Course Syllabus

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CS 422/522 Introduction to Machine Learning

Instructor

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Prerequisites (Professional Knowledge and Technological Skills)

Knowledge of precalculus (variables and functions), linear algebra (matrices and vectors), and probabilistic theory (random variable, common distributions, and probability calculus). Basic computer skills and programming experience with Python.

Course Description

This course provides a broad introduction to machine learning, with an emphasis on the practical aspects of widely used learning techniques and only light mathematical requirements. The course

covers a full stack of machine learning methods commonly used in real-world applications. Topics include data preprocessing methods (e.g., normalization), data representation and dimensionality reduction techniques (e.g., principal component analysis, non-negative matrix factorization, and t-SNE), supervised learning methods (e.g., k-nearest neighbors, linear regression, logistic regression, support vector machines, Naïve Bayes classifiers, decision trees, and neural networks) and their evaluation, as well as clustering algorithms (e.g., k-means, hierarchical clustering, and DBSCAN) and their evaluation.

The course is taught with numerous examples implemented in Python. Students gain exposure not only to popular machine learning techniques but also to hands-on programming experience using Python libraries commonly used in machine learning, such as Scikit-learn, NumPy, Pandas, and Matplotlib. In addition, students will apply the concepts learned in class through a course project, where they work on a practical machine learning application of their choice.

Approaches

The course consists of **module content**, **assignments**, **quizzes**, **a course project**, **two midterm exams**, and **a final exam**. The module content provided on Canvas serves as the primary means for the instructor to introduce key concepts and knowledge to students. Assignments give students the opportunity to practice and reinforce what they have learned. Quizzes and exams are used to assess whether students have mastered the fundamental concepts covered in the course. The course project provides students with an opportunity to gain deeper hands-on experience.

Students are encouraged to form study groups for the course project. Each team should consist of up to two students. Teams may choose either to apply the machine learning methods discussed in class to an interesting dataset or to explore a new machine learning topic. At the end of the semester, each team is required to present their project in class and submit a written report in the format of a typical research paper. Students are encouraged to propose their own project ideas. When needed, the instructor will also provide a list of suggested projects for students to choose from. This exercise helps students gain deeper insight into specific algorithms and promotes collaboration among team members.

Course Learning Objectives (CLOs)

CLO1: Define machine learning and differentiate among different types of learning problems.

CLO2: Describe how the machine learning algorithms introduced in the course work.

CLO3: Identify the strengths and limitations of the machine learning algorithms introduced in the course.

CLO4: Recall evaluation metrics and explain how they are applied to assess models trained using supervised and unsupervised learning methods.

CLO5: Apply the introduced machine learning algorithms to solve practical learning problems.

Schedule

Course Map

Module	Topics	Matched CLOs	Assessments
M1 Mar. 11 ~ Mar. 17	Prerequisite Review	CLO2, CLO5	1.1.5 Assignment: Math Exercise (https://canvas.odu.edu/courses/201302/assignments/3085936) 1.2.3 Assignment: Programming Exercise (https://canvas.odu.edu/courses/201302/assignments/3085937)
M2 Mar. 18 ~ Mar. 24	Introduction and KNN	CLO1, CLO2, CLO3, CLO5	2.1.3 Discussion (https://canvas.odu.edu/courses/201302/assignments/3085934) 2.1.4 Popup Quiz (https://canvas.odu.edu/courses/201302/assignments/3085938) 2.2.3 Popup Quiz (https://canvas.odu.edu/courses/201302/assignments/3085939) 2.3.3 Popup Quiz (https://canvas.odu.edu/courses/201302/assignments/3085940) 2.3.4 Assignment: Programming Exercise (https://canvas.odu.edu/courses/201302/assignments/3085941)
M3 Mar. 25 ~ Mar. 31	Linear Models and Naïve Bayes Classifiers	CLO2, CLO3, CLO5	3.1.3 Popup Quiz (https://canvas.odu.edu/courses/201302/assignments/3085942) 3.2.2 Popup Quiz (https://canvas.odu.edu/courses/201302/assignments/3085944) 3.1.4 Assignment: Programming Exercise (https://canvas.odu.edu/courses/201302/assignments/3085943) Midterm Exam 1 (https://canvas.odu.edu/courses/201302/assignments/3085958)

