CpE/AAI 646 Pattern Recognition and Classification

Department of Electrical and Computer Engineering
Spring 2023

Instructor:	Hong Man
Course Website:	stevens.edu/canvas
Meeting Times:	Friday 12:00 PM to 2:30PM
Classroom Location:	Kidde 360, Canvas and Zoom
Contact Info:	hman@stevens.edu, 201-216-5038
Office Hours:	Thursday 2:00 PM to 4:00 PM or by appointment. https://stevens.zoom.us/j/2078654249
Prerequisite(s):	Probability and statistics (EE 605 or equivalent)
Corequisite(s):	none
Cross-listed with:	none

COURSE DESCRIPTION

Introduction and general pattern recognition concerns, statistical pattern recognition: introduction to statistical pattern recognition, supervised learning (training) using parametric and nonparametric approaches, parametric estimation and supervised learning, maximum likelihood (ML) estimation, the Bayesian parameter estimation approach, supervised learning using nonparametric approaches, Parzen windows, nonparametric estimation, unsupervised learning and clustering, formulation of unsupervised learning problems; syntactic pattern recognition: quantifying structure in pattern description and recognition, grammar based approach and applications, elements of formal grammars, syntactic recognition via parsing and other grammars, graphical approaches, learning via grammatical inference; neural pattern recognition: the artificial neural network model, introduction to neural pattern associators and matrix approaches, multilayer, feed-forward network structure, content addressable memory approaches. The Hopfield approach to pattern recognition, unsupervised learning, self-organizing networks.

STUDENT LEARNING OUTCOMES

This course will provide a comprehensive introduction to pattern recognition methods and related data analysis applications. Upon successful completion, students will be able to

- (Scientific foundations) apply mathematical principles such as linear algebra, probabilities and statistic
- (Engineering foundations) understand the components in common pattern recognition systems and the stages in system design cycle

- (Technical design) analyze a practical pattern recognition problem, provide an effective system solution, and assess the expected system performance
- (Tools) implement pattern recognition system or component using computer language (e.g. C/C++, python) or software (e.g. Matlab)

COURSE FORMAT AND STRUCTURE

- This is a regular lecture based course. Class will meet once per week.

TENTATIVE COURSE SCHEDULE

Class Date	Topic(s)	Readings	Assignment (assigning dates)
Jan 20	Introduction	CPE646-1	
Jan 27	Bayesian Decision Theory	CPE646-2	HW 1
Feb 3	Normal Density, Discriminant Functions	CPE646-3	
Feb 10	Maximum-likelihood Estimation	CPE646-4	HW 2
Feb 17	Bayesian Parameter Estimation	CPE646-4	
Feb 24	Component Analysis	CPE646-5	
Mar 3	Expectation-Maximization	CPE646-6	HW 3
Mar 10	Midterm Exam		
Mar 24	Parzen Window Estimation	CPE646-7	
Mar 31	K Nearest-Neighbor Estimation	CPE646-8	HW 4
Apr 14	Generalized Linear Discriminant Functions	CPE646-9	
Apr 21	Multilayer Neural Networks	CPE646-10	HW 5
Apr 28	Unsupervised Learning	CPE646-11 (optional)	
May 4 (Thursday)	Project Presentation		

COURSE MATERIALS

Textbook(s):

Pattern Classification, Second Edition, Richard O. Duda, Peter E. Hart, David G. Stork, ISBN: 0-471-05669-3, Wiley, Nov 2000

Other Readings:

Computer Manual in MATLAB to Accompany Pattern Classification, 2nd Edition, David G. Stork, Elad Yom-Tov, ISBN: 0-471-42977-5, Wiley, Apr. 2004

Materials:

Comprehensive lecture notes will be provided on Canvas

COURSE REQUIREMENTS

Attendance Attendance is required and will be recorded. Excused absences (religious or medical, noted in via email to the professor prior to the absence occurring) accompanied by proper documentation can be granted.

Homework Homework will be assigned periodically. All problem sets are expected to be completed according to the instructions, and they are usually due in one week after the assignment. Discussion of homework problems among students is permitted, but each student must finish his/her homework independently. Homework submissions are expected to be in a neat and complete form, showing all major steps towards the solutions.

