COMP4220 – Machine Learning

Spring 2025

Instructor:	Prof. Reza Azadeh	reza_zadeh@uml.edu
Lectures:	TR 2:00-3:15	SHA305
Teaching Assistant:	TBA	
Office hours:	T 12:30-13:45	DAN313

Website

We will use Blackboard for tracking grades, assignments, submissions, announcements, and discussions. In case the school goes online, we will use Zoom for lectures and student presentations and the lectures will not be recorded (for more information see the university privacy policy below).

Course Description

This course introduces machine learning topics used in computer science and pattern recognition applications. Students will explore both the theoretical foundations and practical implementations of several important algorithms. Topics include foundations of machine learning, including statistical and structural methods; feature discovery and selection; parametric and non-parametric classification; supervised and unsupervised learning; use of contextual evidence; clustering, recognition with strings; small sample-size problems and applications to larger datasets.

Course Objectives

Upon completion of this course, students will be able to:

- describe and explain supervised and unsupervised algorithms,
- describe linear regression methods and linear classification methods mathematically and understand their implement details,
- explain neural networks and their training techniques,
- describe kernel methods and their use in classification and regression
- understand how clustering methods work
- implement multiple regression and classification algorithms and apply them to toy and real-world problems.

These goals will be evaluated through quizzes, assignments, and projects.

Course Materials/Textbooks/References

Material covered in lectures are from:

[1]. Pattern Recognition and Machine Learning – Christopher Bishop, Springer, 2006.

Note: The PDF format of the textbook has been made available by the author. Link:

https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf

Prerequisites

The formal prerequisites include COMP 1020 Computing II, MATH 3220 Discrete Structures ll, and MATH 3860 Probability & Statistics I.

However, we expect the following non-official prerequisites:

- Multivariate Calculus and basic Linear Algebra: You should be comfortable taking integrals and derivatives and understanding matrix vector operations and notation.
- Basic Statistics and Probabilities: Gaussian distributions, mean, standard deviation, etc.
- Proficiency in Python: All class assignments and projects will be in Python. If you have a lot of programming experience but in a different language (e.g., C/C++/MATLAB) you will probably be fine by going through a few python tutorials.

Attendance

Students are expected to attend class regularly, as regular attendance is one of the most important contributors to student success. However, students may occasionally need to miss class due to illness, emergency, or caring for a sick family member. I try to be very accommodating to students who are experiencing attendance challenges, but you must communicate your situation with me regularly and with as much advance notice as possible. Likewise, if I should need to miss class, I will communicate with you via Blackboard and Slack as soon as possible with clear instructions.

If the campus is closed due to weather or other unforeseen circumstances, we do not hold any virtual sessions. However, please check Blackboard/Slack for information about deadline extensions on projects and labs.

Teaching methods:

The course material will be discussed through lectures, coding demonstrations, and discussions. The student understanding will be evaluated through homework assignments, quizzes, midterm and final exams.

Grading

Grades will be calculated according to the following criteria:

A. Participation (6%)

As mentioned before, students are expected to attend class regularly and we strongly recommend attending and participating in all lectures throughout the semester. The student participation will be measured through pop-up quizzes.

B. Assignments (64%)

There will be 9 assignments throughout the semester. The one assignment with lowest grade will be dropped, and the remaining 8 assignments are each worth 8% of your final course grade.

Late policy: Because the lowest assignment is being dropped, we will not be rescheduling deadlines for submissions missed due to travel, job interviews, and minor illnesses. Special considerations will be made for serious or extended circumstances. Please contact Prof. Reza Azadeh ahead of the deadline to ask about special arrangements.

C. Midterm (10%)

There will be a midterm exam worth 10% of the final grade. The format of this exam will be like the other assignments.

Late policy: The midterm exam is due at the time and date indicated in class schedule. No extension is allowed. Special considerations will be made for serious or extended circumstances. Labs will be completed individually. Please contact Prof. Reza Azadeh ahead of the deadline to ask about special arrangements.

D. Final (20%)

There will be a final exam worth 20% of the final grade. The format of this exam will be like the other assignments and the midterm.

