EMORY UNIVERSITY | Office of the Senior Vice President for Research

Introduction to Descriptive Research Administration Statistics using Excel

Research Analytics Summit
March 2024

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Agenda

- Emory University's Research Enterprise
- Research Data Analytics Team and Roles
- NSF HERD Survey Quick Overview
- Data Management and Quality (always important!)
- Descriptive Statistics in Excel
  - Central Tendency: Mean vs Median
  - Variation: Standard Deviation
  - Correlation
  - Outlier detection
- Sample charts and best practices
- Q&A

Emory University's Research Enterprise

- Atlanta, GA
- R1:Very high research activity
- FY23 NSF HERD TRE >$1B
- About 61% Total Federal
- About 26% Total Institutional
- About 66% Health Sciences
- Most of that is from NIH

Research Data Analytics Team and Roles

- Formed in October 2020 and build out since
- 4 Full-Time, 1 Temporary Part-Time, 1 Intern
- Support ORA and SVPR
- Vision: Best Research Administration Unit in the nation
  - #1: Develop Strong and Supported Workforce
  - #2: Pursue and Reach Operational Efficiency
  - #3: Built Robust and Resilient Infrastructure
- Strategic and Competitive Analysis
- Everyone is required to train in Research Administration
- Tools reach from Excel, SQL Developer, Oracle Analytics, SPSS, JMP, PowerBI to Tableau

NSF HERD Survey Quick Overview

- Higher Education Research and Development (HERD) Survey
- Primary source of data on R&D expenditures in higher ED
- More than 900 institutions annually (>$150,000
- Most recent publicly available survey is from FY22
- https://ncses.nsf.gov/surveys/higher-education-research-development/2022#data
- Table 22. Higher education R&D expenditures, ranked by all R&D expenditures, by source of funds: FY 2022

Data Management and Quality (always important!)

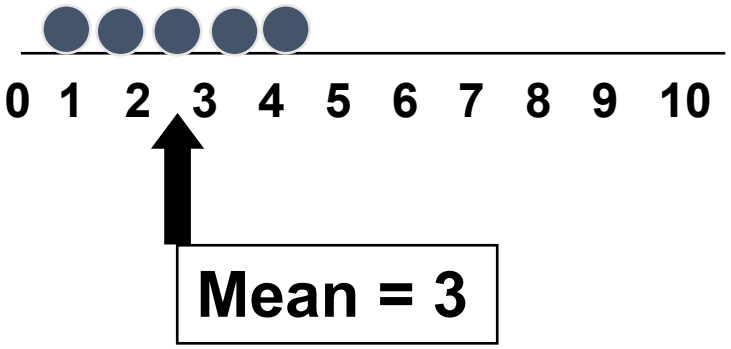
- Data rarely comes in a clean form for analysis
- Always carefully review data and context
- Data cleaning and transformations can be 80% of the work
- See examples in NSF HERD Survey Table 22
    - Dollar amounts are in thousands of dollars
    - Headers and footnotes
    - Extra and blank columns
    - NA as a data point

Descriptive Statistics in Excel: Central Tendency

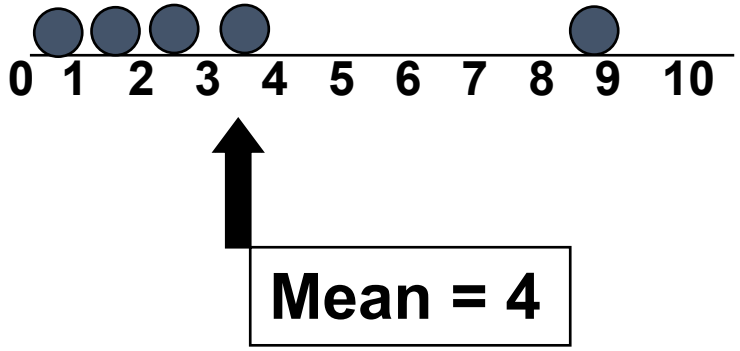
- Mean, most common measure, simple average
- Median, the middle number 50% above and below
- How to do this in Excel
  - More than 1 option
  - Long way
  - Pivot Tables for means only
  - Data Analysis Add-In

The Arithmetic Mean

- The most common measure of central tendency
- Mean = sum of values divided by the number of values
- Affected by extreme values (outliers)



