Data Mining for Engineering Applications

IE 5640 Fall 2024 • Class: Tuesday/Friday (9:50 -11:30 am), Hastings Suite 102
Department of Mechanical & Industrial Engineering, Northeastern University

SCHEDULE AND INSTRUCTOR

Lectures: Tuesday/Friday - 9:50 -11:30 am *Location:* Hastings Suite 102 & This Link for online students

Instructor: Mohammad Amin Javadi, Ph.D. - *Office:* 342B SN - *Email:* m.javadi@northeastern.edu
Instructor office hours: Tuesday/Friday – 11:40am – 12:40 pm (Zoom Link)

TA: TBD - *Email:* TBD@northeastern.edu - *TA office hours:* Will be announced when needed (Zoom Link)

COURSE DESCRIPTION

This course introduces data mining concepts and statistics/machine learning techniques for analyzing and discovering knowledge from large data sets that occur in engineering domains such as manufacturing, etc. The topics covered in this course include data reduction, exploration, visualization, mining association rules and collaborative filtering, classification, and prediction. The course discuses data mining case studies that are drawn from manufacturing, retail, business, and other sectors.

LEARNING OBJECTIVES

After the successful completion of this course, students will be able to:

- Understand basic concepts in machine learning.
- Learn the fundamentals of data mining.
- Realize the components of data mining algorithms.
- Perform data mining tasks on specific applications.

TEXTBOOK AND COMPUTING REQUIREMENT

The following is the textbook for this course.
Data Mining for Business Analytics: Concepts, Techniques and Applications in Python, Galit Shmueli et al., 2019, Wiley
Additional reading materials and references will be provided by the professor during the course.
This course will be held mostly in a regular classroom. However, a few lab sessions may also be required to demonstrate the theoretical concepts in practice. Software requirements will be discussed when appropriate.

COURSE STRUCTURE

This course is held two times a week through in-person class. The lecture meetings are designed to present course content. During the course, project and homework assignments/labs will be assigned to understand student's mastery of the course materials. Completion of these assignments will be used to assess student's creativity and application of the course content. Further explanation of these tasks can be found later in this syllabus.

ONLINE STUDENTS

Procedures (exams, ...) for online students will be communicated in class.

COURSE EXPECTATIONS

Students are expected to strive for excellence, this means they:

- Actively participate in class every week.
- Do all homework assignments/labs before due dates.
- Fully participate in all group activities and projects.
- Perform all preparatory work/reading as assigned.

GRADING

In-class students:		On-line students:	
Homework assignments	32%	Homework assignments	34%
Group projects	66%	Group projects	66%
Participation	2%		

This course uses the Northeastern standard grading scheme:				
A [93-100) A- [90-93)	B+ [87-90) B [84-87) B- [80-84)	C+ [77-80) C [74-77) C- [70-74)	D+ [67-70) D [64-67) D- [60-64)	F (Below)

ASSIGNMENTS

Homework assignments are administered using Northeastern Canvas and must be submitted individually unless specified otherwise. Collaborative work (including group discussions and study sessions) is encouraged (Note: collaborative work is **NOT** the same as sharing answers! Refer to the academic integrity section in this syllabus). Homework solutions will be computer-based. Assignments must be submitted as a **SINGLE** file or **FILLED OUT**, unless directed by the professor otherwise. The file name for **ALL** submissions should follow this format: FirstNameLastName_AssignmentTitle (e.g. my submission for the first homework assignment would be MohammadJavadi_Homework#1).
Submissions are due at 11:59 pm on the specified due date. **LATE** submissions are only accepted due to an emergency with appropriate written documentation. When authorized by the professor, makeup work may be discussed on a case-by-case basis. The project will be discussed later. Each team will be asked to turn in a written report and possibly give a presentation.

CLASS RESOURCES

CANVAS Login through Northeastern portal: https://canvas.northeastern.edu

SCHEDULE

Schedule is subject to change. For the most up-to-date version, refer to your Canvas.

