CS 6180: Generative AI

Graduate Course, Khoury College of Computer Sciences
Northeastern University, Vancouver Campuses
Spring 2026 Semester

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Class Hours:	10:45am - 12:45pm (Pacific Time)	1:45pm - 3:45pm (Eastern Time)
Class Location:	Section 1: Online Asynchronous	Watch at your own pace or Join remotely
	Section 2: Vancouver	Attend in-person: West Georgia 1524
Instructor:	Dr. Ryan Rad r.rad@northeastern.edu	
	Office Hour: Wed, 1-2pm & 3-3:30pm (Pacific Time)	
TAs	Jiayi Zhang, Kalhar Pandya, Ackshay Rajasekar	

Course Pre-requisite: Completion of at least one of the following graduate-level courses in Machine Learning or Artificial Intelligence:

- **CS 5100** – Foundations of Artificial Intelligence
- **CS 5180** – Reinforcement Learning and Sequential Decision Making
- **CS 6120** – Natural Language Processing
- **CS 6140** – Machine Learning
- **CS 7140** – Advanced Machine Learning
- **CS 7150** – Deep Learning

These courses provide the necessary background in ML/AI fundamentals. Equivalent courses from other Northeastern colleges may be considered with instructor approval. Students must demonstrate prior coursework covering core ML/AI topics, including supervised and unsupervised learning, neural networks, deep learning fundamentals, and reinforcement learning.

1. Course Description

Generative AI is revolutionizing industries by enabling machines to produce human-like text and solve complex tasks. This course provides students with both the theoretical foundation and practical skills to understand, analyze, and apply generative AI techniques effectively. The course begins with foundational concepts in AI and machine learning, progresses to advanced natural language processing (NLP), transformer models, and large language models (LLMs), and concludes with cutting-edge techniques like prompt engineering, domain-specific adaptations, and retrieval-augmented generation (RAG). Students will gain the knowledge and skills needed to apply generative AI to real-world problems while critically engaging with its ethical implications and future trends.

1.2 Course Objectives

By the end of this course, students will be able to:

1. **Understand Core Architectures**: Grasp the foundational concepts of neural networks, transformers, large language models (LLMs), and vision-language models (VLMs).
2. **Analyze Advanced Techniques**: Compare and contrast generative AI methodologies, including prompt engineering, fine-tuning, Reinforcement Learning by Human Feedback (RLHF), retrieval-augmented generation (RAG), and multimodal generation techniques.
3. **Implement and Deploy Models**: Develop and deploy generative AI models for text and visual domains using current frameworks and best practices.
4. **Adapt Pre-Trained Models**: Fine-tune and apply pre-trained LLMs and VLMs for domain-specific applications through transfer learning and specialized adaptations.
5. **Evaluate Ethical and Societal Implications**
   Critically assess ethical challenges, responsible usage, and societal impacts of advanced generative AI systems, including multimodal applications.

2 Course Structure

The course is structured into **4 modules**, each designed to build a progressive understanding of generative AI, from foundational concepts to advanced applications and future directions.

Module 1: Foundations of AI and ML (2 sessions)
Establish a strong foundation in AI and Machine Learning concepts, focusing on deep learning fundamentals.
- **Session 1:** Introduction to AI and Machine Learning
- **Session 2:** Deep Learning Fundamentals

Module 2: Foundations of NLP and Sequential Modeling (2 sessions)
Introduce Natural Language Processing (NLP) fundamentals and sequential modeling techniques for modern text processing and generation.
- **Session 3:** Fundamentals of NLP, Embeddings and Vector Spaces
- **Session 4:** Sequential Modeling, from RNN to Transformer

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Module 3: LLMs and Their Applications (4 sessions)
Explore advanced techniques for leveraging large language models (LLMs), including domain-specific adaptations, retrieval-augmented generation, and fine-tuning.
- **Session 5:** Text Generation and Large Language Models (LLMs)
- **Session 6:** Prompt Engineering
- **Session 7:** Domain-Specific LLMs and Retrieval-Augmented Generation (RAG)
- **Session 8:** Domain-Specific LLM Fine-Tuning and RLHF

Module 4: Multimodal, AI Agents, MLOps, and Future Directions (3 sessions)
Apply generative AI knowledge to design AI agents and explore MLOps practices, ethical considerations, and future trends in generative AI.
- **Session 9:** Vision-Language Models (VLMs) & Multimodal Generation
- **Session 10:** AI Agents
- **Session 11:** MLOps for Gen AI & Ethical, Societal, and Environmental Impact

