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Course Information

Course Number and Title: CSC 6621: Applied Machine Learning

Credits: 4

Course Description

This course introduces concepts of machine learning that explore the study and construction of algorithms that can learn from and make predictions on data.

Topics include conceptual aspects of machine learning, feature engineering, an introduction to deep learning, and applications of machine learning and deep learning. Students will reinforce their learning of machine learning algorithms with hands-on laboratory exercises for development of representative applications.

Course Objectives

The following table outlines the course objectives and major assessments for this course.

Objectives	Assessments
Describe the fundamental concepts and application of supervised, unsupervised, semi-supervised, and reinforcement learning.	Problem Sets, Paper Reviews
Compare modern deep neural network architectures, such as dense neural networks, CNNs, encoder-decoders, GANs, and transformers.	Problem Sets, Paper Reviews
Transform raw data into meaningful, informative, and relevant features that contribute to the effectiveness of machine learning algorithms.	Mini Projects
Implement deep learning models using popular libraries and frameworks for real-world problems and applications.	Mini Projects, Final Project
Apply agent and state-based frameworks to solve diverse problems, including game playing.	Problem Sets, Mini Projects
Apply algorithms to identify optimal policies, while considering trade-offs among completeness, optimality, time complexity, and space complexity.	Problem Sets, Mini Projects

Present results of machine learning and AI projects effectively to both technical and non-technical audiences.	Paper Reviews, Final Project
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Pre-Requisite Courses

([CSC 5610](#) or CSC 2621) and (MTH 2130 or MTH 2340 or [MTH 5810](#)) or instructor consent) (quarter system prereq: CS 2300).

COURSE DETAILS

Text and Resource List

Required Books

This class doesn't have any required readings. All materials will be delivered in the synchronous sessions or by the course instructor.

Optional Books

The following is a recommended list of books:

- Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J. (2023). [Dive into Deep Learning](#). Cambridge University Press.
- T. Hastie, R. Tibshirani and J. Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd edition), Springer-Verlag, 2017.
- Sutton, R. S., & Barto, A. G. (2014, 2015). [Reinforcement learning: An introduction](#). MIT press
- Poole, D. L., & Mackworth, A. K. (2010). [Artificial Intelligence: foundations of computational agents](#). Cambridge University Press.

Additional Required Resources

In addition to required readings in the course, the instructor may post articles and videos pertinent to each module's topics in the learning management system. Readings may be taken from sources such as websites, documentaries, blogs, etc.

Course Structure

The course will follow this general pattern:

- Overview
- Readings
- Instructional Content
- Discussion
- Mini Project
- Problem Sets
- Q&A Forum

Outline of Course

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This asynchronous online course will be broken up into modules, each of which will last one week. The following outline presents the topics to be covered in each module.

Module 1:	Classical Machine Learning
Module 2:	Feature Engineering
Module 3:	Introduction to Deep Learning
Module 4:	Hyperparameter Tuning
Module 5:	Student Paper Presentation
Module 6:	Introduction to Classical AI
Module 7:	Reinforcement Learning
Module 8:	Final Project Presentations

GRADING

Achievement in this course will be assessed through completion of the following activities:

Assignment Type	Grade %
Problem Sets	10%
Paper Review	10%
Mini Projects	50%
Final Project	30%
Total	100%

Assignment Type Descriptions

Problem Sets

Problem sets, presented in the form of online quizzes, will be made available to reinforce your understanding of the fundamental concepts covered in lectures. These quizzes will comprise both multiple-choice and true-or-false questions, serving as a tool to ensure retention of the key principles introduced during the course.

Mini Project

In the mini projects, you will be tasked with applying various machine learning algorithms covered in class to address real-world challenges utilizing authentic datasets. The primary objective of these mini projects is to provide you with hands-on experience in translating theoretical concepts into practical implementations. Additionally, you will develop skills in crafting professional reports that effectively communicate the results obtained, along with your analysis and observations.

Initial Proposal Paper Review (Group)

Another crucial aspect of this course involves reading and presenting research papers. Initially, you will be responsible for suggesting potential research papers that interest you for review. The instructor will subsequently approve one of the proposed papers to avoid any duplications in team presentations. This process ensures a diverse range of topics covered during class discussions.

Paper Review and Presentation (Group)

Once your proposal for paper review is approved, you and your team members will thoroughly read and analyze the selected research paper. Subsequently, each team will present the algorithms introduced in the research papers during synchronous sessions. After the presentations, there will be a class discussion, allowing for questions and insights on the presented topics. Reading and presenting research papers contribute significantly to intellectual growth, skill development, and staying attuned to the dynamic landscape of knowledge in machine learning.

