Data Basics

Colby Community College

Definition

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	loan_amount	interest_rate	term	grade	state	total_income	homeownership
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 row is called a **case** or **observational unit**.

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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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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 $1, 2, 3, \ldots, 25$ are assigned randomly to 25 subjects in a clinical trail. The identification numbers are?

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The numbers in Example 5 don't actually measure or count anything.

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Example 7

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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Example 10

A grade school teacher measures the heights of his students.

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Example 12

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 14

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 16

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.
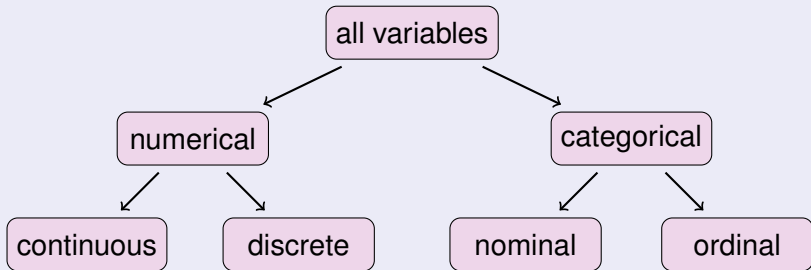
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Heights of 180cm and 90cm for a high school student and a preschool student are at the ratio level of measurement. (The starting point is 0cm and 180cm is twice as tall as 90cm.)
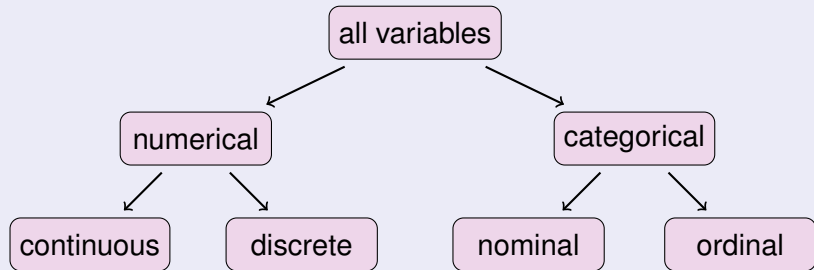
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Example 18

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.)

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```
                        all variables
                       /            \
                numerical          categorical
                /      \            /        \
        continuous   discrete    nominal    ordinal
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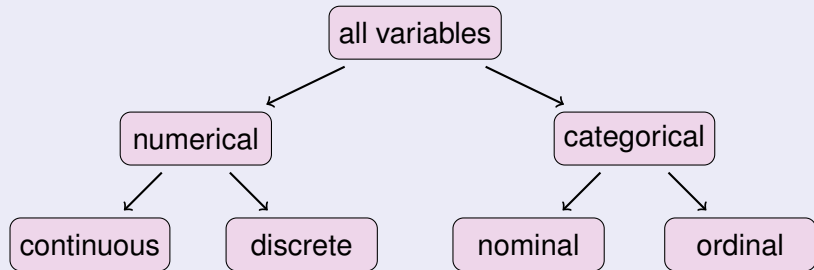

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If your data consists of real numbers, then it is usually continuous.

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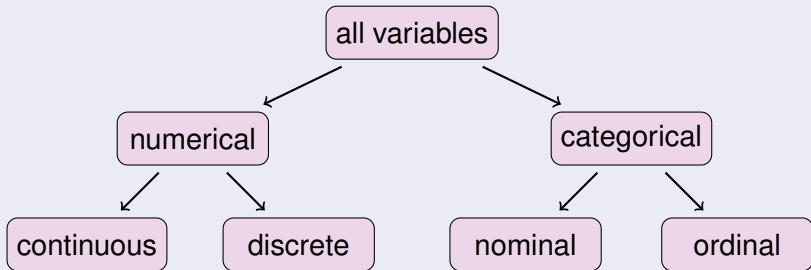
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If your data consists of only integers, then it is usually discrete.

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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Example 19

Scatterplot with Homeownership Rate on the vertical axis and Percent of Units in Multi-Unit Structures on the horizontal axis. Labeled points: Thomas County, KS. (18.3%, 65.1%); Washington D.C. (43.5%, 61.7%); St. Louis, MO (53.5%, 47.2%); Charlottesville, VA (43.5%, 41.3%); San Fransisco, CA (66.6%, 37.5%).

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It is impossible to be both associated and independent.

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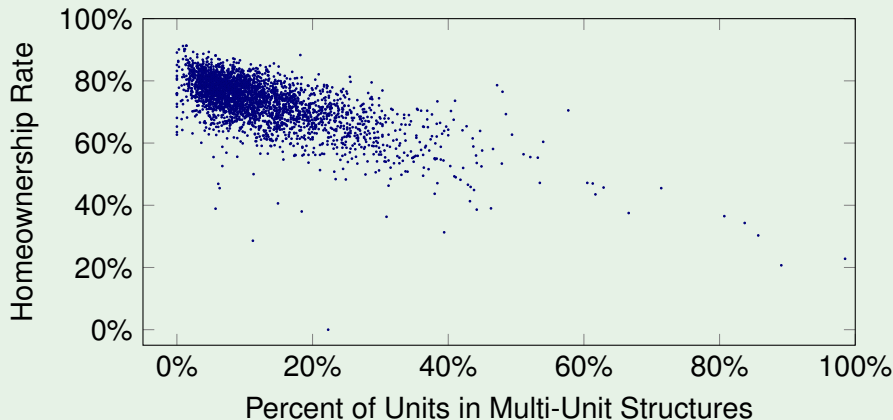
Are the Multi-Unit Structure Rate and the Homeownership Rate associated?

