

Lies, Damn Lies, and Statistics:  
Incorporating Information Literacy Frames in an Introductory Statistics Course

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The three frames from the *Framework for Information Literacy for Higher Education* (2015) that I highlighted for incorporation in my sections of STT 215 Introductory Statistics are Information Creation as a Process, Research as Inquiry, and Scholarship as Conversation.

Information Creation as a Process is especially relevant to statistics. In fact, doing statistics involves multiple processes: collecting, cleaning, representing, and analyzing data. To stress the importance of information literacy, I have included a lesson on “bad” graphs, data visualizations which can be misleading. In the lesson, students will learn how to recognize misleading graphs and how to create graphs that are better representative of the data and more informative to the viewer.

The frames Research as Inquiry and Scholarship as Conversation mesh beautifully with the course project that my STT 215 students complete at the end of the semester. I have worked to revise that project in three ways: stronger guidance in terms of topic selection, inclusion of peer review, and provisions to archive student projects.

Included in this project are:

- Lesson plans
- Class slides
- Modified graphic organizer
- Course Project Materials

**Lesson: Bad Graphs and How to Avoid Them (or How NOT to Lie with Statistics)**

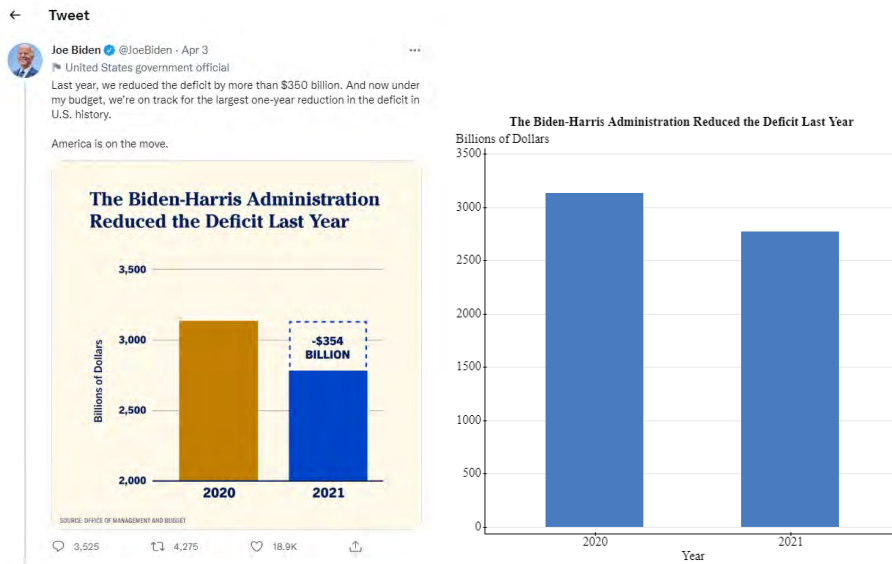
SLOs: By the end of the lesson, students should be able to

1. Identify misleading graphic displays and their attributes.
2. Recommend more informative data representations.
3. Reflect on how data visualizations transform data and to create new information (Information Creation as a Process).

**Introduction: Bad graph inspection**

The Office of Management and Budget produced this graphic which President Biden tweeted in April.

The second graph shows the same information. What do you notice?



Link: [Twitter Publish](#)

From: [Deficient deficit depiction - Junk Charts \(typepad.com\)](#)

**Today you will learn more about misleading graphs and how to avoid them. You will then apply your knowledge by working collaboratively to select a misleading graph, analyze it, and improve it.**

**To begin, visit the site below for an overview.**

**Overview:** <https://towardsdatascience.com/misleading-graphs-e86c8df8c5de>

**Do:** working with your group, find an example of a bad graphic, analyze the features that make it misleading, and create a better graphic (as we did with the deficit data). Use these resources as a start:

