UCLA College | Physical Sciences
Statistics

STATS 10 - Chapter 2
Descriptive Statistics and Visualizing Data

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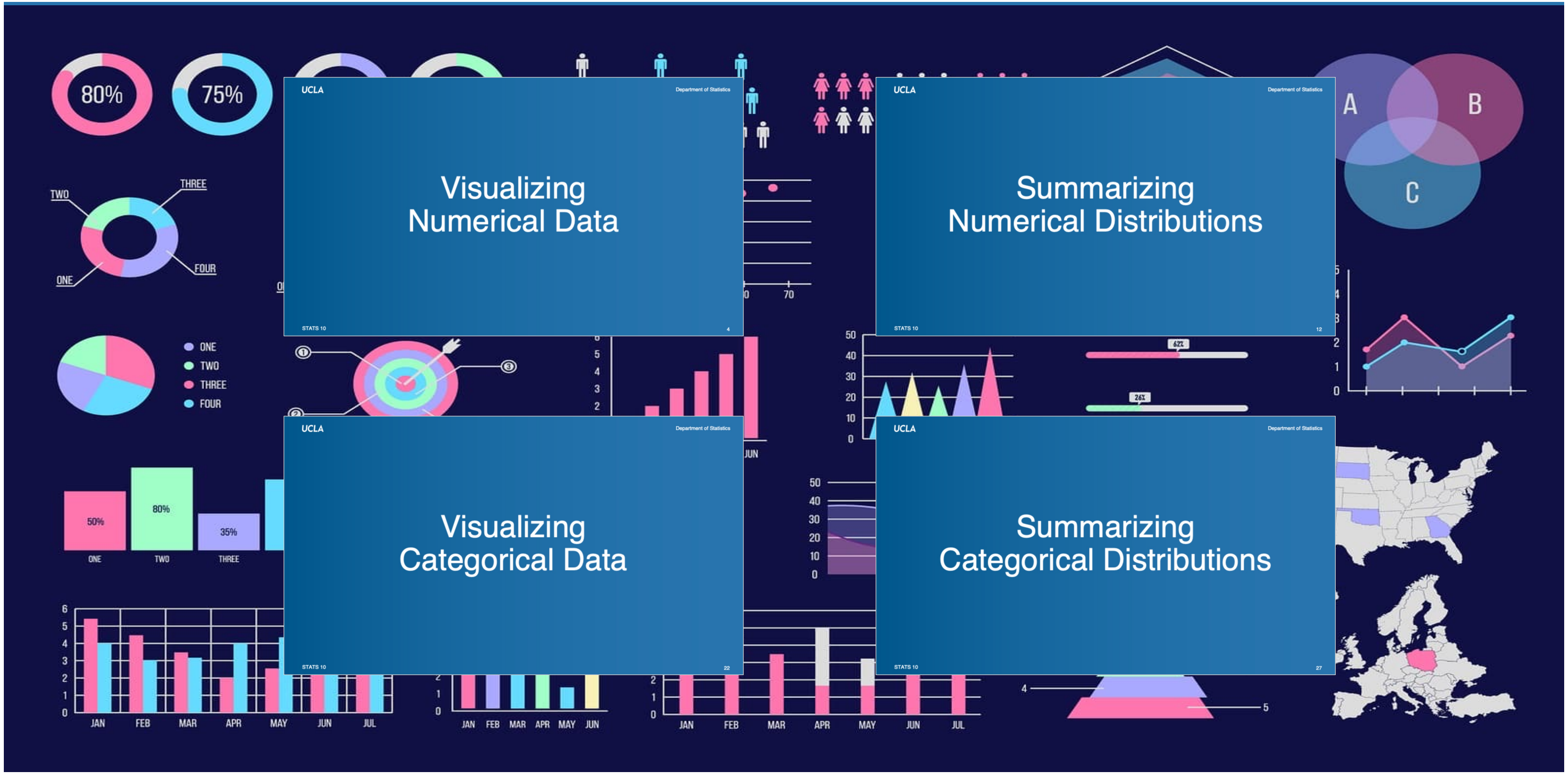
Department of Statistics

Topics



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Visualizing Numerical Data

STATS 10 4

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Summarizing Numerical Distributions

STATS 10 12

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Visualizing Categorical Data

STATS 10 22

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Summarizing Categorical Distributions

STATS 10 27

Examining Distributions

Distribution -- The most important tool for organizing the variation in data.

what values the variable takes, and how often the variable takes those values.

Distributions are important because:

- Make comparisons between groups
- Examine data for errors
- Learn about real-world processes

Graphics can be extraordinarily powerful ways of organizing data, detecting patterns and trends, and communicating findings.

Visualizing Numerical Data

Dot Plot

Construct a dot plot:

Put a dot above a number line for each value occurs in the data.

If a value occurs more than once, we stack dots on top of each other.

Example:

Here are the launch-temperatures of the first 25 shuttle missions (in degrees F) in the U.S.

