MATH 312-01 Statistical Inference

Ganesh Malla
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Class Room: Smith Hall 349
Class Time: 8:30 - 9:45 AM, TR
Office hours: 10:00 - 11:00 AM, Monday 02:30 - 03:30 PM, Thursday or by appointment
(If my office door is open, you may knock the door for help!)


Pre-requisite: MATH 256, or MATH 311, or equivalent

Course Purpose: The purpose of the course Statistical Inference is to present theoretical statistical inferring methods with their applications. The material covered is pretty mathematical but it is of interest primarily to students who requires a very deep understanding of statistical inferences (Estimation and Hypothesis testing). This would prepare students to be ready to take any graduate level statistic courses in any discipline. Students will also learn some computer simulation techniques using the statistical software R.

Coverage of the course

1. Background Topics
   1.0 Introduction to R
   1.1 Transformations of variables of the discrete type
   1.2 Transformations of variables of the continuous type, The Jacobean of transformation
   1.3 Types of convergences
   1.3.1 Convergence in probability
   1.3.2 Convergence with prob. =1
   1.3.3 Laws of large numbers

2. Estimation
   2.1 Statistics
   2.1.1 Examples of Statistics
   2.2 Estimation by the Method of Moments
2.3 Estimation by the Method of Maximum Likelihood
2.4 Properties of Estimators
2.5 Examples of Estimators and their Properties
2.6 Properties of Maximum Likelihood Estimators
2.7 Confidence Intervals
2.7.1 Pivotal quantity
2.8 Bayesian estimation

3 Hypothesis Testing
3.1 Introduction
3.2 Terminology and Notation
3.2.1 Hypotheses
3.2 Tests of Hypotheses
3.2.3 Size and Power of Tests
3.3 Examples
3.4 One-sided and Two-sided Tests
3.4.1 Case (a) Alternative is one-sided
3.4.2 Case (b) Two-sided Alternative
3.4.3 Two Approaches to Hypothesis Testing
3.5 Two-Sample Problems
3.6 Connection between Hypothesis testing and CI’s

4 Chi-square Distribution
4.1 Distribution of $S^2$
4.2 Chi-Square Distribution
4.3 Independence of $X$ and $S^2$
4.4 Confidence Intervals for $\sigma^2$
4.5 Testing Hypotheses about $\sigma^2$

5 Fisher’s F Distribution
5.1 Derivation
5.2 Properties of the F distribution
5.3 Use of F-Distribution in Hypothesis Testing
5.4 Pooling Sample Variances
5.5 Confidence Interval for $\sigma^2_1 / \sigma^2_2$

6 t-Distribution
6.1 Derivation
6.2 Properties of the t-Distribution
6.3 Use of t-Distribution in Interval Estimation
6.4 Use of t-distribution in Hypothesis Testing

7 Analysis of Categorical Data
7.1 Introduction
7.2 Goodness–of–Fit Tests
7.3 Contingency Tables
7.3.1 Method
8 Simple Linear Regression
8.1 Introduction
8.2 Estimation of \( \alpha \) and \( \beta \)
8.3 Estimation of \( \sigma^2 \)
8.4 Inference about \( \hat{\alpha} \), \( \hat{\beta} \), and \( \hat{\sigma}^2 \)
8.5 Correlation

**Technology:** You need **Internet access** for use in communication and for use of the blackboard. Blackboard will be used to post all the course information and materials including partial lecture notes. Free online **software R** be used as a computing tool.

**NB:** All electronic devices including internet/Cell phone must be off during class.

**Participation and attendance:** Regular attendance is expected. However, your grade is not directly determined by your attendance. Poor attendance will be interpreted as a poor attitude toward your grade, and, in such a case, no mercy will be shown to the individual that has a grade that is border-line. Regardless of the reason that a class may be missed, you are still responsible for the material covered, and for turning your homework in on time. You are always encouraged to ask questions and clear your doubts in class. The lesson format will vary from day to day with students expected to read and write in and outside of class, speak within problem solving groups, address the class, and listen to the ideas of others.

**Homework:** There will be 4-8 problems on each homework (HW) assignment and there will be 7 or 8 HW. There will be few quizzes and quiz dates will be announced in class at least 5 days ago.

**Evaluation scheme:** Grade points will be divided approximately as follows:
- Homework /Quiz: 22%
- Project: 08%
- Tests (2 @ 22% each): 44%
- Final exam: 26%

**Project work:** Students need to do a project, and present during the final weeks of the semester. The outline of the project will be given soon!

**TESTS:** All tests are closed book and closed notes. Make-up tests will be given only when written evidence to support the absence is accepted.

**Exam schedule**
- **Test 1** Thurs, Feb 20
- **Test 2** Tues, April 15
Final exam  Tues, May 6    8:30–10:20

Notes
1. There will be a short review session before each test.
2. The coverage of the Tests and Final Exam
   - Test 1: The lecture classes from Jan 14 to the 1st Test
   - Test 2: The lecture classes between the 1st and 2nd Tests
   - Final Exam: Problems similar to ones from Test 1, and Test 2, and course material covered after the 2nd Test.

Grading Scale

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Assistance
• I will be available for the assistance at the posted office hours or by appointment when needed.

Academic Honesty (XU Student Code of Conduct): A standard of honesty, fairly applied to all students, is essential to a learning environment. Students abridging a standard of honesty must accept the consequences: penalties are assessed by appropriate classroom instructors or other designated people.

**Disclaimer**
Please be aware that although this syllabus provides a general guideline/description of this course, it is still subject to change. Any changes concerning the items contained in this document will be announced in class or posted on the course website.

Thank you!