- [https://junkcharts.typepad.com/junk\\_charts/](https://junkcharts.typepad.com/junk_charts/)
- [https://iase-web.org/islp/apps/gov\\_stats\\_graphing/GoodBad/GoodBadGraphs.pdf](https://iase-web.org/islp/apps/gov_stats_graphing/GoodBad/GoodBadGraphs.pdf)
- [https://en.wikipedia.org/wiki/Misleading\\_graph](https://en.wikipedia.org/wiki/Misleading_graph)
- <https://www.statisticshowto.com/probability-and-statistics/descriptive-statistics/misleading-graphs/>

**Post:** share the original graphic, your analysis, and your new graphic on Canvas.

**Reflect:** how can graphics create new information?

## STT 215 Introductory Statistics, First week introduction to course and project

### Lesson: How can statistics help us understand the world?

SLOs: By the end of the lesson, students should be able to

1. Identify how statistics can be used to inform issues in world news
  2. Reflect on the uses and limitations of statistics
  3. Consider what it means that scholarship as a conversation
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### Introduction: Worldview Upgrader

Visit the link below and take the 18-question quiz about your perceptions of global issues.

<https://upgrader.gapminder.org/>

Discuss your results with your group. What was surprising? What new questions do you have?

**Overview:** Today you will learn more about how statistics can help us understand global issues including poverty & wealth, public health, the environment, and more.

To begin, we will watch a video presentation by the late Hans Gosling, a public health researcher, who founded the gapminder website that we just visited: [200 Countries, 200 Years, 4 Minutes \(BBC Four\)](#).

**Do & Post:** In a similar vein, the podcaster and author Tim Harford uses data and statistics to understand the world around us in his podcast *More or Less*. What global issues are of particular interest to you? Select a particular podcast episode as a group. Listen. Summarize by answering the following questions and posting your responses to the Canvas discussion board.

- **Listen**
- **Post**
  - What is the topic of your selected podcast?
  - How is statistics relevant to this topic?
  - How does statistics illuminate this topic?
  - What new questions does statistics bring to the topic?
  - What new questions do you have about this topic?
- **Comment**
  - Provide a constructive comment on another group's post.

**(Next class, once postings are up)**

**Reflect:**

- Were there any similar threads across the different groups' posts? Differences?
- Did this process spark any ideas for your course project? What questions are you curious about? What data could you collect that are relevant to those questions? What existing datasets could you possibly find?

## **STT 215 Introductory Statistics, Introduction to Course Project**

### **Slideshow & Project Description included**

#### **Lesson: Introduction to Course Project**

SLOs: By the end of the lesson, students should be able to

1. Draft a research question for their course project (Research as Inquiry)
    - a. Select their population of interest
    - b. Determine whether to collect data themselves or to use an existing dataset
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#### **Introduction: Intro to Course Project presentation (slides) with sample project and project rubric**

**Do:** Break into groups and begin to brainstorm your project. Use the graphic organizer to help you formulate your plan. Once you have decided on your project design, complete the project proposal and submit on Canvas.

## Works cited

- Archambault, Susan. "Research Exploration Exercise." *CORA (Community of Online Research Assignments)*, 2015. <https://www.projectcora.org/assignment/research-exploration-exercise>.
- "Framework for Information Literacy for Higher Education", American Library Association, February 9, 2015. <http://www.ala.org/acrl/standards/ilframework> (Accessed May 6, 2022)  
Document ID: b910a6c4-6c8a-0d44-7dbc-a5dcbd509e3f
- Harford, T. (n.d.). *More or less: Behind the stats*. BBC Radio 4. Retrieved May 6, 2022, from <https://www.bbc.co.uk/programmes/p02nrss1/episodes/downloads>
- Fung, K. (2022, April 11). *Deficient deficit depiction*. Junk Charts. Retrieved May 6, 2022, from [https://junkcharts.typepad.com/junk\\_charts/2022/04/deficient-deficit-depiction.html](https://junkcharts.typepad.com/junk_charts/2022/04/deficient-deficit-depiction.html)

