Georgia Institute of Technology

Course Syllabus: CS7643 Deep Learning

Fall 2026

Delivery: 100% Web-Based on Canvas, with submissions on Canvas/Gradescope

Dates course will run: Aug 24th, 2026 – Dec 17th, 2026

Instructor Information

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General Course Information

Description

Deep learning is a sub-field of machine learning that focuses on learning complex, hierarchical feature representations from raw data. The dominant method for achieving this, artificial neural networks, has revolutionized the processing of data (e.g. images, videos, text, and audio) as well as decision-making tasks (e.g. game-playing). Its success has enabled a tremendous amount of practical commercial applications and has had a significant impact on society.

In this course, students will learn the fundamental principles, underlying mathematics, and implementation details of deep learning. This includes the concepts and methods used to optimize these highly parameterized models (gradient descent and backpropagation, and more generally computation graphs), the modules that make them up (linear, convolution, and pooling layers, activation functions, etc.), and common neural network architectures (convolutional neural networks, recurrent neural networks, etc.). Applications ranging from computer vision to natural language processing and decision-making (reinforcement learning) will be demonstrated. Through in-depth programming assignments, students will learn how to implement these fundamental building blocks as well as how to put them together using a popular deep learning library, PyTorch. In the final project, students will apply what they have learned to real-world scenarios by exploring these concepts with a problem that they are passionate about.

Pre- &/or Co-Requisites

Students must have a strong mathematical background (linear algebra, calculus especially taking partial derivatives, and probabilities & statistics) and at least an introductory course in Machine Learning (e.g. equivalent to CS 7641). This is not a soft requirement: This should **NOT** be your first ML class, and self-study (e.g. online Coursera/Udacity courses) do not count. While you may be able to do OK on some parts of the class, other parts such as quizzes will be difficult to do if you do not have any background in ML. **Strong** programming skills (specifically Python) are necessary to complete the assignments.

Course Objectives

- Describe the major differences between deep learning and other types of machine learning algorithms.

- Explain the fundamental methods involved in deep learning, including the underlying optimization concepts (gradient descent and backpropagation), typical modules they consist of, and how they can be combined to solve real-world problems.
- Differentiate between the major types of neural network architectures (multi-layered perceptrons, convolutional neural networks, recurrent neural networks, etc.) and what types of problems each is appropriate for.
- Select or design neural network architectures for new data problems based on their requirements and problem characteristics and analyze their performance.
- Describe some of the latest research being conducted in the field and open problems that are yet to be solved.

Course Materials

Course Text

Deep Learning - Foundations and Concepts, by Christopher M. Bishop and Hugh Bishop. Full text available for download here.https://www.bishopbook.com/

Additional Materials/Resources

All additional reading materials will be available via PDF on Canvas.

Course Website and Other Classroom Management Tools

All course materials and videos are located on Canvas.

Technology Requirements and Skills

We will use several technology platforms to help facilitate the course. UNIX-like OS experience is recommended as well as some familiarity with using and setting up cloud virtual environments.

Computer Hardware and Software

1. High-speed, reliable Internet connection
2. Laptop or desktop computer with a minimum of a 2 GHz processor and 8 GB of RAM
3. Assignments can be completed on Windows/Linux/Mac — a CUDA compatible GPU is helpful but not necessary
4. Quizzes use Honorlock desktop which is only supported on Windows and Mac
5. Complete Microsoft Office Suite or comparable and ability to use Adobe PDF software (install, download, open and convert)
6. Mozilla Firefox, Chrome browser, and/or Safari browsers (Chrome required for on-boarding quiz)

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Canvas

This class will use Canvas to deliver course materials to online students. ALL course materials and quiz assessments will take place on this platform.

Gradescope

This class will use Gradescope to handle all assignment and project submissions.

Ed

This class will use Ed Discussion to handle all questions, announcements, and discussions. Additionally, Ed provides access to all lesson modules videos and related materials.

PACE

This class may include access to PACE computing services. PACE provides access to virtual environments to work on assignments and the project. You can request environments with specific compute and GPU requirements (depending on availability).

Assignments & Grading

Assignment Distribution

Assignments	Weight
On-Boarding Quiz	(Required to verify identity using proctoring software)
Pre-requisites problem set (PS0) and Quiz 0	1.00%
Assignments (4)	54.00%
Quizzes (equally weighted)	25%
Final Project (including proposal)	20%
Ed Participation Bonus	1% extra credit for top 3 endorsed posters

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Grading Scale

Your final grade will be assigned as a letter grade, with ***at least*** the following grades (i.e., 90 or greater will definitely be an A).

