Lecture 1
Introduction
Readings: IntroStat Chapters 1; OpenIntro Chapter 1

STAT 8010 Statistical Methods I
May 16, 2023

Whitney Huang
Clemson University

Who is the instructor?

Who am I?

- **Fourth year** Assistant Professor of Applied Statistics and Data Science

- Born in Laramie, Wyoming, grew up in Taiwan

- With a B.S. in Mechanical Engineering, switched to Statistics in graduate school

- Got a Ph.D. (Statistics) in 2017 at Purdue University.

How to reach me?

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Who is the instructor?

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Class Overview

Basic Concepts

Sampling Techniques

- **Email:** wkhuang@clemson.edu

- **Office**: O-221 Martin Hall

- **Office Hours**: TBD and by appointment via Zoom

Class Policies / Schedule

Logistics

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- **Course modality:** Asynchronous online

- There will be two online exams and a (comprehensive) online final. The (tentative) dates for the two exams are:

    - **Exam I**: May 31, Wednesday

    - **Exam II**: June 12, Monday

   The **Final Exam** will be given on Thursday, June 22

- There will be some homework assignments (~ 5):

    - To be uploaded to Canvas by 11:59 pm ET on the due dates

    - Worst grade will be dropped

- No classes on May 29 (Memorial Day)

Class Website

CANVAS and my teaching website (link:
https://whitneyhuang83.github.io/STAT8010/
2023SummerI.html)

- Course syllabus [Link] / Announcements

- Lecture slides/notes

- Homework assignments

- Exam and homework schedule

- Data sets for lectures and homework

- R codes

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Reference Books

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An Introduction to Statistical Methods and Data Analysis, 7th Edition. **Lyman Ott and Micheal T. Longnecker, Duxbury, 2015**; **ISBN-13:** 978-1305269477
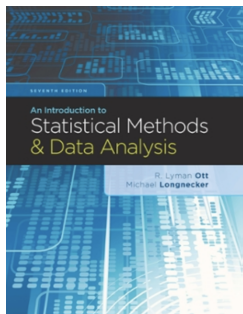
OpenIntro Statistics, 4th Edition. **David Diez, Mine Çetinkaya-Rundel, and Christopher D Barr, 2019**

Evaluation

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- Grade Distribution:

Homework:	20%
Exam I	25%
Exam II	25%
Final Exam	30%

- Letter Grade:

>= 90.00	A
88.00 ~ 89.99	A-
85.00 ~ 87.99	B+
80.00 ~ 84.99	B
78.00 ~ 79.99	B-
75.00 ~ 77.99	C+
70.00 ~ 74.99	C
68.00 ~ 69.99	C-
<= 67.99	F

Schedule

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Week	Topic
1	Introduction & Exploratory Data Analysis
2	Probability
3	Sampling; Inference for a Single Population Mean
4	Inference for Multiple Population Means
5	Categorical Data Analysis; Correlation and Regression
6	Regression Analysis

Computing

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We will use software to perform statistical analyses. The recommended software for this course is R / R Studio

- a **free**/**open-source** programming language for statistical analysis

- available at `https://www.r-project.org/` (R); `https://rstudio.com/` (Rstudio)

- Youtube videos showing how to install R and RStudio [Link]

You are welcome to use a different package (e.g. SAS, JMP, SPSS, Minitab) if you prefer (but at your own risk)
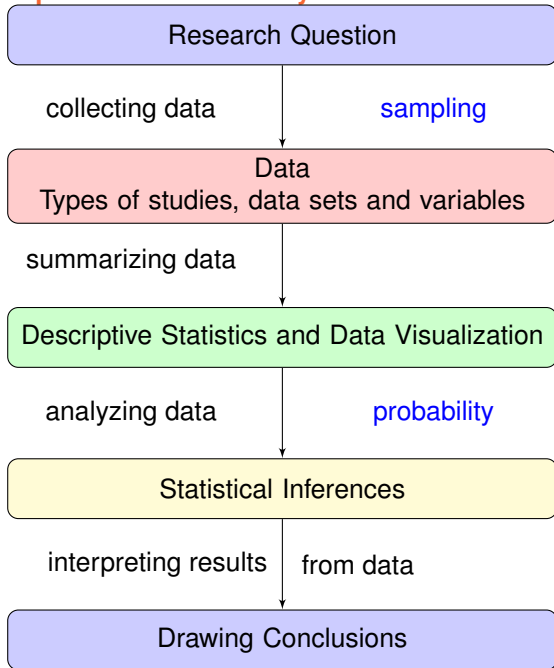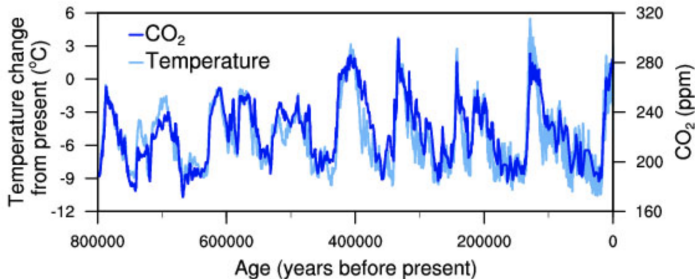
Class Overview