Final Project Initial Proposal (Group)

The final project is an integral component of this course. To initiate the final project, you and your team will be required to submit a project proposal comprising three potential topics of interest. In this proposal, you will also describe the datasets you intend to utilize along with their sources. The instructor will then review and approve one of the topics, giving preference to your primary choice, while also ensuring there are no duplications among the selected topics for the final projects across the class.

Final Project (Group)

For the final project, your task is to tackle a real-world problem of your choosing using authentic datasets. To maintain project momentum, each team will be required to demo initial progress to the instructor by implementing a baseline model. The subsequent phase involves enhancing the baseline model and conducting comparisons with alternative algorithms. The culmination of the project will be an in-class presentation by each team during the 16th week of the course.

Grading Scale

Grades are determined by cumulative average point total as follows:

Letter	Range
A	93% +
AB	89-92.9%
B	85-89.9%
BC	81-84.9%
C	77-80.9%
CD	74-76.9%

D	70-73.9%
F	69.9% or less

Program Eligibility

A graduate student at MSOE is in good academic standing unless the graduate student's cumulative GPA is less than 3.00 or the student receives a grade of F in any class during the previous academic term.

A graduate student not in good academic standing is subject to academic probation, suspension, or termination terms of which are established by the students' graduate program and administered by its program director.

COURSE POLICIES

Late Assignment Policy

It is very important that work be turned in on time or you will find it very difficult to catch up. All work in the course (e.g., projects, papers, exams, quizzes, etc.) will be due by 11:59 pm ET on the date noted on the class calendar.

Any assignment submitted after the due date will have 10% deducted from points earned for each day that it is late. Students should reach out to their instructor immediately to discuss any concerns.

Faculty Communication and Feedback

At the beginning of the course, make sure that you understand the instructor's preferred mode of communication and any specific communication protocol. One of the best ways to be effective as a graduate student is to understand each individual instructor's expectations and operate within those boundaries. If you have concerns about communication or feedback, you should always go to the professor first. Students should explain their concern as clearly as possible without judgment or emotion. Effective communication is an important graduate-level skill, and every interaction is an opportunity to develop this skill.

Citation Expectations

All research work submitted should be properly cited using APA standards. For more information and tools to assist, refer to the information available through the [Walter Schroeder Library References, Citations, and Style Guides website](#).

PROGRAM POLICIES

Mission Statement

MSOE is the university of choice for those seeking an inclusive community of experiential learners driven to solve the complex challenges of today and tomorrow.

Credit Policy

Academic work in this program is measured by credit unit. A unit of credit represents that amount of time and effort both within and outside of formal settings that a student devotes to a particular class. At the graduate level, course credit is determined by the College or School and is consistent with practices in the disciplines.

Student Integrity

As an institution of higher learning, MSOE is committed above all to the educational development of its students as responsible and principled human beings. As such, MSOE is accountable to all whom it serves and by whom it is scrutinized. The university has a priority interest in promoting personal integrity and in ensuring the authenticity of its graduates' credentials.

The university is similarly mindful that the professions, business and industry are concerned with ethical behavior no less than the professional practice of their members and employees. Therefore, MSOE students preparing for professional careers and leadership roles that are founded on responsibility and trust, must observe and be guided by the highest standards of personal integrity both in and out of the classroom.

The expectations of the university with respect to academic and classroom integrity are reflected in, but not limited to, the following guidelines:

1. Each student must recognize that even a poorly developed piece of work that represents their best efforts is far more worthwhile than the most outstanding piece of work taken from someone else.
2. Students must observe the rules established by a faculty member for a particular course.
3. Assignments prepared outside of class must include appropriate documentation of all borrowed ideas and expressions. The absence of such documentation constitutes "plagiarism," which is the knowing or negligent use of the ideas, expressions or work of another with intent to pass such materials off as one's own. It is an act of plagiarism if a student purchases a paper or submits a paper, computer program, or drawing claiming it to be theirs when they did not write it.
4. Each student should consistently prepare for examinations so as to reduce temptation toward dishonesty.
5. A student may not share examination answers with others for the purpose of cheating, nor should they, intentionally or through carelessness, give them an opportunity to obtain the same.
6. Academic dishonesty or cheating includes the act of obtaining or attempting to obtain credit for academic work through the use of any dishonest, deceptive or fraudulent means. Cheating at MSOE includes but is not limited to:
 - Copying, in part or in whole, from another's test or homework assignments, worksheets, lab reports, essays, summaries, quizzes, etc.
 - Copying examinations and quizzes, in whole or in part, unless approved by the instructor.
 - Submitting work previously graded in another course unless this has been approved by the course instructor or by departmental policy.
 - Submitting work simultaneously presented in two courses, unless this has been approved by both course instructors or by the department policies of both departments.
 - Communicating electronically (unless approved by the instructor) during examinations with the intent to seek or provide answers.
 - Attempting to present as the student's own work, materials or papers purchased or downloaded from the Internet.
 - Violating discipline specific health, safety or ethical requirements to gain any unfair advantage in lab(s) or clinical assignments

