Statistics 509 / Economics 580 / CS&SS 509

Introduction to Mathematical Statistics
Autumn Quarter 2020

Instructor: Thomas Richardson; e-mail: thomasr@uw.edu
Office hours: W 4:30-6:00; zoom

Teaching Assistant: Anupreet Porwal; e-mail: porvaa@uw.edu
Office hours: M10-11; T 4:30-5:30

Lecture Time:
Tu 2:30-4:20
Th 2:30-3:50

Quiz sections:
(AA) F 12:30 - 1:20
(AB) F 1:30 - 2:20

Course web-page: http://www.stat.washington.edu/tsr/s509

Purpose of the course: This course is an introduction to the mathematical theory of probability and statistical inference at the calculus level. The course explains the basic theory and principles underlying statistical methods. Emphasis will be on mastering concepts and techniques needed for subsequent work in econometrics and statistics. Students who complete Stat 509 / Econ 580 will be well prepared to study the application of statistical methods in courses such as Stat 502, 504, or Econ 581, 582, or similar courses in other applied fields.

Pre-requisites: Stat 311, Econ 281 or equivalent. Math 124, 125, 126, and a course in linear algebra. Math 324 is recommended, as the course makes use of multivariate calculus.

Textbook: A.S. Goldberger, A course in Econometrics.
I have assigned readings from this book on the topics covered in lectures. You will get much more from the lectures if you do the reading in advance.

Supplementary textbooks:
J. Rice: Mathematical Statistics and Data Analysis.
J.D. Angrist, J.-S. Pischke: Mostly Harmless Econometrics.
Introduction to R See: http://www.r-project.org
Depending on the time available, additional articles may be assigned.
Software: We will use the statistical software environment R. This is freely available from: [http://www.r-project.org](http://www.r-project.org)

Some homework exercises will require you to use R in order to perform simulations. I also use a Graphing Calculator program for demonstrations in class. This software is not required, but it is cheap, and I recommend it (see web-page).

Laptop and Internet Access: Some classes and quiz sections will involve software demonstrations. The UW has a number of laptops that can be checked out by students. For details see: [https://stlp.uw.edu/overview](https://stlp.uw.edu/overview)

The UW has a list of links to resources for students here that may be helpful if you are having difficulty obtaining internet or other services in your accommodation.

Whiteboard: I intend to use [https://scribbletogether.com](https://scribbletogether.com); this provides a web accessible whiteboard.

Homework: Problems will be assigned approximately weekly. You will typically have a week in which to work on the homework. You will be asked to upload a single pdf with your solution (hand writing + CamScanner is OK); you will need to input which question is on which page; we will also ask you separately to upload your R code to Canvas. Homework will typically be due by early morning Friday (Seattle Time). Late homework will not be accepted since solutions may be covered in the Friday quiz section. Each homework will contribute towards approximately 5% of the total grade. Thus you should turn in homework even if you are unable to finish all of it in time. A subset of homework questions will be graded. Homework grades will subsequently be combined to form an overall percentage. The algorithm for making this conversion will be specified later.

All homework solutions provided are to be used solely by students in this class. I will report anyone found using past solutions or providing solutions to other students in future (see Academic Integrity below). Similarly for obtaining or soliciting help from online websites.

Uploading to commercial websites: Materials provided in this course are solely for the students in the course. They may not be uploaded to commercial websites.

Religious Accommodation Policy: Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW’s policy, including more information about how to request an accommodation, is available at Faculty Syllabus Guidelines and Resources. Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form available at [https://registrar.washington.edu/students/religious-accommodations-request/](https://registrar.washington.edu/students/religious-accommodations-request/)
**Evaluation:** The final grade will be made up as follows:

- Homework: 30%;
- Midterm 30%;
- Final 35%;
- Participation 5%.

Grades are computed from the final percentage by dividing the overall percentage by 25. Incomplete grades will not be assigned except in extraordinary circumstances.

**Midterm:** The midterm will be on Tuesday, November 3, 2:30 - 3:50 PM (Seattle Time), with additional time for uploading your solution. *This is Election Day; if the timing of the exam creates problems for you in voting, please let me know.*

**Final:** The final will be on Tuesday, December 15, 4:30 - 6:20 PM (Seattle Time) It will include material covered during the whole quarter.

There will be more than one version of each exam.

Exams will be open notes, open books, but internet access is not permitted. *You are strongly encouraged to prepare one or two sheets of formulae.*

We will make arrangements for students in time zones that are distant. If you are in this situation, and have not previously notified us, please do so by Tuesday, October 6.

Make-up exams will not be given except in extraordinary cases (certified medical condition, family emergency etc.)

**Lectures:** Lectures will be on Zoom and will be recorded. We will also use breakout rooms to discuss problems. I will sometimes nominate one person in each breakout room to report back to the class.

**Participation:** It helps the whole class if you ask questions during lectures, answer questions posed by the instructor, or are involved in quiz section and on the discussion boards. Participation is mandatory and will be graded based on self-report. The expectation is that each student will participate about once per week (full credit for meeting this expectation). The following count as participation: (i) ask a question or make a comment in lecture, quiz section; (ii) answer a question in lecture or quiz section; (iii) summarize breakout discussion; (iv) post on the Canvas discussion board.

**Quiz Sections:** The TA will go over homework during the quiz and will also answer questions that you may have concerning the homework that is due the following week. The TA will perform some software demonstrations.