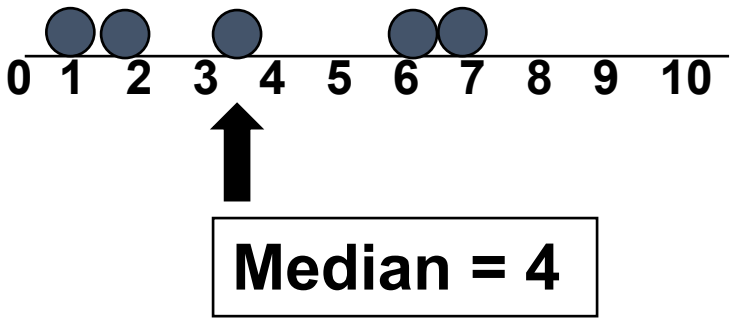
$$\frac{1+2+3+4+5}{5} = \frac{15}{5} = 3$$

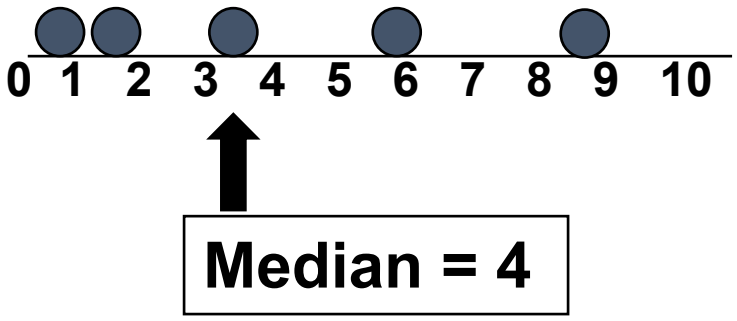


$$\frac{1+2+3+4+10}{5} = \frac{20}{5} = 4$$

The Median

- In an ordered array, the median is the “middle” number (50% above, 50% below)





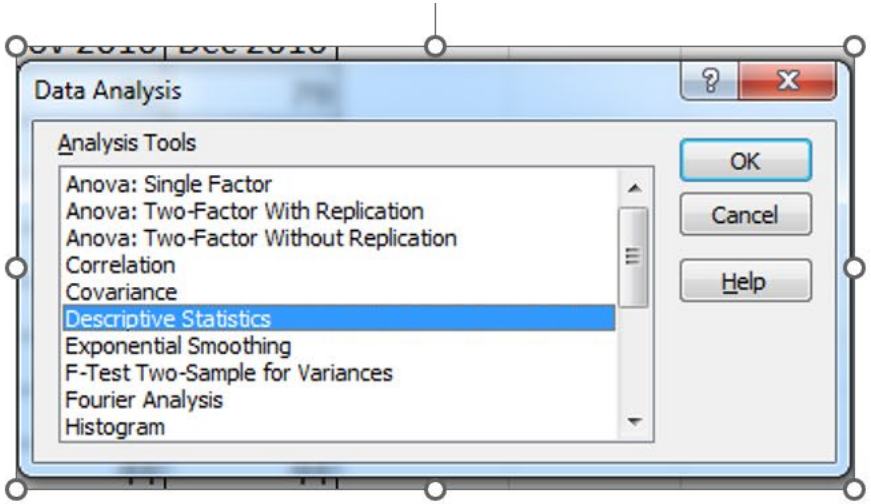
- Less affected by extreme values

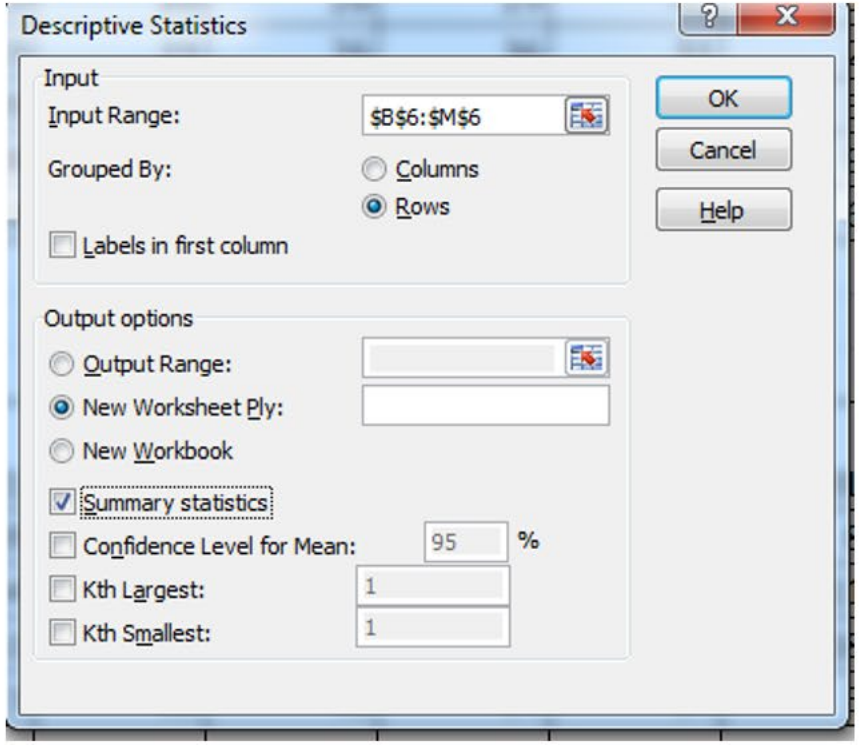
Which measure to choose?