66,70,69,80,68,67,72,70,70,57,63,70,78,67,53,67,75,70,81,76,79,75,76,58,29

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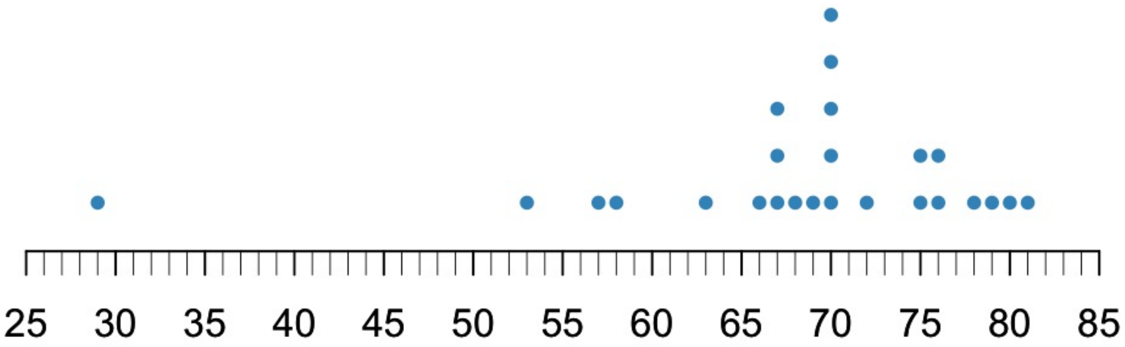
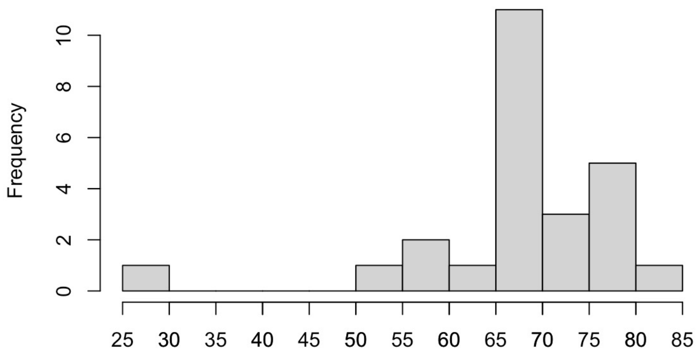


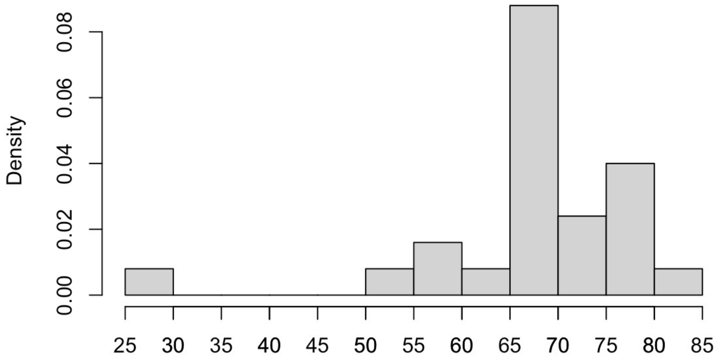
Histogram

Construct a histogram:

1. Group data into **intervals (bins)** of equal width.
2. Count the number of observations that fall into each bin.
3. Draw a vertical bar over the bins, the height is the proportional to the frequency in each interval.

Changing the vertical scale (**frequency/density)** does not change the shape





Example

Exam grades

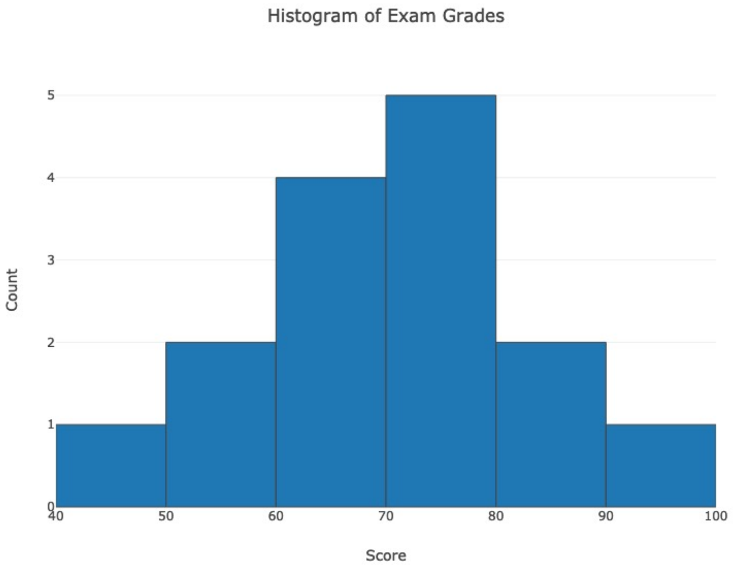
88, 48, 60, 51, 57, 85, 69, 75, 97, 72, 71, 79, 65, 63, 73

1. Choose intervals: e.g., 10 points wide, [40-50), [50-60), …, [90-100]
2. Count:

Score	**[40, 50)**	**[50, 60)**	**[60, 70)**	**[70, 80)**	**[80, 90)**	**[90, 100]**
Count						

Example

Score	[40, 50)	[50, 60)	[60, 70)	[70, 80)	[80, 90)	[90, 100]
Count	1	2	4	5	2	1

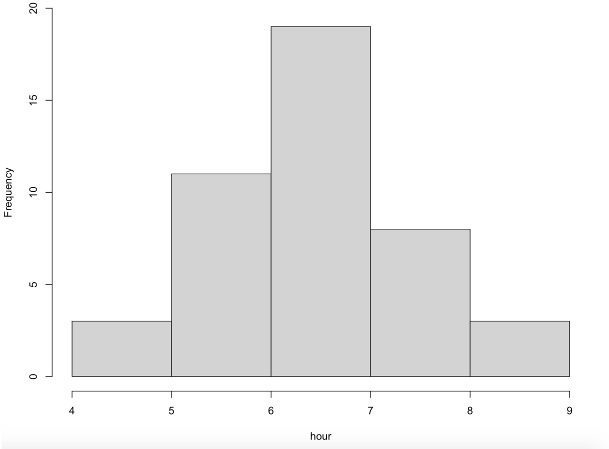


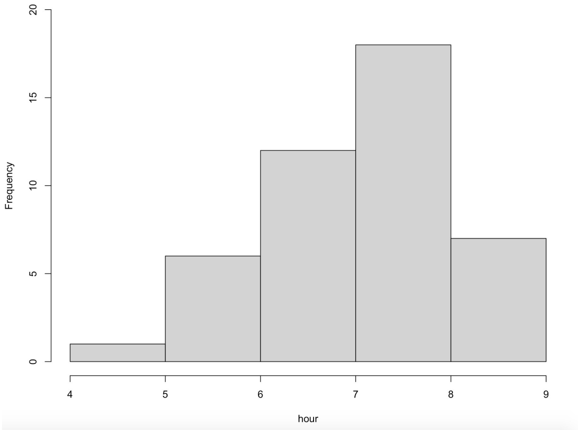
Boundary points

Observations may land right on the edge (or boundary) of two bins. We need to decide which bin these edge cases would fall into.