# Bad Graphs and How to Avoid Them

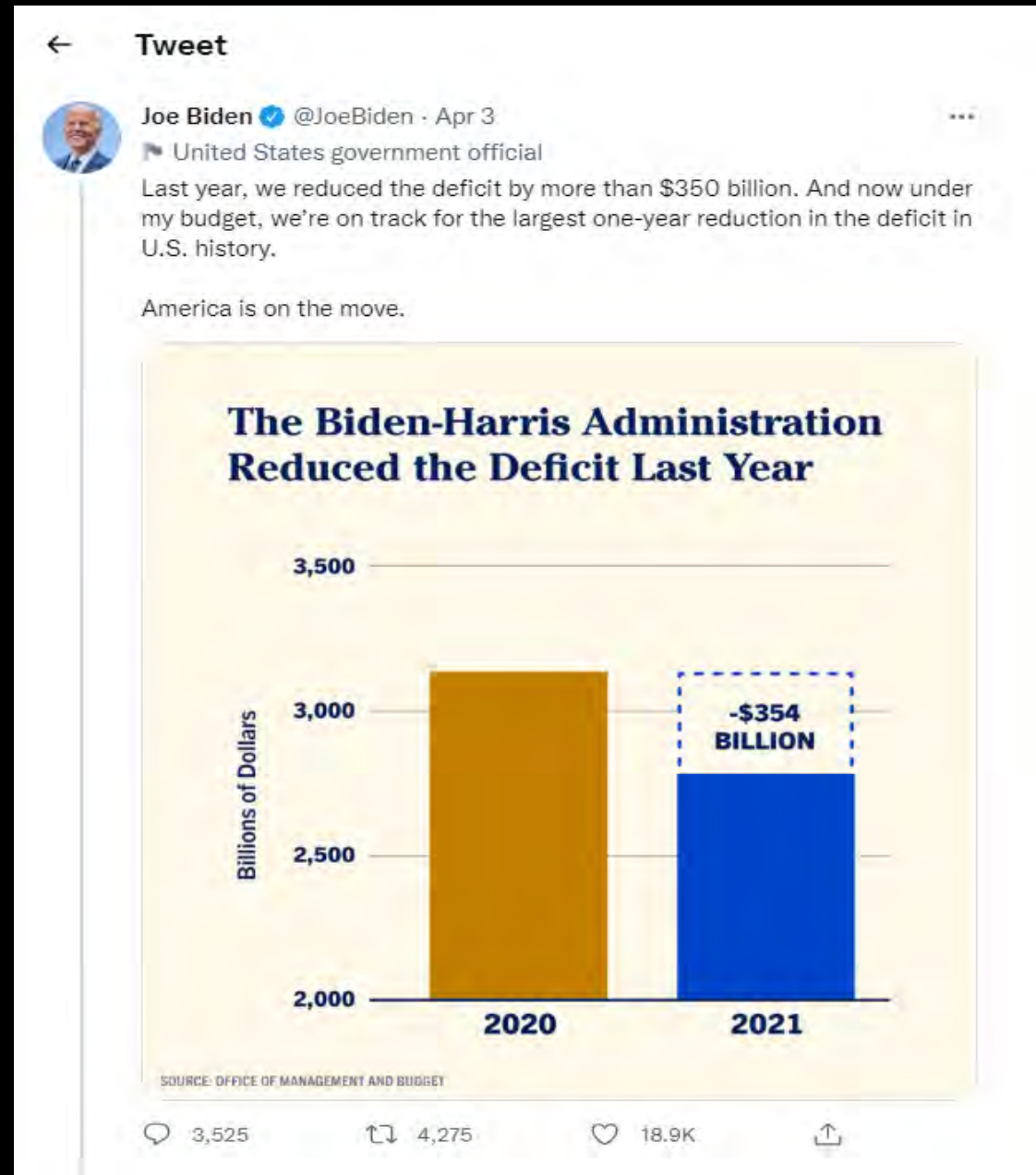
STT 215



# What do you notice?

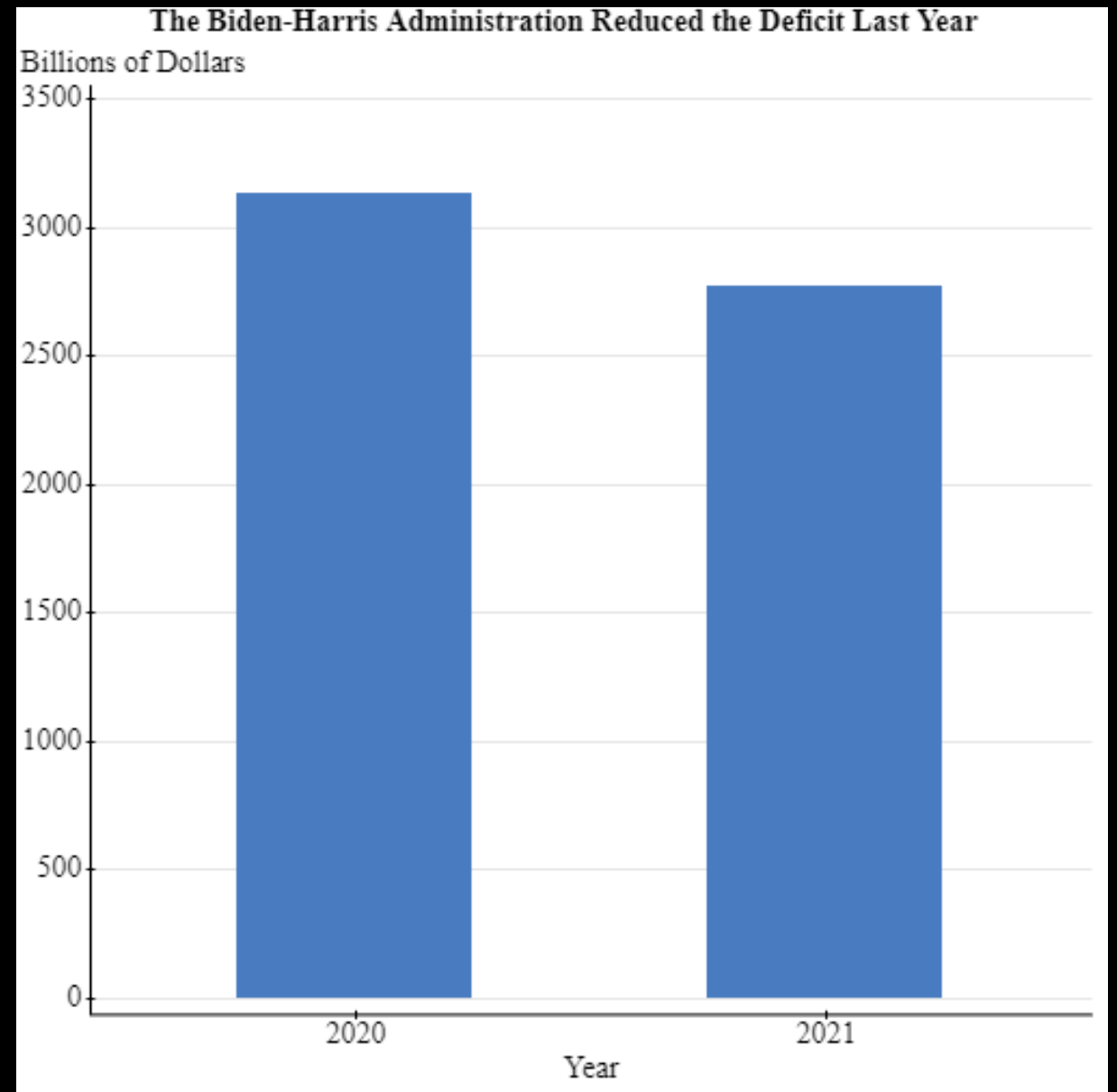
Link: [Twitter Publish](#)

From: [Deficient deficit depiction - Junk Charts \(typepad.com\)](#)



# Better representation

- The y-axis starts at 0 which allows us to see the absolute difference (-3132 vs -2772)





