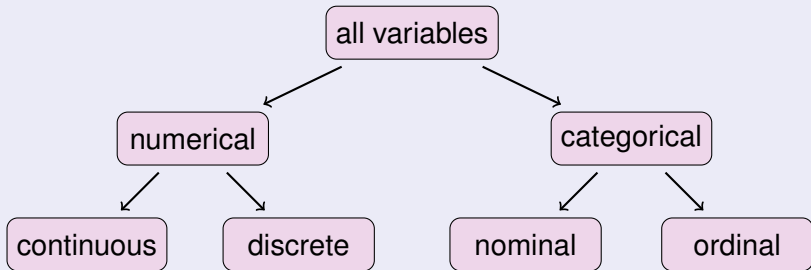
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Note

For simplicities sake, we will often treat ordinal data as nominal data.

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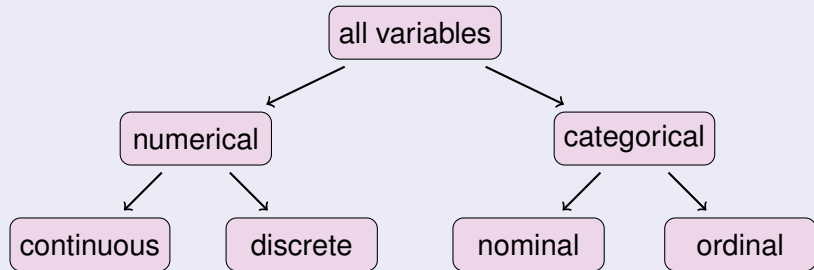
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Note

If your data consists of only integers, then it is usually discrete.

Data Set

The following slides will use the `county` data set, which contains data on all 3142 counties in the United States.

| variable | description |
|--------------------------------|--|
| <code>name</code> | County names. |
| <code>state</code> | State names. |
| <code>pop2000</code> | Population in 2000. |
| <code>pop2010</code> | Population in 2010. |
| <code>pop2017</code> | Population in 2017. |
| <code>pop_change</code> | Population change from 2010 to 2017. |
| <code>poverty</code> | Percent of population in poverty in 2017. |
| <code>homeownership</code> | Home ownership rate, 2006-2010. |
| <code>multi_unit</code> | Percent of housing units in multi-unit structures, 2006-2010. |
| <code>unemployment_rate</code> | Unemployment rate in 2017. |
| <code>metro</code> | Whether the county contains a metropolitan area. |
| <code>median_edu</code> | Median education level (2013-2017). |
| <code>per_capita_income</code> | Per capita (per person) income (2013-2017). |
| <code>median_hh_income</code> | Median household income. |
| <code>smoking_ban</code> | Describes whether the type of county-level smoking ban in place in 2010, taking one of the values “none”, “partial”, or “comprehensive”. |

Relationships Between Variables

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- If homeownership is lower than the national average in one county, will the percent of multi-unit structures in that county tend to be above or below the national average?
- Does a higher than average increase in county population tend to correspond to counties with higher or lower median household incomes?
- How useful a predictor is median education level for the median household income for US counties?

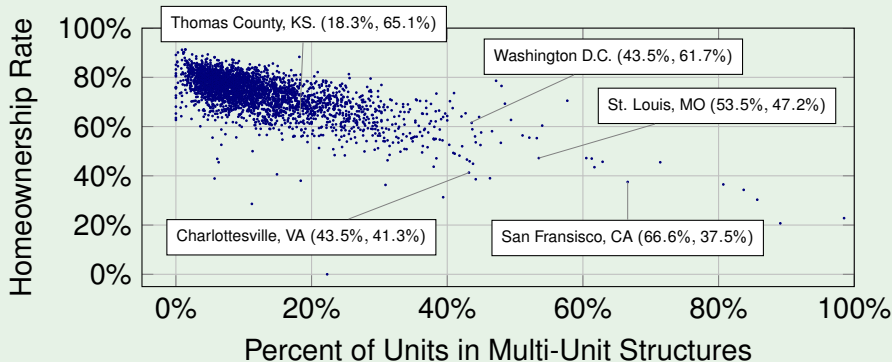
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A **scatterplot** is a plot of paired (x, y) numerical data with a horizontal x -axis and a vertical y -axis. The horizontal axis is used for the first variable (x), and the vertical axis for the second variable (y).

