Syllabus - DS683 Graph Neural Networks
Fall 2025

Code: DS 683
Time: Friday, 2:30PM – 5:20PM
Location: CULM111
Mode: Face-to-Face

Instructor: Mengjia Xu
Office: GITC 2116
Email: mx6@njit.edu
Office Hours: Mon (1:45pm-3:10pm), Thu (12:15pm-12:55pm, Webex). If these hours do not work with your schedule, appointments are also available by email.

Teaching Assistant/Grader: TBD

Note: Your messages will be answered by the end of the next day. Grades for all items will be posted during the week after their due date. For issues with your grades, contact the grader and cc the instructor.

Tutoring: NJIT provides a tutoring service. Please contact one of the available tutors. Please check the website for updates regularly as they may change the information.

Course Description

Graphs provide a natural framework for representing complex relationships between various objects. Graph Neural Networks (GNNs) have gained significant importance in both academic research and industrial applications. This course introduces GNNs and explores foundational concepts, algorithms, and diverse applications. Students will learn the fundamentals of graph theory, and key models, e.g., Graph Convolutional Networks (GCNs), Graph Attention Networks (GATs), advanced graph diffusion models, and integrations of GNNs with sequential models for temporal graph modeling. The course will cover practical applications across fields like social networks, bioinformatics, and finance, focusing on hands-on implementation and problem-solving. By the end, students will be skilled in designing and applying GNN models to real-world datasets.

Prerequisites

DS675

Course Textbooks

There is no required course textbook. The course will draw material from several sources, including

the instructor's own notes. Some optional resources include:

- [B1] Graph Representation Learning by William L. Hamilton.
- [B2] Geometric Deep Learning Grids, Groups, Graphs, Geodesics, and Gauges by Michael M.Bronstein, Joan Bruna, Taco Cohen, Petar Veličković.
- [B3] Network Science by Albert-László Barabási.
- (Optional) Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg.

Learning Outcomes

By the end of the course, you will be able to:

- Learn how to model structured data with graphs.
- Understand fundamental graph theory, and prevalent graph neural network architectures.
- Design and implement various GNN architectures.
- Apply GNNs to solve problems in domains such as social networks, biology, chemistry, and recommendation systems.
- Evaluate and optimize GNN models for performance and scalability.
- Stay updated with the latest research and advancements in GNNs.

Grading Policy

The grading policy is designed to reflect the NJIT Grading Legend.

Final grades for all assignments will be based on the following percentages:

Quizzes **(Short Quizzes - 10% - Midterm Exam 15%)**	**25%**
Class participation	**10%**
Homeworks	**30%**
Projects **Milestone-1 (10%), Milestone-2 (5%), Milestone 3 (20%)**	**35%**

Letter to Number Grade Conversions

Raw numerical scores will be converted to letter grades using the following bounds.

A	B+	B	C+	C	F
≥93	≥85	≥70	≥60	≥50	<50

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Course Work

Quizzes (10% of grade): Weekly Canvas quizzes reinforcing the material of each module, will help you keep up with the most important theoretical concepts. These quizzes are not proctored.
Class Participation (10% of grade): You are expected to attend classes and participate in classes by listening and understanding class contents and asking related questions. You are also expected to participate in weekly Canvas discussions prompted by the instructor, with meaningful questions and responses related to the week's topics or assignments.
Homeworks (30% of grade): Assignments will be given every two weeks to provide an opportunity to apply course concepts throughout the learning period. Five homework assignments of equal grading weight.
Mid-term Exam (15% of grade): In-person exam, 90 minutes. Students are expected to bring a fully charged laptop, as the exam will be on Canvas with LockDown browser. Each student is allowed to bring at most 5 pages of notes. In the event the exam has to take place online, Respondus Monitor will be used for proctoring.
Project (35% of grade): The project will consist of three milestones, with weights 10%, 5%, and 20%. You will have opportunities to iterate and revise your work based on peer, TA, and instructor's feedback.

Course Topic Schedule (Tentative)

The topics covered in this course include the following, presented in the approximate order in which they will be taught. This list of topics is to be considered as a *reference* that can be adjusted through the course of the semester to address changing needs.

