**Spring 2025 COSC 750: NEURAL NETWORKS AND DEEP LEARNING**

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**Faculty:** Dr. Yifan Guo. **Email:** yguo@towson.edu. **Office:** YR 436. **Office Hours:** Th 6:30 – 7:30 pm.
**Class Hours:** Th 7:30 –10:10 pm. **Classroom:** YR-202.

**Note:** NO CLASS on Thursday March 20th (Spring Break).

**Web page**: Class information and materials will be posted on Blackboard. Visit Blackboard often for project assignments, grades, notes, last-minute announcements.

**Course Description**

This is an elective course for graduate students in computer science majors. It is a hands-on orientated course. This course covers the fundamental principles, architectures, algorithms, and applications of deep neural networks, including feedforward neural networks, backpropagation, convolutional neural networks, recurrent neural networks, LSTM, GRU, autoencoders, and generative models. Also, this course will also introduce emerging topics in deep neural networks. The assumption is that you already know the basic fundamental principles of machine learning. COSC 600 and COSC 750 are the prerequisites for the course. Students who do not meet the prerequisites MUST talk to the instructor after the first day of class.

**Recommended Reading References**

- *Deep Learning* by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, The MIT Press, 2016.
- *Deep Learning with PyTorch* by Eli Stevens, Luca Antiga, and Thomas Viehmann, Manning Publications, 1st Edition, 2020.

**Course Objectives**

At the end of the course:

- Students will be familiar with the fundamental principles, architectures, algorithms and applications of deep neural networks.
- Students will improve their ability to solve real-case problems with hands-on coding experiences.
- Students will learn the in-depth mathematical analysis of each type of deep neural networks.
- Students will know the cutting-edge research topics in deep learning.

**Grading**

Module Projects (3) 60%
- Module Project 1: Bike Sharing
- Module Project 2: Dog Recognition
- Module Project 3: TV Script Generation

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Final Project (1) 40%

Grades will be assigned as follows:

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| **A** | 90-100 | **B** | 75-79.99 | **F** | Below 60 |
| **A-** | 85-89.99 | **C** | 70-74.99 | | |
| **B+** | 80-84.99 | **D** | 60-69.99 | | |

**Towson University Repeat Policy**

Students may not repeat a course more than once without prior permission of the Academic Standards Committee.

**Course Schedule**

| Week | Topics | Project Assignments |
|---|---|---|
| **Module 1: Fundamentals of Deep Neural Networks (Week 1 - 4)** | | |
| 1 | Course Overview; Introduction to Deep Neural Networks; Introduction to PyTorch; Connection with Google Colab; | Module Project 1 Release on 1/27/2025. |
| 2 | Feedforward Neural Networks; Multiple Layer Perceptron (MLP) | |
| 3 | Empirical risk minimization; Backpropagation; Gradient Descent; Calculus of Backpropagation; | |
| 4 | Optimizers in Deep Learning; Stochastic Gradient Descent (SGD); Module Project 1 Guide; Project Demo; | |
| **Module 2: Convolutional Neural Networks (Week 5 - 7)** | | |
| 5 | Convolutional Neural Networks (CNNs); | Module Project 2 Release on 2/24/2025. Module Project 1 Due on 3/2/2025. |
| 6 | Transfer Learning; Hyper-parameters Tuning; | |
| 7 | Mathematical Perspective of CNNs; Module Project 2 Guide; Project Demo; | |
| 8 | **Spring Break** | Module Project 2 Due on 3/23/2025. |
| **Module 3: Recurrent Neural Networks (Week 9 - 11)** | | |
| 9 | Recurrent Neural Networks (RNNs); Backpropagation through time (BPTT); Brainstorms of Final Project Topics; | Module Project 3 Release on 3/24/2025 |
| 10 | Long short-term memory (LSTM); Gated Recurrent Unit (GRU); | Final Project Proposal Due on 4/6/2025. |
| 11 | Mathematical Perspective of RNNs; Module Project 3 Guide; Project Demo; | |
| **Module 4: Deep Generative Models (Week 12 - 13)** | | |
| 12 | Autoencoders; Variational Autoencoders; | Module Project 3 Due on 4/20/2025. |
| 13 | Generative Adversarial Networks; Optional Project 4 Guide; Project Demo; | Final Project Mid-term Review Due on 4/27/2025. |
| **Module 5: Emerging Topics in Deep Learning (Week 14 - 15)** | | |
| 14 | Adversarial Attacks and Adversarial Robustness of Deep Learning; | |
| 15 | Privacy and Security Issues in Federated Deep Learning; | |
| 16 | **In-class Final Projection Presentations** | Final Project Report Due on 5/18/2025. |