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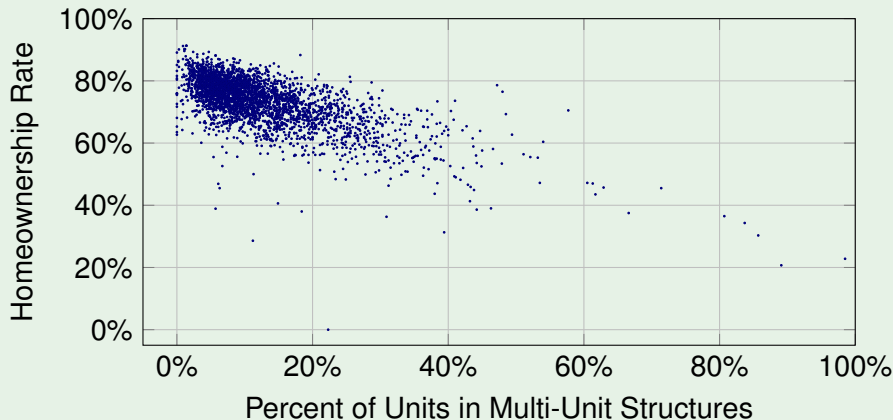
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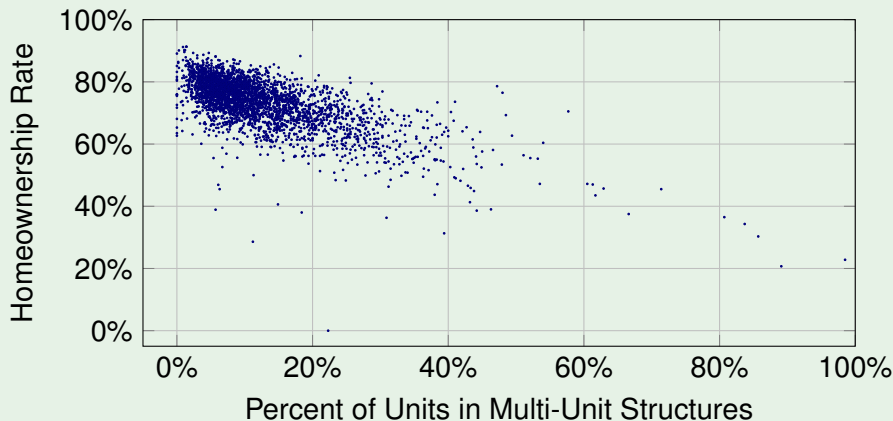
It is impossible to be both associated and independent.

Example 19



Are the Multi-Unit Structure Rate and the Homeownership Rate associated?

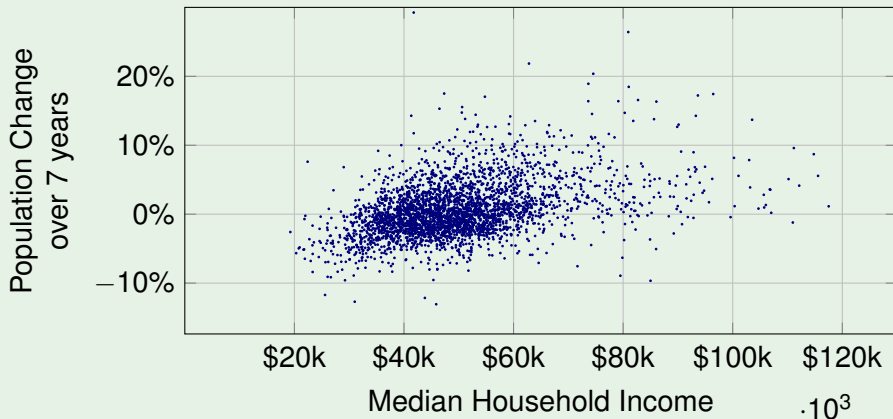
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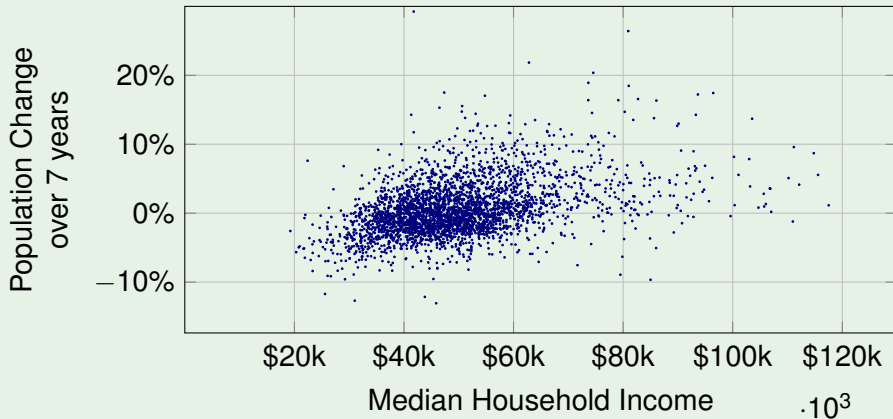
Yes, they are negatively associated.

Example 20



Are the Median Household Income and the Population Change associated?

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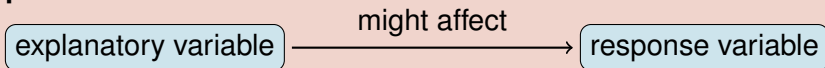
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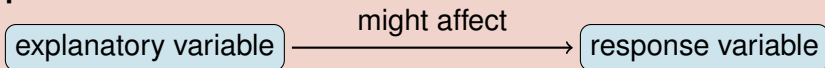
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Note

Labeling a variable like this does **nothing** to guarantee that a causal relationship exists!

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In general, causation can only be inferred from a randomized experiment.

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- **Observational study:** We gather police reports about collisions and use them to determine if the person was listening to music or not.
- **Experiment:** We randomly assign subjects to either listen to music while driving or listen to nothing. We then count how many collisions each subject is involved in.