Week	Date	Topic	Readings	Due Work
Week 1	Fri 9/5	Introduction and Course Overview	[B1] Ch 1 [B2] Ch 1 [B3] Ch 1	
Week 2	Fri 9/12	Basics of Graph Theory	[B1] Ch 2 [B2] Ch 2	Hwk 1 out
Week 3	Fri 9/19	Graph Embedding with Shallow Neural Networks	[B1] Ch3	project initiation
Week 4	Fri 9/26	Basics of Graph Neural Networks (Spectral vs Spatial methods)	[B1] Ch5	Hwk 1 due Hwk 2 out
Week 5	Fri 10/3	Overview of GNN architectures (GCNs, GATs, MPNNs, GraphSAGE, GINE, etc.)	[B1] Ch5	
Week 6	Fri 10/10	Theory of GNNs	[B1] Ch7	Hwk 2 due Hwk 3 out
Week 7	Fri 10/17	Integrate GNNs with LLMs	Papers	project milestone #1
Week 8	Fri 10/24	***Midterm Exam***		Summary quiz
Week 9	Fri 10/31	Hyperbolic GNNs in Riemannian Manifolds	Papers	Hwk 3 due Hwk 4 out project milestone #2
Week 10	Fri 11/7	Knowledge Graph Reasoning	[B1] Ch 4	

Week 11	Fri 11/14	Temporal Graph Representation Learning	[B3] Ch 6	Hwk 4 due Hwk 5 out
Week 12	Fri 11/21	Advanced Topics of GNNs (e.g., Physics-Informed GNNs and Graph Neural Operators, Graph Diffusion Models)	[B1] Ch 9 papers	project milestone #3
Week 13	Wed 11/26 (Friday Class Meet)	Applications of GNNs in Diverse Domains (e.g., computer vision, NLP, biology, neuroimaging, weather forecasting, transportation.)	papers	Hwk 5 due
Week 14	Fri 12/5	Project Presentation		Project presentation

* All homeworks, quizzes (multiple-attempts), and milestones are due on Sunday, at 23:59.

Feedback

Assignment solutions will be distributed for each assignment, along with general class-level feedback from the grader. Occasionally, and when needed, you will also receive individualized comments directly on your assignment notebook. You can also always directly inquire about a specific grade item. In that case, please email both the instructor and the grader.

Policy for Late Work

In the case when a student is unable to complete an assignment or other serious reasons, these must be communicated and documented promptly. In any other case, each hour of delay after the due date will incur a 2% score reduction. No extensions will be granted. However, the lowest programming score and the two lowest quiz assignments scores for each student will be dropped.

Exam Information and Policies

This course has two proctored quizzes. These will take place in the classroom, and presence is required. The quizzes will be on the LockDown browser, so please make sure you bring your computers charged. The majority of your grade is based on authentic assessment, meaning that you will be assessed and graded on your ability to deliver real-world outputs as well as your participation and feedback to other students.

Collaboration and External Resources for Assignments

Some of the assignment problems will be quite challenging. You are advised to first try to solve all the problems on your own. For problems that persist you are welcome to talk to the instructor during office hours, or raise questions in the Weekly Discussion Forum. In consulting with others, you are allowed to exchange general ideas and approaches only: unless you are given explicit permission to do so in the assignment statement, the full solutions themselves must be worked out by you alone.

Generative AI Tools and Other External Resources

Sometimes you may come across code, text or other helpful information online, or you may be able to generate it using AI tools such as ChatGPT or other Large Language Models (LLMs). In most cases, you will be allowed to integrate this information into your solution. However, if you do, you must always give the appropriate credit and citations (e.g. links) for the material you use (especially when you use the code and text you found online). In the case you use an LLM, you must say that you did so and present the entire transcript of your "conversation" with it, which should show what you asked and how you guided it, or were guided by it to the delivered solution. Your "conversation" with it must be entirely yours, and sufficiently different from that of other students. Failure to give appropriate credit when using the work of others (whether human or AI) is considered plagiarism and may lead to disciplinary action under NJIT's Academic Integrity policy.

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Academic Integrity

"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the NJIT academic code of integrity policy.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu"

Weekly Expectations

The course is organized into modules. Each week consists of one module. Each week, the students should attend the week's lecture. The students are also expected to read the corresponding sections of the textbook, and participate in a class discussion forum as prompted by the instructor. The students must also be aware of any assignments due at the end of each week.

Additional Information and Resources

Netiquette

Throughout this course, you are expected to be courteous and respectful to classmates by being polite, and active participants. You should respond to discussion forum assignments in a timely manner so that your classmates have adequate time to respond to your posts. Please respect opinions, even those that differ from your own, and avoid using profanity or offensive language.

Accessibility

This course is offered through an accessible learning management system. For more information, please refer to Canvas's Accessibility Statement.

Requesting Accommodations The Office of Accessibility Resources and Services works in partnership with administrators, faculty, and staff to provide reasonable accommodations and support services for students with disabilities who have provided their office with medical documentation to receive services. If you are in need of accommodations due to a disability, please contact the Office of Accessibility Resources and Services to discuss your specific needs.

Resources for NJIT Online Students

NJIT is committed to student excellence. To ensure your success in this course and your program, the university offers a range of academic support centers and services. To learn more, please review these Resources for NJIT Online Students, which include information related to technical support.