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2.1 Weekly Schedule*

Week	Date	Topics	In-Class	Notes
1	Jan 07	• Introduction to AI and Machine Learning		Bring a smile & tons of energy! HW1 releases Jan 07-09
2	Jan 14	• Deep Learning Fundamentals		
3	Jan 21	• Fundamentals of NLP, Embeddings and Vector Spaces	🧠 Act 1	HW 2 releases Jan 21-23 HW 1 is due Jan 23
4	Jan 28	• Sequential Modeling from RNN to Transformer	🧠 Act 2	
5	Feb 04	• (Large) Language Models	🧠 Act 3	HW 2 is due Feb 06 HW 3 releases Feb 04-06
6	Feb 11	• Prompt Engineering	🧠 Act 4	
7	Feb 18	• Retrieval-Augmented Generation (RAG)	🧠 Act 5	HW 4 releases Feb 18 HW 3 is due Feb 20 Reflection 1 due Feb 20
8	Feb 25	• Fine-Tuning and RLHF	🧠 Act 6	HW 4 is due Feb 27
9	Mar 04	• Spring Break		Enjoy your break! 🌸🎿🏂🥾❄️
10	Mar 11	• Vision-Language Models & Multimodal • Mixture of Experts (MOE)	🧠 Act 7	Project Proposal (M1) is due Mar 13
11	Mar 18	• Generative AI Agents	🧠 Act 8	
12	Mar 25	• MLOps for Gen AI / LLMOps	🧠 Act 9	
13	April 01	• Project Progress Presentation		Project Progress (M2) is due Apr 01
14	April 08	• Course Wrap-Up and Future Directions		
15	April 15	• Final Technical Interviews – 1:1		Interviews: Apr 9-10 & Apr 13 Final Deliverables (M3) due Apr 15

* This schedule is subject to change as we navigate through the term. The latest schedule can be found on Canvas.

2.1 Pre-class Work

This course like many other MSCS courses at Khoury will be taught using a pedagogical technique known as the Hybrid classroom. In this approach, there will be a combination of asynchronous (online) materials that you will be expected to study on your own, and synchronous (in-class) activities and discussions, in which important concepts will be reviewed and students are expected to participate at scheduled times. The asynchronous component will be the primary means by which the course materials are delivered. And then during class, you will apply your understanding of these core concepts through carefully-chosen problems and activities, which will enable you to solidify your knowledge.

Our classrooms require much more focus and preparation time, for both the instructor and the students. We will devote our class time to the computational thinking process: resolving obstacles, developing conceptual understanding, communicating solutions supported by evidence, and creating efficient algorithms that solve our problem. Through this process, you will better develop your confidence, creativity, and critical-thinking skills, preparing you to become *computer scientists* (not just programmers).

In order for this course to be a meaningful learning experience, you will need to come to each class well-prepared, with all assigned readings and videos complete. This emphasis on pre-class work is the reason why our class meets for only 2 hours each week, compared to other four-credit courses at Northeastern

that meet for 3.25 hours each week. If you do not complete the pre-class work, it will make it that much harder for you to successfully complete the Homeworks, Programming Projects, and Quizzes. The workload for this course is calibrated such that the **middle 50% of students** will spend **approximately 13 to 17 hours per week** on all course-related activities. Please plan your schedule accordingly, recognizing that individual variances may place you outside this range.

2.2 In-class Work (only for section 2)

You are strongly encouraged to bring your laptop or phone to class so that you can participate in the activities. Most lectures will feature interactive activities and/or polls that support the material being presented. You must be present in class to complete the activity or take the poll (participating in an online activity while not attending the synchronous session will be considered academic dishonesty and will be treated harshly). Each instructor may have a different style for assigning participation grades, but historical grading information suggests that each style results in a similar overall grade distribution. Participation grades will be posted on Canvas, and regularly updated.

Students are expected to attend classes regularly, take quizzes, and submit assignments and other work at the times specified by the instructor. Students who are absent repeatedly from class or labs will be evaluated by faculty responsible for the course to ascertain their ability to achieve the course objectives and to continue in the course. Instructors may include, as part of the semester's grades, marks for the quality and quantity of the student's participation in class.

PLEASE DON'T BE LATE. You are an essential part of the class. Your participation is an essential part of the class. If you are late, please be courteous to others when entering.