- The **mean** is generally used, unless extreme values (outliers) exist.
- Then **median** is often used, since the median is not sensitive to extreme values. For example, median stolen property values may be reported for a city; it is less sensitive to outliers.

MS Excel Statistics Tools

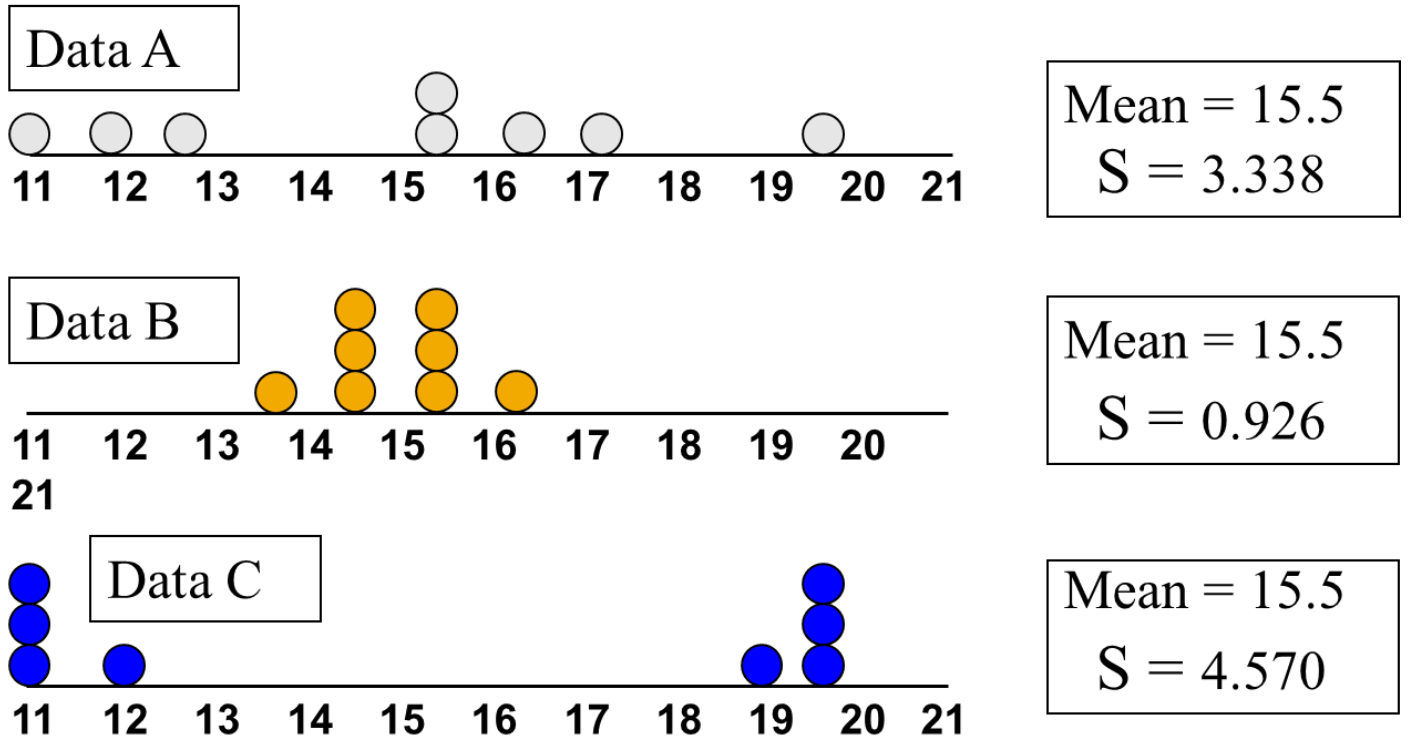
- You could enter the formula, or use the formula tool in Excel … OR….
- Use the Analysis tool Pak