Project The intention of the term project is to give students an opportunity to investigate a specific topic in the areas of pattern recognition and machine learning. It can be either a research project or survey project. A research project will attempt to solve a practical pattern recognition problem, and produce a publishable research report on the proposed method and the outcome. A survey project will provide a comprehensive literature review on a well selected topic that may have significant impact to future pattern recognition development. It is recommended to take the project in teams. Each team will present its project report in the last lecture of the course.

Exams There will be a midterm exam. It is an open-book-open-notes exam. No communication is allowed among students in this class during the exam.

GRADING PROCEDURES

Grades will be based on:

Homework	(20 %)
Exam (midterm)	(40 %)
Team Project	(40 %)

Late Policy:

To encourage you to stay on schedule, due dates have been established for each assignment; 20% of the total points will be deducted for assignments received 1-6 days late; assignments received more than 1 week late will receive 0 points. Extensions and exceptions can be granted for appropriate reasons.

ACADEMIC INTEGRITY

Students in graduate courses (600 level) are bound by the Graduate Student Code of Academic Integrity.

Graduate Student Code of Academic Integrity

All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at www.stevens.edu/provost/graduate-academics.

EXAM ROOM CONDITIONS

The following procedures apply to the exam for this course. As the instructor, I reserve the right to modify any conditions set forth below by printing revised Exam Room Conditions on the exam.

1. Students may use the following devices during exams. Any electronic devices that are not mentioned in the list below are not permitted.

Device	**Permitted?**	
	Yes	No
Laptops	X	
Cell Phones		X
Tablets	X	
Smart Watches		X
Google Glass		X
Other (specify)		X

2. Students may use the following materials during exams. Any materials that are not mentioned in the list below are not permitted.

Material	**Permitted?**	
	Yes	No
Handwritten Notes *Conditions*: no restriction	X	
Typed Notes *Conditions*: no restriction	X	
Textbooks *Conditions*: no restriction	X	

Readings *Conditions*: lecture notes and homework solutions	X	
Other (specify)		X

3. Students <u>are not</u> allowed to work with or talk to other students during exams.

LEARNING ACCOMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other such disabilities in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

Disability Services Confidentiality Policy

Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

For more information about Disability Services and the process to receive accommodations, visit https://www.stevens.edu/office-disability-services. If you have any questions please contact: Phillip Gehman, the Director of Disability Services Coordinator at Stevens Institute of Technology at pgehman@stevens.edu or by phone (201) 216-3748.

INCLUSIVITY

Name and Pronoun Usage

As this course includes group work and in-class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your name and/or pronouns, please inform the instructor of the necessary changes.

Inclusion Statement

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester. Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements.

You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

MENTAL HEALTH RESOURCES

Part of being successful in the classroom involves a focus on your whole self, including your mental health. While you are at Stevens, there are many resources to promote and support mental health. The Office of Counseling and Psychological Services (CAPS) offers free and confidential services to all enrolled students who are struggling to cope with personal issues (e.g., difficulty adjusting to college or trouble managing stress) or psychological difficulties (e.g., anxiety and depression). Appointments are strongly encouraged and can be made by phone (201-216-5177) or in-person (on the 7th floor of the Howe Center). CAPS is open from 9:00 am – 5:00 pm Mondays, Wednesdays, Thursdays and Fridays and from 9:00 am – 7:00 pm on Tuesdays during the Fall and Spring semesters.

EMERGENCY INFORMATION

In the event of an urgent or emergent concern about the safety of yourself or someone else in the Stevens community, please immediately call the Stevens Campus Police at 201-216-5105 or on their emergency line at 201-216-3911. These phone lines are staffed 24/7, year round. Other 24/7 resources for students dealing with mental health crises include the National Suicide Prevention Lifeline (1-800-273-8255) and the Crisis Text Line (text “Home” to 741-741). If you are concerned about the wellbeing of another Stevens student, and the matter is *not* urgent or time sensitive, please email the CARE Team at care@stevens.edu. A member of the CARE Team will respond to your concern as soon as possible.