John A. Reif, Jr. Department of Civil & Environmental Engineering

Machine Learning and Data Analytics for Civil Engineering Systems
(Tuesdays from 6:00 PM to 8:50 PM)

Course Description:
This course provides students with hands-on and fundamental knowledge of machine learning, data science, and data mining methodologies for scraping, manipulating, transforming, cleaning, visualizing, summarizing, and modeling large-scale data using analytical tools. This course includes data management and analysis, data wrangling and exploration, unsupervised learning, pattern recognition, supervised learning for classification and regression purposes, data preprocessing, and model training and evaluation. Students will explore the capabilities of these concepts in addressing the challenging and interesting problems in the field of civil engineering, and they will develop skills to apply these techniques to solve multiple real-world civil engineering problems. Python programming language will be introduced and used throughout this course to illustrate practical examples and to show students how to apply the learned techniques into practice. Students can bring their own dataset for their final project presentations and reports.

Course Pre-requisites:
CS 101, MATH 211, and MATH 279: Basic knowledge of Programming, Calculus, Statistics and Probability. No prior knowledge of Python or machine learning is required though.

Course Lecture Hours and Credits:
This is a three-lecture hours and three-credits course.

Course Learning Outcomes:
This course provides students with hands-on experience and state-of-the-art knowledge to model and analyze big datasets and to solve challenges, issues, and practical cases faced in civil engineering, infrastructure systems, and construction. The student learning outcomes include:

1. Develop an understanding of the recent developments and applications in the field of machine learning
2. Learn Python programming language and the associated libraries/packages for data management and data analysis
3. Build and evaluate regression and classification models for prediction purposes
4. Apply various supervised and unsupervised machine learning methods to model data

Course Instructor:
Rayan H. Assaad, PhD, A.M.ASCE (Website: https://sciis.njit.edu)
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Office Hours: Tuesdays 4:00 PM to 5:30 PM or by e-mail or appointment. Feel free to stop by my office at any time of your convenience. I will try to meet you immediately unless I have a very pressing deadline or a conflicting scheduled meeting.

Course Textbooks:

There is no required textbook for this course. However, the following books are recommended:

- Jake VanderPlas. "Python Data Science Handbook", 1st Edition, O'Reilly Media, 2016, ISBN-13: 978-1491912058.
- Aurélien Géron. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", 2nd Edition, O'Reilly Media, 2019, ISBN-13: 978-1492032649.
- Sebastian Raschka and Vahid Mirjalili, "Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2", 3rd Edition, Packt, 2019, ISBN-13: 978-1789955750.

Other References and Reading Material:

Additional references and reading material might be provided to students to enhance their understanding of the course's material, the covered topics, and the discussed concepts.

Canvas and Technology Requirement:

All course materials will be available on Canvas. It is the student's responsibility to check the course page on Canvas regularly. Students are expected to have a working computer to participate in this course. It is highly recommended that students bring their personal computer (i.e., laptop) to the class to have hands-on and fundamental knowledge of the covered machine learning concepts and applications. If you do not have a computer, please contact the Dean of Students.

Course Requirements:

- Assignments: Each student will be requested to submit 3 assignments. All due dates are already noted in the below course schedule.
- Midterm: Each student is expected to take 1 in-class midterm scheduled during class time as noted in the below course schedule.
- Project: A group project needs to be submitted by the end of the semester. To gauge the progress of students throughout the semester in relation to their project, students will be requested to submit project updates. All due dates are already noted in the below course schedule. A separate document will detail the requirements and expectations of such final project.

Course Grade Breakdown:

3 Assignments	30%
1 Mid-Term (in-class)	30%
Final Project Presentation	10%
Project Updates/Report	30%
Potential Extra-Credit Work	5%

Course Grading:

Cumulative points in all course requirements will be rounded to the next highest whole number (for example 84.1 will be rounded to 85 and 95.7 will be rounded to 96). Afterwards, your final grade will be determined according to the following scale:

≥90	A
≥85 and ≤89	B^+
≥80 and ≤84	B
≥75 and ≤79	C^+
≥70 and ≤74	C
<70	F

Withdrawals:

To ensure consistency and fairness in application of the NJIT policy on withdrawals, student requests for withdrawals after the deadline will not be permitted unless extenuating circumstances (e.g., major family emergency or substantial medical difficulty) are documented. The course Professors and the Dean of Students are the principal points of contact for students considering withdrawals.

Course Specific Policies:

- Eating and use of cell phones are strictly prohibited during class time.
- Professional conduct in all matters related to class activities (i.e., sitting, talking, and discussing matters) is required at all times.
- The specific nature of this class demands active participation during class discussions. The objective of these discussion is to enrich the course environment, enhance student learning experience, foster critical thinking, and strengthen your communication skills. Thus, please get engaged and know that you are NOT being evaluated at all on the answers you provide in class. Also, please realize that there is no reason to take a back seat and be shy as there is no embarrassment whatsoever from any reasonable attempt to provide an answer.
- Students are required to attend all lectures to maximize their benefit and are required to arrive on time to minimize disturbance to the learning environment. Unexcused absence will result in a zero being assigned for any required in-class course task (including exams and midterms), and no make-up will be given. Bearing the aforementioned in mind, some absences can be excused due to reasons beyond a student control (i.e., a surgery or accident for example). In such unlikely event, immediate communication with the Instructor may help generate some timely solutions that cannot work out afterwards.
- You need to complete ALL course requirements in order to earn a passing grade.
- All assignment, final project, and extra credit work should be computer typed in a neat and organized manner. Any submission should have a cover page including university name, department name, course number, instructor name, nature of submission (i.e., assignment, final project, or extra credit), your name, due date, and date of submission.
- Assignments are due at 11:59 PM according to the below course schedule. Late submissions will be penalized 10% of the points for each day late, up to 48 hours; after which the assignment will be recorded as a zero with no exceptions. Having a prior excused absence from attending

a specific class does not warrant missing a submission date. Post excused absence – if any – will be handed on case by case basis.

