Northeastern
College of Engineering

CSYE 7380 Theory and Practical Applications of AI Generative Modeling
Summer 2025

Course Information
Course Title: Theory and Practical Applications of AI Generative Modeling
Course Number: CSYE 7380
Term and Year: Full Summer 2025
Credit Hour: 4.000
CRN: 53377
Course Format: Traditional

Instructor Information
Full Name: Yizhen Zhao
Email Address: yizhenzhao@northeastern.edu
Office Hours: One Hour After Each Lecture Weekly & By Appointment

Instructor Biography
Dr. Yizhen Zhao received her PhD from Johns Hopkins University. Before she joined Northeastern University, she had been working as a quant specialized in machine learning, algorithm trading and financial risk modeling for years. Dr. Yizhen Zhao's research and work experience cover both the buy-side and the sell-side finance, which allows her to incorporate Wall Street practice into the classroom for students. Her teaching philosophy emphasizes project-based learning. In her classes, students work on real-world problems to advance their knowledge in data science, fin-tech and software engineering.

Teaching Assistant Information
Full Name: TBA
Email Address: TBA
Office Hours: TBA

Course Prerequisites

The prerequisite for the course follows the program's requirement for taking CSYE7380. Students are expected to be comfortable with statistics, matrix analysis and at least one type of programming language. Much of the course addresses machine learning and deep learning algorithms, and students who are deficient in statistics may find it difficult to keep up. I will do my best to teach the course at a level appropriate for someone who has not had any instruction in finance. Some background material may be taught using matrix analysis, statistics, and stochastic calculus; this material will only be used for the demonstration of concepts, and you will not be tested on it. I will make myself available before and after classes if you would like to meet to further discuss class material or related topics.

Course Description

The course serves as an extension to the INFO6105 Data Science Engineering Methods and Tools (former INFO7374 Machine Learning in Finance & Python) and covers algorithms pertaining to generative AI. The course focuses on both theory and applications. Students will learn the quantitative models and metrics that drive the success of popular Generative AI applications such as Recurrent Neural Networks (RNN), Long Short-term Memory Model (LSTM), Attention Mechanism, Transformer Models, Convolutional Neural Networks (CNN), Generative Adversarial Networks (GAN) and Reinforcement Learning and Deep Q Learning, etc. Students will also develop hands-on Generative AI projects using popular deep learning cloud computing tools that include TensorFlow and PyTorch. Lectures and coding lab sessions are enriched with case studies and examples ranging from trading, image synthesis, text translation and generation, etc. to showcase the application of generative AI in various fields such as natural language processing, trading, finance, entertainments, etc. The course includes eight chapters: Lecture 1 How Generative AI differs from traditional machine learning methods. Lecture 2 Recurrent Neural Networks (RNN). Lecture 3 Long Short-term Memory Model (LSTM). Lecture 4 Attention Mechanisms. Lecture 5 Transformer and Large Language Model. Lecture 6 Convolutional Neural Networks (CNN) and Generative Adversarial Networks (GAN). Lecture 7 Reinforcement Learning and Deep Q Learning. Lecture 8 Principles of Responsible AI.

Course Learning Outcomes

The student will be able to accomplish the following tasks after completing this course.

- Understanding of Generative AI Concepts: Students will develop a solid understanding of the fundamental concepts, principles, and techniques underlying Generative AI. This includes knowledge of generative models, such as GANs, VAEs, as well as their architecture, training methods, and evaluation metrics.
- Practical Skills in Implementing Generative AI Models: Students will gain hands-on experience in implementing and training generative AI models. They will learn how to work with popular deep learning frameworks, such as TensorFlow or PyTorch, and apply them to create and train generative models for various tasks, such as image generation, text generation, or music synthesis.
- Ability to Evaluate and Fine-Tune Generative Models: Students will learn how to evaluate the quality and performance of generative models. They will understand metrics and techniques used for assessing the output of generative models, such as inception score, Fréchet Inception Distance (FID), or human evaluation. Additionally, they will gain insights into fine-tuning generative models to improve their results.
- Application of Generative AI in Real-World Scenarios: Students will explore the application of generative AI models in various domains, such as computer vision, natural language processing, creative arts, or data augmentation. They will identify suitable use cases and build their own generative AI applications. Students will deeply engage in Generative AI programming and explore innovative applications within

the field of Generative AI. They will have opportunities to contribute to the advancement of the field, experiment with cutting-edge techniques, and explore new directions for generative modeling.

