Fall 2023

MATH 680-001, Fall 2023: Advanced Statistical Learning

Wenge Guo

MATH 680: Advanced Statistical Learning
Fall 2023 Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

Course Description: This course builds on the material in MATH 478 or MATH 678 and serves as a second graduate course in data science with emphasis on statistics. It covers many topics in high dimensional data analysis, including LASSO, SCAD and other regularization procedures, sparse PCA, sparse k-means, and asymptotic theory for high dimensional models. This course will provide students with necessary theoretical and computational skills to understand, design, and implement modern statistical learning methods, including ensemble learning (bagging, random forest, and boosting). Students will use the R statistical software.

Number of Credits: 3

Prerequisites: MATH 478 or MATH 678 or permission by instructor.

Course-Section and Instructors:

Course-Section	Instructor
Math 680-001	Professor W. Guo

ffice Hours for All Math Instructors: Fall 2023 Office Hours and Emails

Required Textbook:

Title	*The Elements of Statistical Learning: Data Mining, Inference, and Prediction*
Author	Hastie, Tibshirani, and Friedman
Edition	2nd
Publisher	Springer
ISBN #	78-0387848570
Reference Book	An Introduction to Statistical Learning: with Applications in R, by James, Witten, Hastie, and

	Tibshirani (2023), 2nd edition, Springer. An Introduction to Statistical Learning: with Applications in Python, by James, Witten, Hastie, and Tibshirani (2021), 1st edition, Springer.

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, November 13, 2023**. It will be strictly enforced.

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Homework	20%
Project	40%
Final Exam	40%

Your final letter grade will be based on the following tentative curve.

A	90 - 100	C+	75 - 80
B+	85 - 89	C	70 - 75
B	80 - 85	F	0 - 70

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be strictly enforced.

Exams: There will be a cumulative final exam during the final exam week:

Final Exam Period	December 17 - December 23, 2023

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

Makeup Exam Policy: There will be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times.

ADDITIONAL RESOURCES

Further Assistance: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

Accommodation of Disabilities: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you need an accommodation due to a disability, please contact the Office of Accessibility Resources and Services at oars@njit.edu, or visit Kupfrian Hall 201 to discuss your specific needs. A Letter of Accommodation Eligibility from the office authorizing student accommodations is required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website at:

https://www.njit.edu/accessibility/

Important Dates (See: Fall 2023 Academic Calendar, Registrar)

Date	Day	Event
September 4, 2023	Monday	Labor Day
September 5, 2023	Tuesday	First Day of Classes
September 11, 2023	Monday	Last Day to Add/Drop Classes
November 13, 2023	Monday	Last Day to Withdraw
November 21, 2023	Tuesday	Thursday Classes Meet
November 22, 2023	Wednesday	Friday Classes Meet
November 23 to November 26, 2023	Thursday and Saturday	Thanksgiving Recess - Closed
December 13, 2023	Wednesday	Last Day of Classes
December 14, 2023	Thursday	Reading Day 1
December 15, 2023	Friday	Reading Day 2
December 17 to December 23, 2023	Sunday to Saturday	Final Exam Period

Course Outline

Date	Lecture	Chapter	Topic	Assignment

Week 1 9/5	1	Chapter 1	**Overview and Introduction,** **Application Examples.**	
Week 2 9/12	2	Chapter 2	**Overview of Supervised Learning:** **Statistical Decision Theory**	
Week 3 9/19	3	Chapter 4	**Binary Classification (I): Basics** **Binary Classification (II): Logistic Regression, Discriminant Analysis**	Homework 1
Week 4 9/26	4	Chapter 2	**Multiclass Classifications**	
Week 5 10/3	5	Chapter 4	**Nonlinear Classification Methods: K-nearest neighbor (KNN) methods**	
Week 6 10/10	6	Chapter 4	**Nonlinear Discriminant Analysis: QDA and RDA**	Homework 2
Week 7 10/17	7	Chapter 14.5 & 3	**Linear Regression Models**	
Week 8 10/24		Chapter 3	**Variable Selection for Linear Regression** **Shrinkage Methods by LASSO**	
Week 9 10/31	8	Chapter 3 & 7	**Model Selection and Assessment**	Homework 3
Week 10 11/7	9	Chapter 4.5 & 12	**Support Vector Machines**	

Week 11 11/14	10	Chapter 9 & 8.7	**Tree-based Methods**	
Week 12 11/21	11		**FINAL EXAM:** **Tuesday ~ Nov 21, 2023** **Friday, Nov 24: Thanksgiving Recess**	Homework 4
Week 13 11/28	12	Lecture notes	**Uncertainty Quantification (I): Standard conformal prediction**	
Week 14 12/5	13	Lecture notes	**Uncertainty Quantification (II): Conformal prediction under distribution shift**	
Week 15 12/12			**Students' Project Presentation**	