Descriptive Statistics in Excel: Variation Standard Deviation

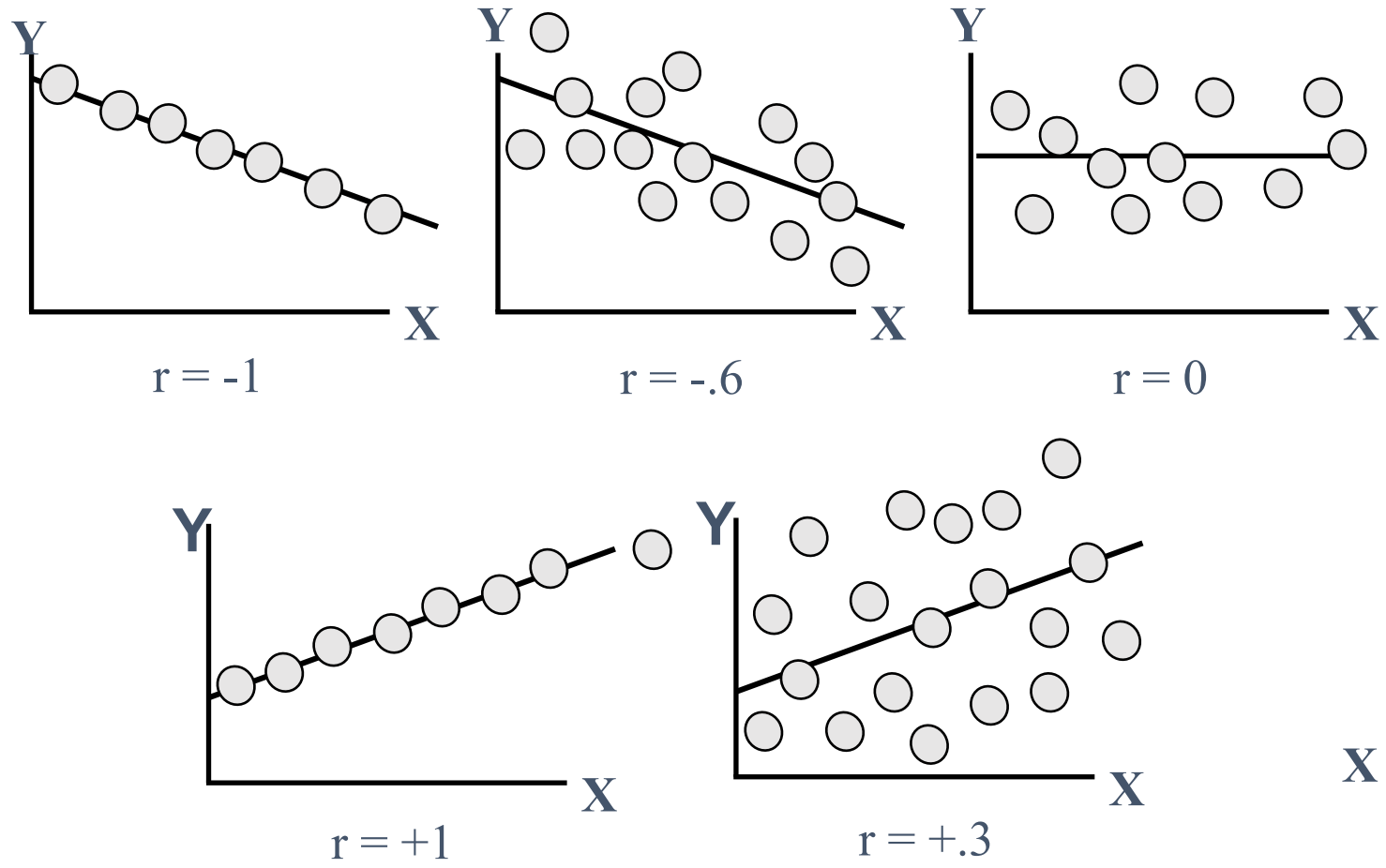
- Most commonly used measure of variation
- Shows variation about the mean
- Has the same units as the original data



Correlation

- Correlations measures the relative strength of the ***linear*** relationship between two variables.
- Unit free
- Ranges between –1 and 1
- The closer to –1, the stronger the negative linear relationship
- The closer to 1, the stronger the positive linear relationship
- The closer to 0, the weaker any linear relationship

The Correlation Coefficient



What does it mean?