- Ethical Considerations and Responsible AI Development: Students will develop an awareness of the ethical implications and challenges associated with generative AI. They will learn about potential biases, fairness issues, privacy concerns, and the responsible use of generative models. They will be encouraged to think critically and consider the ethical implications when working with generative AI technologies.

Required Tools and Course Textbooks.
Python

Course Schedule/Topics Covered. The schedule presented here is tentative and subject to change. Some topics may take more or less time than anticipated. Additional topics may be included as time permits and/or according to the students' preference.

Week	In Class Topic	Assignment Due
1	Lecture 1 Introduction to Generative AI	TBD on an ongoing basis
2	Coding Lab: Supervised Machine Learning Unsupervised Machine Learning vs Generative AI	TBD on an ongoing basis
3	Lecture 2 Recurrent Neural Networks (RNN) Coding Lab: Applications of RNNs in Natural Language Processing and Trading	TBD on an ongoing basis
4	Lecture 3 Long Short-Term Memory Model (LSTM) Coding Lab: Applications for LSTM in Natural Language Processing and Trading	TBD on an ongoing basis
5	Lecture 4 Attention Mechanism I Coding Lab: Recurrent Neural Networks (RNNs) vs Attention Mechanism	TBD on an ongoing basis
6	Lecture 4 Attention Mechanism II Coding Lab: Self-Attention Mechanism. Multi-head Self-Attention & Masked Self-Attention	TBD on an ongoing basis
7	Lecture 5 Transformer Models I Coding Lab: Speech Recognition, Text Translation, BERT, Encoder-Decoder structure, Controllable Chatbot	TBD on an ongoing basis
8	Independence Day	
9	Lecture 5 Transformer Models II Coding Lab: BERT, RAG, Large Language Models & ChatGPT: Fine Tuning vs Prompting	TBD on an ongoing basis
10	Lecture 6 Generative Adversarial Network I Coding Lab: Review Convolutional Neural Networks (CNN)	TBD on an ongoing basis

11	Lecture 6 Generative Adversarial Network II Coding Lab: Generative Adversarial Network (GAN) Full Anatomy & Experiment	TBD on an ongoing basis
12	Lecture 7 Reinforcement Learning I Coding Lab: Reinforcement Learning and Trading Strategy Design	TBD on an ongoing basis
13	Lecture 7 Reinforcement Learning II Coding Lab: Deep Q Learning and Trading Strategy Design	TBD on an ongoing basis
14	Lecture 8 Introduction to Responsible AI + Review Session	TBD on an ongoing basis
15	Final Exam	

Assignment Grading

Three Quizzes	15%
Final Exam	35%
Projects and Assignments Presentation	30%
Coding Competition (Class Participation)	10%
Attendance	10%
Extra Credit	5%

Grading Scale

Percentage Range	Letter Grade	Grade Point Equivalent
95.0–100.0%	A	4.000
90.0–94.9%	A-	3.667
87.0–89.9%	B+	3.333
84.0–86.9%	B	3.000
80.0–83.9%	B-	2.667
77.0–79.9%	C+	2.333
74.0–76.9%	C	2.000
70.0–73.9%	C-	1.667
69.9% and Below	F	0.000

Incomplete Grades

An incomplete grade may be reported by the instructor when a student has failed to complete a major component of a required course, such as homework, a quiz or final examination, a term paper, or a laboratory project. Students may make up an incomplete grade by satisfying the requirements of the instructor. Be aware that instructors' policies on the granting of incomplete grades may vary and that the final decision on an incomplete grade is up to the instructor. **Instructors may deny requests for an incomplete grade.** If the missing assignment(s) have not been submitted to the instructor within 30 days from the end of the term in which the course was offered, or the agreed upon due date, the grade entered will reflect the student's grade in the course for the work completed and the missing assignments receiving no credit toward the final grade.