BE PRESENT WHEN YOU ARE ATTENDING CLASS. Please do not distract yourself from the class by doing other activities such as phone calls, email, facebook, chat/IM/texting, games, web surfing – unless it has a direct bearing on the course. Then, by all means, surf away!

3 Course Assessment

There are several methods of assessment in this course.
- **Homework Assignments**   **40%**
  - 4 Individual HomeWorks, Each 10%
- **Final Team Project**   **30%**
  - Milestone 1: Project Proposal – 2% , Milestone 2: Project Progress/Presentation – 5%,
  - Milestone 3: Project Final Deliverable - 23%
- **Technical Interview**   **20%**
  - Individual, synchronous
- **Course Reflections**   **2%**
  - 2 Individual Reflections, each 1%
- **In-Class Activities**   **8%**
  - **[In-person section]** Requires attendance (best 8 out of 9)
  - **[Online section]** Asynchronous activities or quizzes (best 8 out of 9)

Note: Most assignments and deliverables will be due on Fridays at 5pm (PT) / 8pm (ET).

3.1 Assessment Description

- **Homework Assignments - 40% (4 x 10%)**
  These assignments consist of multi-part questions based on key concepts and techniques introduced during class. All assignments are to be completed individually and may include programming tasks

that reinforce generative AI concepts such as fine-tuning models or implementing foundational AI techniques.

- **Reflection - 2% (2 x 1%)**
  There will be two course reflection surveys and essays, each combo will be worth 1.5%

- **Technical Interview - 20%**
  You will be required to participate in a 20-30 - minutes, 1:1 synchronous interview with the Professor/TAs. This interview will assess your overall understanding of the course concepts and your final project.

- **Final Team Project - 30%** (three milestones)
  The project involves three milestones:
    o **Milestone 1 (2%)**: Project Proposal – Submit a detailed plan outlining the project objectives, methodology, and expected outcomes.
    o **Milestone 2 (5%)**: Project Presentation – Present your project progress and findings.
    o **Milestone 3 (23%)**: Project Final Deliverable – Submit a comprehensive report detailing your project results, methodology, and conclusions.

3.2 Late/Makeup Policy

All tasks and assignments have specific due dates and times. **Your work is late if it is not turned in by the deadline.**

Built-in Flexibility: The course already includes substantial flexibility:
- Weekly activities: Only your top 8 out of 9 scores count
- Homework assignments: Given ~2 weeks to complete, providing ample time for planning

Late Penalties:
- **In-class activities and final project:** Not accepted late (no exceptions)
- **Homework assignments:** Will be accepted up to 48 hours late with 5% penalty every 6 hours (rounded up). Example: A 90-point assignment submitted 7 hours late receives 81 points (90 × 0.90). Submissions beyond 48 hours receive zero.

No Make-ups or Extensions: Extensions create cascading delays, disadvantage students who submit on time, and complicate solution releases and grading. Given the built-in flexibility above, make-up assignments and extensions **will not be granted**. The dropped activities and extended homework deadlines are designed to accommodate typical challenges (short-term illness, job interviews, other coursework, travel, technical difficulties, overlapping deadlines, family visits).

Extraordinary Circumstances Only: True emergencies (hospitalization, family crisis) will be handled individually and require documentation. You must notify the instructor as soon as reasonably possible—it is your responsibility to ensure your situation is communicated and acknowledged.

What Doesn't Qualify: Poor time management, overlapping deadlines, job interviews, travel, or minor illness are already accommodated by the course's flexible grading structure. Do not request extensions for these situations.

3.3 Grade Calculations

Grades will be calculated on an absolute basis: there will be no overall curving. The mapping of raw point totals to letter grades is given below. Please note that these grade boundaries may move slightly at the discretion of the instructor, but the grade boundary for A is unlikely to change.

93.00–100.00	A
90.00–92.99	A-
86.00–89.99	B+
82.00–85.99	B
77.00–81.99	B-
73.00–76.99	C+
69.00–72.99	C
65.00–68.99	C-
0.00–64.99	F

3.4 Grading Appeal

We strive to provide as much details as possible and model solutions will made available when possible. If you have concerns regarding the grading of your work and would like to respectfully ask us to regrade your work, please let us know *right away* by opening a regrade request by posting a ***private message***, (visible to TAs and Professor only) on Piazza or via email, make sure to provide all details at ***once*** for consideration. All regrade requests must be submitted *within 7 days from your receipt of the graded work*. If your regrade request is closed and you feel that the response was not satisfactory, you may appeal to the instructor via one single email detailing all your reasons within *48 hours of the initial decision*.