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

Assignment Due Dates

All assignments are due at **08:00:00 AM Eastern Time (ET)** on the day the assignment is due, unless otherwise noted. If you are located outside of ET, Canvas will display the due dates in your local time (which can be changed by editing your personal Canvas settings). We will not accept assignments submitted late due to time zone issues, so do verify your desired settings as there are no exceptions.

Every homework deliverable and project deliverable will have a 48-hour **grace period** during which no penalty will apply. This is intended to allow you time to verify that your submission has been submitted (we recommend you re-download it and look it over to make sure all questions/deliverables have been answered). Canvas will show your submission as late, but you do not have to ask for this grace period. **Deliverables after the grace period will receive a grade of 0.**

There is no grace period for taking quizzes and no make-up work for missed assignments. For documented medical or personal emergencies, see *Medical and Emergency Accommodations* under Student Support.

Project

The project is a group assignment comprising 2-4 members (instructor permission is required for other group arrangements; strong justification will be needed for approval). The class project is meant for students to (1) gain experience implementing deep models and (2) try Deep Learning on problems that interest them. The amount of effort should be at the level of one homework assignment per group member. The deliverables of the final project are:

1. A self-contained report of your project containing links to
2. A GaTech github repository containing your work. The repository should be set to private until one week until the submission deadline. After that, it should be set to public for grading purposes.
3. **Project Video Submission.** Each team must submit a short video (8–10 minutes max) in which you talk through your approach and walk through your code, showing that you genuinely did the work and understand it — including how you tested it and what your results show. It's graded alongside your report and code, not in place of them. Production quality doesn't matter; being able to speak to your project does.

Your final write-up will be structured like a paper from a computer vision conference (CVPR, ECCV, ICCV, etc.). We will release this template as well as rubric. The final PDF should completely address all the points in the rubric that will be released.

Academic Integrity

Plagiarism & Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. All students enrolled at Georgia Tech, and all its campuses, are to perform their academic work according to standards set by faculty members, departments, schools and colleges of the university; and cheating and plagiarism constitute fraudulent misrepresentation for which no credit can be given and for which appropriate sanctions are warranted and will be applied. For information on Georgia Tech's Academic Honor Code, please visit http://www.catalog.gatech.edu/policies/honor-code/ or http://www.catalog.gatech.edu/rules/18/.

You are encouraged to discuss problems and papers with others as long as this does not involve the copying of code or solutions. After discussions, all materials that are part of a submission should be wholly your own. Any public material that you use to gain an understanding of the materials (open-source software, help from a textbook, or substantial help from a friend, etc.) should be acknowledged explicitly in anything you submit to us. To re-emphasize, no matter what the source *you cannot copy any existing code*, from other students, online, or otherwise, and all code must be wholly your own code that you wrote by yourself. Additionally, you **CANNOT** submit any AI-assisted (e.g. based on large language models such as Github Copilot) text or coding responses in part or whole; again, every piece of text or code you submit must be wholly your own. If you have any doubts about whether something is legal or not, please do check with the class Instructor or the TA.

We will actively check for cheating, and any act of dishonesty will result in a Fail grade. Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

AI Collaboration

We will use the AI-based assistance policy developed by David Joyner. We treat AI-based assistance, such as ChatGPT and Copilot, the same way we treat collaboration with other people: you are welcome to talk about your ideas and work with other people, both inside and outside the class, as well as with AI-based assistants.

However, all work you submit must be your own. You should never include anything that was not written directly by you. If referencing materials, include proper citation including quotation marks and in-line citation for direct quotes. Lack of proper citation will be treated as a case of academic misconduct.

If you are unsure where the line is between collaborating with AI and copying from AI, we recommend the following heuristics:

Heuristic 1: Never hit "Copy" within your conversation with an AI assistant. You can copy your own work into your conversation, but do not copy anything from the conversation back into your assignment.

Instead, use your interaction with the AI assistant as a learning experience, then let your assignment reflect your improved understanding.

Heuristic 2: Do not have your assignment and the AI agent open at the same time. Similar to above, use your conversation with the AI as a learning experience, then close the interaction down, open your assignment, and let your assignment reflect your revised knowledge.

