Lecture 1

Introduction

STAT 8010 Statistical Methods I
January 9, 2020

Whitney Huang
Clemson University

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Who is the instructor?
Class Policies / Schedule
Tell us about yourself
Class Overview
Terminology and Basic Concepts

Notes

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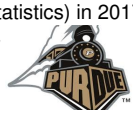
Who am I?

- **First 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 my Ph.D. (Statistics) in 2017 at Purdue University



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How to reach me?

- **Email:** wkhuang@clemson.edu
- **Office**: O-221 Martin Hall
- **Office Hours**: TR 11:00am – 12:00pm and by appointment

Notes

Class Policies / Schedule

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Logistics

- We will meet TR 9:30am – 10:45am at M-104 Martin
- There will be two in-class exams and a (comprehensive) final. The (tentative) dates for the two exams are:
  - **Exam I**: Feb. 13, Thursday
  - **Exam II**: Mar. 26, Thursday

  The **Final Exam** will be given on Wednesday, Apr. 29, 8:00 am - 10:30 am.
- There will be some homework assignments ($\sim$ 7):
  - Will be due Tues by 9:30am
  - Worst grade will be dropped
- No classes on Mar. 17 & 19 (Spring Break)

Notes

Class Website

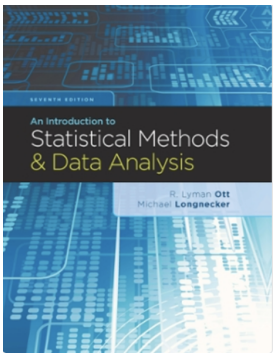
CANVAS and my teaching website (link: https://whitneyhuang83.github.io/stat8010_2020Sp.html)

- Course syllabus [Link] / Announcements
- Lecture slides/notes
- Homework assignments
- Exam and homework schedule
- Data sets for lectures and homework

Notes

Recommended Textbook

An Introduction to Statistical Methods and Data Analysis, 6th Edition. **Lyman Ott and Micheal T. Longnecker, Duxbury, 2010**; **ISBN-13:** 978-1305269477



Notes

Evaluation

- 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

Notes

Tentative Topics and Dates

Week	Topic
1	Introduction
2	Data Summary and Display
3	Intro to Probability & Probability Distributions I
4	Probability Distributions II
5	Normal Distribution & Central Limit Theorem
6	Exam I
7	Statistical Inference for a Single Sample
8	Statistical Inference for Two Samples
9	One Way ANOVA & Multiple Comparisons
10	Randomized Complete Block Designs
11	No Classes–Spring Break
12	Exam II
13	Inference on Proportions
14	Contingency Table Analysis
15	Correlation and Simple Linear Regression I
16	Simple Linear Regression II

Notes

Computing

We will use software to perform statistical analyses. The recommended software for this course are JASP and R/Rstudio

- **JASP**
  - a **free**/**open-source** graphical program for statistical analysis
  - available at https://jasp-stats.org/
- R/ RStudio
  - a **free**/**open-source** programming language for statistical analysis
  - available at https://www.r-project.org/ (R); https://rstudio.com/ (Rstudio)

You are welcome to use a different package (e.g. SAS, JMP, SPSS, Minitab) if you prefer

Notes

Tell us about yourself

Notes

Tell us about yourself

- Your name
- Degree program
- Your background in Statistics/Computing

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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

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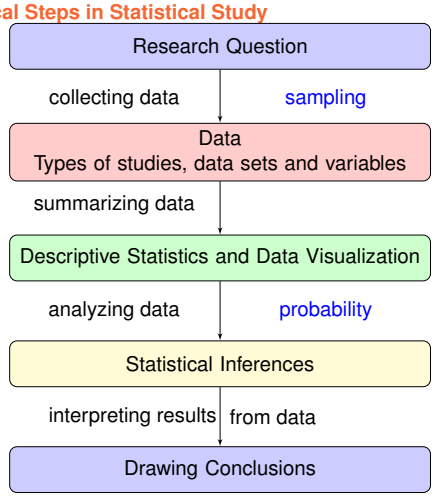
Typical Steps in Statistical Study



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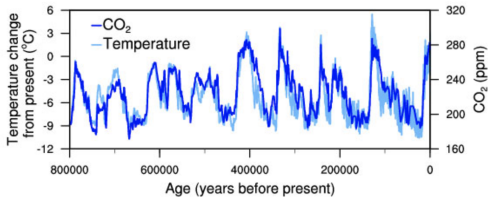
Temperature and Carbon Dioxide CO_2



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?

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Terminology and Basic Concepts

Notes

Terminology

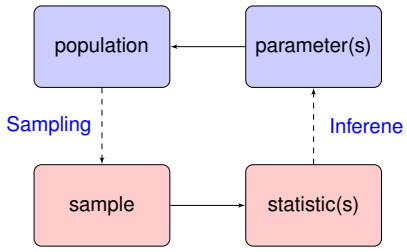
- A **unit** is a single entity (person or object) whose characteristics are of interest
- A **population of units** is the complete collection of units about which information is sought
- A **population** is a set of all measurements corresponding to each unit in the entire collection of units about 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

Notes

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



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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
  - Nominal: order does not matter e.g. Gender
  - Ordinal: order does matter e.g. Education levels
- Quantitative variable: has numeric values that indicate how much or how many of something. Quantitative data uses either the **interval** or **ratio** scale
  - 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

Notes

Example

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).

Notes

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

Notes

Observational vs. Experimental Studies

Depending on how the study were 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.

Notes

Example

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.

Notes

Types of Data sets

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

- Cross-sectional dat: 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

Notes

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.

Notes

Collecting Data: Statistical Sampling

In Statistics, sampling is the procedure to select a subset from a statistical population that is representative of the population. There are several types of sampling as follows:

- Simple random sampling (SRS): a sample selected such that each element in the population has the same probability of being selected
- Stratified random sample: elements in the population are first divided into groups and a simple random sample is then taken from each group

Notes

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

Notes

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 14^{th} 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

Notes

Summary

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

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