- Any other act committed that defrauds or misrepresents, including aiding or abetting in any of the actions defined above.
 - Claiming credit for a group project or paper when the individual student made little or no contribution to the group's product.
 - Accessing reference documents during an exam or quiz unless approved by the course instructor.
7. A student of integrity will not support, encourage or protect others who are involved in academic dishonesty in any way, and will furthermore attempt to dissuade another student from engaging in dishonest acts.

A student who acts without integrity in an academic setting shall be subject to sanctions. Sanctions are at the discretion of the instructor and may take one of many forms. Example sanctions include written reprimand, penalty on an assignment or exam, or "F" grade for the assignment, exam or course. If the instructor assigns an "F" for the course, the student will not be allowed to drop the course. If the student believes the sanction was unwarranted, they have the right to appeal following established procedures. All breaches of academic integrity will be reported to the vice president of academics using the required form. Upon recommendation of the instructor or at their initiation, the vice president of academics may decide that repeated or extremely serious acts of dishonesty may be grounds for more severe disciplinary action. Such cases will be referred to the dean of students per section 18 of the Student Conduct Code.

Nondiscrimination Statement

Milwaukee School of Engineering admits students of any race, gender, color, national and ethnic origin to all the rights, privileges, programs and activities generally accorded, or made available, to students at the university. It does not discriminate on the basis of race, ethnicity, color, creed, religion, sex, (including pregnancy and pregnancy-related disabilities), age, national origin/ancestry, arrest record, conviction record, physical or mental disability, military and veteran status, sexual orientation, gender identity, genetic characteristics, marital status, or any other characteristic protected by local, state or federal law in administration of its educational policies, admission policies, scholarship and loan programs, and athletic and other institutionally administered programs. MSOE also maintains its longstanding policy as an Equal Opportunity/Affirmative Action Employer for its faculty and administrative staff.

Online Student Learning Expectations

All students in this program are expected to have completed the student orientation course. Through this orientation course, you will learn how to navigate the course and use the various tools that you will need in order to effectively participate and submit assignments. You are also expected to have all the equipment and software needed to be successful in the course.

All students are expected to contribute to their own learning as active and well-prepared participants. Modules will provide various opportunities for reading, reflection, applied experiences, collaboration, and writing. Since these activities are woven through the entire module and generally do not require your electronic presence at any particular time or day, there should be no need to "miss" class. You should plan on spending the same amount of preparation and "in-class" time on this course as you would if you were taking the course face-to-face.

Be Patient and Stay Calm

Problems with technology will inevitably arise. Don't worry, and just keep smiling. Please be patient with your instructor, and your instructor will be patient with you. Your instructor will always take technical problems into account if the situation warrants it.

Logging On

The learning activities for each module are carefully sequenced and offered in small chunks so you can accomplish reasonable amounts throughout the module. You should log on to the course website regularly to work through course materials and participate in course discussions.

Posting Responses

Interaction between students is an important part of this course and requires prompt postings and responses. In an attempt to be efficient with our time and considerate of everyone's schedules—beyond the requirements of this course—we will operate under a consistent time structure for posting assignments and responding to online discussions.

Submitting Assignments

You will submit all other types of individually written assignments to the appropriate assignment dropbox. Unless otherwise noted, assignments will be due by 11:59 p.m. ET on the date noted on the class calendar.

Group Collaboration

As you advance in your careers, it becomes increasingly important to develop the skill of influencing others and working collaboratively. Similarly, in most workplaces, you will need to collaborate or negotiate with others in order to accomplish their goals.

Teamwork in courses offers an opportunity for you to learn virtual team leadership and team theory. It is important that you treat your team members with the same respect that you would treat coworkers. Team members will become part of your professional network, so if you work effectively with them, they may become a lifetime resource.