- Typically:
- greater than .7 = strong correlation
- between .4 and .7 = moderate correlation
- between .2 and .4 = weak correlation
- below .2 = no correlation (similar for negative values)

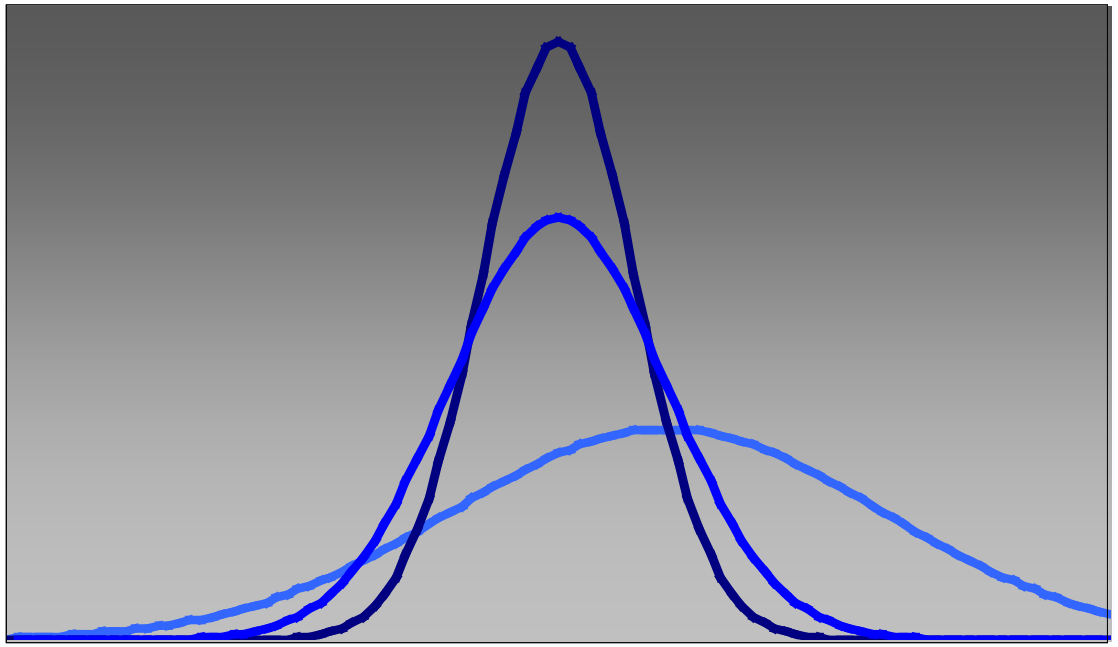
	A	B	C
1		*Row 1*	*Row 2*
2	Row 1	1	
3	Row 2	0.47162	1
4			

Descriptive Statistics in Excel: Outlier Detection

- Outlier Detection
- Why does that matter
- How do to this in Excel

The Normal Distribution aka Bell Curve

- ‘Bell Shaped’ or symmetrical
- Mean, Median and Mode are equal
- Spread is measured by standard deviation
- Infinite number of normal distributions



The Standardized Normal Distribution

- Translate from X to the standardized normal (the “Z” distribution) by subtracting the mean of X and dividing by its standard deviation:

$$Z = \frac{X - \mu}{\sigma}$$

Locating Extreme Outliers Z-Score

$$Z = \frac{X - \overline{X}}{S}$$

where X represents the data value

$\overline{X}$ is the mean

S is the standard deviation

Locating Extreme Outliers Z-Score

- To compute the Z-**score** of a data value, subtract the mean and divide by the standard deviation.
- The Z-score is the number of standard deviations a data value is from the mean.
- A data value is considered an extreme outlier if its Z-score is less than -3.0 or greater than +3.0.
  Note: Applied research -2 and +2
- The larger the absolute value of the Z-score, the farther the data value is from the mean.

