Department of Electrical and Computer Engineering

ECE 381: Applied Machine Learning

Credits and contact hours: 3 credits, 4 contact hours (2 hours lecture, 2 hours lab)

Instructor: Dr. Tao Han,
Email: tao.han@njit.edu

Catalog Course Description:

This course is to prepare the students for the new environment of machine learning and artificial intelligence. The course is composed of two main parts: 1) basic applied machine learning techniques including deep learning, regression, classification, convolutional neural networks, generative adversarial networks, and model compression; and 2) introduction to PyTorch, colab, and jupyter notebook and provide students with hands-on experience of developing and implementing machine learning solutions.

Prerequisites:

1. Basic programming languages, e.g. Python.

Textbook and Reading Materials (Optional):

- "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aur´elien G´eron
- "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto
- "Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play" by David Foster

Specific Course Learning Outcomes (CLOs):

The student who completes the course will:

1. Understand the basics of machine learning and neural networks
2. Gain an understanding of the design and optimization of machine learning models
3. Gain knowledge of convolutional neural networks (CNN) for computer vision
4. Gain knowledge of reinforcement learning (RL)
5. Gain knowledge of generative adversarial networks (GAN) for AI content generation and Transformer
6. Gain hands-on knowledge and experience in designing and implementing machine learning algorithms on mobile and IoT devices

Relevant student outcomes (ABET):

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (CLO 1-5)

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (CLO 1-5)
3. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies (CLOs 1-5)
4. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives (CLO 6)
5. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (CLO 6)

Tentative Course Outline

Given the evolving nature of machine learning and artificial intelligence, the course may incorporate additional content not initially outlined in the syllabus to enhance learning opportunities and reflect the latest advancements in the field, while current content may also be modified or removed to ensure relevance and alignment with emerging trends.

<table>
<tr><th>Weeks</th><th>Lecture</th><th>Lab</th></tr>
<tr><td>1</td><td>Introduction to Machine Learning</td><td>Team formation and get familiar with NVIDIA Jetson platform</td></tr>
<tr><td>2</td><td rowspan="2">Deep Learning Techniques,
Assignment 1: Regression Experiments,
Quiz 1</td><td rowspan="2">Lab 1: Image Classification (Jetson AI)</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">Convolutional Neural Network (CNN),
ResNet ,
Quiz 2</td><td rowspan="2">Lab 2: Real-Time Image Regression for RoI Detection</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td rowspan="2">TinyML, Neural Network Compression
Transfer Learning,
Quiz 3</td><td rowspan="2">Lab 3: Advanced Object Detection And Visual Transformers</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="3">Deep Reinforcement Learning,
Assignment 2: DRL Experiment,
Quiz 4</td><td rowspan="2">Lab 4: Generative Ai –Text-To-Image And Natural Language Generation</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td><td rowspan="2">Final Project Proposal Presentation</td></tr>
<tr><td>11</td><td rowspan="3">Generative Adversarial Networks (GAN),
Transformer, Diffusion Models,
Quiz 5</td></tr>
<tr><td>12</td><td rowspan="2">Work on Final Project</td></tr>
<tr><td>13</td></tr>
<tr><td>14</td><td>Large Language Models</td><td rowspan="2">Final Project Presentation and Report</td></tr>
<tr><td>15</td><td></td></tr>
</table>

Policies:

All students must familiarize themselves with official university-wide academic policies

Grading:

Quizzes	30% (5 quizzes, 6% each)
Coding Assignment	20% (2 assignments, 10% each)
Labs	30% (lab 1: 5%, lab 2: 5%, lab 3: 10%, lab 4: 10%)
Final Project	20% (Project topic (proposal): 5%, Presentation: 10%, Final report: 5%)

Course Project:

You will work in teams of **up to 2** students to complete the lab and final project, applying AI techniques such as machine learning frameworks, deep learning, or reinforcement learning using Jetson AI platform.

Extra Credit Rules for Course Project:

- Eligibility: Extra credit will be awarded to the top 3 teams in the course project.
- Voting Process:
  - Each student will cast votes for their top 3 favorite teams.
  - Votes will be tallied, and the teams with the highest overall votes will be ranked 1st, 2nd, 3rd, 4th, and 5th place.
  - In case of a tie, the instructor will make the final decision on ranking after reviewing the tied teams' projects.
- Extra Credit Allocation:
  - 1st place team: **+8%** extra credit
  - 2nd place team: **+6%** extra credit
  - 3rd place team: **+4%** extra credit
  - 4th place team: **+2%** extra credit
  - 5th place team: **+1%** extra credit

Makeup Quiz Policy: There will be **NO MAKE-UP QUIZZES** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the ECE Department Office/Instructor that the exam will be missed.

Religious Observance: NJIT is committed to supporting students observing religious holidays. Students must notify their instructors in writing of any conflicts between course requirements and religious observances, ideally by the end of the second week of classes and no later than two weeks before the anticipated absence.