STAT 6289.10 - Statistical Deep Learning (Fall 2023)

Course and Contact Information

- **Course:** Statistical Deep Learning, STAT 6289.10
- **Semester:** Fall 2023
- **Meeting Time:** Monday 12:45 PM - 03:15 PM
- **Location:** 725 23rd Street NW, Tompkins Hall, Room 204

Instructor

- **Name**: Fang Jin
- **Email**: fangjin@gwu.edu
- **Instructor Office Hours**: Monday: 11:00 AM – 12:00 PM
- **Office Location:** Rome Hall 769

Course Description

This course will introduce deep learning models with applications to a broad of topics in computer vision, specially focus on image classification, natural language processing, and sequence data prediction. We will introduce the architecture of deep neutral networks and algorithms. Besides the theoretical foundation of neural networks, including backpropagation and stochastic gradient descent, students also get hands-on experience building deep neural network models with Python. We will demo how to use PyTorch to develop neural networks from scratch. Students will learn how to build a variety of deep neural networks, such as convolutional neural network (CNN), recurrent neural network (RNN), Reinforcement learning (RL), long short-term memory (LSTM), NLP and Word Embeddings, and generative adversarial network (GANs). At the end of this course, students will gain foundational knowledge of deep learning algorithms and get practical experience to train and build a variety of sophisticated neural networks.

Course Expectations:

STAT 6201 Mathematical Statistics I

Software requirement: familiar with Python

Learning Outcomes

As a result of completing this course, students will be able to:

1. Apply existing deep neural networks, implement neural networks, identify architecture parameters, and apply DL to some classical applications
2. Build and train deep learning methods to solve classical deep learning problems, for example, develop a Convolutional Neural Network for visual detection and recognition tasks, develop a word embedding model to process natural language processing, develop and tune a deep reinforcement learning model.
3. Design test sets and analyze bias/variance for building deep learning applications, design optimization algorithms to improve neural networks efficiency.

Required Textbooks, Materials and Recommended Readings

Suggested References

- Deep Learning with Python, by François Chollet
  http://faculty.neu.edu.cn/yury/AAI/Textbook/Deep%20Learning%20with%20Python.pdf
- Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, by Aurélien Géron,
  https://www.lpsm.paris/pageperso/has/source/Hand-on-ML.pdf
- Deep Learning, by Aaron Courville, Ian Goodfellow, and Yoshua Bengio https://github.com/janishar/mit-deep-learning-book-pdf
- Deep Learning with Pytorch, by Eli Stevens, Luca Antiga, Thomas Viehmann

Course Schedule: The table (below) provides the initial distribution of topics discussed over the weeks in the semester. **This schedule is tentative and subject to change**. All changes will be announced in class or on the course website (Blackboard). Students are responsible for making sure they are informed about announcements.

Week	Date	HW Release	Content
1	8.28	HW0 (setup environment)	Introduction, Deep learning overview
2	9.4 (Labor Day)		No class
3	9.11		Neural Networks, Regularization, Optimization
4	9.18	HW1	Backpropagation, Training,
5	9.25	HW1 presentation	Convolutional Neural Networks,
6	10.2		CNN
7	10.9	HW2	DNN training details
8	10.16	HW2 presentation	RNN, LSTM
9	10.23		Deep Reinforcement Learning
10	10.30		Midterm project presentation
11	11.6	HW 3	Generative Adversarial Networks
12	11.13	HW3 presentation	Text Analysis, Natural Language Processing
13	11.20 (Thanksgiving)		No class
14	11.27	HW 4	NLP, word embedding
15	12.4	HW4 presentation	Large Language Model, ChatGPT
16	12.11		Final Project Presentation

Grading

- **Pop up Quiz** (20%): Quiz will be released on the class. Will release 4 quizzes. If missed any quiz, no make-up opportunities, unless asked for leave ahead of time. Each quiz accounts for 5%.
- **Homework** (40%): Individual homework. We will release 4 assignments. Each homework account 10%, due **before class**, unless noted otherwise. Late homework will deduct by 20% per day.
- **Homework Presentation** (5%): When the homework due, 5 students will be volunteered to present their homework solutions to the class, or randomly selected. No homework presentation will not get this credit. Each student expected to present one of the homework.

✧ **Midterm Project** (10%)**:**

Students have the freedom to choose one of the following options:

- Design your own midterm project (10%): You can choose your own dataset, decide your method, and implement it. Present your project design and results in the class.
- Demo other's project (10%): students can select an interesting project from other's work, implement yourself, understand how each step works, and demo the whole project in the class.

✧ **Final Project** (25%): You will form teams of 2 to finish a project, the content will be decided later. Individual teams are accepted. You will present your final project on the last day of class. You will be graded on your approach, methods, and the quality of your presentation.

✧ Students are expected to spend 6 hours per week outside of classroom.

