Correlation (part 2)

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Introduction

- The last presentation introduced Pearson's **correlation coefficient** as summary measure used to describe the relationship between two quantitative variables
- This presentation will cover several misconceptions and common mistakes when applying the correlation coefficient

Mistake #1 - Non-linear Relationships and Outliers

From Cook & Swayne's *Interactive and Dynamic Graphics for Data Analysis*:

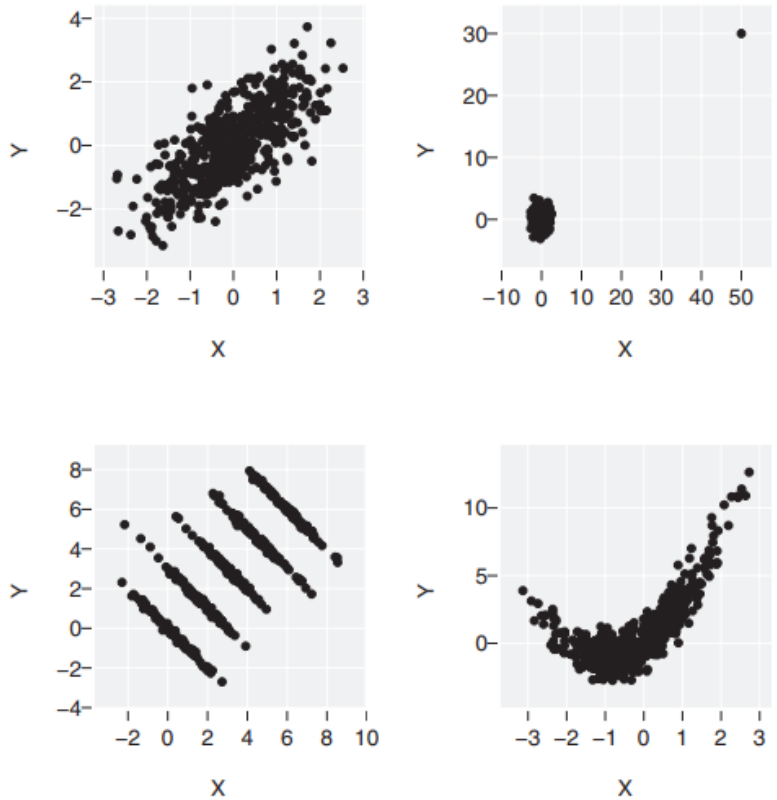


Fig. 6.1. Studying dependence between X and Y. All four pairs of variables have correlation approximately equal to 0.7, but they all have very different patterns. Only the top left plot shows two variables matching a dependence modeled by correlation.