This heuristic includes avoiding using AI directly integrated into your composition environment: just as you should not let a classmate write content or code directly into your submission, so also you should avoid using tools that directly add content to your submission.

Deviating from these heuristics does not automatically qualify as academic misconduct; however, following these heuristics essentially guarantees your collaboration will not cross the line into misconduct.

Proctoring Information

To verify the identity of all GT online students, all online students are *required* to complete the on-boarding quiz that uses Honorlock. Honorlock is utilized for student identity verification and to ensure academic integrity. Honorlock provides student identity verification via facial and ID photos. You may also be asked to scan the room around you. The on-boarding quiz will be a practice quiz that will not affect your grade in the course. You can take the on-boarding quiz as many times as you want. All potential violations are reviewed by a human. The Honorlock support team is available 24/7. While Honorlock will not require you to create an account or schedule an appointment in advance, you will need Google Chrome, the Honorlock Chrome Extension, and the Honorlock desktop application.

Student Support

Medical and Emergency Accommodations

Students who experience documented medical or personal emergencies may request accommodations through the **Dean of Students Office** (404.894.2565 or https://studentlife.gatech.edu/services/academic-financial-personal-assistance) or the **Office of Disability Services** (404.894.2563 or http://disabilityservices.gatech.edu/). With a recommendation from one of these offices, the course may allow up to 7 days beyond the original deadline to complete any assessment (quiz or assignment).

Accommodation requests may be made retroactively if the student was incapacitated and unable to request in advance. However, no assessment may be completed more than 7 days after its original deadline, regardless of reason. Students who are unable to complete coursework within this window should consider an Incomplete (or Withdrawal, if applicable) through the Dean of Students Office. Students may be permitted to submit provisionally while documentation is pending. If an accommodation letter is not received by the end of the term, the assessment will receive a 0, or the grade of the student's last valid on-time submission if one exists.

Important: To protect your privacy, do not send personal or medical information directly to course staff. All accommodation requests must go through the Dean of Students Office or the Office of Disability Services.

Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at 404.894.2563 or http://disabilityservices.gatech.edu/, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible to set up a time to discuss your learning needs.

Mental Health Resources and Support Services

Campus Resources

Georgia Tech Police Department
Emergency: Call 911 | 404-894-2500

Dean of Students Office
404-894-2565 | studentlife.gatech.edu
Afterhours Assistance Line & Dean on Call: 404-894-2204

Center for Assessment, Referral and Education (CARE)
404-894-3498 | care.gatech.edu

Collegiate Recovery Program
404-894-2575 | counseling.gatech.edu

Counseling Center
404-894-2575 | counseling.gatech.edu

Health Initiatives
404-894-9980
healthinitiatives.gatech.edu

LGBTQIA Resource Center
404-385-4780 | lgtbqia.gatech.edu

Stamps Psychiatry Center
404-894-1420

VOICE
404-385-4464 | 404-385-4451
24/7 Info Line: 404-894-9000 | voice.gatech.edu

Women's Resource Center
404-385-0230 | womenscenter.gatech.edu

Veterans Resource Center
404-894-4953 | veterans.gatech.edu

Community Resources

Georgia Crisis and Access Line
1-800-715-4225
The crisis line is staffed with professional social workers and counselors 24 hours per day, every day, to assist those with urgent and emergency needs.

Trevor Project
1-866-488-7386
Trained counselors are available to support anyone in need.

National Suicide Prevention Hotline
1-800-273-8255
A national network of local crisis centers that provides free and confidential emotional support to people in suicidal crisis or emotional distress 24/7.

Georgia State Psychology Clinic
404-413-2500
The clinic offers high quality and affordable psychological services to adults, children, adolescents, families and couples from the greater Atlanta area.

Communication and Conduct

Communication Policy

You are responsible for knowing the following information:

1. Anything posted to this syllabus
2. Anything emailed directly to you by the teaching team (including announcements via Ed Discussion), 24 hours after receiving such an email or post.

Because Ed announcements are emailed to you as well, you need only to check your Georgia Tech email once every 24 hours to remain up to date on new information during the semester. Georgia Tech generally recommends students check their Georgia Tech email once every 24 hours. So, if an announcement or message is time sensitive, you will not be responsible for the contents of the announcement until 24 hours after it has been sent.