I encourage you to spend your time and energy where it serves you the most which will be learning from past mistakes and self-improvement. While we reserve your right to ask for a re-grade, we find debating grades an incredible drain on course staff time and energy and prevents us from serving students well and focusing on most important aspects of the course.

4 Course Materials

There is an associated Canvas page for this course. I will use it to post weekly reading assignments, lecture materials, labs, feedback, and grades.

4.1 Textbook: The required reading for this course is provided on the course website. Students are expected to read each week's materials as well as view any of the supplemental videos before attempting that week's assignments. Trying to do the assignments without reading the posted material or watching the videos will make the assignments much harder than they are designed to be. For some of you, it will be necessary for you to review the module's material more than once to truly understand the material.

4.2 Programming Language: In this course, we will work with a language that is most widely used in Machine Learning & AI, which is Python.

5 General Policies

5.1 Attendance

According to Khoury's policy for Vancouver campus, students must attend classes in-person after the course add deadline of Jan 20th. While we understand the convenience of attending classes from home, the positive impact of in-person attendance on the learning outcome and students' performance is undeniable. We would like to maximize the benefits of in-person classes, including interactive/hands-on learning, distraction-free environment, networking, and relationship building. _Students enrolled in **Section 1 (Online Asynchronous)**_ are not required to attend live classes. However, you must check the Course Website or Piazza at least every other day for announcements and updated materials.

Sometimes you cannot avoid missing a class. If you need to be away from class, it is your responsibility to catch up on the materials discussed in the class. In case of illness or other emergencies, you might be provided with a temporary link to join the class virtually. However, if you have an ongoing condition that prevents you from attending classes in-person, please email your instructor to discuss your situation.

5.2 Academic Integrity

Students must work individually on all homework assignments. We encourage you to have high-level Unless otherwise stated (e.g., group projects), all assignments reflect individual work. While you may have high-level discussions with classmates about concepts and ideas, there is to be no direct collaboration—when you submit an assignment, it must be entirely your own work.

Code Reuse Policy: You may reuse small snippets of example code found online (e.g., StackOverflow) provided it is properly attributed. If you use more than three lines of code from any source, include where it came from (a URL or notation such as "MATLAB help files" is sufficient). For entire functions, note the source at the beginning of the code segment, include any original credit information, and provide a qualitative description of what you used and what you changed or contributed. If you're concerned that attribution might make it appear you didn't complete the assignment yourself, please discuss this with the instructor.

Examples of Academic Dishonesty:
- Working with one or more partners on an individual assignment
- Submitting work done by another student, with or without their knowledge
- Submitting work primarily found on the web or provided by someone outside this class
- Submitting work from anyone who previously took this course at any institution
- Providing or receiving significant help on an assignment

Consequences: Academic integrity violations may result in failing the course. Both the student who copies and the student who provides their work to be copied are subject to these consequences.

Audit Policy: If there are concerns regarding submitted work, students may be audited and invited to a one-on-one interview with course staff. Students must complete this interview within one week of receiving the invitation.

If you are unsure about this policy, **ask the instructor**.

The university's academic integrity policy discusses actions regarded as violations and consequences for students: https://osccr.sites.northeastern.edu/academic-integrity-policy/

5.3 Use of AI-Assisted Technology

In this course, every assignment is an opportunity to demonstrate your deep understanding and expertise. While we permit the judicious use of AI-assisted technology, the dynamic must remain clear: you must lead the AI; the AI should not lead you.

AI tools—such as Gemini, Claude, and ChatGPT—can be useful for productivity, but they must be strictly explicitly managed. These tools should be primarily used as intellectual leverage to **enhance your understanding** of the material, not merely to generate the solution (partial or full). You are the architect!

It is critical to remember that AI tools are supplementary aids. They serve to expand the breadth of your research, but they cannot replace the necessity of your unique contributions. The true essence of your submissions lies in **your** original thought, **your** critical analysis, and **your** personal interpretation of data.

While AI can offer suggestions, it is incumbent upon you to critically evaluate, correct, and synthesize these elements. AI outputs should be meticulously reviewed and contextualized with a clear understanding of their relevance and validity.

As you engage with AI technology, ethical use and academic integrity are paramount. This includes the proper attribution of AI-assisted content and ensuring that **the final submission is unequivocally the result of your own intellectual labor, voice, and direction.**

5.4 Reasonable Accommodations

The goal is that every student should be able to participate in this course. If you require any special accommodations, let me know immediately so that we can work out appropriate arrangements.