Attendance/Late Work Policy

Attendance Policy

In each term, students enrolled in on-ground sections are expected to be on campus and attending class beginning with the first day of classes. Students in online sections are expected to log in and participate in class beginning with the first day of classes.

Students who join a class after the first day of class during the university add period, or who are approved for late registration by the instructor and the Graduate School of Engineering, are responsible for all coursework missed prior to enrolling. In the interest of students' success, the college does not support the arrival of students to class after the university add deadline. Enrolled students who do not attend class during the first week of a semester risk being dropped from the course.

In cases where an enrolled student cannot arrive to campus by the first day of class due to circumstances beyond their control, it is the student's responsibility to contact the instructor for approval and notify the Graduate School of Engineering.

Students registered in MGEN courses (INFO, CSYE, and DAMG) are allowed a maximum of 2 absences per course, with 3 or more absences resulting in an 'F' for that course. Course instructors are not expected to make accommodations and students are expected to inform their instructors of any absences in advance of the class. Should a student anticipate being unable to attend 3 or more classes, they should discuss their situation with their Academic Advisor to explore other types of leave and accommodations in accordance with the University's academic and global entry expectations. Students may be asked to share communications about class absences with their Academic Advisor. If a student is sick long-term or experiences a medical issue that prevents class attendance, it is strongly encouraged that they speak with their Academic Advisor (coe-gradadvising@northeastern.edu) to learn more about the Medical Leave of Absence. International students should review the Office of Global Services webpage to understand their visa compliance requirements.

Teaching Assistants (TAs) or Instructional Assistants (IAs) will be present at each class to collect student attendance.

Late Work Policy

Students must submit assignments by the deadline in the time zone noted in the syllabus. Students must communicate with the faculty prior to the deadline if they anticipate work will be submitted late. Work submitted late without prior communication with faculty will not be graded.

Course Evaluations

Student feedback on their learning experience is valuable and helps improve future courses. We encourage all students to complete the course evaluation surveys when they become available.

Surveys are distributed at both the midterm mark and the end of the term via email and are completely anonymous and confidential. Any questions about the surveys can be directed to mgen-programs@coe.northeastern.edu

MGEN Student Feedback

Students who would like to provide the MGEN unit with anonymous feedback on this particular course, Teaching Assistants, Instructional Assistants, professors, or to provide general feedback regarding their program, may do so using this survey: https://neu.co1.qualtrics.com/jfe/form/SV_cTlAbH7ZRaaw0Ki

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.

The following is a broad overview, but not an all-encompassing definition, of what constitutes a violation of academic integrity:

Cheating: The University defines cheating as using or attempting to use unauthorized materials, information, or study aids in any academic exercise. When completing any academic assignment, a student shall rely on their own mastery of the subject.

Fabrication: The University defines fabrication as falsification, misrepresentation, or invention of any information, data, or citation in an academic exercise.

Plagiarism: The University defines plagiarism as using as one's own the words, ideas, data, code, or other original academic material of another without providing proper citation or attribution. Plagiarism can apply to any assignment, either final or drafted copies, and it can occur either accidentally or deliberately. Claiming that one has "forgotten" to document ideas or material taken from another source does not exempt one from plagiarizing.

Unauthorized Collaboration: The University defines unauthorized collaboration as instances when students submit individual academic works that are substantially similar to one another. While several students may have the same source material, any analysis, interpretation, or reporting of data required by an assignment must be each individual's independent work unless the instructor has explicitly granted permission for group work.