# Today you will...



**LEARN MORE ABOUT MISLEADING GRAPHS AND HOW TO AVOID THEM.**



**APPLY YOUR KNOWLEDGE BY WORKING COLLABORATIVELY TO SELECT A MISLEADING GRAPH, ANALYZE IT, AND IMPROVE IT (AS WE JUST DID!).**



**SHARE YOUR FINDINGS ON A CANVAS DISCUSSION BOARD.**

# Resources

- **Overview: read this first**
  - <https://towardsdatascience.com/misleading-graphs-e86c8df8c5de>
- **Bad Graphs Galore: select one graphic from these sites to analyze and improve**
  - [https://junkcharts.typepad.com/junk\\_charts/](https://junkcharts.typepad.com/junk_charts/)
  - [https://iase-web.org/islp/apps/gov\\_stats\\_graphing/GoodBad/GoodBadGraphs.pdf](https://iase-web.org/islp/apps/gov_stats_graphing/GoodBad/GoodBadGraphs.pdf)
  - [https://en.wikipedia.org/wiki/Misleading\\_graph](https://en.wikipedia.org/wiki/Misleading_graph)
  - <https://www.statisticshowto.com/probability-and-statistics/descriptive-statistics/misleading-graphs/>
- **Post the original graphic, your critique, and the revision in a new thread on the Discussion Board below: [insert for each section]**

# Reflection

- Let's look at the graphics you chose, your analysis, and your revisions.
- How can graphics create new information?
- When viewing graphs, what aspects will you pay close attention to?
- When creating data representations, what kinds of things will you consider?



# Course Project

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STT 215

SPRING 2022

# Course Project Timeline

FEB/SEPT PLAN + PROPOSE	MARCH/OCT GATHER	APRIL/NOV ANALYZE	LAST CLASS PRESENT
Find group members Use the Canvas discussion board	Coordinate on group space in Canvas	Generate summary statistics and graphs, including association analysis	Share results with class as a poster or video
Determine topic, population + general question	Gather data <ul style="list-style-type: none"><li>In-person survey</li><li>Existing dataset</li></ul>	Provide inferential statistics (confidence intervals or hypothesis tests) Interpret results in context	Upload project to Canvas
<u>Survey</u> : Draft of survey with methodology OR <u>Dataset</u> : Find reliable dataset	Collect data in spreadsheet	Reflect on the results  Provide peer review to another group	Complete the collaboration survey
Proposal due _____	Data due _____		Presentations on ____

# Final Presentation Elements

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## Presentation that includes

- Your question of interest and population
- Description of methodology for survey or existing dataset
- Description of data
  - Summary statistics (mode, proportion, mean, median)
  - Summary displays (bar charts, pie charts, histograms, boxplots, dot plots)
  - Association analysis (scatterplots, contingency tables, side-by-side boxplots)
- Inference using your data
  - Confidence intervals for population parameter (Ch. 8)
  - Hypothesis tests (Ch. 9)
  - Comparisons between two groups (Ch. 10)
- Results & Conclusions
  - What did you learn? What new questions do you have? Did you answer your question of interest?

Presentation may be:  
**slides on class computer**  
or  
**actual trifold poster**

**Either way, turn in digital format on Canvas.**



## Project Overall Rubric

Criterion	Points Possible	Points Earned
Topic of interest presented with background information and sources	5	
Research question clearly stated, including description of population	10	
<b>Survey option:</b> Survey methodology is rigorous (sample is random, representative, of appropriate size) <b>Dataset option:</b> Survey methodology is rigorous (sample is random, representative, of appropriate size) OR Experimental procedures that include controlled, randomized assignment and double-blinding	15	
Summary statistics and graphs are correctly presented	15	
Inferential statistics (confidence intervals or significance tests) are correctly computed and interpreted	15	
Discussion of findings and conclusions are reasonable	20	
Clarity of presentation	10	
Peer review feedback to <u>other</u> group was clear and constructive	5	
Group collaboration rating	5	
<b>Total</b>	<b>100</b>	

# Project Rubric



# Sleep & Breakfast Habits of Intro Statistics Students

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Previous research\* indicates that some sleep habits are related to frequency of breakfast consumption. I am curious about whether there is a relationship between amount of sleep intro statistics students get and whether or not they eat breakfast.