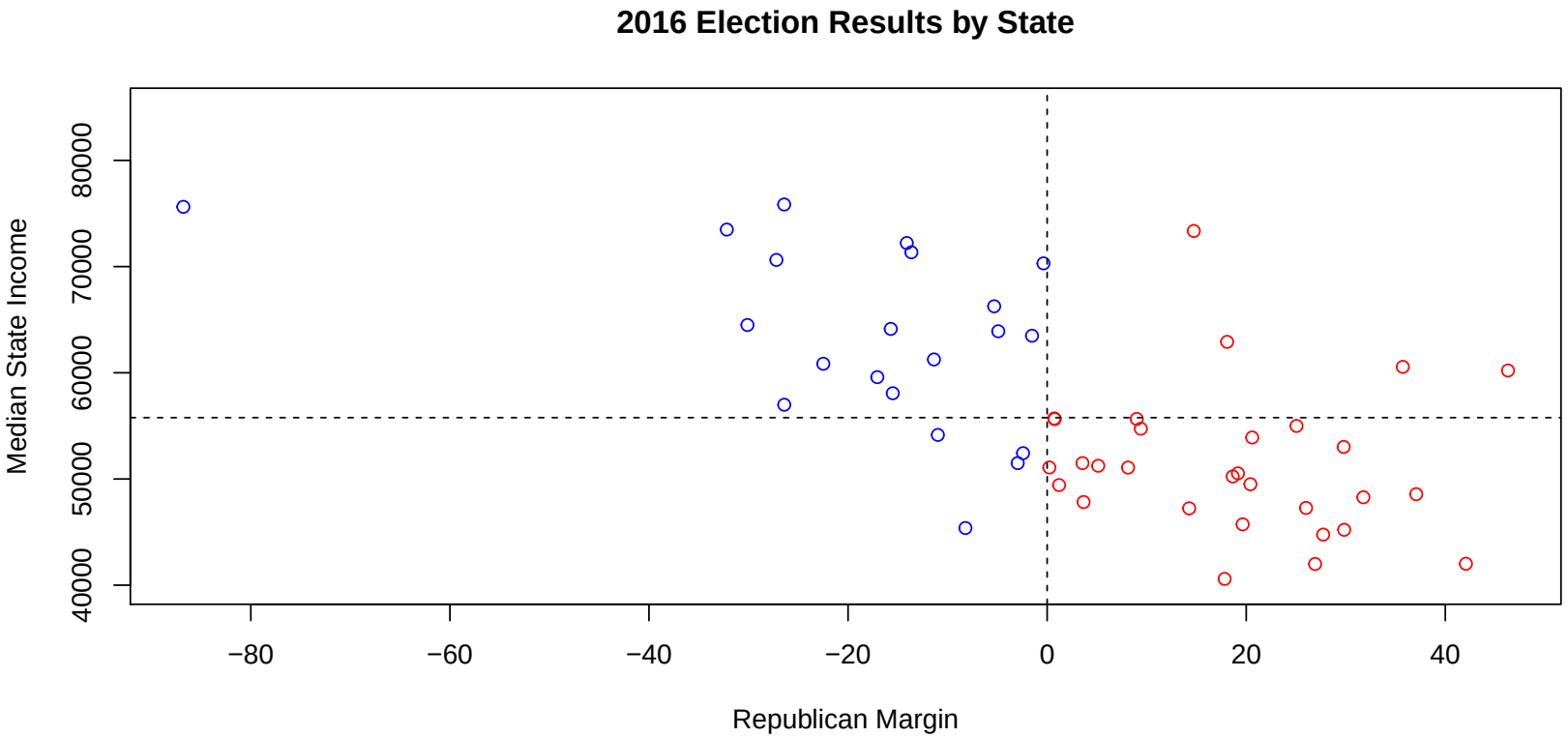
Advice

- Always check the scatterplot before blindly jumping to the correlation coefficient
- Do not report the correlation coefficient in situations where it can be misleading (outliers, non-linear relationships, omitted variables)

Mistake #2 - Ecological Correlations

- **Ecological correlations** compare variables at an ecological level (ie: The cases are aggregated data - like countries or states)
  - There is nothing inherently bad about this type of analysis, but the results are often misconstrued
- Let's look at the correlation between a US state's median household income and how that state voted in the 2016 presidential election

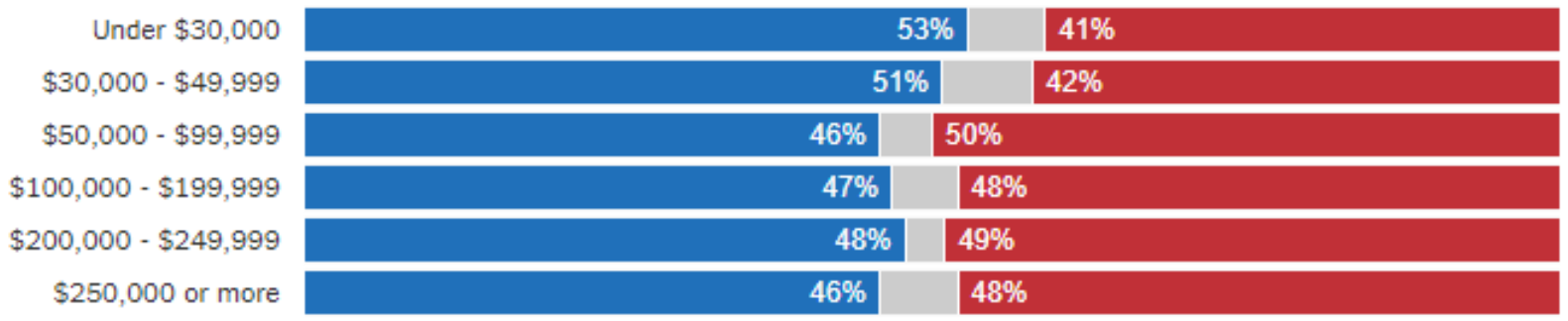
Ecological Correlations



- $r = -.63$, so do republicans earn lower incomes than democrats?

The Ecological Fallacy

Using 2016 exit polls, conducted by the NY Times (Link), we can get a sense of how party vote and income are related *for individuals*:



- Looking at individuals as cases there is an opposite relationship between political party and income

