Northeastern
College of Engineering

CSYE 7380: Theory & Practical Applications of Generative AI

Course Information
Course Title: Theory & Practical Applications of Generative AI Modelling
Course Number: CSYE 7380
Term and Year: Fall 2025
Credit Hour: 4 credits
CRN: 17572
Course Format: Traditional

Instructor Information
Full Name: Ramkumar Hariharan
Email Address: rmhariharan123@gmail.com
Office Hours: TBD

Instructor Biography
Ramkumar Hariharan is Program Director and Data Science Engineering Faculty at Northeastern, Seattle. He is also Senior Scientist at Northeastern's Institute for Experiential AI (EAI). Previously, he has led multiple high-impact data-driven projects at some of the leading institutes in Seattle. These include Fred Hutch, University of Washington (UW), and the Institute for Systems Biology. His areas of focus include data analyses, data visualization, and predictive analytics of both structured and unstructured data.Ram has a 17-year history of developing and delivering more than 20 computational, biomedical, and data science courses at a variety of levels. His courses, lectures, online teaching, and motivational talks have been overwhelmingly well-received in Seattle, Japan and in India. Ram has been on Television in India and in the US. Ram serves as affiliate of UW e-sciences institute, bootcamp leader at General Assembly, and mentor with Springboard. He has also led education and training programs for Fred Hutch. He specializes in using powerful, yet simple analogies to explain seemingly complex computational and data science concepts and math.Ram's teaching philosophy is grounded in one strong belief: there is no one size fits all approach to teach, or to learn a new concept.

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

Course Prerequisites
Please review academic course catalog

Course Description
We will dive deep into state-of-the-art technology that powers today's AI like ChatGPT, DALL-E, and GitHub Copilot! This course will introduce you to the world of artificial neural networks, deep learning, how they differ from classical machine learning algorithms, while slowly building our conceptual

framework for generative AI. We will be covering cutting-edge models like large language models, stable diffusion and the transformer architecture. You'll explore how these models generate text, images, and structured data, learning hands-on how to build them using Python, langchain, huggingface and PyTorch. With the rapid growth of tools like ChatGPT, mastering generative AI and learning how best to use them is key for students aiming to excel in data science. We will dive into best practices for prompt engineering.

Course Learning Outcomes

1) Foundational Knowledge: Develop a solid understanding of AI foundations, artificial neural networks, and deep learning, and how these differ from traditional machine learning algorithms. Difference between predictive and generative models.
2) **Generative Model Expertise**: Gain practical experience with large language models and variational autoencoders to generate text, images, and structured data using huggingface and PyTorch.
3) **Industry Application Readiness**: Acquire the skills to apply generative AI in real-world scenarios, preparing for careers in data science and AI-powered industries, with insights into technologies like ChatGPT, DALL-E, and GitHub Copilot.

Required Tools and Course Textbooks.

1. Deep Learning : Foundations and Concepts, Christopher Bishop and Hugh Bishop, 2024 Edition, Springer.
2. Generative AI Foundations in Python: Discover key techniques and navigate modern challenges in LLMs, Carlos Rodriguez, Samira Shaikh, 2024, Packt.

Course Schedule/Topics Covered

Date	In Class Topic	Assignment Due
09/08	Course overview, Admin Trivia, Compute Env, Projects, Teams, Expectation, Huggingface, Pytorch, GPUs, Colab, Kaggle	
09/15	Generative AI Probabilistic Foundations & LLM Usecase	
09/22	Deep Representation Learning Foundations	
09/29	Deep Learning Through Code	Assignment I Released
10/06	Variational Autoencoders: Theory & Practice	Project Titles, Theme Due
10/13	Iindigenous People's Day: No Classes	Assignment I Deadline
10/20	LLMs from Scratch Part I	
10/27	LLMs from Scratch Part II	Assignment II Released
11/03	Enter the Transformers	
11/10	Three huggingface usecases & Prompt engineering	Assignment II Deadline In-person quiz (objective questions)
11/17	Diffusion (Stable !) in Gen AI theory & practice	
11/24	Fall Break	
12/01	Agentic AI	Project Submission Due
12/08	Project Presentations	

Assignment Grading

Please insert all assignment grades and weights for the course. Example below:

- Attendance – See Guidelines Below
- Assignment 1 – 25%
- Assignment 2 – 25%
- In class Quiz – 25%
- Final Project – 25%

Grading Scale

	87-89.9% B+	77-79.9% C+	
95-100% A	84-86.9% B	74-76.9% C	
90-94.9% A-	80-83.9%B-	70-73.9% C-	69.9% or below F

Students will work on a final project with deliverables due at several milestones during the term as marked on the course schedule. The first part of the term will be spent identifying a topic relevant to the course material, planning the project, writing a high quality proposal, and reviewing the proposals of your peers. The second part of the term will be focused on completing the project, writing the report, and presenting the results. Details of what is expected by each milestone will be posted on the course website.

We expect students to work in groups of three on the final project. However, we will consider groups of one or two if presented with a strong argument for it. Keep in mind that larger teams are expected to undertake more ambitious projects. Part of the final project grade will depend on the challenge and originality of your project.

Our Artificial Intelligence Policy

We take a fair use policy to the class. You are encouraged to use any chatbots or AI Tools you prefer, for assisting with learning, helping better complete assignments and in building the project. Please make sure you explicitly state what all you used the chatbot for, and what's your contribution to the work you turned in. Also, keep screenshots of your conversation with the chatbot while using it to complete class assignments or project. You will be asked to explain your code during code review where you are not allowed to use an AI tool.

Collaboration Policy
You are welcome to collaborate on problem sets and the final project. However:
• You must work independently on each problem before you discuss it with others.
You must write the solutions on your own.
• You must acknowledge outside sources and collaborators.
You may use ChatGPT/LLM, but you must:

• Acknowledge the way you would for a collaboration partner.
• Be transparent, save your chats, submit with assignments

Assignments

There will be two assignments during the semester, each including 3–5 problems for all students . The assignments will include both theoretical and programming problems.

Late policy: late assignments will lose 5% of total points for each day that it is submitted late. However, an extension up to 3 days can be granted without late points deducted if 75 % of the assiggnment, demonstrating substantial effort andcorrectness, is submitted on the due date. Simply resubmit the completed assignment within four days after the due date

Attendance Policy

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 automatic 'F' for that course.** Students are expected to inform their instructors of any absences in advance of the class; 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-mgen-gradadvising@northeastern.edu) to learn more about the Medical Leave of Absence. 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 in accordance with the University's academic and global entry expectations. 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.

End-of-Course Evaluation Surveys
Your feedback regarding your educational experience in this class is particularly important to the College of Engineering. Your comments will make a difference in the future planning and presentation of our curriculum.

At the end of this course, please take the time to complete the evaluation survey at **https://neu.evaluationkit.com**. Your survey responses are **completely anonymous and confidential**. For courses 6 weeks in length or shorter, surveys will be open one week prior to the end of the courses; for courses greater than 6 weeks in length, surveys will be open for two weeks. An email will be sent to your Northeastern University Mail account notifying you when surveys are available.

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 http://www.northeastern.edu/osccr/academic-integrity-policy/ to access the full academic integrity policy.

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_cTIAbH7ZRaaw0Ki

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
Northeastern University and the Disability Resource Center (DRC) 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 DRC, students must provide appropriate documentation that demonstrates a current substantially limiting disability.

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

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

Diversity 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.

Please visit http://www.northeastern.edu/oidi/ for complete information on Diversity 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 911.

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