I asked a random sample of 34 students enrolled in STT 215 in Fall 2021 two questions:

“How much sleep did you get last night?” and

“Did you eat breakfast this morning?”

\*MacPherson, A. R., & Dautovich, N. D. (2021). Bed and breakfast: The role of sleep in breakfast intake. *Journal of Social, Behavioral, and Health Sciences*, 15, 107–122. <https://doi.org/10.5590/JSBHS.2021.15.1.09>



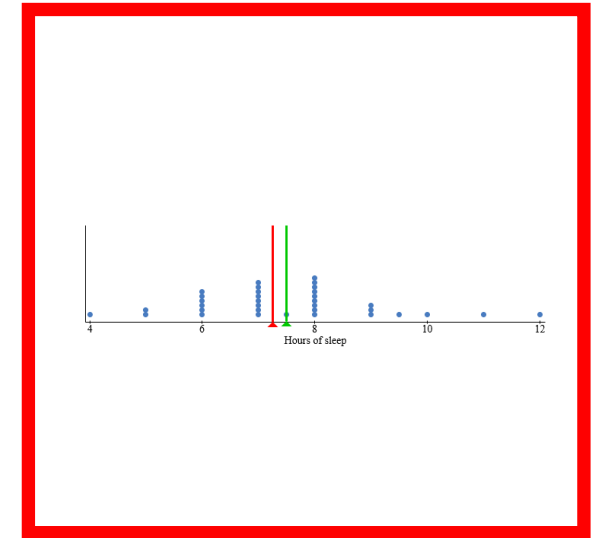
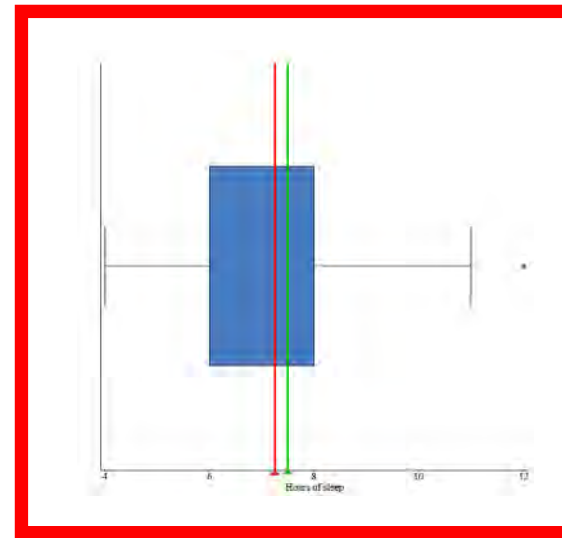
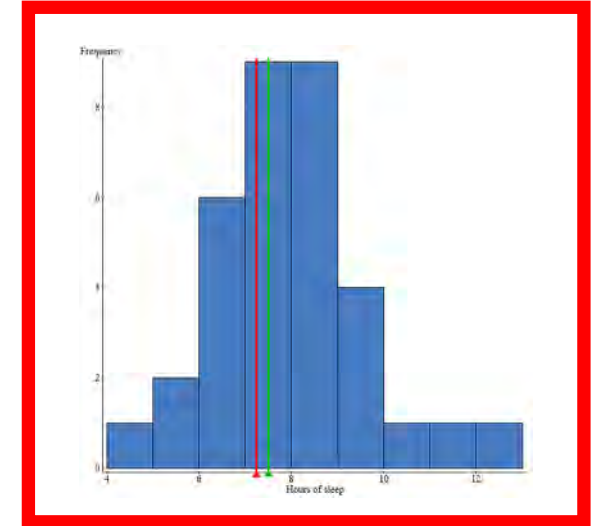
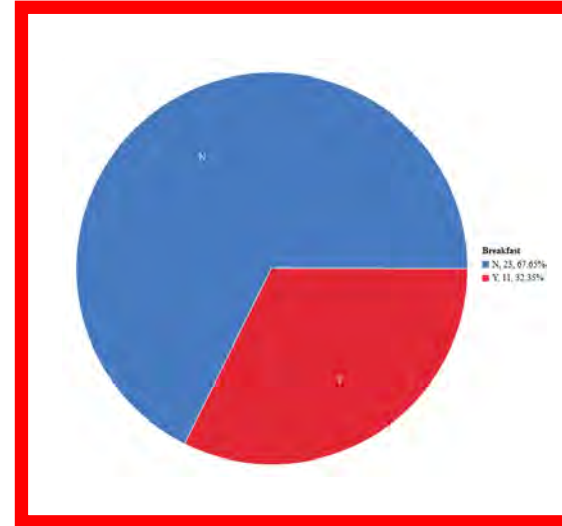
# Description of data