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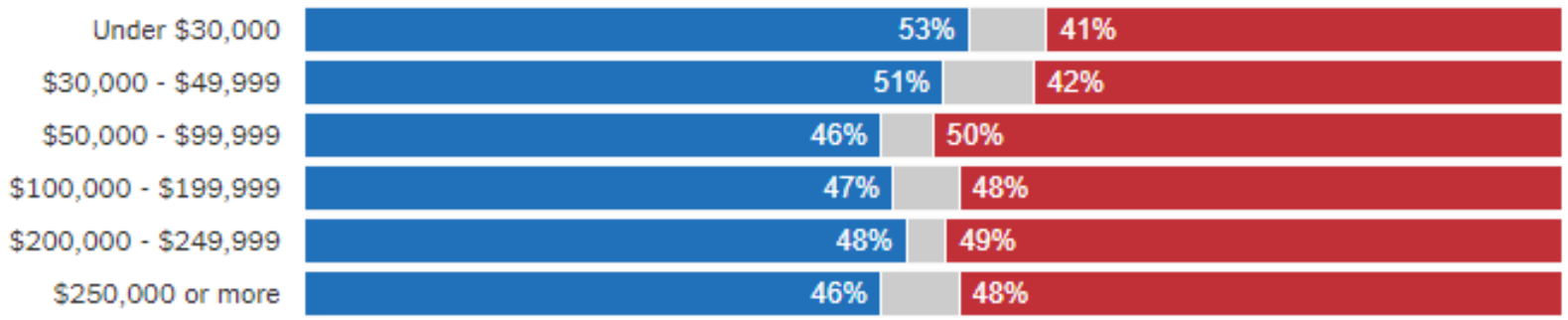
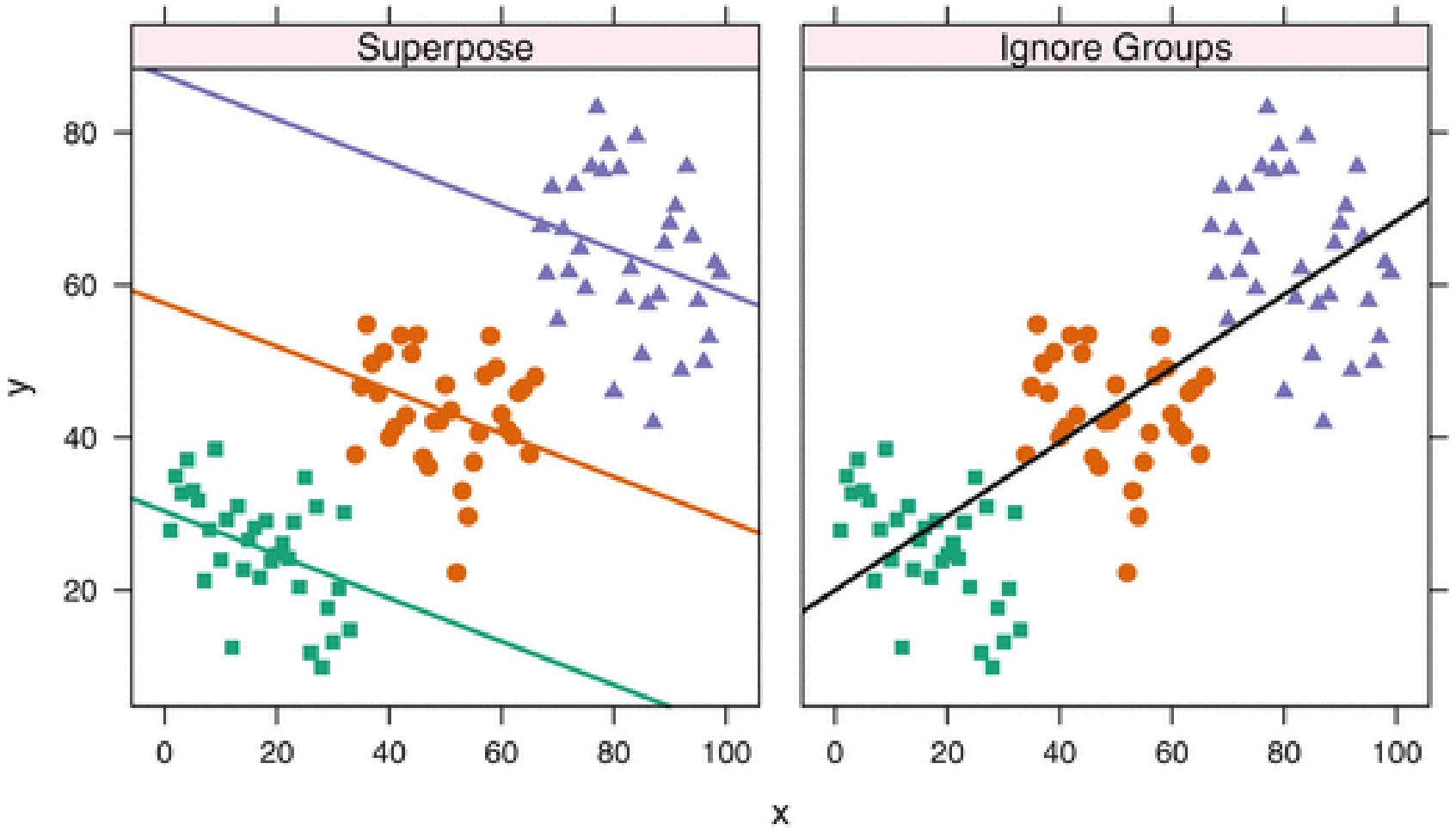


- Looking at individuals as cases there is an opposite relationship between political party and income
- This "reversal" is an example of the **ecological fallacy**
  - Inferences about individuals cannot necessarily be deduced from inferences about the groups they belong to
  - The lesson here is we should use data where the cases align with who/what we're aiming to describe

Ecological Fallacy

The ecological fallacy can result from ignoring an important grouping variable:



Advice

- Always base your analysis around cases you're actually interested in
  - For example, analyze states when you're actually interested in talking about people
- Always explore your data thoroughly by considering scatterplots that color the points by group