Stat 312: Introduction to Theory and Methods of Mathematical Statistics II (Lecture 002), Spring 2019

Instructor Information
Name: Xiaowu Dai
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Office Hours: Wed. 2:30 p.m. - 4:30 p.m. and Thu. 2:30 p.m. - 4:30 p.m.

Course Information
Credits: 3 units
Time: TuTh 2:30 p.m. - 3:45 p.m.
Location: SMI 331

TA Information
Name: Behzad Aalipur Hafshejani
Office: 1276 Medical Sciences Center
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Office Hours: Wed. 5 p.m. - 6 p.m. and Thu. 5 p.m. - 6 p.m.

Other Drop-In Tutoring Sevice
The College of Engineering's Undergraduate Learning Center will be available Sunday-Thursday, 6:30-9PM, on the 3rd floor of Wendt Commons. The first day of tutoring is Monday, February 4, 2019. See their website `http://ulc.engr.wisc.edu`.

Main Text
Devore, *Probability and Statistics for Engineering and the Sciences, 9th ed,* Cengage Learning, 2016.

Supplementary Texts
Keener, *Theoretical Statistics: Topics for a Core Course*, Springer 2010.
Lehmann and Casella, *Theory of Point Estimation*, Springer 1998.
Lehmann and Romano, *Testing Statistical Hypotheses*, Springer 2005.
Gelman & Hill, *Data Analysis Using Regression and Multilevel/Hierarchical Models* (for applied examples).

Mathematical Prerequisites

I expect that you'll have a good working knowledge of probability theory (Stat 311, or an equivalent course), including (but not limited to) these concepts: probability distributions, probability density functions, random variables, independence of events/random variables, expected values, and variance. I also expect some familiarity with certain canonical distributions: Binomial, Poisson, Normal, Exponential, Gamma, etc. You should also have a good working knowledge of both differential and integral calculus.

Communication

Outside of lecture, I may make periodic announcements to the class via the university-supplied classlist. It is imperative that you make sure your @wisc.edu email address is working. I will use **Learn@UW** as the course website. All homework assignments and any handouts will be posted there, as well as your grades and a discussion forum.

Computing

Periodically I will assign homework problems that require using a computer. If you have a statistical or scientific computing package that does what is necessary, you may use it; however, I may not be able to offer any technical support. I will use R, which is free, open-source and extremely powerful. You can download R at cran.r-project.org.

Homework

There will be **six** homework assignments throughout the semester. You will have approximately two weeks to complete each one (although some exceptions may arise). You have to work on homework **independently**. New homework assignments will be posted to Learn@UW. They will be due two weeks later in **the beginning of class**.

To receive full credit on homework problems, you must justify all your answers, showing supporting work and demonstrating sound, appropriate reasoning. Homework will be graded by the TA, and graded homeworks

will be passed back in class. The homework assignment with the **lowest score** will be dropped before final grades are calculated. For questions about homework grading, please first contact to TA.

Exams

There will be two midterm exams on **Feb. 14** and **Mar. 14** during the usual lecture time. You may bring **one** 8.5×11 inch sheet of paper for notes for the midterm (front and back). The final exam will be **May 2** from 2:30-3:45 a.m. at SMI 331. The final exam will be cumulative.

Grading

Homework (projects): 30%; Midterm I: 20%; Midterm II: 20%; Final exam 30%.

Tentative Schedule

We will cover a few most important topics in Mathematical Statistics.

1. *Statistical decision theory*: Frequentist and Bayesian.
2. *Point estimation:* Exponential families, estimators; Bias and variance; Maximum likelihood estimation; Method of moments.
3. *Confidence intervals:* Interpretation and construction; Normal, t and large sample intervals; Intervals based on maximum likelihood estimators.
4. *Hypothesis testing:* General hypothesis testing (Neyman-Pearson) framework; Type I and type II errors; Power; FDR control.
5. *Two sample tests:* t- and Z-tests for comparing two population means or proportions in independent samples; t- and Z-tests for comparing paired samples; power and sample size calculations; Mann-Whitney test for two independent samples; Wilcoxon signed-rank test for paired samples.

6. *ANOVA:* Model formulation, constructing ANOVA tables, F-test for equality of means, assumptions and diagnostic plots for checking them; Kruskal-Wallis test for equality of means.

7. *Simple linear regression:* Model formulation; Model interpretation; Confidence intervals; Assumptions and diagnostic plots for checking them.

8. *Categorical data analysis:* Fisher's exact test; Pearson's chi-squared statistic; Chi-square tests for independence and homogeneity; Goodness-of-fit tests.

9. *Topics on large-sample theory*: High-dimensional testing; Multiple testing; Selective inference.

10. *Topics on machine learning*: Decision tree; Random forest; Gradient boosting; Support vector machines.