- Put "boundary" observations in the bin on the left.
  Then 5 would go into the bin from 4 to 5.
- Put "boundary" observations in the bin on the right.
  Then 5 would go into the bin from 5 to 6.

Be consistent!

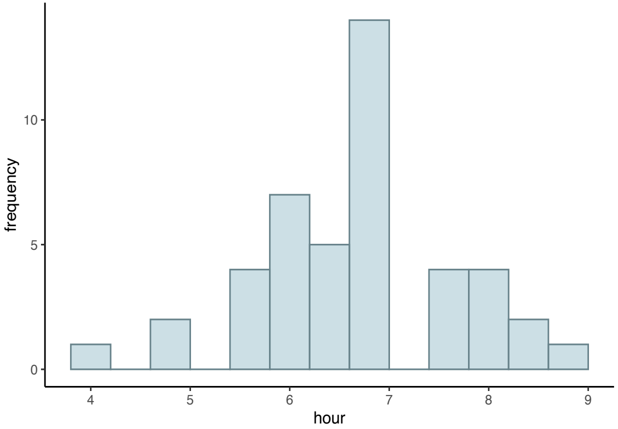


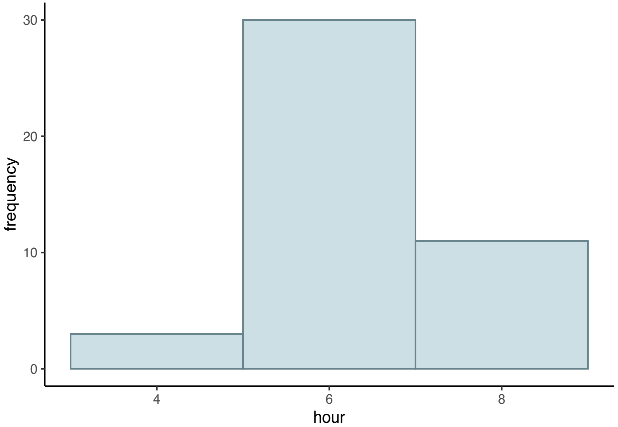


Histogram Bin Widths

- Bin width is the width of the interval.
- Changing the width of the bins in a histogram changes its shape.
- Too many bins show too much detail while too little bin shows too little.

[Data source] [Plot tool]





Summarizing Numerical Distributions

Important Features of a Numerical Distribution

When describing a numerical distribution, we should consider the following features:

Shape

Center (Typical Value)

Spread (Variability)

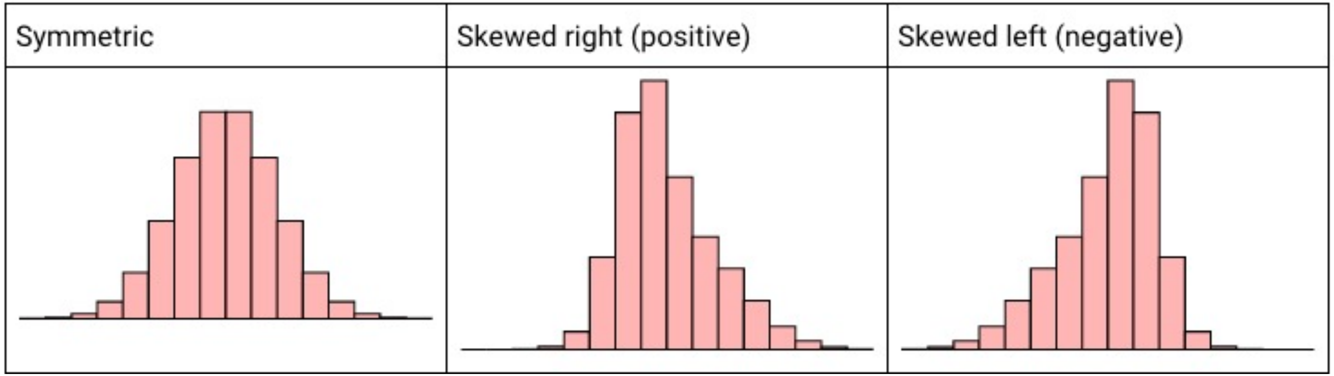
Outliers

Shape I – Symmetry/Skewness

Symmetric: left and right side roughly the same

Skewed:

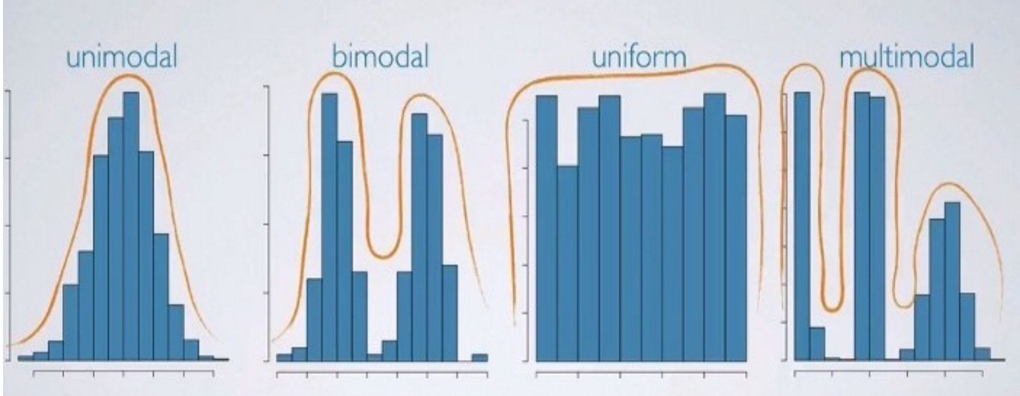
- Right-skewed/positively skewed: tail goes to the right
- Left-skewed/negatively skewed: tail goes to the left
- The right- and left-skewness refers to the direction of the tail, not to where the bulk of the data is.