Homework	40%	Homework assignments, individual work. Will release 4 homework
Pop up Quiz	20%	4 quizzes will be released on the class.
Midterm Project	10%	Individual work, will release on the class.
Homework Presentation	5%	Each student can choose to present one of their homework once.
Final project	25%	Team work, form 2-member team, will release in the class.

Grading Distribution

✧ The usual grading scale will be used. This scale may be curved to raise student grades at the instructor's discretion.

[94, 100] A

[90, 94) A-

(87, 90) B+

[83, 87] B

[80, 83) B-

(77, 80) C+

[73, 77] C

[70, 73) C-

(67, 70) D+

[63, 67] D

[60, 63) D-

<60 F

Class Design

The class time will be divided into lecture session and lab session.

- ✧ First two hours will be lecture session.
- ✧ The last half an hour will be lab session. The purpose is to get familiar with python programming and deep learning design/implementation.

Useful materials

- Computation Resource. Kaggle.com and Google Colab (https://colab.research.google.com/) offer free CPU/GPU, which is fairly enough for the course projects.
- Dataset search. Google Dataset Search (https://datasetsearch.research.google.com/) is a popular API.
- GitHub projects. For more materials about deep learning, search GitHub with keywords "awesome" + "field" is a good choice. For instance, "awesome deep learning" (*https://github.com/ChristosChristofidis/awesome-deep-learning*), "awesome reinforcement learning" (*https://github.com/aikorea/awesome-rl*).
- Some interesting projects, for example, https://data-flair.training/blogs/deep-learning-project-ideas/

- ✧ We will be mainly using Blackboard to release assignments, announcements, and material passed to the class during the week. Please check Blackboard frequently. You can find it at blackboard.gwu.edu.

University policies

Academic Integrity Code

Academic integrity is an essential part of the educational process, and all members of the GW community take these matters very seriously. As the instructor of record for this course, my role is to provide clear expectations and uphold them in all assessments. Violations of academic integrity occur when students fail to cite research sources properly, engage in unauthorized collaboration, falsify data, and otherwise violate the Code of Academic Integrity. If you have any questions about whether or not particular academic practices or resources are permitted, you should ask me for clarification. If you are reported for an academic integrity violation, you should contact the Office of Student Rights and Responsibilities (SRR) to learn more about your rights and options in the process. Consequences can range from failure of assignment to expulsion from the university and may include a transcript notation. For more information, please refer to the SRR website (https://studentconduct.gwu.edu/academic-integrity), email rights@gwu.edu, or call 202-994-6757.

University policy on observance of religious holidays

Students must notify faculty during the first week of the semester in which they are enrolled in the course, or as early as possible, but no later than three weeks prior to the absence, of their intention to be absent from class on their day(s) of religious observance. If the holiday falls within the first three weeks of class, the student must inform faculty in the first week of the semester. For details and policy, see “Religious Holidays” at provost.gwu.edu/policies-procedures-and-guidelines.

Use of Electronic Course Materials and Class Recordings

Students are encouraged to use electronic course materials, including recorded class sessions, for private personal use in connection with their academic program of study. Electronic course materials and recorded class sessions should not be shared or used for non-course related purposes unless express permission has been granted by the instructor. Students who impermissibly share any electronic course materials are subject to discipline under the Student Code of Conduct. Please contact the instructor if you have questions regarding what constitutes permissible or impermissible use of electronic course materials and/or recorded class sessions. Please contact Disability Support Services at disabilitysupport.gwu.edu if you have questions or need assistance in accessing electronic course materials.

Academic support

Writing Center

GW's Writing Center cultivates confident writers in the University community by facilitating collaborative, critical, and inclusive conversations at all stages of the writing process. Working alongside peer mentors, writers develop strategies to write independently in academic and public settings. Appointments can be booked online at gwu.mywconline.

Academic Commons

Academic Commons provides tutoring and other academic support resources to students in many courses. Students can schedule virtual one-on-one appointments or attend virtual drop-in sessions. Students may schedule an appointment, review the tutoring schedule, access other academic support resources, or obtain assistance at academiccommons.gwu.edu.

Support for students outside the classroom

Disability Support Services (DSS) 202-994-8250

Any student who may need an accommodation based on the potential impact of a disability should contact Disability Support Services at disabilitysupport.gwu.edu to establish eligibility and to coordinate reasonable accommodations..

Counseling and Psychological Services 202-994-5300

GW's Colonial Health Center offers counseling and psychological services, supporting mental health and personal development by collaborating directly with students to overcome challenges and difficulties that may interfere with academic, emotional, and personal success. healthcenter.gwu.edu/counseling-and-psychological-services.

Safety and Security

- In an emergency: call GWPD 202-994-6111 or 911
- For situation-specific actions: review the Emergency Response Handbook at: safety.gwu.edu/emergency-response-handbook
- In an active violence situation: Get Out, Hide Out, or Take Out. See go.gwu.edu/shooterpret

Stay informed: safety.gwu.edu/stay-informed