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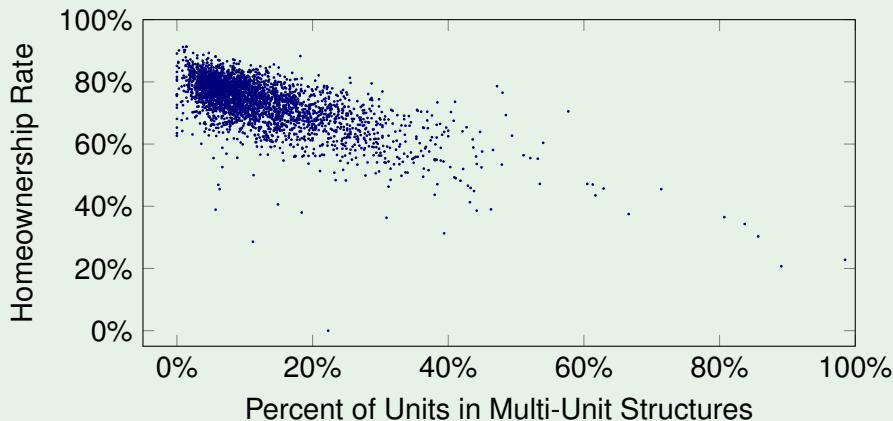
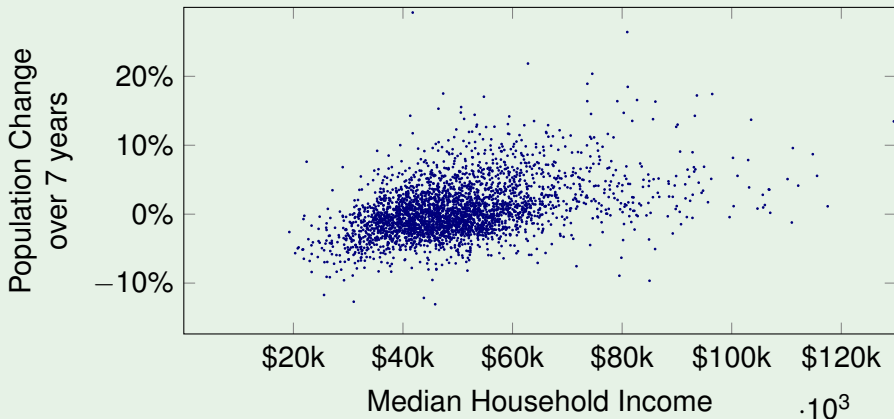*Are the Multi-Unit Structure Rate and the Homeownership Rate associated?*

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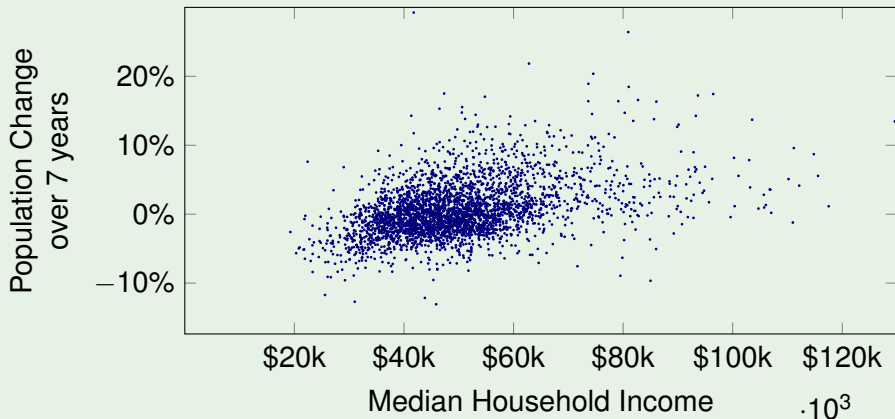
Example 21

Are the Median Household Income and the Population Change associated?

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Consider the question:

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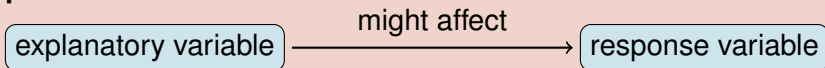
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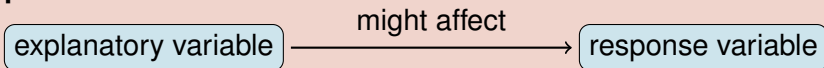
Note

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.