

## **MATH 680: Advanced Statistical Learning** *Fall 2020 Graduate 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.

**DMS Online Exam Policy Fall 2020:** Exams will be proctored using both Respondus LockDown Browser+Monitor and Webex. Students will be required to join a Webex meeting from their phone with their cameras on, and to access the exam through LockDown Browser on a Mac or Windows PC with webcam. Students must follow all instructions related to environment checks and camera positioning.

Please be sure you read and fully understand our [DMS Online Exam Policy](#).

### **COURSE INFORMATION**

**Course Description:** This course builds on the material in **MATH 478** and **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

**Office Hours for All Math Instructors:** [Fall 2020 Office Hours and Emails](#)

**Required Textbooks:**

<b>Title</b>	<i>The Elements of Statistical Learning: Data Mining, Inference, and Prediction</i>
<b>Author</b>	Hastie, Tibshirani, Friedman
<b>Edition</b>	2nd
<b>Publisher</b>	Springer

ISBN #	978-0387848570
Reference Books	<i>An Introduction to Statistical Learning: with Applications in R</i> , James, et al., 2013, Springer.

**University-wide Withdrawal Date:** The last day to withdraw with a **W** is **Monday, November 9, 2020**. 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	30%
Project	35%
Final Exam	35%

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

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

**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.

**Homework Policy:** Homework problems will be assigned in class.

**Exams:** There will be one comprehensive final exam. Exams are held on the following days:

Final Exam	December 15, 2020
------------	-------------------

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:** To properly report your absence from a midterm or final exam, please review and follow the required steps under the DMS Examination Policy found here:

- [http://math.njit.edu/students/policies\\_exam.php](http://math.njit.edu/students/policies_exam.php)

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

## ADDITIONAL RESOURCES

**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 are in need of accommodations due to a disability please contact Chantonette Lyles, Associate Director of Office of Accessibility Resources and Services at **973-596-5417** or via email at [lyles@njit.edu](mailto:lyles@njit.edu). The office is

located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Office of Accessibility Resources and Services authorizing your accommodations will be 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/studentsuccess/accessibility/>

**Important Dates** (See: [Fall 2020 Academic Calendar](#), [Registrar](#))

Date	Day	Event
September 1, 2020	T	First Day of Classes
September 5, 2020	S	Saturday Classes Begin
September 7, 2020	M	Labor Day
September 8, 2020	T	Monday Classes Meet
September 8, 2020	T	Last Day to Add/Drop Classes
November 9, 2020	M	Last Day to Withdraw
November 25, 2020	W	Friday Classes Meet
November 26-29, 2020	R - Su	Thanksgiving Recess - University Closed
December 10, 2020	R	Last Day of Classes
December 11 & 14, 2020	F & M	Reading Days
December 15 - 21, 2020	T - M	Final Exam Period

## Course Outline

Date	Lecture	Chapter	Topic	Assignment
WEEK 1 9/1	1	Chapter 1	Overview and Introduction, Application Examples.	
WEEK 2 9/8	2	Chapter 2	Overview of Supervised Learning: Statistical Decision Theory	Homework 1
WEEK 3 9/15	3	Chapter 4	Binary Classification (I): Basics Binary Classification (II): Logistic Regression, Discriminant Analysis	
WEEK 4 9/22	4	Chapter 18 & 2	Binary Classification (III): Extension to High Dimensional Classification Problems Nonlinear Classification Methods: K-nearest neighbor (Knn) methods.	Homework 2
WEEK 5 9/29	5	Chapter 4	Multiclass Classifications Nonlinear Discriminant Analysis (I): QDA and RDA	
WEEK 6 10/6	6	Chapter 4	Nonlinear Discriminant Analysis (II): PCA Linear Regression Models	Homework 3
WEEK 7 7	7	Chapter 14.5 & 3	Variable Selection for Linear Regression Shrinkage Methods by LASSO	

10/13				
<b>WEEK 8</b> 10/20		Chapter 3	Nonlinear Discriminant Analysis (II): PCA Linear Regression Models	Statistical Learning Project Homework 4
<b>WEEK 9</b> 10/27	8	Chapter 3 & 7	Beyond LASSO Model Selection and Assessment	
<b>WEEK 10</b> 11/3	9	Chapter 4.5 & 12	Modern Classification vis Separating Hyperplanes Support Vector Machines	Homework 5
<b>WEEK 11</b> 11/10	10	Chapter 12	Multiclass Support Vector Machines Optimization Programming	
<b>WEEK 12</b> 11/17	11	Chapter 9 & 8.7	Tree-based Methods: Classification and Regression Trees Bagging	Homework 6
<b>WEEK 13</b> 11/24	12	Chapter 10	Boosting and Additive Trees Friday, Nov 27: Thanksgiving Recess	
<b>WEEK 14</b> 12/1	13	Chapter 14	Cluster Analysis	
<b>WEEK 15</b> 12/8			Students' Project Presentation Friday, Dec. 11: Reading Day 1	
<b>WEEK 16</b> 12/15			<b>FINAL EXAM:</b> Tuesday ~ December 15, 2020	

*Updated by Professor W. Guo - 9/5/2020  
Department of Mathematical Sciences Course Syllabus, Fall 2020*

---