Shape II -- Modality

Number of modes (peaks)

- **Unimodal**: single mode
- **Bimodal**: two modes
- **Multimodal**: more than two modes
- **Uniform**: no apparent peaks

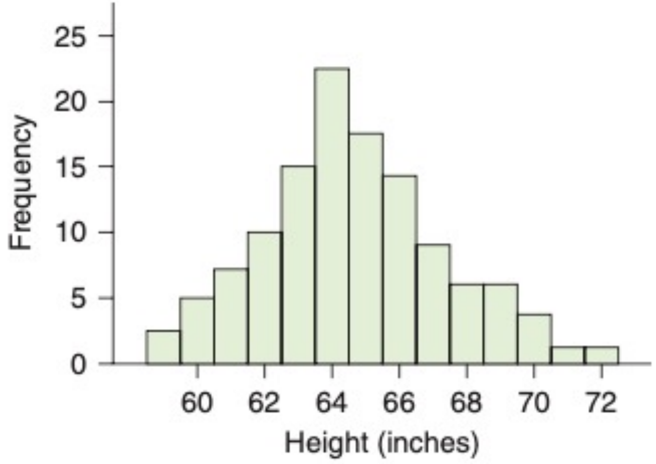


Center I

The typical data value

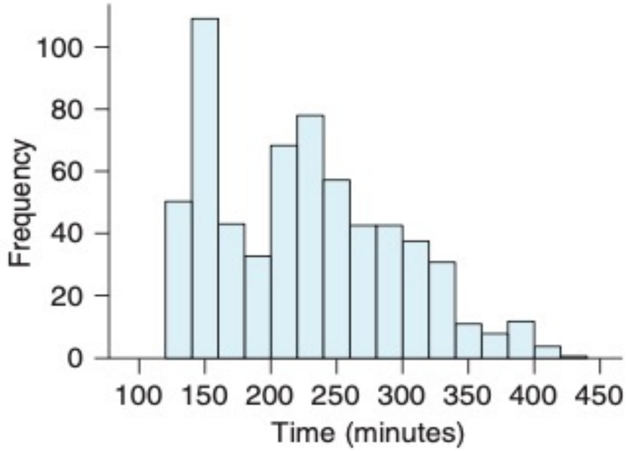
What are the typical values for the following examples?

123 college women’s heights



The finishing times for two different marathons.

- Marathon in the 2012 Olympic Games
- A marathon in Portland, Oregon



Center II

Numerical variables are often summarized using numbers to communicate their central tendency.

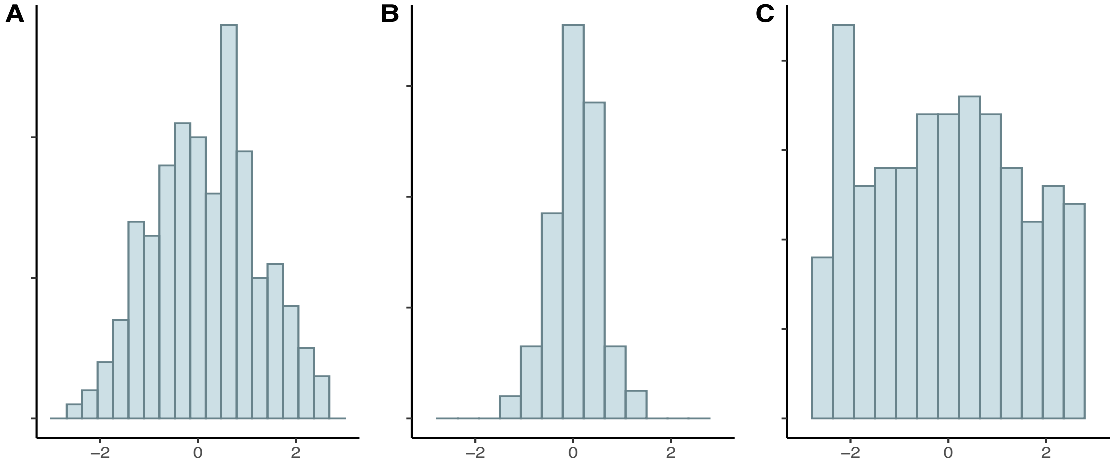
Different measures for the center

- **Mean:** the average of observed data values
- **Median:** the middle value that divides the ordered data into half
- **Mode:** the most frequent value

Spread / Variability

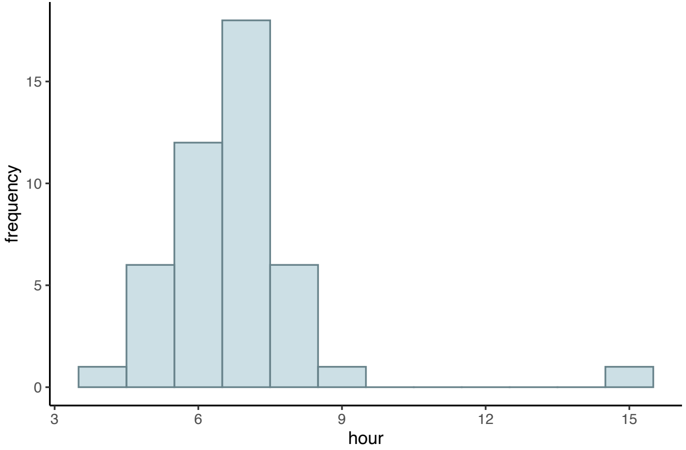
How spread out the data is from the center