**Mailing List:** There is an e-mail list for this course. Your UW address will automatically be registered. (It is your responsibility to get e-mail forwarded if you use another account.)

**Discussion Board:** We will use the Canvas class discussion board as a way to facilitate asynchronous discussion.
Questions: Please do not hesitate to raise questions about the material in class. If you have any concerns about any aspect of the class please let me know as soon as they arise. You can talk to me before or after class, during office hours, or you can send me e-mail. I will also accept (constructive!) anonymous notes or e-mail. The Teaching Assistant will also be available during office hours to answer questions that you may have.

Academic integrity: Collaboration and discussions are allowed and encouraged in this class, but copying or letting others copy your work amounts to plagiarism. This includes copying model solutions, e.g. from prior years. Although cheating occurs seldom in graduate classes, if it does, I will take the following action: assign a grade of 0.0 for the exam/homework where the cheating occurred, and report the incident to the Graduate School Committee on Academic Conduct, which will decide upon an appropriate University course of action.

Disability Resources for Students (DRS): Your experience in this class is important to me. If you have already established accommodations with DRS, please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to: mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at (206) 543-8924 or uwdrs@uw.edu or http://depts.washington.edu/uwdrs/.

DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

Subject to Change: This is a time of considerable uncertainty due to many factors. The syllabus may be changed or revised if circumstances necessitate it.
## Provisional Course Outline

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Readings</th>
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<tbody>
<tr>
<td>Th 1 Oct</td>
<td>Review: Probability</td>
<td>G 1-2.1; R1</td>
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<tr>
<td>Tu 6 Oct</td>
<td>Univariate Probability Distributions</td>
<td>G 2.2-4; (R 2.1-2)</td>
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<tr>
<td>Th 8 Oct</td>
<td>Functions of Random Variables</td>
<td>G 2.5-3.1; (R 2.3)</td>
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<tr>
<td>Tu 13 Oct</td>
<td>Expectations: Univariate Case</td>
<td>G 3.2-5; (R 4.1-2)</td>
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<tr>
<td>Th 15 Oct</td>
<td>Moment generating functions (mgfs)</td>
<td>R 4.5</td>
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<tr>
<td>Tu 20 Oct</td>
<td>Bivariate Probability Distributions</td>
<td>G 4; (R3)</td>
</tr>
<tr>
<td>Th 22 Oct</td>
<td>Functions of Two Random Variables</td>
<td>(R 3.6)</td>
</tr>
<tr>
<td>Tu 27 Oct</td>
<td>Expectations: Bivariate Case</td>
<td>G 5; (R 4.3; 4.4)</td>
</tr>
<tr>
<td>Th 29 Oct</td>
<td>Independence; Normal Distributions</td>
<td>G 6; (R 3.4)</td>
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<tr>
<td>Tu 3 Nov</td>
<td>Midterm</td>
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<td>Th 5 Nov</td>
<td>Bayesian inference</td>
<td>R 8.6; Handout</td>
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<tr>
<td>Tu 10 Nov</td>
<td>Bayesian inference</td>
<td>R 8.6; Handout</td>
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<tr>
<td>Th 12 Nov</td>
<td>Univariate Sampling Distributions</td>
<td>G 8.1-8.4; (R 7)</td>
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<td>Tu 17 Nov</td>
<td>Hypothesis Testing</td>
<td>(R 9.1-3)</td>
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<td>W 18 Nov</td>
<td>Interval Estimation</td>
<td>G 11.5; (R 9.4)</td>
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<tr>
<td>Th 19 Nov</td>
<td>Parameter Estimation</td>
<td>G 11.1-3; (R 8.5)</td>
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<tr>
<td>Tu 24 Nov</td>
<td>Asymptotic Distribution Theory (I)</td>
<td>G 9; (R 5)</td>
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<td>Th 26 Nov</td>
<td>Thanksgiving Holiday</td>
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<tr>
<td>Tu 1 Dec</td>
<td>Asymptotic Distribution Theory (II)</td>
<td>G 10; (R 5)</td>
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<td>Th 3 Dec</td>
<td>Maximum Likelihood</td>
<td>G 12.4; (R 8.1-8)</td>
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<td>Tu 8 Dec</td>
<td>The Cramér-Rao Inequality</td>
<td>G 12.2-4; (R 8.5.3, 8.7)</td>
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<tr>
<td>Th 10 Dec</td>
<td>Asymptotic Confidence Intervals</td>
<td>G 12.2-4; (R 8.5.3, 8.7)</td>
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<tr>
<td>M 14 Dec</td>
<td>Review</td>
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<td>Tu 15 Dec</td>
<td>Final</td>
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G, R indicate assigned sections from Goldberger and (optional) Rice. I will also make some assignments from *Mostly Harmless*...

### Errata for Goldberger *A Course in Econometrics*

1. p.97 line 2 from bottom should read:
   
   \[ \ldots \text{and } \lim G_n(t) = 1 \text{ for all } t > c, \text{ then we say} \ldots \]

2. p.108, line 7 from bottom, equation should read:
   
   \[ V(S_{XY}) = (n-1)^2(\mu_{22} - \mu_{11}^2)/n^3 + (n-1)(\mu_{11}^2 + \mu_{20}\mu_{02})/n^3 \]

3. p.135 line 9 from bottom ‘convex’ should be ‘concave’.