Math 5080: Statistical Inference I

University of Utah – Fall 2020

Course Section: Math 5080-002
Meetings: Monday, Wednesday, 6:00 - 7:30 PM, Online Synchronous

Instructor: Tom Alberts
E-mail: alberts@math.utah.edu
Phone: 801-585-1643 (I will rarely be in my office this semester so better to e-mail)
Office: LCB 114
Office Hours: 5:00 - 6:00 PM Monday or Wednesday, or by appointment
Homepage: Online via Canvas. Official announcements and homework assignments
will be posted there. Check in on Canvas at least twice per week for
announcements and updates.

Format

This class is listed as an ***IVC*** course in the university catalog, which stands for *Interactive Video Conferencing*. This means that the class will be delivered "synchronously", i.e. live and at the time listed but entirely online.

We will meet via the Zoom video conferencing software. If you don't have Zoom you can download it for free from zoom.us/download. It is strongly suggested that you have a webcam and microphone to fully participate in the class but you should not need anything else. It is also possible to dial in to hear the audio with just a phone.

The Zoom meeting details can be found on the Canvas page, or by e-mailing the instructor.

My intent is to make this a "semi-flipped" classroom. I will produce short lecture videos for you to watch before the class, and then during the class time itself I will answer questions about the videos or add more context. I hope to make the class time as interactive as possible and so I encourage your questions during that time. I will also be happy to go over your homework problems (see more about homework below) and do more worked examples. Occasionally I may split everyone into groups via the breakout rooms feature and have you discuss a problem together.

During class time I ask that everyone keep their microphones muted so as to eliminate background noise. You may also turn off your video if you so desire. If you would like to ask a question feel free to unmute yourself and interrupt me. If you are speaking please do turn on your video, if possible. It's also helpful if you identify yourself verbally so that I know who is speaking.

Classes will be recorded and made available on Canvas, so if you need to miss a

lecture you can always watch it later. Class recordings will not be made available to the general public and will be deleted at the end of the semester, but be aware that a recording will exist for a few months. Because of this, please refrain from giving out any sensitive personal information during class time, such as grade information, ID numbers, housing details, etc.

Attendance

There are only three dates that you are required to attend class: the dates of the first and second midterm and the final exam. See the section below on important dates for the specific dates. *Note that the dates of the midterm **may** change slightly in consultation with the class. If they do change I will let you know a week beforehand via Canvas.*

Technical Requirements

To attend the live version of the class you need a computer with the Zoom software and a relatively strong internet connection. A microphone and camera are strongly recommended for class attendance but not strictly required.

You will, however, need a microphone and camera for taking the midterms and the final exam. Exams will be monitored on Zoom, **at the regular class time and the announced final exam time.** I will ask you to turn on your camera and I will monitor the exam. This will also give you the opportunity to ask questions about the exam. If this arrangement will be impossible for you please let me know as soon as possible.

You will also need to access Canvas regularly to receive class announcements, access the videos, and obtain homework. You will also submit your homework and exams online via Canvas.

If you have a tablet or a similar computerized writing surface, the simplest method is usually to download the exam or homework pdf, write directly on that, and then reupload it to Canvas. Otherwise, if you have a printer you can print out the exam, write on that, and then scan and upload the writeup. If you do not have a printer you can simply write your solutions on a blank piece of paper, clearly indicating which problem you are solving. If you do not have a scanner there are many apps that convert your smartphone into a scanner. **Please make sure you have an app that can convert the files into pdf format.**

Please only upload one file per homework/midterm/exam. All files should be converted into pdf format so that I can mark them up online for you to receive comments.

Office Hours

Office hours will be at the time listed on the first page and conducted via Zoom. The Zoom meeting details can be found on the Canvas page.

If you intend to come to office hours please do try to send me an e-mail beforehand so that I can know to expect you. If many people intend to come I may assign blocks of meeting times.