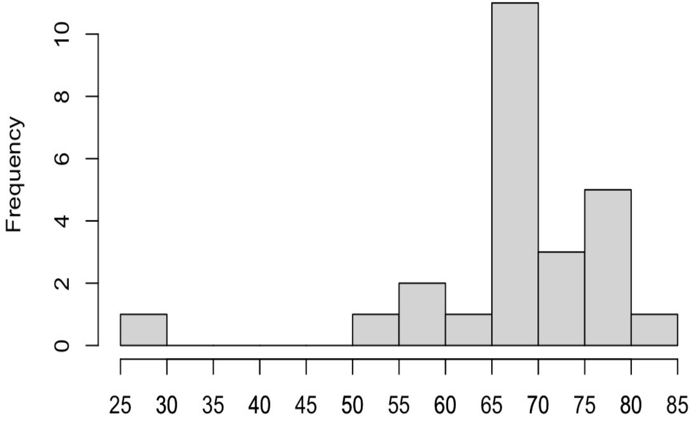
- The data values are tightly clustered around the center, little variability
- Data values are scattered far from the center, high variability



Outliers

- Extremely small or large values
- Data values that don’t fit into the pattern of the distribution





Any potential outliers should be identified and investigated.

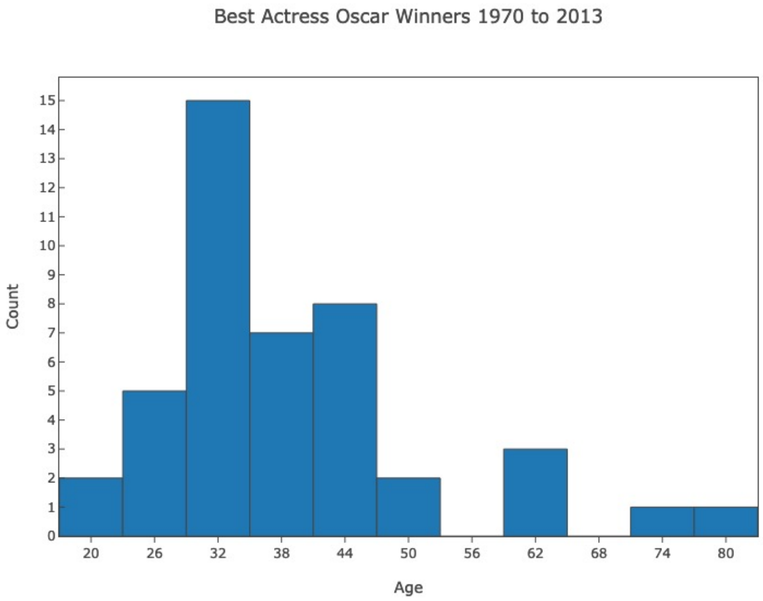
Summarizing a Numerical Distribution

Checklist:

- **Shape**
  - Is the distribution symmetric or skewed?
  - How many peaks are there?
- **Center**
  - Where do most of the values lie?
  - What is the typical value(s)?
- **Variability**
  - How much variability is there?
  - Are the data values clustered closely together, or spread far apart?
- **Outliers**
  - Any extreme/unusual value?

Exercise

Best Actress Oscar Winners



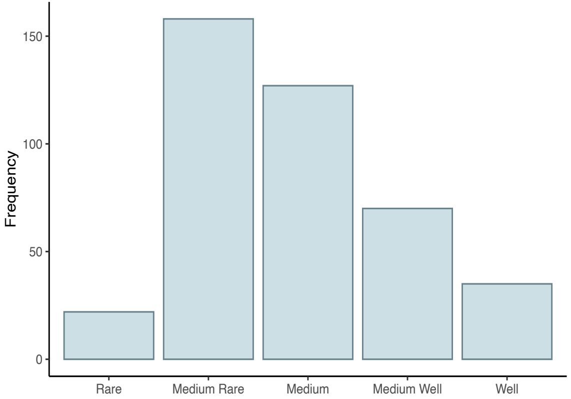
Visualizing Categorical Data

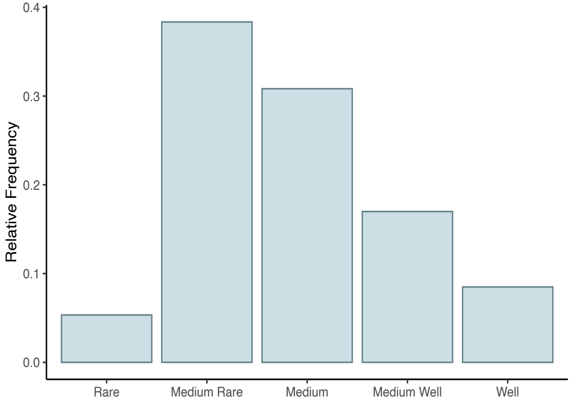
Bar Chart

- Horizontal axis – data categories
- Vertical axis – (relative) frequency for each category

Example: Steak preference of 412 American steak eaters [StatCrunch]

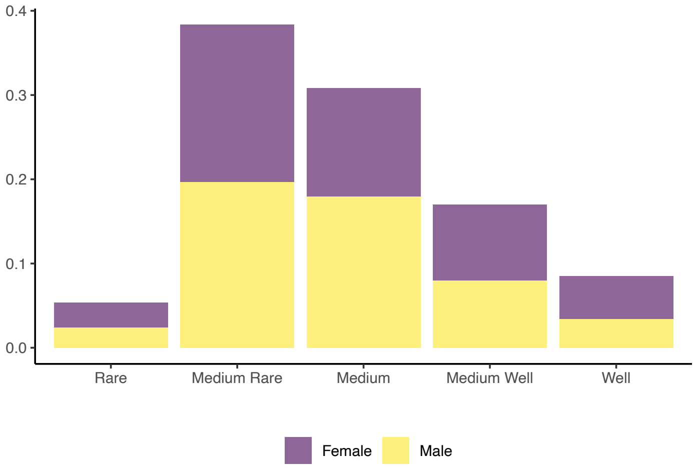
Preference	Rare	Medium Rare	Medium	Medium Well	Well
Frequency	22	158	127	70	35