## Module Project Policies

- Module projects will be assigned in Module 1 - 3. There will be tentatively **3 module project assignments** throughout the semester. **The deadline for every assignment is indicated in the schedule**.
- In each module project, it is composed of three parts.
  Part A: Written Problems of This Module
  Part B: Code Implementation of This Project
  Part C: Follow-up Problems of This Project (Note: please ensure that you have finished Part B already before answering the questions in Part C.)
- The students should make all efforts to submit homework assignments on time by the deadline. All submissions are through BlackBoard. The total points of each assignment are 100. There are potentially extra bonus points in each assignment. Bonus points will help improve your final total performance. Each day of delay will be penalized with 3%.
- **Late submissions will NOT be accepted for any reason and will receive a ZERO after the solutions have been discussed in class or posted on the Blackboard.** Usually, the solution will be posted online one week after the deadline of each module project.
- Students will **work individually** on each project assignment.

## Final Project Policies

- The final project will require students to apply a deep learning technique covered during the semester to discover knowledge in a real-world dataset and to solve a real-case problem.

- The final delivery is composed of two parts.
  Part A: In-class Presentation [40%]  Part B: Final Project Report [60%]
- **To initialize the final project, students need to submit a one-page proposal by 4/6/2025**. The proposal form will be published on the Blackboard for reference. Students will receive the responses from the instructor within one week after the proposal's submission.
- **To keep track of the final project status, students need to submit a one-page mid-term review to indicate the paid efforts to the final project by 4/27/2025**. The midterm-review form will be published on the Blackboard for references. Students will receive the responses from the instructor within one week after the mid-term review's submission.
- **The in-class final project presentation is scheduled on Thursday, May 15th, 2025, 7:30 – 10:10 pm.**
- The final report should follow **the IEEE conference paper format with at least four pages**. A template of the final report will be released on Blackboard. The final report should include (but not be limited to) the following sections: Abstract, Introduction, Related Work, Main Methodology, Experiments, and Conclusion. **The final report is due on Sunday, May 18th, 2025, 11:59 pm**.
- **It is forbidden that the final report the student submit in this course is also re-used by another course. Once found, the student will receive a zero score for the final project.**
- Students are required to submit the proposal form and the mid-term form in time. Failing to submit these two forms in time will prevent the process from advancing. **It is not accepted that the student submits the final report directly without negotiations with the instructor in advance. In such cases, students will receive a zero score for the final project.**
- All submissions are through BlackBoard. The total points of the final project are 100.

**Class Policies**

- **It is strongly recommended to bring your personal computers in class since we have a couple of in-class coding demos. It would be quite helpful if you could follow the step-by-step coding in the class.**
- It is the student's responsibility to read the lectures and their corresponding materials before the class.
- It is expected that students will make every attempt to arrive to class on time or notify the instructor otherwise. Class attendance is mandatory. It is the responsibility of the student to determine and understand clearly the attendance policy.
- All cell/smart phones are to be turned OFF during class (unless needed for a true emergency).
- Food is NOT allowed to be consumed during lectures; however, fully covered drinks may be allowed.

**Policies on Cheating and Plagiarism**

- All project assignments for this class are individual in nature except group submissions allowed by the instructors.
- Students turning in program assignments determined to be copied from others in the class or from an external/Internet source (with/without the citation) will be given a grade of zero for the programming assignments.
- Students determined to have cheated on in-class/open book/online exams, quizzes, class assignments, either by copying from other student's papers, or by possession and use of unallowed materials/Internet source, will be given an 'F' for the course.
- A statement on cheating and plagiarism distributed to all students may be found in the Graduate Catalog, Appendix F.
- All incidents of cheating and plagiarism will be reported to the department committee and university judicial committee (Office of Judicial Affairs) and can lead of to the student enrollment being TERMINATED.

**Disability statement**

If you may need an accommodation due to a disability, please contact me privately to discuss your specific needs. A memo from Disability Support Services (DSS) authorizing your accommodation will be needed.