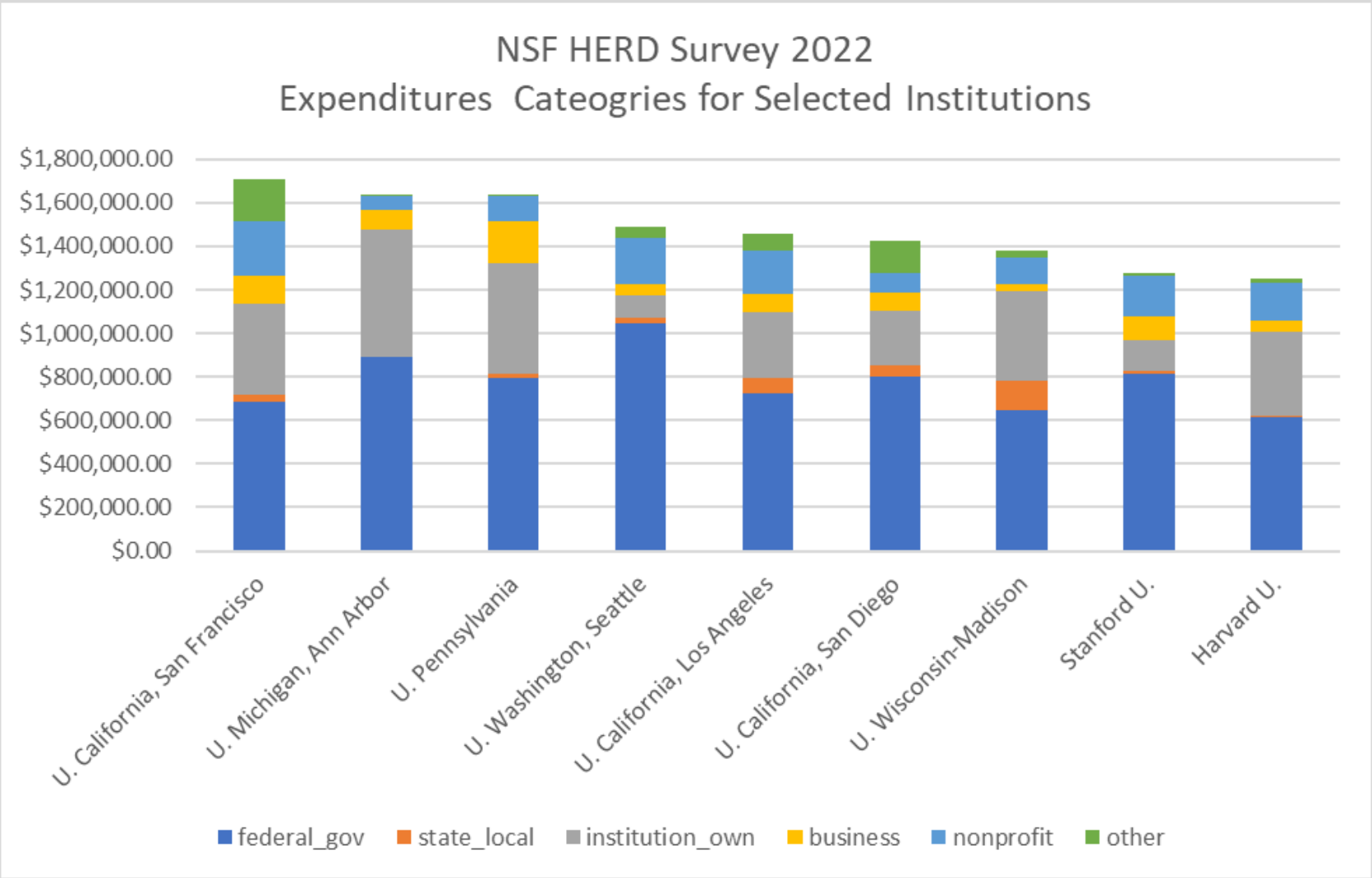
Locating Extreme Outliers Z-Score

- Suppose the mean of the number of proposals submitted is 490 for a month in your fiscal year, with a standard deviation of 100 proposals.
- You just had a month with 620 proposal submissions. Was that a true outlier?
- Compute the z-score for that month.

$$Z = \frac{X - \overline{X}}{S} = \frac{620 - 490}{100} = \frac{130}{100} = 1.3$$

- A score of 620 is 1.3 standard deviations above the mean and would not be considered a true outlier.

Descriptive Statistics in Excel: Sample Charts



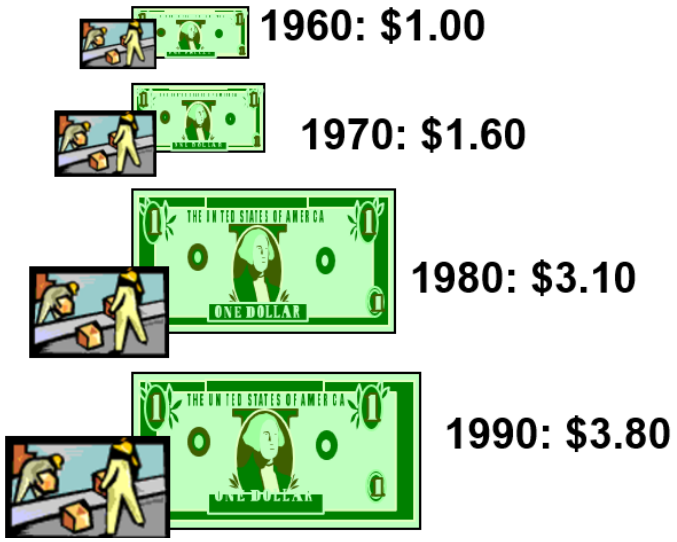
Best Practices for Charts

- The graph should not distort the data.
- The graph should not contain unnecessary adornments (sometimes referred to as chart junk).
- The scale on the vertical axis should begin at zero.
- All axes should be properly labeled.
- The graph should contain a title.
- The simplest possible graph should be used for a given set of data.