Participation in Academically Dishonest Activities: The University defines participation in academically dishonest activities as any action taken by a student with the intention of gaining an unfair advantage over other students.

Facilitating Academic Dishonesty: The University defines facilitating academic dishonesty as intentionally or knowingly helping or contributing to the violation of any provision of this policy.

Please visit https://osccr.sites.northeastern.edu/academic-integrity-policy/ to access the full academic integrity policy.

University Health and Counseling Services

As a student enrolled in this course, you are fully responsible for assignments, work, and course materials as outlined in this syllabus and in the classroom. Over the course of the semester if you experience any health issues, please contact UHCS.
For more information, visit https://www.northeastern.edu/uhcs.

Student Accommodations/Disability Access Services (DAS)
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, students must provide appropriate documentation as provided by the DAS office.

If the course is conducted in an on-ground (in-person) format, students are expected to attend class physically as scheduled. Professors are **not required to provide virtual attendance links** unless a student has documented accommodation approved by the **Disability Access Services (DAS) office** and their **Academic Advisor**. If a student requires accommodation for remote participation, they must submit a formal request through the **Disability Office** and coordinate with their **Academic Advisor** prior to the course start date.

For more information, visit https://disabilityaccessservices.sites.northeastern.edu/

Office of Global Services
As an F-1, J-1, or Study Permit student, you must meet certain obligations in order to maintain lawful nonimmigrant status. Maintaining status is necessary in order to retain eligibility for the benefits of F-1 or J-1 status, such as employment authorization and program extension, and can be crucial to a successful application for a change or adjustment of nonimmigrant status in the future. Failure to maintain your nonimmigrant status can result in serious problems with immigration and *could lead to deportation from the U.S. or Canada*.

Students must maintain on-ground presence throughout the academic term. At Northeastern, there are four different defined instructional methods: Traditional, Hybrid, Live Cast, and Online. Traditional, Hybrid, and Live Cast courses meet the Visas' on-ground presence requirements. **Online courses do not meet the Visas' on-ground presence requirements.**

Students enrolled in Summer courses should adhere to OGS guidelines on maintaining status during the Summer term.

For more information please visit, https://international.northeastern.edu/ogs/current-students/understanding-visa-requirements/guidelines-on-maintaining-status/

Library Services
The Northeastern University Library is at the hub of campus intellectual life. Resources include over 900,000 print volumes, 206,500 e-books, and 70,225 electronic journals.

For more information and for education specific resources, visit https://library.northeastern.edu Network Campus Library Services: Northeastern University Library Global Campus Portals

24/7 Canvas Technical Help
For immediate technical support for Canvas, call 617-373-4357 or email help@northeastern.edu
Canvas Student Resources: https://canvas.northeastern.edu/student-resources/

For assistance with my Northeastern e-mail, and basic technical support:
Visit ITS at https://its.northeastern.edu
Email: help@northeastern.edu
ITS Customer Service Desk: 617-373-4357

Belonging at Northeastern
Fostering a community of belonging is essential to the advancement of Northeastern University's mission of teaching and research. Our university is stronger as a result of the varied backgrounds, experiences, and perspectives that all members of our global community bring to the pursuit of knowledge.
Embracing this pluralism is not the work of one office, department, or academic unit. It is a shared responsibility that spans disciplines and boundaries. By harnessing the power of our differences, we will continue to light the path to bold new ideas and life-changing discoveries. For more information, please visit https://belonging.northeastern.edu/

Title IX
Northeastern University complies with federal, state, and provincial civil rights laws and prohibits discrimination within any of its programs, activities, and services in accordance with *Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title IX of the Education Amendments Act of 1972, Age Discrimination Act of 1975, U.S. Department of Homeland Security Regulation 6 C.F.F. Part 19, and other applicable civil rights laws and regulations*.
In case of an emergency, please call 911.

*Please visit **https://ouec.northeastern.edu/services/** for a complete list of reporting options and resources both on- and off-campus*.