M4 Apr. 1 ~ Apr. 7	Decision Tree, Ensemble Learning, and Neutral Networks	CLO2, CLO3, CLO5	**4.1.3 Popup Quiz** (https://canvas.odu.edu/courses/201302/assignments/3085945) **4.2.4 Popup Quiz** (https://canvas.odu.edu/courses/201302/assignments/3085947) **4.1.4 Assignment: Programming Exercise** (https://canvas.odu.edu/courses/201302/assignments/3085946) **Assignment: Course Project Proposal** (https://canvas.odu.edu/courses/201302/assignments/3085956)
M5 Apr. 8 ~ Apr. 14	Evaluation of Models Trained with Supervision	CLO5	**5.5 Popup Quiz** (https://canvas.odu.edu/courses/201302/assignments/3085948) **5.6 Assignment: Programming Exercise** (https://canvas.odu.edu/courses/201302/assignments/3085949) **Midterm-Exam 2** (https://canvas.odu.edu/courses/201302/assignments/3085959)
M6 Apr. 15 ~ Apr. 21	Unsupervised learning Intro and K-means	CLO2, CLO3, CLO5	**6.1.4 Popup Quiz** (https://canvas.odu.edu/courses/201302/assignments/3085950) **6.2.3 Popup Quiz** (https://canvas.odu.edu/courses/201302/assignments/3085951)
M7 Apr. 22 ~ Apr. 28	Hierarchical Clustering, DBSCAN, and Evaluation of Clustering	CLO2, CLO3, CLO4, CLO5	**7.1.3 Popup Quiz** (https://canvas.odu.edu/courses/201302/assignments/3085952) **7.2.4 Popup Quiz** (https://canvas.odu.edu/courses/201302/assignments/3085953)
M8 Apr. 29 ~ May 5	Representation Learning	CLO2, CLO5	**8.3 Popup Quiz** (https://canvas.odu.edu/courses/201302/assignments/3085954) **Assignment: Course Project** (https://canvas.odu.edu/courses/201302/assignments/3085955) **Final Exam** (https://canvas.odu.edu/courses/201302/assignments/3085957)

Textbook

Introduction to Machine Learning with Python: A Guide for Data Scientists by Andreas C. Muller and Sarah Guido, ISBN-10: 1449369413

Attendance Policy

No regular class attendance is needed.

Grading Policy

Grading

Item	Weight
Module 02 Discussion	2%
Popup Quizzes (Thirteen quizzes)	26%
Assignments (Six math/programming exercises)	20%
Course Project Proposal	10%
Course Project Final Product	20%
Midterm Exam 1	6%
Midterm Exam 2	6%
Final Exam	10%

Due Date Extension Policy

Any submission that is more than THREE days past due will NOT be graded.

Everyone gets ONE time free 3-day extension.

After that, all past-due submissions will be graded with this formula: $0.5^N \times g$, where N is the number of days past due and g is the grade of the submission as if it were on time.

Honor Code

This course requires a lot of interaction, and thus discussions of ideas are encouraged. However, for all homework assignments, students are expected to write their OWN code, simple sharing and copying from other students, ChatGPT, and similar tools are prohibited, which will be considered as a violation of honor code.

Students are expected to follow the ODU Honor Code for all assignments and tests. Any violations will be dealt with strictly according to university policy. Despite that this course requires a lot of interaction, and thus discussions of ideas are encouraged, the work submitted must be students' own. Similar wise, ChatGPT and such tools may be used to get some ideas, but the work submitted must be students' own.

Drop Policy

As per University guidelines. See the University Calendar for drop dates.

Accessibility

Old Dominion University is committed to ensuring equal access to all qualified students with disabilities in accordance with the Americans with Disabilities Act. The Office of Educational Accessibility (OEA) is the campus office that works with students who have disabilities to provide and/or arrange reasonable accommodations.

- If you experience a disability which will impact your ability to access any aspect of my class, please present me with an accommodation letter from OEA so that we can work together to ensure that appropriate accommodations are available to you.
- If you feel that you will experience barriers to your ability to learn and/or testing in my class but do not have an accommodation letter, please consider scheduling an appointment with OEA to determine if academic accommodations are necessary.

The Office of Educational Accessibility is located at 1021 Student Success Center and their phone number is (757)683-4655. Additional information is available at the OEA website: **http://www.odu.edu/educationalaccessibility/ (http://www.odu.edu/educationalaccessibility/)**

Academic Dishonesty

Old Dominion University is committed to students' personal and academic success. In order to achieve this vision, students, faculty, and staff work together to create an environment that provides the best opportunity for academic inquiry and learning. All students must be honest and forthright in their academic studies. Your work in this course and classroom behavior must align with the expectations outlined in the Code of Student Conduct, which can be found at www.odu.edu/oscai. The following behaviors along with classroom disruptions violate this policy, corrupt the educational process, and will not be tolerated.

Cheating: Using unauthorized assistance, materials, study aids, or other information in any academic exercise.

Plagiarism: Using someone else's language, ideas, or other original material without acknowledging its source in any academic exercise.

Fabrication: Inventing, altering or falsifying any data, citation or information in any academic exercise.

Facilitation: Helping another student commit, or attempt to commit, any Academic Integrity violation, or failure to report suspected Academic Integrity violations to a faculty member.

Academic dishonesty will be reported to the Office of Student Conduct & Academic Integrity and may result in sanctions up to and including expulsion from the University.