5.5 Student Feedback

Your opinions are very important to us. All students are strongly encouraged to use the TRACE (Teacher Rating and Course Evaluation) system https://www.northeastern.edu/trace/ near the end of the course to evaluate this course. A reminder about TRACE should arrive via email about two weeks before the end of the course. In addition, I will be asking for your feedback at least once about halfway through the semester. However, if you have concerns about the course, don't wait until you are asked. You can contact me any time!

5.6 Classroom Environment

In our commitment to fostering an environment that optimizes teaching and learning, we hold every participant accountable for maintaining a civil and non-disruptive forum for the discussion of ideas. This expectation extends beyond the physical classroom to encompass online platforms such as Canvas and Piazza.

5.6.1 In-Class Conduct: Students are expected to conduct themselves in a manner that supports a constructive learning environment. This includes showing respect for differing opinions, engaging in discussions based on facts and documentation rather than prejudices and personalities, and refraining from disruptive or disrespectful behavior. Constructive criticism is welcome, but it should be free from harassing statements.

5.6.2 Online Platform Etiquette: The respectful and responsible use of online platforms is integral to our classroom environment. These platforms are extensions of our physical classroom, and the same principles of engagement apply. They are not venues for exerting peer pressure, openly criticizing course difficulties in a non-constructive manner, or for personal grievances. Please use these platforms to support each other's learning, ask questions, and engage in meaningful discussions. The instructors reserve the right to intervene in conversations, either in person or online, that do not align with these

expectations. Repeated unprofessional or disrespectful conduct may impact your grade and could lead to more severe consequences. Remember, part of the learning process in this course involves respectful engagement with ideas and people, whether face-to-face or through digital mediums.

5.7 Title IX, anti-discrimination, sexual assault and harassment

Northeastern University and its faculty are committed to creating a safe and open learning environment for all students. If you or someone you know has experienced discrimination (including discrimination based on sex, gender, gender identity, gender expression, sexual orientation, pregnancy or pregnancy related condition, race, religion, national origin, disability status, veteran status etc.), or sexual violence (including sexual harassment, sexual assault, dating/domestic violence, or stalking), please know that help and support are available. Northeastern strongly encourages all members of the community to take action, seek support, and report incidents of discrimination, harassment, and sexual violence to the Office for University Equity and Compliance (OUEC) through the [Online Reporting Form] (https://web.studentally.com/#/report/northeastern).

Please be aware that faculty members are Mandatory University Reporters who are required to disclose information about alleged discrimination, harassment, and sexual violence to the OUEC. If the OUEC receives a report, a member of their office will reach out to offer information about available rights, support resources and pathways towards a resolution as a member of the campus community. Community members are not required to respond to this outreach.

If you, or another community member you know wishes to speak to a confidential resource who does not have this reporting responsibility, please contact any of the following confidential resources. These confidential resources are not required to report allegations of discrimination to the University without your signed release.

- Find@Northeastern: Offers 24/7 mental health support via phone at 877.233.9477 (in the U.S.) or +1.781.457.7777 (outside the U.S.).
- Sexual Violence Resource Center: The SVRC provides confidential, trauma-informed support services to Northeastern students who have experienced any form of sexual violence (i.e., sexual assault, sexual harassment, sexual exploitation, domestic/dating violence, and/or stalking). Request services online at bit.ly/svrequestform.
- Confidential Resource Advisor: The CRA provides confidential, restorative informed support services to Northeastern students who have been accused of sexual or identity-based harm. Request services online at bit.ly/svrequestform.
- Pregnant / parenting students: Please know that the OUEC, housing the University's Title IX Coordinator, can work with students who are pregnant and/or parenting to ensure they have equal access to education programs and activities. For additional support, please contact OUEC (ouec@northeastern.edu).
- Please visit ouec.northeastern.edu for a complete list of reporting options and support resources both on- and off-campus and contact the OUEC (ouec@northeastern.edu) at any time.

5.8 Students With Disabilities

The goal is that every student should be able to participate in this course. If you require any special accommodations, let me know immediately so that we can work out appropriate arrangements.

Students who have disabilities who wish to receive academic services and/or accommodations should visit the Disability Access Services (DAS) (https://disabilityaccessservices.sites.northeastern.edu/) or call (844) 688-6287.

If you have already done so, please provide your letter from the DAS to the instructor early in the semester to arrange those accommodations.