CS 6180 Syllabus

Course Description

All course materials, including assignments, grades and announcements are published on the coursework website for CS 6180 (go https://northeastern.instructure.com/courses/193114).

CS 6180 offers students an opportunity to obtain both the theoretical foundation and practical skills to understand, analyze, and apply generative AI techniques effectively. Covers natural language processing, recurrent neural networks, transformer models, autoregressive models, variational auto-encoders, generative adversarial networks, diffusion models and interpretability.

Learning Goals

- Define what generative models are.
- Understand Recurrent Neural Networks' (RNNs) architecture, advantages and limitations.
- Explore Long Short-Term Memory (LSTMs) and how they improve RNNs.
- Learn about advanced variant of RNNs which use attention.
- Analyze the Transformer architecture.
- Understand the general family of autoregressive models.
- Explore Variational Auto-Encoders (VAEs), Generative Adversial Networks (GANs) and diffusion models.
- Obtain an introductory understanding of Interpretability and its importance in analyzing language models.

Course schedule

In general, the lectures are scheduled for Monday and Wednesday 3:00 PM - 4:40 PM PDT.

The Instructional Team

The instructional team is here to help you learn. We are available during office hours and will also answer questions posted in Ed Discussion (see below for more information). For personal matters, you can send a direct email to the members of the instructional team.

Instructor

Dr. Nadim Saad (He/Him), n.saad@northeastern.edu
Nadim is an Assistant Teaching Professor in Computer Science and Data Science in Khoury College of Northeastern University. He received both his MS and Ph.D. in Computational and Mathematical Engineering from Stanford University. In his free time, Nadim enjoys running, swimming, climbing and skiing. I'm very excited to see many familiar faces in this class!
Languages: English, French, Arabic and some Spanish (happy to learn more from you).

Teaching Assistant

TBD

Assessment

Your final grade will be based on assignments, project and one quiz:

- Assignments count for 50%. There are 7 assignments. Only the six highest scores are counted. The assignments are essential aids: they help you understand material deeper and help prepare you for the project and quiz. Assignments are always due before 11:59 pm PDT. See the course calendar for all deadlines. Note that because we only count the six highest assignment scores, missing up one homework assignment due to unforeseen circumstances will not affect your final grade. Whenever an assignment is graded, you will have three days to go over the provided comments and resubmit your work, in case you lost some credit. In the updated parts, you will need to answer three questions: What was not correct previously? Why wasn't it correct? What is your new solution? You can gain back the lost points.
- The project counts for 30%. The project will allow you to apply everything you learned in this class to a real-world problem. There will be four main components for the project:
  - Project proposal (6%)
  - Progress report (6%)
  - Final report (10%)
  - In class oral presentation (8%)
- The quiz counts for 20%. The quiz will be given during the Wednesday lecture in week 11.

Assignments will be administered through Gradescope, which has been linked to Canvas (and you should be automatically enrolled). If you have any issues with Gradescope, please report on the Piazza course page or send me an email and I'll be more than happy to help you. I will post guidelines to let you know how to submit assignments on Gradescope.

Support

The office hour schedule (in Pacific time) is as follows (Pacific):

Thursday	Nadim: 1:00 PM - 4:00 PM

Support outside of Office hours

We will provide additional support on Piazza. The teaching team will monitor the board and respond to posted questions in a timely fashion every weekday. You can and are encouraged to answer questions too. Post, answer, discuss: the more you do, the faster the help you will receive.

Computers and Software

In this course, we will make use of Python for both the computational components of the assignments and the project.

Textbook and Notes

There are no required textbooks for this class, and you should be able to learn everything from the class lectures and assignments. However, if you would like to pursue more advanced topics or get another perspective on the same material, here are some great resources:

(a) Dan Jurafsky and James H. Martin. Speech and Language Processing (2024 pre-release)

(b) Jacob Eisenstein. Natural Language Processing

(c) Lewis Tunstall, Leandro von Werra, and Thomas Wolf. Natural Language Processing with Transformers

(d) Deep Generative Models CS 236 Course Notes.

(e) Natural Language Processing with Deep Learning CS 224N Course Notes.

Note that some of these books use different notation and terminology from this course, so it may take some effort to make the appropriate connections. Happy helping you in office hours!