University Use of Electronic Email

A university-assigned student e-mail account is the official university means of communication with all students at Georgia Institute of Technology. Students are responsible for all information sent to them via their university-assigned e-mail account. If a student chooses to forward information in their university e-mail account, the student is responsible for all information, including attachments, sent to any other e-mail account. To stay current with university information, students are expected to check their official university e-mail account and other electronic communications on a frequent and consistent basis. Recognizing that some communications may be time-critical, the university recommends that electronic communications be checked minimally twice a week.

Online Student Conduct and (N)etiquette

Communicating appropriately in the online classroom can be challenging. All communication, whether by email, Ed, Canvas, or otherwise, must be professional and respectful. In order to minimize this challenge, it is important to remember several points of **"internet etiquette"** that will smooth communication for both students and instructors.

1. *Read first, Write later*. Read the ENTIRE set of posts/comments on a discussion board before posting your reply, to prevent repeating commentary or asking questions that have already been answered.
2. *Avoid language that may come across as strong or offensive.* Language can be easily misinterpreted in written electronic communication. Review email and discussion board posts BEFORE submitting. Humor and sarcasm may be easily misinterpreted by your reader(s). Try to be as matter of fact and as professional as possible.
3. *Follow the language rules of the Internet.* Do not write using all capital letters, because it will appear as shouting. Also, the use of emoticons can be helpful when used to convey nonverbal feelings. 😊
4. *Consider the privacy of others.* Ask permission prior to giving out a classmate's email address or other information.
5. *Keep attachments small*. If it is necessary to send pictures, change the size to an acceptable 250kb or less (one free, web-based tool to try is picresize.com).

6. *No inappropriate material.* Do not forward virus warnings, chain letters, jokes, etc. to classmates or instructors. The sharing of pornographic material is forbidden.

NOTE: *The instructor reserves the right to remove posts that are not collegial in nature and/or do not meet the Online Student Conduct and Etiquette guidelines listed above.*

Student-Faculty Expectations Agreement

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22/ for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Subject to Change Statement

The syllabus and course schedule may be subject to change. Changes will be communicated via the Canvas announcement tool. It is the responsibility of students to check Ed Discussions, email messages, and course announcements to stay current in their online courses.

Course Schedule

Week/Dates	Modules/Lessons	Deliverables
1 **Aug 24th**	Module 1: Introduction to Neural Networks Go through Welcome/Getting Started Lesson 1: Linear Classifiers and Gradient Descent Readings: • Ch 1 Deep Learning Revolution • Ch 2 Probabilities • Ch 3 Standard Distributions • Ch 4 Single-layer Networks: Regression • Ch 5 Single-layer Networks: Classification (skip §5.2.5, 5.2.6) • Ch 7 Gradient Descent, §7.1-2 Error Surface and Optimization • Appendix A Linear Algebra. • **LeCun et al., Nature '15** • Shannon, 1956	Quiz #0: Course pre-requisites and policies **Due Aug 31st 8:00 AM ET** (**NO GRACE PERIOD**) Pre-req Problem set (PS0) **Aug 31st 8:00 AM ET** (**NO GRACE PERIOD**)
2 **Aug 31st**	Lesson 2: Neural Networks Readings: • Ch 6 Deep Neural Networks • Ch 8 Backpropagation • Matrix calculus for deep learning • Automatic Differentiation Survey, Baydin et al.	Quiz #1: Linear Classifiers and Gradient Descent (Lesson 1) and Neural Networks (Lesson 2) **Due Sept 7th 8:00 AM ET (NO GRACE PERIOD)**
3 **Sept 7th**	Lesson 3: Optimization of Deep Neural Networks Readings: • §5.2.5, 5.2.6 Classifier Accuracy and ROC Curve • §7.3-4 Convergence and Normalization • Ch 9 Regularization	Assignment 1 **Due Sept 14th 8:00 AM ET (grace period until Sept 16th)**
4 **Sept 14th**	Module 2: Convolutional Neural Networks (OPTIONAL) Lesson 4: Data Wrangling Lesson 5: Convolution and Pooling Layers Readings: • Preprocessing for deep learning: from covariance matrix to image whitening • cs231n on preprocessing	Quiz #2: Optimization of Deep Neural Networks (Lesson 3), and Convolution and Pooling Layers (Lesson 5) **Due Sept 21st 8:00 AM ET (NO GRACE PERIOD)**