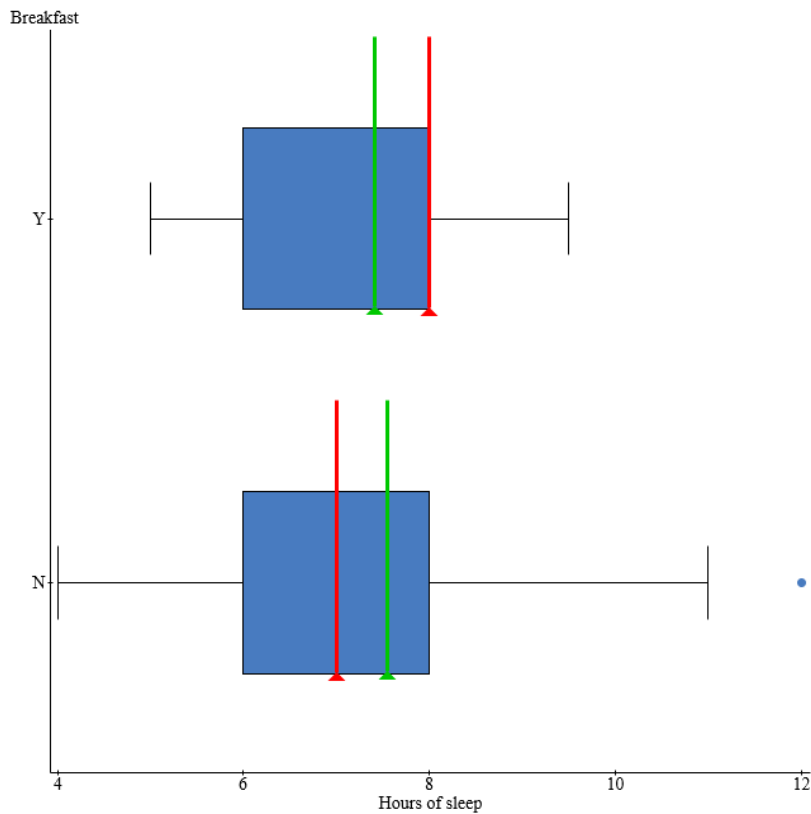
Of the 34 statistics students surveyed,

- 23 students did not eat breakfast (67.6%)
- 11 students did eat breakfast (32.4%)

The summary statistics for hours of sleep are

	Hours of sleep, n=34
Mean	7.5
Standard deviation	1.67
Median	7.25





	Ate breakfast, n=11	Did not eat, n=23
Mean	7.41	7.54
Standard deviation	1.36	1.83
Median	8	7

# Inference: Confidence Intervals and Significance Tests

Do intro stats students who eat breakfast get a different amount of sleep compared to students who do not eat breakfast?

95% confidence interval for the difference between means: (-1.021, 1.281)

## Significance Test for the difference between means

Assumptions: quantitative data, independent random samples, no skew

Hypotheses:

Null  $H_0: \mu_1 = \mu_2$  OR  $H_0: \mu_1 - \mu_2 = 0$

Two-sided  $H_a: \mu_1 \neq \mu_2$

Determine significance level:  $\alpha = 0.05$

Test statistic:

t-statistic = 0.23 with df=25.97

P-value = 0.82

We fail to reject the null hypothesis. We do not have evidence that intro stats students who eat breakfast get a different amount of sleep compared to students who do not eat breakfast.