Motivation: Why Study Statistics?

- To be able to effectively conduct (empirical) research

- To be an informed "consumer"

- To further develop critical and analytic thinking skills

Typical Steps in Statistical Study

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Research Question

collecting data   sampling

Data
Types of studies, data sets and variables

summarizing data

Descriptive Statistics and Data Visualization

analyzing data   probability

Statistical Inferences

interpreting results | from data

Drawing Conclusions

Temperature and Carbon Dioxide CO_2

Temperature change (light blue) and carbon dioxide change (dark blue) measured from the EPICA Dome C ice core in Antarctica (Jouzel et al. 2007; Lüthi et al. 2008).

Research questions:

- Does temperature correlate with CO_2? If so, how to predict temperature using CO_2?

- Can we make some statement about the causation between temperature and CO_2?

Basic Concepts

Terminology

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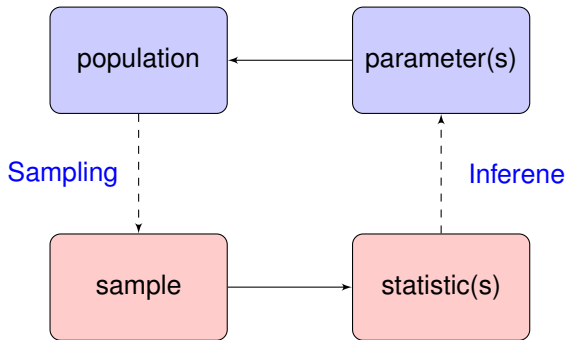Schedule

Class Overview

Basic Concepts

Sampling Techniques

- A **unit** is a single entity (person or object) whose characteristics are of interest

- A **population of units** is the complete collection of units about which information is sought

- A **population** is a set of all measurements corresponding to each unit in the entire collection of units about which information is sought

- A **sample** is a subset of measurements selected from the population of interest

Statistical Science concerned with using sample information to make inference about populations

Population (parameters) vs. Sample (statistics)

- We use parameter(s) to describe the population of interest

- We use statistic(s) to describe the sample with respect to the population of interest

Understanding Data: Types of variables

A **variable** is a characteristic of a unit that may vary for different observations

There are two main types of variables, qualitative (aka categorical) and quantitative (aka numerical)

- Qualitative variable: has labels or names used to identify an attribute of a unit. Qualitative data use either the **nominal** or **ordinal** scale of measurement

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    - Interval: difference of quantities that are meaningful but ratios of quantities that cannot be compared e.g. temperature with the Celsius scale

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    - Interval: difference of quantities that are meaningful but ratios of quantities that cannot be compared e.g. temperature with the Celsius scale

    - Ratio: ratios of quantities that are meaningful e.g. Height

Example

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Grade	Major	GPA	Credit hours
Sophomore	Psychology	3.14	30
Senior	Spanish	2.89	105
Senior	Religion	3.01	99
Freshman	Philosophy	2.45	12

1. How many units are in the data set?

2. How many variables are in the data set?

3. What type of variable is each variable in the data set (be sure to answer both qualitative or quantitative as well as nominal, ordinal, interval, or ratio).