Textbooks

No textbooks are officially required. I will post all videos, homework, solutions, and quizzes online, so the book is only required if you want to follow along with the lectures. This course and its followup Math 5090 are based off of this book:

- *Introduction to Probability and Mathematical Statistics.*
  2nd edition, by Bain and Engelhardt
  Available through the campus bookstore or Amazon

The style of the book is by now rather dated (although the content remains as true as ever). There are several more modern treatments available, which I also recommend if you want supplemental reading:

- *Probability and Mathematical Statistics: Theory, Applications, and Practice in R.*
  1st edition, by Mary C. Meyer
- *Mathematical Statistics with Applications*.
  7th edition, by Wackerly, Mendenhall, and Scheaffer

Other Resources

- https://stat.utexas.edu/videos/r
  UT Austin Department of Statistics and Data Science Lecture Videos on R -- especially see the *Statistical Inference* section. There is also a good instructional video on installing R and R Studio.
- https://www.coursera.org/specializations/statistics
  Coursera *Statistics with R Specialization* -- offered by Duke University
- https://ocw.mit.edu/courses/mathematics/18-655-mathematical-statistics-spring-2016/index.htm
  MIT Open Courseware class on *Mathematical Statistics*

Purpose of Course

This course is about statistical inference. It concentrates on inference problems for univariate iid data. This means data that is generated from multiple repetitions of the same experiment, with the outcome of each experiment being a single number. Even though it is the same experiment being repeated the data is never identical because of random effects that corrupt the outcome.

We will primarily focus on **parametric inference**, the idea of which is:

- Choose a *family* of probability distributions that accurately models the data generated by your experiment. In practice one must choose the family based on your own intuition and experience, but in this class you are often just told which family to use.
- Your chosen family of distributions will be indexed by *parameters*. It is assumed that the data is generated by a particular member of the family corresponding to some specific parameters, but they are unknown to you. The goal is to determine which function of the data is the best estimate of the hidden parameters.
- Finally you have to choose which type of estimate to return: a *point estimator* (a single number), an *interval estimator* (an entire range of estimates), or a *Bayesian estimator* (a probability distribution on the unknown parameters that reflects the observations from the data).

In a broad sense the purpose of this class is the *optimality theory* of estimation. There are many different possible estimators for the hidden parameters, and we will focus on which estimators are optimal and in which sense they are optimal. This does require some relatively sophisticated mathematics.

Topics from Bain and Englehardt

We will review some probability topics (Chapters 6 and 7) and cover sampling distributions, point estimation, sufficiency and completeness, and interval estimation (Chapters 8-11). Math 5090 will deal with hypothesis testing and basic linear models, which amounts to Chapters 12-15 of the book. See the separate timeline file for a schedule of topics. This year I might use the online nature of the class to deviate from this schedule, but if I do so I will let you know..

Prerequisites

This course assumes a solid knowledge of Calculus (at least Calc I, II, and III), linear algebra (Math 2270), and probability theory (Math 5010). If you're not comfortable with all of those you will probably struggle in this course. This course covers **theoretical statistics** and is highly mathematical. If you are more interested in an applied statistics course this is probably not the one for you. For a list of all statistics related courses at the University of Utah see mstat.utah.edu

During class time and in pre-recorded videos I intend to explain some of the concepts using simulations in the statistical language R. You are not required to know R or even to learn it in this course, but putting in the effort to do so will be highly beneficial.

If you are unfamiliar with R please go to

https://www.r-project.org/about.html

There are millions of other websites where you can learn about it. I will also use the RStudio environment for working with R scripts and displaying results:

https://rstudio.com/

Both are free to download and I highly encourage you to do so. All scripts that I use will be made available on the Canvas page so you can tinker with them yourselves. Note that you have to install R and R Studio separately, and you should install R first.

Homework

For this online semester I will assign weekly homework. Homework will be assigned weekly and due by the end of each Wednesday, except for the weeks in which there is a midterm. I will try to post the next assignment by the Wednesday before. For about half of the homework problems I will give you the solutions beforehand and you can hopefully learn from those. Three of the homework problems will not have solutions and you will need to write those up and submit them. See the "Technical Requirements" section for more details of how to submit. Of those three homework problems I will grade only one and that will form your weekly homework score. Solutions will be provided for all three problems.

I also encourage you to work on the homework problems together in groups. This way you can discuss and learn from each other.

In the final grade I will drop the two lowest scores of your homeworks. Because of this no late homeworks are accepted, except in extenuating circumstances such as illness. In this case you should let me know as soon as possible that you need to submit late.

Protocol for Taking Quizzes, Midterms, and Finals

The online nature of this course presents unique challenges for the delivery, taking, and submission of timed exams. Dealing with this issue will require some flexibility and ingenuity on the part of all of us.

All exams will be administered through Canvas and Zoom. They will need to be accessed **during class times**, you will have a pre-defined time period during which to take them, and then you will need to re-upload your solutions at the end. I will try to give ample time for you to download and upload quizzes.