Diversity

- This is an inclusive classroom. Everybody has a name and a pronoun. I am committed to referring to you with the correct pronoun. Please feel free to correct me if I make a mistake.
- As your instructor, I care deeply about your well-being. Please speak with me if you are having any academic or personal difficulties. It's very important that we stay connected.

Access and Accommodations

The Disability Resource Center (DRC) is dedicated to partnering with the diverse population of students, staff, and faculty who we serve at Northeastern and in the surrounding community. We strive to provide exemplary service, education, and resources in the work that we do.

If you experience disability, please register with the DRC. Professional staff will evaluate your needs, support appropriate and reasonable accommodations, and prepare an Academic Accommodation Letter for faculty. To get started, or to re-initiate services, please visit https://drc.sites.northeastern.edu/.

Collaboration

You may collaborate with your fellow classmates on the assignments, but each person must submit their own assignment and code. All code which you submit must be your own. In addition to the academic integrity policy below, the following rules apply when collaborating with classmates:

- If you have had a substantive discussion of any homework or programming solution with a classmate, then be sure to cite them in your report. If you are unsure of what constitutes "substantive", then email me. You will not be penalized for working together!
- You must not copy answers or code from another student either by hand or electronically. Another way to think about it is that you should be talking English with one another, not Python.
- You may consult online resources as part of your course work, but you may not copy code from online sources. If you get an idea of how to solve a problem from an online source, include a short citation at the top of your .py file.

Academic Integrity Policy

The Academic Integrity Policy articulates Northeastern's expectations of students and faculty in establishing and maintaining the highest standards in academic work.
See https://osccr.sites.northeastern.edu/academic-integrity-policy/ for more information on the Academic Integrity Policy.

Course Schedule

Week 1	Monday 09/01/2025 No class: Labor Day	Wednesday 09/03/2025 Lecture 1: Intro to Generative Learning and Review of Neural Networks
Week 2	Monday 09/08/2025 Lecture 2: Representation of Words HW1 released	Wednesday 09/10/2025 Lecture 3: Recurrent Neural Networks (RNNs)
Week 3	Monday 09/15/2025 Lecture 4: Recurrent Neural Networks (RNNs) HW1 due, HW2 released	Wednesday 09/17/2025 Lecture 5: Long Short-Term Memory (LSTMs)
Week 4	Monday 09/22/2025 Lecture 6: Long Short-Term Memory (LSTMs) HW2 due, HW3 released	Wednesday 09/24/2025 Lecture 7: Attention
Week 5	Monday 09/29/2025 Lecture 8: Attention HW3 due, Project Proposal released	Wednesday 10/01/2025 Lecture 9: Transformers
Week 6	Monday 10/06/2025 Lecture 10: Transformers	Wednesday 10/08/2025 Lecture 11: Autoregressive Models Project Proposal due, HW4 released
Week 7	Monday 10/13/2025 No class: Indigenous Peoples Day	Wednesday 10/15/2025 Lecture 12: Autoregressive Models HW4 due, HW5 released
Week 8	Monday 10/20/2025 Lecture 13: Variational Autoencoder (VAE)	Wednesday 10/22/2025 Lecture 14: Variational Autoencoder (VAE) HW5 due, Project Progress Report released
Week 9	Monday 10/27/2025 Lecture 15: Variational Autoencoder (VAE)	Wednesday 10/29/2025 Lecture 16: Generative Adversarial Networks (GANs)

Week 10	Monday 11/03/2025 Lecture 17: Generative Adversarial Networks (GANs)	Wednesday 11/05/2025 Lecture 18: GANs Project Progress Report due
Week 11	Monday 11/10/2025 Lecture 19: Diffusion Models	Wednesday 11/12/2025 Quiz
Week 12	Monday 11/17/2025 Lecture 20: Diffusion Models HW6 and Project Final Report released	Wednesday 11/19/2025 Lecture 21: Diffusion Models
Week 13	Monday 11/24/2025 Lecture 21: Interpretability HW6 due, HW7 released	Wednesday 11/26/2025 No class: Fall break
Week 14	Monday 12/01/2025 Lecture 22: Project Presentations	Wednesday 12/03/2025 Lecture 23: Project Presentations HW7 due
Week 15	Monday 12/08/2025 No class (Finals week)	Wednesday 12/10/2025 No class (Finals week) Project Final Report due