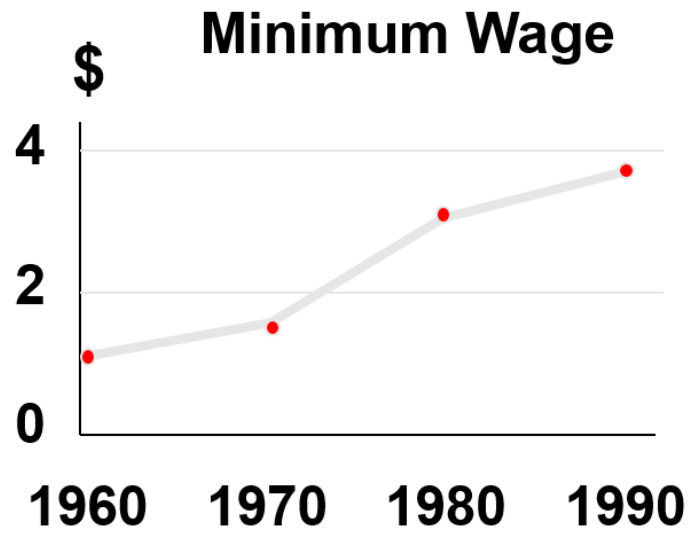
Best Practices for Charts

Graphical Errors: Chart Junk

Bad Presentation



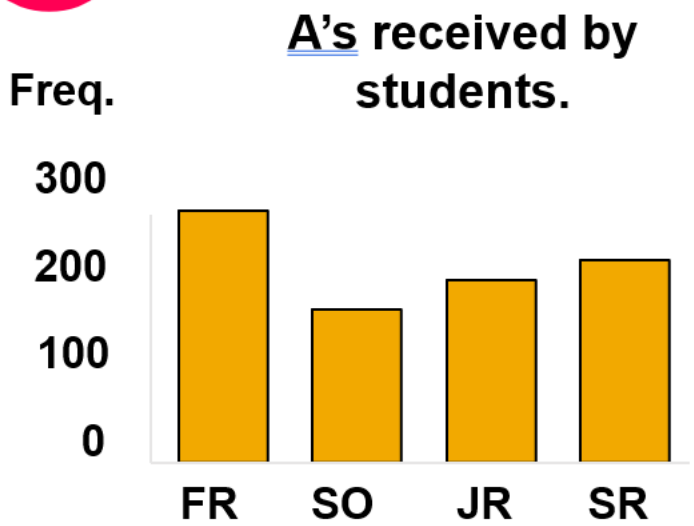
Good Presentation



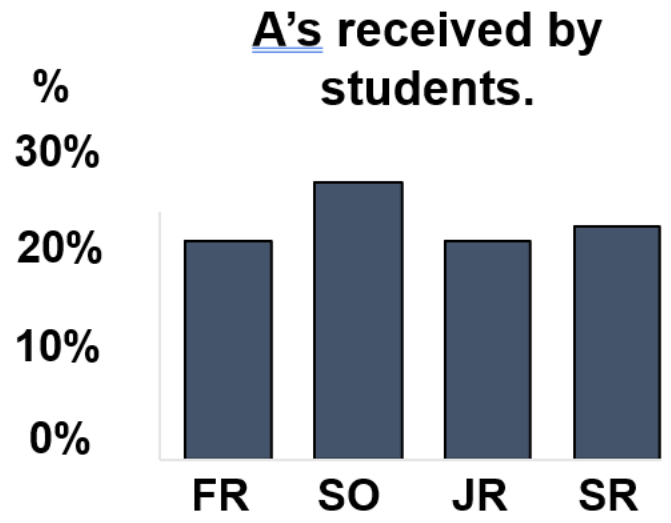
Best Practices for Charts

Graphical Errors: No Relative Basis

Bad Presentation



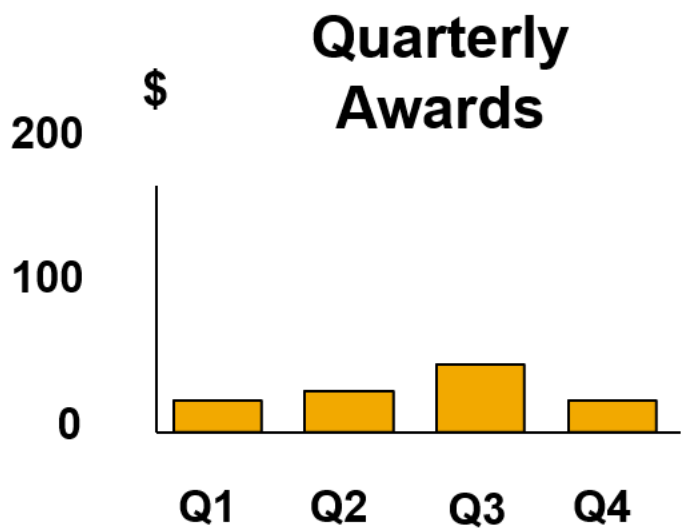
Good Presentation