On Wednesday of the first week we will have a mock quiz to go over these procedures. This quiz will only review material that you should already know, primarily from our Math 5010, but will not be graded.

All quizzes and exams will be open book, including the final exam. You are also allowed to access the internet as a tool for looking up definitions and information about different probability distributions. You are **NOT** allowed to consult with other students during quizzes and exams, and you are **NOT** allowed to use online tutoring or answer sites such as Chegg, TutorMe, etc. to obtain answers to exams. These sites will be actively monitored for the posting of exam and quiz questions, and they are actively cooperating with our university to investigate cases of potential fraud and abuse. ***Violations of these rules can lead to disciplinary procedures from the Dean of Students.***

Grading

Homework: 30%
Midterms: 2 @ 20% each
Final Exam: 30%

Typically letter grades are assigned as: **A:** 93%+, **A-:** 86%-92%, **B+:** 80%-85%, **B-:** 74% - 80%, **C+:** 68%-73%, **C:** 61%-67%, **C-:** 55%-60%, **D:** 50%-54%, **E:** < 50%

Important Dates

First class	Monday, August 24th
Last day to add, drop, elect credit or no credit, or audit	Friday, September 4th
Labor Day (no class)	Monday, September 7th
Midterm 1	Wednesday, October 7th
Last day to withdraw from classes	Friday, October 16th
Midterm 2	Wednesday, November 11th
Last day of in person instruction (doesn't affect us)	Wednesday, November 25th
Thanksgiving (no class)	November 26th and 27th

Last class	Wednesday, December 2nd
Final exam	Monday, December 7th @ 6PM

Communication

Class announcements will be done via email through the Canvas server. You will be responsible for any information contained in them as well as the information announced in class. Students should check Canvas regularly and set up notifications that are directly forwarded to their e-mail inbox. You should also regularly check your UMail or forward it to an address that you monitor regularly.

COVID Specific Details

Protocol in the Case of a Stay-at-Home Order

Should another stay at home order go into place the online nature of this course means that it should be largely unaffected. In this situation I intend to keep teaching following the same format and schedule. However I can imagine that for some students a stay-at-home order may come with additional burdens, and if you are in this case please e-mail me and I will work with you individually to come up with solutions.

Protocol in the Case of Sickness

If I happen to get sick I will arrange an alternative instructor. Luckily I am able to live as a hermit during this time so hopefully my chances of sickness are low. Should one of you happen to get sick please let me know via e-mail and we will work out an arrangement for future quizzes and exams. A reminder that all students, faculty, and staff who are given a positive COVID diagnosis must self-report at coronavirus.utah.edu

Fall Break and Post Thanksgiving

Fall break was originally scheduled to run from October 4th-11th but has since been cancelled. During this week all classes will be delivered online. The delivery and schedule for this course will remain the same during this period.

All classes will also be online the week of Monday, Sept 28th to Friday, Oct 2nd. The delivery and schedule for this course will remain the same during this period.

All classes will also be online the week after Thanksgiving, from Monday, Nov 30th until the last day of classes on Friday, December 3rd. The delivery and schedule for this course will remain the same during this period.

University of Utah Resources and Policies

ADA Statement

The University of Utah is fully committed to policies of nondiscrimination and equal opportunity. The Americans with Disabilities Act requires that reasonable accommodations be provided for students with physical, cognitive, systemic learning, and psychiatric disabilities, and the University seeks to provide equal access to its programs, services, and activities for people with disabilities. Reasonable prior notice is necessary to arrange such accommodations, and students are responsible for obtaining the accommodations and notifying the instructor through official channels early in the semester.

Addressing Sexual Misconduct

Title IX makes it clear that violence and harassment based on sex and gender (which Includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, SSB 328, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677.

Campus Safety

The University of Utah values the safety of all campus community members. To report suspicious activity, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.

Student Names and Personal Pronouns

Class rosters are provided to the instructor with the student's legal name as well as "Preferred first name" (if previously entered by you in the Student Profile section of your CIS account, which managed can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class or on assignments. Please advise me of any name or

pronoun changes so I can help create a learning environment in which you, your name, and your pronoun are respected. If you need any assistance or support, please reach out to the LGBT Resource Center. https://lgbt.utah.edu/campus/faculty_resources.php

Diversity and Inclusivity Statement

It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

Undocumented Student Support Statement

Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit dream.utah.edu

Wellness Statement

Personal concerns such as stress, anxiety, relationship difficulties, depression, cross---cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness at www.wellness.utah.edu or 801-581-7776.