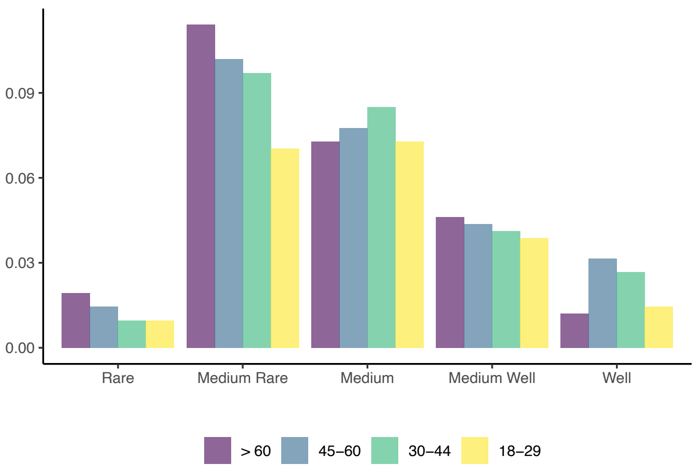


Grouped Bar Chart

Stacked Bar Chart



Side-by-Side Bar Chart



Bar Chart vs. Histogram

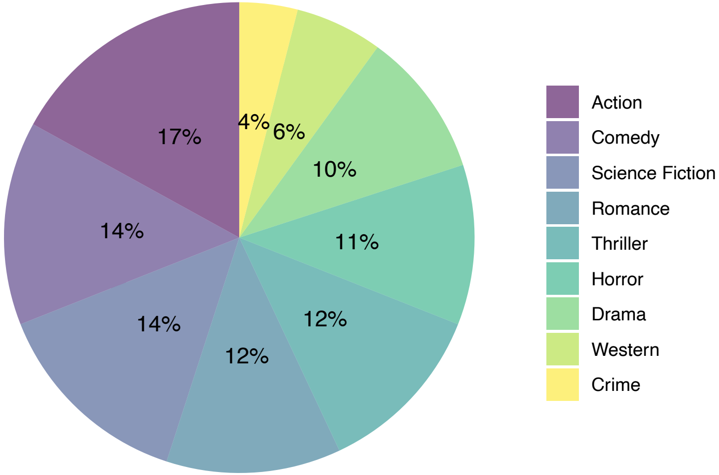
	Bar Chart	Histogram
Data	Categorical	Numerical
Bars	Usually do not touch; Gaps in between	Usually touch; Gap indicates no values
Bar width	Does not matter; No meaning	Width matters; Width same for all bars
Order	Order can change	X-axis values sorted in ascending order

Pie Chart

A circle divided into pieces. Each piece represents a **category** in the data, and the area of each piece is proportional to the **relative frequency/percentage** of the subjects in each category.

The percentages should sum up to 1.

Example: favorite type of movie [StatCrunch]



Summarizing Categorical Distributions

Describing a Categorical Distribution

Two main components:

- **Mode**: typical outcome, category of the highest frequency
  - There may be more than one mode if more than one value is tied for occurring most frequently
- **Variability/Diversity**
  - If many observations spread across many different categories, then the variability is high
  - If many observations fall into the same categories, then the variability is low

Choose a Graph

Which graph would you choose to visualize the data below?

Cell Phone Use	0-4 hours	4-8 hours	9-12 hours	12+ hours
Female	7	9	5	4
Male	10	5	4	1

A. Histogram
B. Dot plot
C. Pie Chart
D. Side-by-Side Bar Chart

Misleading Graphs

Misleading Graphs

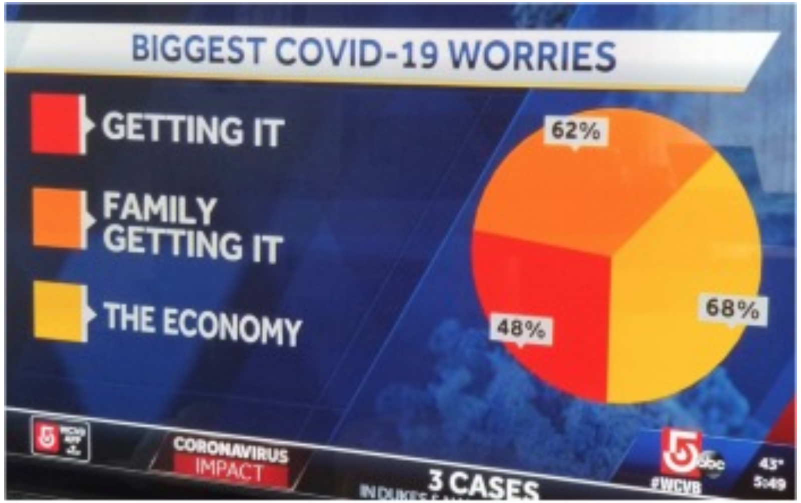
Caution!

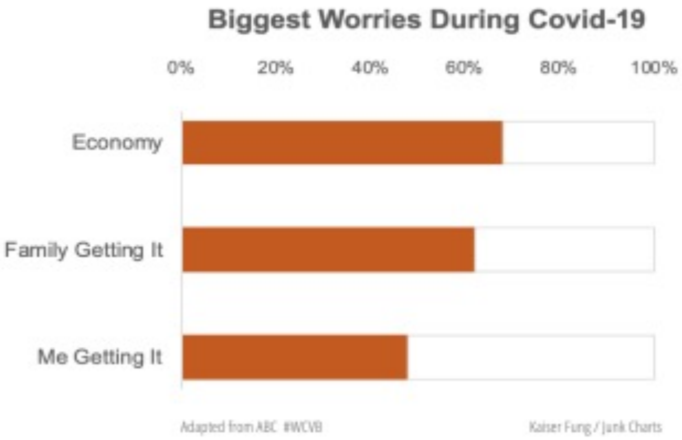
Misleading graphs play tricks with our eyes and lead to wrong conclusions.

