

Fall 2025
Comp/EECE 4741/6741: Introduction to Neural Networks and Deep Learning
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Catalog Description: Artificial Neural Network, Multi-layer Perceptron, Learning Theory, Deep Learning, Convolutional Neural Network, Transformer, Visualization Tools for DL methods such as Grad-Cams.

Course Description: This course aims to enhance both theoretical understanding and practical application for students with a solid foundation in introductory machine learning concepts, encouraging exploration of advanced techniques and their real-world applications.

Prerequisites:

1. Strong programming skills, preferably in Python/Pandas/C++
2. Basic knowledge of statistics and mathematics (linear algebra, calculus, probability)

Textbook/ Reference:

1. Deep Learning (Adaptive Computation and Machine Learning series) Illustrated Edition by Ian Goodfellow (Author), Yoshua Bengio (Author), Aaron Courville (Author), ISBN-10 0262035618; ISBN-13 978-0262035613, The MIT Press.
2. Reinforcement Learning, second edition: An Introduction (Adaptive Computation and Machine Learning series) 2nd Edition by Richard S. Sutton (Author), Andrew G. Barto (Author), ISBN-10 0262039249, ISBN-13 978-0262039246, Bradford Books.

Course Objectives:

1. Grasp the intricate workings of advanced ANN and DL algorithms along with their fundamental theories for deeper insights and mastery.
2. Practical expertise in deploying these algorithms to tackle real-world challenges effectively.
3. Develop skills to critically analyze and improve training, testing, and validation of models.
4. Delve into the principles of model thinking to tackle real-world challenges effectively.
5. Understand the convergence of ANN/DL with other fields.

Course Policies:

1. Emphasis on hands-on learning and collaboration is strongly encouraged.
2. Regular attendance and active participation in class discussions is mandatory.
3. Late submissions of assignments will incur a penalty unless prior permission is obtained.
4. Academic integrity is strictly enforced. For details about rights and responsibilities, please see <https://www.memphis.edu/osa/students/academic-misconduct.php>

Methods of Evaluation:

The grade (Typically > 95 = A+, 90-94 = A, 85-89 = A-, 80-84 = B+, 75-79=B, 70-74=B-, 65-69 =C+, 60-64=C, 55-59 = C-, 50-54 = D and below 49 = F) is determined based on performance:

1. 5 short quizzes (15%)
2. Five programming assignments (50%)
3. Class tests on foundational ANN and DL concepts (10%)
4. Final class project aligned with student/faculty interest or final exam (20%)
5. Participation in class (5 %)

Course Outline:

- 1.
2. Week 1: Introduction to Artificial Neural Network
 - a. Brief History of ANN and DL
 - b. Multilayer Perceptron
 - c. Learning theories
3. Week 2-4: Deep Learning Fundamentals
 - a. Neural Networks: Architecture and Backpropagation
 - b. Convolutional Neural Networks for Object Detection and Classification
 - c. Recurrent Neural Networks for Time Series Analysis
 - d. Hopfield Networks
 - e. Transfer Learning and Fine-tuning
4. Week 5-8: Advanced Topics in Deep Learning
 - a. Generative Adversarial Networks (GANs)
 - b. Autoencoders and Variational Autoencoders
5. Week 8-10: Deep Reinforcement Learning
 - a. Fundamentals of Reinforcement Learning
 - b. Q-learning and Deep Q Networks (DQNs)
 - c. Policy Gradient Methods Bi-clustering and Co-clustering
6. Week 10-12: Ethical Considerations and Bias in ML
 - a. Understanding and Mitigating Bias in Machine Learning Models
 - b. Model Visualization and Explanation
 - c. Ethical Considerations in AI and ML

Journals:

1. IEEE Transactions on Pattern Analysis and Machine Intelligence
2. IEEE Transactions on Neural Networks
3. Journal of Machine Learning Research
4. Machine Learning (Springer)
5. Artificial Intelligence

Conference Proceedings:

1. IEEE Conference on Computer Vision and Pattern Recognition
2. NIPS (Conference on Neural Information Processing Systems)
3. ICML (International Conference on Machine Learning)
4. IJCAI (International Joint Conference on Artificial Intelligence)
5. IJCNN (International Joint Conference on Neural Network)