- Poor performance in the class (for example, not submitting two assignments or recording less than 50% in two assignments or obtaining a grade less than the average grade of the class minus twice the standard deviation, etc.) automatically warrants an academic alert. If your performance deems you under two academic alerts, you should automatically provide an improvement plan that is accepted by the Instructor.
- The most reasonable human attention is provided in grading all course requirements but in the unlikely event that something is overlooked one way or the other, there will be no problem whatsoever to revise your grade on such submission.

Students with Disabilities:

NJIT is fully committed to providing students with documented disabilities equal access to programs and activities. If you have - or believe that you may have - a physical, medical, psychological, or learning disability that may require accommodations, please contact the Office of Accessibility Resources and Services (https://www.njit.edu/studentsuccess/node/5).

Copyright:

All course content (including this syllabus, lecture materials, homework assignments, and exams) is protected content. Students should not make copies of any course materials or distribute these materials in the public domain.

Academic Integrity:

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. ***Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.*** *If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu*

Tentative Course Outline/Schedule:**

**The Instructor reserves the full right to amend or change this tentative schedule, according to class progress, with consultation with the students.

Week	Date	Topic	Notes
1	Tuesday, January 21, 2025	Course Information + Introduction to Machine Learning	-
2	Tuesday, January 28, 2025	Introduction to Python	-
3	Tuesday, February 04, 2025	Data Management and Analysis	Submission of Group Names for Final Project
4	Tuesday, February 11, 2025	Data Management and Analysis (continued)	-
5	Tuesday, February 18, 2025	Data Exploration and Visualization	Project Update #1 due by 11:59 PM
6	Tuesday, February 25, 2025	Unsupervised Learning	Assignment 1 due by 11:59 PM
7	Tuesday, March 04, 2025	Supervised Learning: Regression Algorithms	-
8	Tuesday, March 11, 2025	Supervised Learning: Regression Algorithms (continued)	Assignment 2 due by 11:59 PM
9	Tuesday, March 18, 2025	Spring Break – No Class	-
10	Tuesday, March 25, 2025	Supervised Learning: Classification Algorithms (60 mins) + In-Class Midterm (90 mins)	In-Class Midterm (90 mins)
11	Tuesday, April 01, 2025	Supervised Learning: Classification Algorithms (continued)	Project Update #2 due by 11:59 PM
12	Tuesday, April 08, 2025	Data Preprocessing, Training, and Prediction	Assignment 3 due by 11:59 PM
13	Tuesday, April 15, 2025	Data Preprocessing, Training, and Prediction (continued)	-
14	Tuesday, April 22, 2025	Project Presentations	Project Presentation due by 4:00 PM
15	Tuesday, April 29, 2025	No Class (Teams meet/prepare for the final project report)	Project Report due by 11:59 PM
16	Tuesday, May 06, 2025	No Class (Thursday Classes Meet)	-

Spring 2025 University Calendar

January	20	Monday	Martin Luther King, Jr. Day
January	21	Tuesday	First Day of Classes
January	25	Saturday	Saturday Classes Begin
January	27	Monday	Last Day to Add/Drop a Class
January	27	Monday	Last Day for 100% Refund, Full or Partial Withdrawal
January	28	Tuesday	W Grades Posted for Course Withdrawals
February	3	Monday	Last Day for 90% Refund, Full or Partial Withdrawal, No Refund for Partial Withdrawal after this date
February	17	Monday	Last Day for 50% Refund, Full Withdrawal
March	10	Monday	Last Day for 25% Refund, Full Withdrawal
March	16	Sunday	Spring Recess Begins - No Classes Scheduled - Univ Open
March	22	Saturday	Spring Recess Ends
April	3	Thursday	Wellness Day - No Classes Scheduled - University Open
April	7	Monday	Last Day to Withdraw
April	18	Friday	Good Friday - No Classes Scheduled - University Closed
April	20	Sunday	Easter Sunday - No Classes Scheduled - University Closed
May	6	Tuesday	Thursday Classes Meet
May	7	Wednesday	Friday Classes Meet
May	7	Wednesday	Last Day of Classes
May	8	Thursday	Reading Day 1
May	9	Friday	Reading Day 2
May	10	Saturday	Final Exams Begin
May	16	Friday	Final Exams End
May	18	Sunday	Final Grades Due
May	19	Monday	Master's and PhD Candidate Commencement - Bloom Wellness and Events Center
May	21	Wednesday	Undergraduate Candidate Commencement - Prudential Center