Week/Dates	Modules/Lessons	Deliverables
	• Ch 10 Convolutional Networks, §10.1-2 Computer Vision and Convolutional Filters • **Optional:** Khetarpal, Khimya, et al. Re-evaluate: Reproducibility in evaluating reinforcement learning algorithms." (2018). See related blog post	
5 **Sept 21st**	Lesson 6: Convolutional Neural Network Architectures Readings: • §10.2.8 Example network architectures	
6 **Sept 28th**	Lesson 7: Visualization Lesson 8: Advanced Computer Vision Architectures Readings: • Understanding Neural Networks Through Deep Visualization • Grad-CAM: Visual Explanations from Deep Networks via Gradient-based Localization • Fully Convolutional Networks for Semantic Segmentation • §10.3-6 Visualizing CNNs, Object Detection, and Image Segmentation	Assignment 2 due **Oct 5th 8:00 AM ET (grace period until Oct 7th)**
7 **Oct 5th**	Module 3: Structured Neural Representations Lesson 9: Introduction to Structured Representations Lesson 10: Language Models Readings: • Ch 11 Structured Distribution • Ch 12 Transformers, §12.2.4-6 Autoregressive Models, RNNs, BPTT	Quiz #3: Convolutional Neural Network Architectures (Lesson 6), Visualization (Lesson 7), Advanced Computer Vision Architectures (Lesson 8) **Due Oct 12th 8:00 AM ET (NO GRACE PERIOD)**

Week/Dates	Modules/Lessons	Deliverables
8 **Oct 12th**	Lesson 11: Neural Attention Models Readings: • Attention is all you need • BERT Paper • The Illustrated Transformer • §12.1 Attention • §12.3 Transformer Language Models	
9 **Oct 19th**	Lesson 12: Neural Machine Translation Module 4: Advanced Topics Lesson 13: Generative Models Readings: • Tutorial on Variational Autoencoder • NIPS 2016 Tutorial: Generative Adversarial Networks • Ch 16 Continuous Latent Variables, §16.3 Evidence Lower Bound • §16.4.4 Four Approaches to Generative Modeling • Ch 17 Generative Adversarial Networks • Ch 19 Autoencoders, §19.2 Variational Autoencoders • Ch 20 Diffusion Models	Assignment 3 **Due Oct 26th 8:00 AM ET (grace period until Mar 28th)**
10 **Oct 26th**	• Lesson 14: Embeddings Readings: • word2vec tutorial • word2vec paper • StarSpace paper • §12.2.1 – 12.2.3 Embeddings, Tokenization, and Bag of Words • Ch 13 Graph Neural Networks	(**Oct 31st Withdrawal Deadline**) Project Proposal **Due Nov 2nd 8:00 AM ET** (**grace period until Nov 4th**)
11 **Nov 2nd**	Lesson 15: PyTorch and Scalable Training Lesson 16: Bias and Fairness Readings: None	Quiz #4: Module 3 **Due Nov 9th 8:00 AM ET (NO GRACE PERIOD)**

Week/Dates	Modules/Lessons	Deliverables
12 **Nov 9th**	Lesson 17: Deep Reinforcement Learning Readings: • MDP Notes (courtesy Byron Boots) • Notes on Q-learning (courtesy Byron Boots) • Policy iteration notes (courtesy Byron Boots) • Policy gradient notes (courtesy Byron Boots) • Murphy, RL: An Overview (arXiv 2412.05265v5): §2.5 Q-learning: off-policy TD; §3.1 Policy gradient methods; §3.2 Actor-critic methods; §3.3 Policy improvement methods	Assignment 4 **Due Nov 16rd 8:00 AM ET (grace period until Nov 18th)**
13 **Nov 16th**	Lesson 18: Unsupervised and Semi-Supervised Learning Readings: • Ch 15 Discrete Latent Variables • §16.1 PCA • §16.4; §16.4.1-4.4.3 Nonlinear Latent Variables • §19.1 Deterministic Autoencoders	Quiz #5: Module 4 **Due Nov 23rd 8:00 AM ET (NO GRACE PERIOD)**
14 **Nov 23rd**	Lesson 19: Translation at Facebook and Automated Speech Recognition (ASR) Readings: • §12.4.3 Audio data • §12.4.4 Text-to-speech	
15 **Nov 30th**	Wrap-Up	Final Project Due **Dec 14th 8:00 AM ET** (**grace period until Dec 16th**)