STAT/MATH 415, Introduction to Mathematical Statistics

Instructor: Le Bao lebao@psu.edu

Section 001: M W F 9:05 AM - 9:55 AM, 273 Willard Bldg
Section 002: M W F 10:10 AM - 11:00 AM, 073 Willard Bldg

Office Hours (Wartik Lab 514-C) Wednesday 11:00 AM~12:00PM
Thursday 2:30 PM~3:50PM
Or by appointment

TA: Christian Schmid cxs5700@psu.edu
Office Hours (Thomas 320) Thursday 9:00am~11:30am

TA: Ching-Chi Yang cuy130@psu.edu
Office Hours (Thomas 320) Tuesday 1:00pm~3:30pm

Prerequisites: STAT/MATH 414

Recommended Materials:
- *Probability and Statistical Inference, ninth edition*, by Hogg, Tanis and Zimmerman. (Chapters 5~9).

General description of the course:
This course provides an introduction to mathematical statistics, covering the fundamentals of statistical inference. The topics covered will include: of Estimation and Hypothesis Testing, Nonparametric statistics, Bayesian Inference, and some theory. It is more of a theoretical course but with examples helping you understand the materials.

Final Grades: Final grades will be determined as follows:
A: 94-100%,  A-: 90-93%,  B+: 88-89%,  B: 84-87%,  B-: 80-83%,
C+: 78-79%,  C: 70-77%,  D: 60-69%,  F: 0-59%
**Required Work:**

1. Eleven weekly homework assignments.
2. Two mid-term examinations.
3. A comprehensive final examination, to be held during the week of May 2-6.
4. Full attendance at classes.

**Grading policy:** Overall scores will be calculated using the following scheme:

<table>
<thead>
<tr>
<th>Assignments and Exams</th>
<th>Weight</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework Assignments</td>
<td>35%</td>
<td>Weekly (in class on Friday)</td>
</tr>
<tr>
<td>Mid-term Exam 1</td>
<td>20%</td>
<td>Feb 26 (in class)</td>
</tr>
<tr>
<td>Mid-term Exam 2</td>
<td>20%</td>
<td>Apr 1 (in class)</td>
</tr>
<tr>
<td>Final Exam</td>
<td>25%</td>
<td>TBD</td>
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</tbody>
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The exams will be closed book. You may bring one regular double-sided formula sheet for the two Midterm exams and up to 3 sheets for the comprehensive final exam.

For each mid-term and final exam, you must bring your PSU student-ID card.

**Course Rules:**

1. Homework assignments will be given on every Friday and due one week after. No late or make-up homework assignments will be accepted, for ANY reason. The lowest grade will be dropped, and only 10 scores will count toward final grade.
2. No "make-up" exams will be given for ANY reason. Early exams *might* be allowed, with prior arrangement, for students with direct conflicts due to other required university programs (chess team, field trip, Blue Band trip, etc..) and that program director must provide a letter requesting that you be excused from the exam at least one week ahead.
3. Students are responsible for all announcements and supplements given within any lecture. Class announcements and materials will be regularly posted on ANGEL, so it is recommended that you check the site frequently.
4. Please turn off all electronic devices (cell-phones, pagers, etc.) BEFORE you enter the classroom. If you need to leave class early, please sit in the rear and leave as quietly as possible.
Academic Integrity:
All Penn State and Eberly College of Science policies regarding academic integrity apply to this course. See http://www.science.psu.edu/academic/Integrity/index.html for details.

ECOS Code of Mutual Respect and Cooperation:
The Eberly College of Science Code of Mutual Respect and Cooperation: http://www.science.psu.edu/climate/Code-of-Mutual-Respect_final.pdf embodies the values that we hope our faculty, staff, and students possess and will endorse to make The Eberly College of Science a place where every individual feels respected and valued, as well as challenged and rewarded.

“Penn State welcomes students with disabilities into the University's educational programs. If you have a disability-related need for reasonable academic adjustments in this course, contact the Office for Disability Services (ODS) at 814-863-1807 (V/TTY). For further information regarding ODS, please visit the Office for Disability Services Web site at http://equity.psu.edu/ods/.

In order to receive consideration for course accommodations, you must contact ODS and provide documentation (see the documentation guidelines at http://equity.psu.edu/ods/guidelines/documentation-guidelines). If the documentation supports the need for academic adjustments, ODS will provide a letter identifying appropriate academic adjustments. Please share this letter and discuss the adjustments with your instructor as early in the course as possible. You must contact ODS and request academic adjustment letters at the beginning of each semester.”

Disabilities statement:
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Campus emergencies:
Campus emergencies, including weather delays, are announced on Penn State Live (http://news.psu.edu/) and communicated to cellphones, email, the Penn State Facebook page, and Twitter via PSUTXT (to sign up, please see http://psutxt.psu.edu).
**Learning Objectives:** Upon successful completion of this course, students are expected to understand following items.

**Parameter Estimation**

1. the difference between a population of interest and a sample obtained from that population
2. what a statistical estimator is and how to compare two estimators in terms of bias and variance
3. how to find an estimator using the maximum likelihood approach
4. how to derive confidence interval limits for a population parameter using a sample estimator that is approximately normally distributed
5. how to interpret and compare confidence intervals in terms of width and coverage probability
6. how sample size affects the margin of error of a confidence interval and how to use a desired margin of error to determine the sample size required for collection
7. how to state the simple regression model and its assumptions
8. the least-squares approach to parameter estimation, particularly for the simple regression model
9. the difference between a prediction interval and a confidence interval for a mean response when using a regression model
10. what correlation is and how to compute the correlation coefficient from sample data
11. how to use sample order statistics to construct a confidence interval for a population percentile
12. how Bayes’ formula is used to define a prior and posterior distribution for a population parameter
13. what a loss function is in the Bayesian context and how it is used to determine a Bayes estimator

**Hypothesis Testing**

1. how to state null and alternative hypotheses and understand the difference between one and two-sided alternatives
2. how a Type I error and a Type II error are defined for a hypothesis test
3. how to compute and interpret a test statistic for a hypothesis test, particularly when considering one population mean, the difference between population means, one population proportion, or the difference between population proportions

4. what a p-value is and how it is used to state a hypothesis test conclusion, given a specified threshold

5. how to interpret exactly what it means to reject a null hypothesis or to fail to reject a null hypothesis

6. how power is defined for a hypothesis test and how this relates to sample size and the assumed value(s) of the population parameter(s)

7. how to conduct a hypothesis test for a linear relationship using the regression model

8. how to state the analysis of variance (ANOVA) model and its assumptions

9. how to state the hypotheses for the ANOVA model, both in words and in terms of the population parameters involved

10. how an ANOVA table is constructed

11. how to conduct a hypothesis test for association with categorical data in a contingency table

12. how to conduct a hypothesis test for goodness of fit

13. how to conduct a hypothesis test for a population median using the sign test and the Wilcoxon signed rank test

*Addition Topics (TBA)*