# Results and Conclusions

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Do intro stats students who eat breakfast get a different amount of sleep compared to students who do not eat breakfast?

While we see a slight difference in terms of the amount of sleep for students who eat breakfast vs. those who don't, the difference in hours of sleep is not statistically significant.

A follow-up study could ask students to record their sleep and breakfast habits for a week or more to get a better sense of the overall pattern.

# STT 215 Course Project

➤ Proposal Due Date:	_____
➤ Data Due Date:	_____
➤ Peer Review Date:	_____
➤ Project Presentation Due Date:	_____

## General Information

For this project, you will collaborate with your peers (2-4 people) to:

- explore a topic of interest by completing a literature review
- develop a research question about your chosen population;
- design a survey including a rigorous sampling methodology AND/OR select an existing dataset to analyze;
- collect data;
- display the data using appropriate graphs and summary statistics, including association analysis;
- provide inferential statistics such as confidence intervals or significance tests;
- analyze and interpret your findings;
- reflect on the process with possible improvements or next steps;
- present your results to the class as a poster, slides, or a pre-recorded video.

## Project Proposal

Before beginning data collection, groups must submit one project proposal on Canvas containing the following information and receive instructor approval:

- Group members' names
- Topic and population of interest with sufficient background information about previous research
- Research question
- Survey Option:
  - Survey with a minimum of two categorical questions and a minimum of two quantitative questions
  - Sampling methodology including sample size and procedures to ensure a random, representative, unbiased sample as well as to document nonresponse
- Dataset Option:
  - Detailed rationale for dataset selection, including explanation of
    - sampling methodology including sample size and procedures to ensure a random, representative, unbiased sample as well as to document nonresponse **OR**
    - experimental procedures that include controlled, randomized assignment and double-blinding

## Project Collaboration

Groups will have a space on Canvas in which to work together equitably and to demonstrate progress. In the case that some group members are not participating meaningfully or fairly, I will meet with the group to negotiate a resolution which may involve dissolving the group or removing the member(s) in question. All group members will complete a collaboration survey to assess how equitably the group functioned as part of the final grade.

## Peer Review

Groups will submit a rough draft of their project to Canvas for peer review by another group using the final rubric to provide feedback.

## Project Presentation: Poster Session

On the last day of class, we hold a poster session and groups will present their projects as a pre-recorded video, poster, or as a slideshow. We will divide the class in half, with the first set of groups presenting at stations around the room as the other half of the class is their audience. Then the halves will switch and the presenting groups will become the audience. Digital versions of presentation materials will be turned in on Canvas and the presentations will count toward the final grade.



## Project Overall Rubric

Criterion	Points Possible	Points Earned
Topic of interest presented with background information and sources	5	
Research question clearly stated, including description of population	10	
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Group collaboration rating	5	
<b>Total</b>	<b>100</b>	

# DEVELOPING YOUR RESEARCH TOPIC

This exercise is designed to help you develop a thoughtful topic for your research assignment. Answer the following questions to help you better understand and refine your thinking about your research topic.

## A What research topic interests you?

*Choose a topic or community issue or that matters to you.*

## B How did you become interested in this topic?

*Why did you choose this topic? In 2 or 3 sentences, explain why you are interested this topic (Examples: This directly impacts me or someone I know by..., or Hearing about this topic stimulated me to learn more because...)*

## C Think about the following elements of your topic:

### WHO

*Who is your population of interest? Do you have access to them or an existing dataset?*

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### WHAT

*What questions can you ask?  
What data can you collect?*

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### WHERE

*What location will provide you with equal access to your population of interest?*

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### HOW

*What methodology will get you a random, representative sample?*

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Modified from

Archambault, Susan. "Research Exploration Exercise." *CORA (Community of Online Research Assignments)*, 2015.

<https://www.projectcora.org/assignment/research-exploration-exercise>.