Week	Date		Topic	Subtopic
1	F	9/6	Preliminaries	**A1.** Introduction
2	Tu	9/10		**A2.** Overview of the Data Mining Process (1)
	F	9/13		**A3.** Overview of the Data Mining Process (2) *(Assignment 1)*
3	Tu	9/17	Data Exploration and Dimension Reduction	**B1.** Data Visualization (1)
	F	9/20		**B2.** Data Visualization (2)
4	Tu	9/24		**B3.** Data Visualization (3)
	F	9/27		**B4.** Dimension Reduction *(Assignment 2)*
5	Tu	10/1	Performance Evaluation	**C1.** Evaluating Predictive Performance (1)
	F	10/4		**C2.** Evaluating Predictive Performance (2)
6	Tu	10/8	Prediction and Classification Methods	**D1.** Multiple Linear Regression *(Assignment 3)*
	F	10/11		**D2.** k-Nearest Neighbors
7	Tu	10/15		Case Study: Predictive Maintenance
	F	10/18		**D3.** The Naïve Bayes Classifier
8	Tu	10/22		**Group Project 1.** Distance Measurement and Analysis in the Cyber-Physical Lab
	F	10/25		**D4.** Classification and Regression Trees (1)
9	Tu	10/29		**D5.** Classification and Regression Trees (2)
	F	11/1		Case Study: Predictive Maintenance
10	Tu	11/5		**D6.** Logistic Regression
	F	11/8		Case Study: Predictive Maintenance
11	Tu	11/12		**D7.** Neural Nets (1)
	F	11/15		**D8.** Neural Nets (2)
12	Tu	11/19		**Group Project 2.** Product Detection System for the Cyber-Physical Lab
	F	11/22		**D9.** Discriminant Analysis
13	Tu	11/26	Mining Relationships Among Records	**E1.** Association Rules and Collaborative Filtering (1)
	F	11/29		Thanksgiving - No Class
14	Tu	12/3		**E2.** Association Rules and Collaborative Filtering (2) *(Assignment 4)*

ATTENDANCE AND PROFESSIONALISM

Attendance is important and expected. Students are responsible for material covered in class if missing lectures. Note that the sessions may not be recorded and there will not be any make-up sessions. You are expected to behave as a professional engineer who is attending a meeting at a company. Behaviors that are disruptive should be avoided in classes and labs, such as the ones listed below:

- Arriving late or leaving early.
- Walking out of class or packing up disruptively before the class is dismissed.
- Using a laptop or a cellphone for not class related work.
- Chatting with neighbors.

ACADEMIC INTEGRITY

A commitment to the principles of academic integrity is essential to the mission of Northeastern University. The promotion of independent and original scholarship ensures that students derive the most from their educational experience and their pursuit of knowledge. Academic dishonesty violates the most fundamental values of an intellectual community and undermines the achievements of the entire University.

As members of the academic community, students must become familiar with their rights and responsibilities. In each course, they are responsible for knowing the requirements and restrictions regarding research and writing, examinations of whatever kind, collaborative work, the use of study aids, the appropriateness of assistance, and other issues. Students are responsible for learning the conventions of documentation and acknowledgment of sources in their fields. Northeastern University expects students to complete all examinations, tests, papers, creative projects, and assignments of any kind according to the highest ethical standards, as set forth either explicitly or implicitly in this Code or by the direction of instructors. Go to https://osccr.sites.northeastern.edu/academic-integrity-policy/ to access the full academic integrity policy.

ACCOMMODATIONS

Northeastern University and the Disability Access Services (DAS) are committed to providing disability services that enable students who qualify under Section 504 of the Rehabilitation Act and the Americans with Disabilities Act Amendments Act (ADAAA) to participate fully in the activities of the university. To receive accommodations through the DAS, students must provide appropriate documentation that demonstrates a current substantially limiting disability. For more information, visit https://disabilityaccessservices.sites.northeastern.edu/.

DIVERSITY, EQUITY AND INCLUSION

Northeastern University is committed to equal opportunity, affirmative action, diversity and social justice while building a climate of inclusion on and beyond campus. In the classroom, members of the University community work to cultivate an inclusive environment that denounces discrimination through innovation, collaboration and an awareness of global perspectives on social justice. It is my intention that students from all backgrounds and perspectives will be well served by this course, and that the diversity that students bring to this class will be viewed as an asset. I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, socioeconomic background, family education level, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. Your suggestions are encouraged and appreciated. Please visit https://diversity.northeastern.edu/ for complete information on Diversity, Equity and Inclusion.

TITLE IX

Title IX of the Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender-identity, in educational programs and activities that receive federal financial assistance. Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including male, female, transgender students, faculty and staff. In case of an emergency, please call NUPD at 617 373 3333. Please visit https://www.northeastern.edu/ouec/ for a complete list of reporting options and resources both on- and off-campus.