Example

Answer what type of variable each of the following are

1. Smoking status

2. Income

3. Level of satisfaction

4. Clothing size (s, m, l, xl)

5. Time taken to run a mile

Observational vs. Experimental Studies

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Depending on how a study was conducted, we have the following types of studies:

- Observational study: a study in which the investigator **observes** a variable of interest of an existing sample in order to draw conclusions

- Experimental Study: a study in which the investigator examines how a response variable behaves when the researcher **manipulates** one or more factors in order to determine the effect of those factors on the response.

Example

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State whether the study is observational or experimental

- A researcher wants to know if smoking during pregnancy leads to children with lower IQ scores. She looks at 200 pregnant women and records smoking status along with the subsequent IQ score (measured a few years after birth)

- A scientist tries his weight loss drug on a group of monkeys with identical diets. 40 monkeys are randomly assigned to either get the drug or not get the drug (20 in each group). The weight gained or lost was recorded for each monkey.

Types of Data sets

Depending on how the data were collected, we have the following types of data sets:

- Cross-sectional data: data collected at the same or approximately the same point in time

- Time series data: data collected over several time periods

- Spatio-temporal data: data collected at different "locations" over several time periods

Example

For this problem, state whether the variables included are cross-sectional or time series

1. United States current temperatures

2. Temperatures in Clemson from 1950-2015

3. Total salary of the LA Lakers throughout the 2010s

4. Salaries of all NBA teams in 2019.

Collecting Data: Statistical Sampling

Statistical sampling is the procedure to select a subset from a statistical **population** that is representative of the population. There are several types of sampling:

- Simple random sampling (SRS): a sample selected such that each element in the population has the same probability of being selected

Simple random sample

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Collecting Data: Statistical Sampling

Statistical sampling is the procedure to select a subset from a statistical **population** that is representative of the population. There are several types of sampling:

- Simple random sampling (SRS): a sample selected such that each element in the population has the same probability of being selected

Simple random sample

- Stratified sample: elements in the population are first divided into groups and a simple random sample is then taken from each group

Stratified sample

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Sampling cont'd

- Cluster sampling: the elements in the population are first divided into separate groups called clusters and then a simple random sample of the clusters is taken that all elements in a selected cluster are part of a sample

Cluster sample

Sampling cont'd

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- Cluster sampling: the elements in the population are first divided into separate groups called clusters and then a simple random sample of the clusters is taken that all elements in a selected cluster are part of a sample

Cluster sample

- Systematic sampling: randomly select one of the first k elements from the population and then every k_{th} element thereafter is picked

Systematic sample

Sampling cont'd

- Cluster sampling: the elements in the population are first divided into separate groups called clusters and then a simple random sample of the clusters is taken that all elements in a selected cluster are part of a sample

Cluster sample

- Systematic sampling: randomly select one of the first k elements from the population and then every k_{th} element thereafter is picked
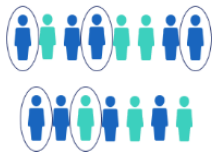
Systematic sample

- Convenience sampling: elements selected from the population on the basis of convenience

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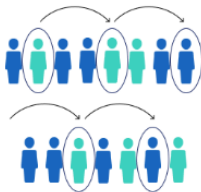
Sampling Techniques

What type of sampling was used?

1. A researcher randomly chooses houses in a town. Once a particular house is chosen everyone living in the house is surveyed

2. A school principal decides to performs an exit interview with every 14th name from a list of graduating seniors

3. A biologist knows that 40% of bats are male and that 60% are female so she randomly selects 20 males and randomly selects 30 females to be in her sample

4. A graduate student wants to do a study on why people like bluegrass music and uses the people she meets at the next show she attends as her sample

5. To get an idea of the average weight of his cattle, a rancher randomly chooses to weigh 25 from his list of the animals
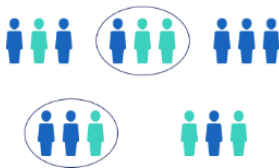
Review: Sampling Techniques

Source:
https://www.scribbr.com/methodology/sampling-methods/

Summary

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Sampling Techniques

In this lecture, we learned

- Typical steps in statistical study

- Terminology

  - Population vs. Sample

  - Types of variables, studies, datasets

- Some Sampling Methods

In next lecture we will learn how to summarize data both
graphically and numerically