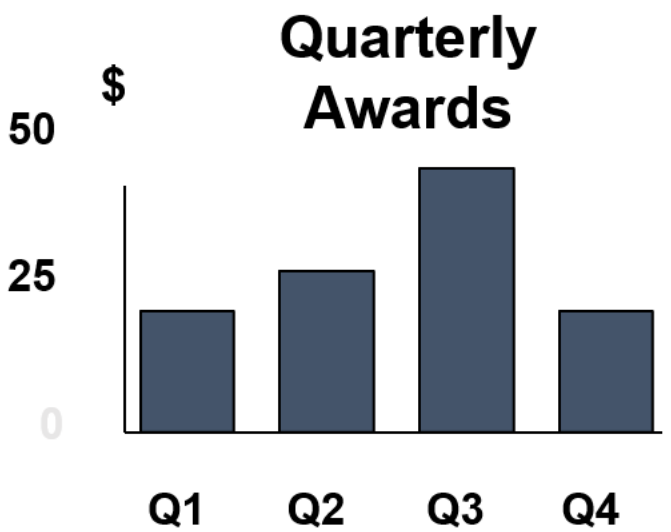
Best Practices for Charts

Graphical Errors: Compressing the Vertical Axis

Bad Presentation

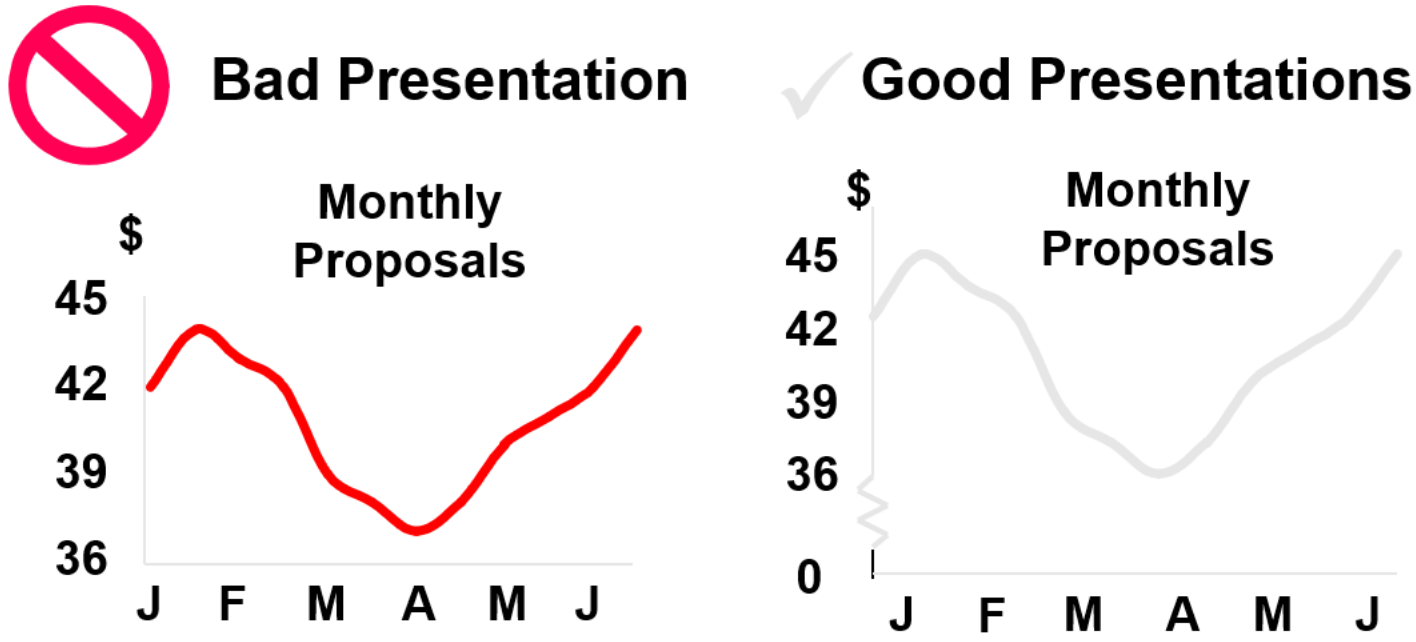


Good Presentation



Best Practices for Charts

Graphical Errors: No Zero Point on the Vertical Axis



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Questions?

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