Late policy: The midterm exam is due at the time and date indicated in class schedule. No extension is allowed. Special considerations will be made for serious or extended circumstances. Labs will be completed individually. Please contact Prof. Reza Azadeh ahead of the deadline to ask about special arrangements.

Extra Credit

You may earn extra credit throughout the semester through the following:

- Solve problems marked as extra credit
- Make a particularly helpful or insightful Blackboard/Slack post, which is endorsed by at least one course staff. [0.2% of total grade]
- Complete the survey at the end of class. Extra credit of 0.3% of total grade if at least 85% of the class completes the survey.

Grading

To calculate students' final grades, we will use the following number to letter grade table:

Number	<60	60-66	67-69	70-72	73-76	77-79	80-82	83-86	87-89	90-92	93-100
Grade	F	D	D+	C-	C	C+	B-	B	B+	A-	A

Submission Formatting

All coding assignments should be written in Python 3.x. Students are encouraged to comment their code. If required, student should use Jupyter Notebook for adding descriptions and explanations in markdown format and discussing their findings via plots and simulations.

Partners

All assignments and projects are expected to be done individually unless specified otherwise.

Course Policies

The course schedule and policies mentioned in this syllabus may change at any time during the term, but all changes will be clearly documented and announced.

Policies for the use of AI Generative Tools

All work submitted in this course must be your own. Copying content (including but not limited to ideas, words, images, videos) that other people created–either directly or in a modified form– without properly acknowledging the creator qualifies as academic misconduct, as does utilizing unauthorized digital tools such as generative AI (e.g., ChatGPT, GPT, DALL-E, Stable Diffusion, Midjourney, GitHub Copilot, and anything after) to create content. Violations of this policy will be dealt with in accordance with UMass Lowell's academic integrity policy. An assignment that is found to have been plagiarized or to have used unauthorized tools will automatically receive a zero and you will not be given an opportunity to repeat the assignment for a passing grade. Depending on the severity of the case, academic misconduct may result in a failing grade in the course. Finally, it is your responsibility to be aware of the academic integrity policy.

Academic Integrity Policy

All students are advised that there is a University policy regarding academic integrity. It is the students' responsibility to familiarize themselves with these policies. Students are responsible for the honest completion and representation of their work.

Academic Honesty Policy

Students are expected to honor and follow all CS department and UMass Lowell policies related to academic honesty and integrity. Violators risk failing the course in addition to any actions taken by the university administration. Cheating will not be tolerated, and students who cheat risk failing the course and possible university administrative actions. Please make sure to review the UMass Lowell's Academic Integrity.

Rule of thumb

Any work you present as your own should represent your own understanding of the material. When external sources were used as significant points of information (sample code, etc.), the source must be referenced in your submission.

Tutoring Resources and Centers for Learning and Academic Support Services (CLASS)

CLASS will be offering tutoring and Writing Center services virtually this fall. Online searchable tutoring schedules are available that include resources on all campuses.

Student Mental Health and Wellbeing

We are a campus that cares about the mental health and well-being of all individuals in our campus community. Your personal health and well-being can impact your success in this course. Students sometimes experience mental health concerns or stressful experiences that interfere with academics and have a negative impact on everyday life. If you or someone you know are experiencing mental health challenges at UMass Lowell, please contact Counseling (information below). Their services are free and confidential, and same day appointments are available.

I am available to talk with you about stresses related to your work in my class. Furthermore, I can assist you in reaching out to any one of a wide range of campus resources, including:

- Counseling Services provides crisis intervention, assessment, referrals, short-term individual counseling, group therapy, and on-call clinicians outside of business hours. They are located at University Crossing Suite 300 and their 24/7 phone number is 978-934-6800.
- UMatter2 is a university-wide initiative to support students and promote mental health. The office may be reached at 978-934-6671.

Consider also reaching out to a friend, faculty, or family member you trust for help getting connected to the support that can help.

Disability Services

If you have a documented disability that will require classroom accommodations, please notify me as soon as possible, so that we might make appropriate arrangements. Please speak to me during office hours or send me an email, as I respect, and want to protect, your privacy. Visit the Student Disability Services webpage for further information.