- **Using the wrong chart**
- **Inappropriate scaling**
  - Omitting the baseline, starting at a value other than 0
  - Manipulating y-axis
- **Using symbols of different sizes rather than bars of equal width**
- **Lack of labels**

Example I

What's wrong with this chart?

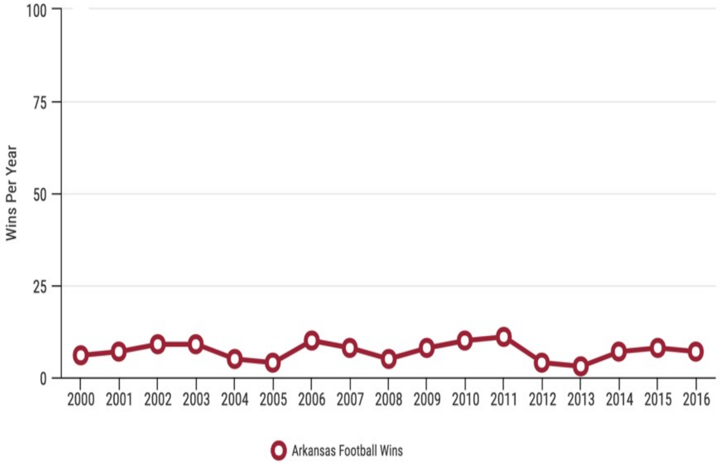


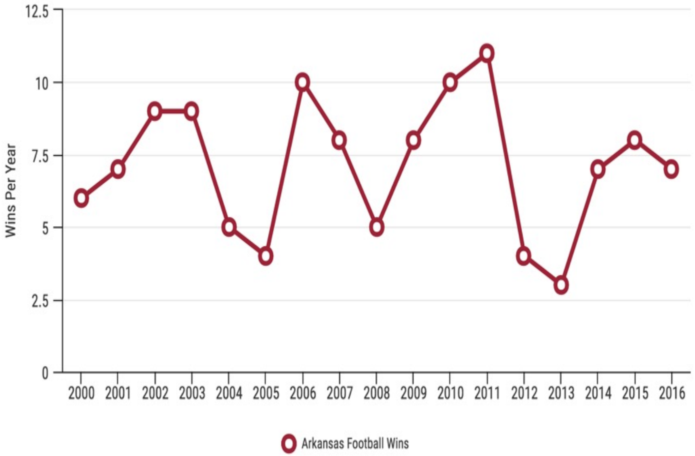


$$62\% + 48\% + 68\% \; = \; 178\% \neq 100\%$$

Example II

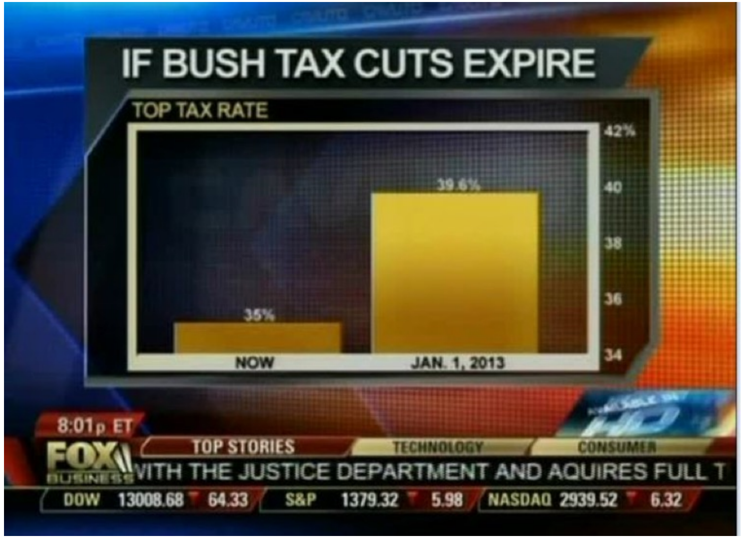
What's wrong with this chart?