Remember that everyone's style of communication is different, and that it is important to listen carefully and adjust your style when necessary to communicate effectively. You should be proactive when you feel there might be a problem in the group. The situation will not improve if you do not address it.

STUDENT SUPPORT

Student Accessibility and Accommodation

MSOE is committed to making its curriculum academically accessible to students with documented disabilities (physical or learning), chronic health conditions, and mental health conditions, as well as to students who become temporarily disabled due to mental and physical health concerns (inclusive of injury and concussion), in line with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act (ADA).

Accommodations can be made for qualified individuals and are designed to create equal educational access for students without compromising the essential elements of our curriculum. Eligibility for accommodations is done on an individual basis determined by student need. Students are required to submit verification documentation prior to receiving accommodations through [Student Accessibility Services](#).

Student Accessibility Services (SAS)

For students with documented disabilities, chronic medical conditions or mental health concerns; MSOE provides services to make reasonable accommodations available. If you are a student who requires or anticipates the need for accommodations, please contact Student Accessibility Services Office at 414-277-

7281, by email at moureau@msoe.edu, or in person at K250 to discuss appropriate accommodations and eligibility requirements.

Title IX-Sexual Misconduct

Student complaints concerning sexual harassment and sexual misconduct are excluded from this student complaint reporting procedure. Instead, the student complaint procedure concerning sexual harassment and sexual misconduct is addressed in the MSOE Sexual Misconduct Policy. Students who are victims of sexual misconduct have the right to report the incident in a confidential manner. For more information concerning sexual harassment and sexual misconduct, or for details on how to report sexual harassment or a sexual misconduct incident in a confidential manner, please refer to the MSOE Sexual Misconduct Policy. Students who wish to file an official report with MSOE concerning an incident involving sexual harassment or sexual misconduct should report directly to the MSOE Title IX Coordinator, Dr. Kip Kussman (414) 277-7225, kussman@msoe.edu or to the MSOE Title IX Deputy Coordinator Gary Shimek (414) 277-7181, shimek@msoe.edu.

Research With Human Participants

MSOE's Institutional Review Board (MSOE IRB) is an administrative body established to protect the rights and well-being of human subjects recruited to participate in research activities. MSOE IRB has jurisdiction over human subject research activities conducted at MSOE, human subject research activities conducted by MSOE employees, students, or agents at any location, and human subject research activities that use MSOE resources. All students, staff, and faculty at MSOE planning to conduct research involving human participants must submit an IRB protocol application package for review by MSOE IRB including proof of relevant training certification. Investigators must obtain written approval from MSOE IRB before human subject recruitment and research may begin.

In accordance with regulatory standards, MSOE IRB is comprised of qualified board members that include at least one non-scientist and one community representative. MSOE's vice president of academics serves as the Institutional Official for MSOE IRB. Human subject researchers (e.g. investigators) at MSOE comply with requirements set forth in the code of Federal Regulations known as the "Common Rule" as well as Wisconsin State laws and MSOE policies. Federally funded multi-site studies requiring single IRB (sIRB) review involve coordinated local oversight by and advanced planning with the MSOE IRB office. In any study, if investigators intend to recruit study participants from locations outside of the United States, the primary investigator (PI) must first secure written approval from MSOE IRB prior to contacting research officials in other countries.

The purpose of IRB oversight is to ensure adequacy of the research plan, to minimize risks, and to maximize benefits for human subjects who participate in research activities. If the investigator is a student, the research must be performed under supervision of an MSOE faculty or staff member who, by their signature, assumes responsibility for the conduct of the research with respect to proper safeguards of the rights of human subjects (participants).

MSOE IRB approval is required before human subject research is undertaken by students for classroom work, independent study, senior design, nursing professional practice projects, surveys, master's degree theses, or any purpose not specifically listed. This includes research with human subjects (participants) conducted for non-academic purposes, as well. Data collection by students or faculty/staff for assessment purposes only does not need MSOE IRB approval. Proposals for research projects conducted as classroom activities need to be submitted to the MSOE IRB if the intention is to share results of the project in a public forum or through publication. Class projects in which results will only be presented to students enrolled in the course and

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instructor(s) assigned to the course do not need IRB approval. It is the instructor's responsibility to ensure that there are minimal risks for both the student researchers and their participants. If the instructor assumes that the project could lead to further presentation of results, either through publication or public forum, those projects will need to be reviewed by the IRB prior to the activity. Results of classroom activities cannot be presented outside of the classroom without IRB approval; retroactive IRB approval is never granted. For further information, please see the IRB Guidelines at <https://libguides.msoe.edu/irb>.