Additionally, Student Disability Services supports software for ALL students. Read&Write Gold is literacy software that allows you to read on-screen text aloud, research and check written work, and create study guides. You can download the software from the IT Software webpage on the UML website: IT Software page

Diversity, Inclusion, and Classroom Community Standards

UMass Lowell—and your professor—value human diversity in all its forms, whether expressed through race and ethnicity, culture, political and social views, religious and spiritual beliefs,

language and geographic characteristics, gender, gender identities and sexual orientations, learning and physical abilities, age, and social or economic classes. Enrich yourself by practicing respect in your interactions, and enrich one another by expressing your point of view, knowing that diversity and individual differences are respected, appreciated, and recognized as a source of strength.

Credit Hour Policy

Federal definition of a credit hour requires that for every course credit awarded, a course must offer 15 hours of instructor-led course activities and 30 hours of out-of-class student work. This means that a standard 3 credit hour course requires 45 hours of instructor-led course activities and 90 hours of out-of-class student work.

University Privacy Statement

UMass Lowell recognizes the importance of mutual trust between students and faculty. Neither faculty nor students may record video or audio of a course or private conversation without all parties' consent. Massachusetts is a two-party consent state, which means it is illegal to record someone without their permission. Recordings of classroom lectures are the intellectual property of the instructor. Instructors have the right to prohibit audio and video recording of their lectures, unless the requesting student is registered with Disabilities Services and recording of class sessions is an approved accommodation. In addition, sharing of or selling recordings of classroom activity, discussions, or lectures with any other person or medium without permission of the instructor is prohibited.

Tentative Schedule

	Date	Session	Topics	H/P/Q/A
T	1/21/2025	Intro	Course syllabus and introduction	
R	1/23/2025	Ch1-Intro	Probability theory	CHK-1
T	1/28/2025	Ch1-Intro	Decision theory, Information theory	
R	1/30/2025	Ch2-PD	Discrete distributions	HW1-out
T	2/4/2025	Ch2-PD	Continuous distributions	HW1-deadline
R	2/6/2025	Ch3-LR	Linear basis function models	HW2-out
T	2/11/2025	Ch3-LR	Bayesian linear regression	HW2-deadline
R	2/13/2025	Ch3-LR	Model comparison and limitations	HW3-out
T	2/18/2025	Ch4-LC	Discreminant functions	HW3-deadline
R	2/20/2025	Ch4-LC	Probabilistic generative models	HW4-out
T	2/25/2025	Ch4-LC	Probabilistic discriminative models	HW4-deadline
R	2/27/2025	Midterm	Midterm exam from the first four chapters	
T	3/4/2025	Ch5-NN	Feed-forward NNs, training, and backpropagation	
R	3/6/2025	Ch5-NN	Regularization, Hessian, and Bayesian NNs	
T	3/11/2025	recess		
R	3/13/2025	recess		
T	3/18/2025	Ch6-KM	Dual representation	
R	3/20/2025	Ch6-KM	Gaussian processes	HW5-out
T	3/25/2025	Ch7-SKM	SVMs	HW5-deadline
R	3/27/2025	Ch7-SKM	RVMs	HW6-out
T	4/1/2025	Ch9-MM	K-means clustering	HW6-deadline
R	4/3/2025	Ch9-MM	Mixture of Gaussians	HW7-out
T	4/8/2025	Ch11-SM	Basic sampling methods	HW7-deadline
R	4/10/2025	Ch11-SM	MCMC	HW8-out
T	4/15/2025	Ch12-CLV	PCA	HW8-deadline
R	4/17/2025	Ch12-CLV	PPCA, KPCA	HW9-out
T	4/22/2025	Ch13-SD	HMMs	HW9-deadline
R	4/24/2025	Ch13-SD	Linear Dynamical Systems	
T	4/29/2025		Boosting, combining models, Course overview	
W	4/30/2025			

- The finalized deadline for the assignments will be announced in the release posts on Blackboard.
- Deadlines are tentative and subject to change.