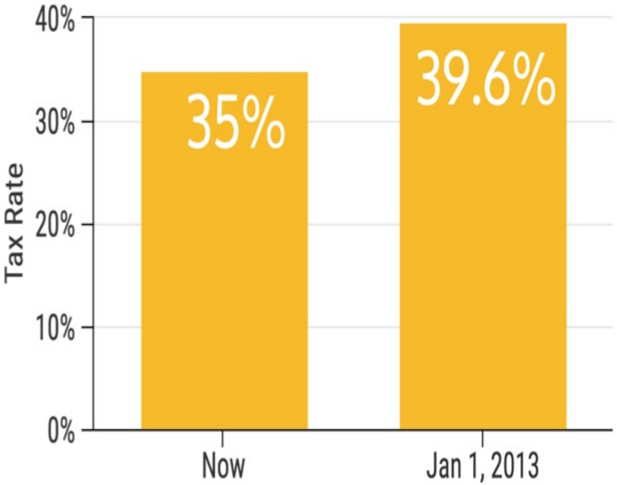




Example III

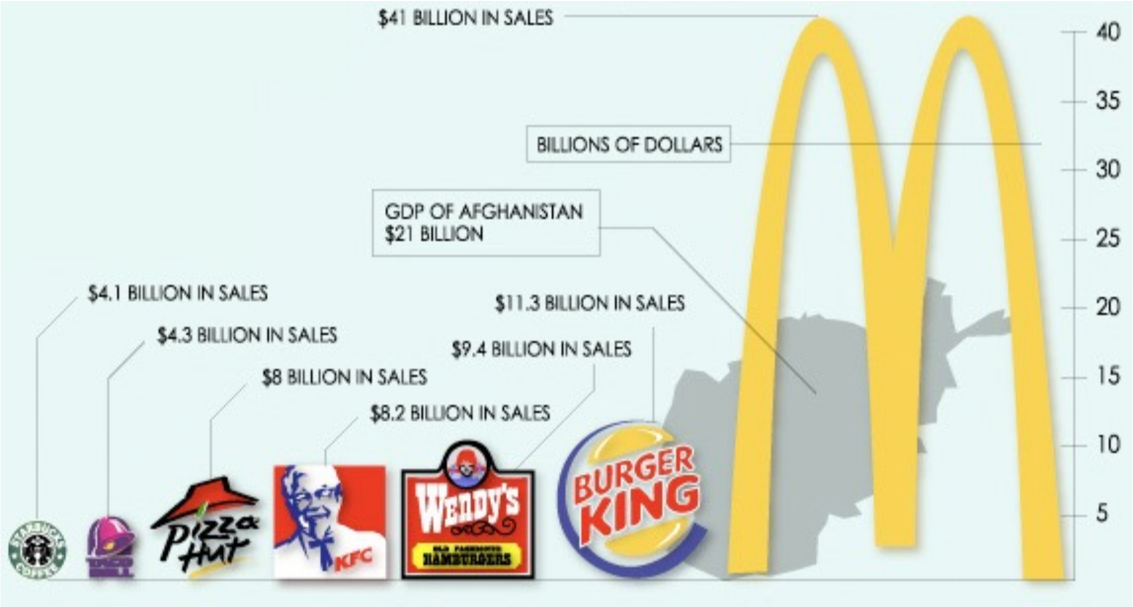
What’s wrong with this chart?



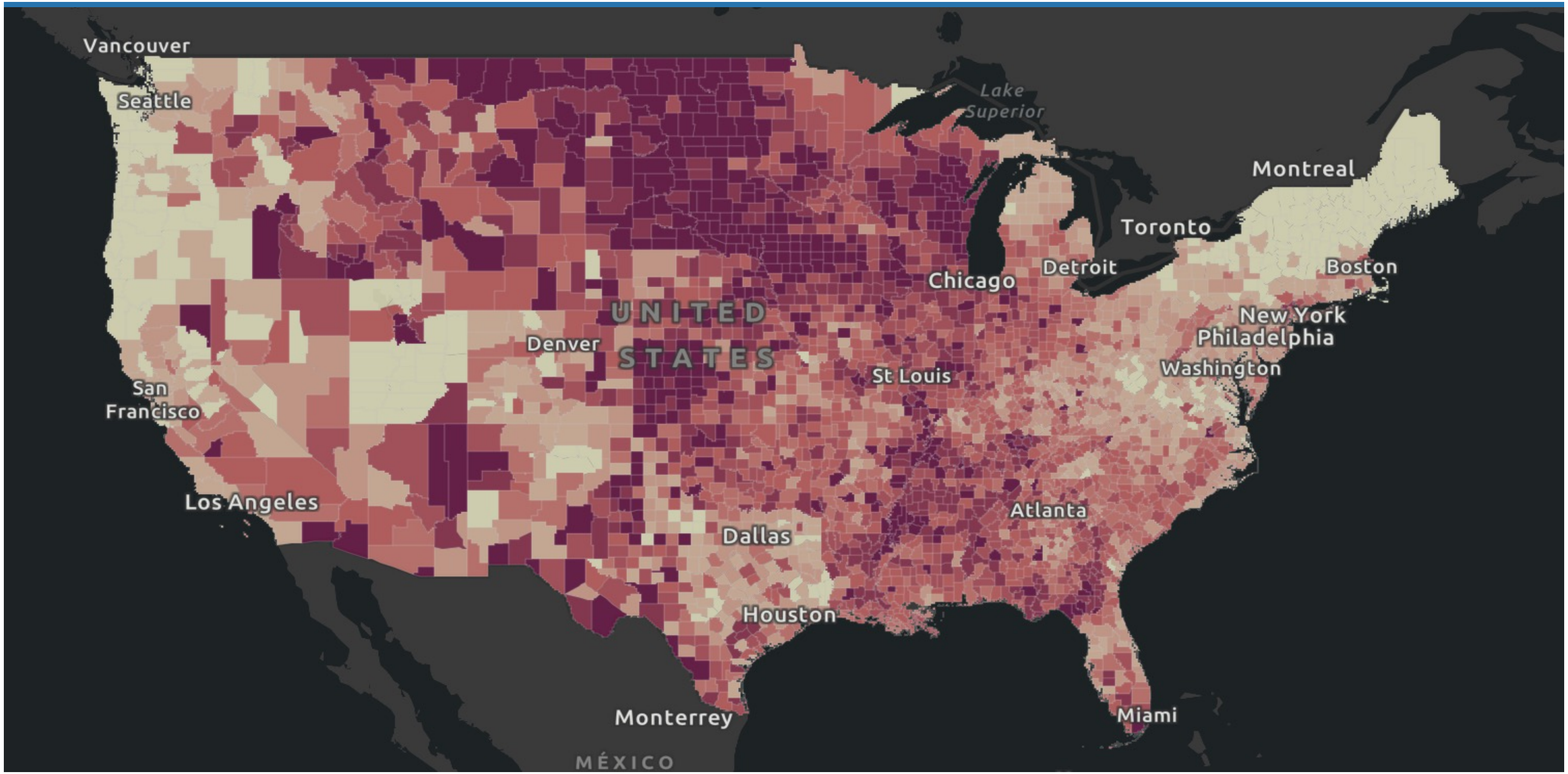


Example IV

What's wrong with this chart?



Other Visualizations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