Master Course Description for EE-443 (ABET sheet)

Title: Machine Learning for Signal Processing Applications

Credits: 4

UW Course Catalog Description

Coordinator: Jenq-Neng Hwang, Professor of Electrical and Computer Engineering

Goals: The goal of this course is to provide senior ECE students with significant machine learning and deep learning experience and introduce them to important laboratory components using cloud-based computing resources for solving real-world signal processing applications.

Learning Objectives: By the end of this course, students will demonstrate the ability to:

- Apply fundamental machine learning knowledge and skills to multi-dimensional signal processing problems on provided real-world training and test data.
- Formulate and solve signal, image, and video processing problems using a variety of machine learning tools and techniques using cloud-based CPU/GPU/TPU computing resources.
- Simulate performance of various machine learning algorithms on real-world signal processing problems and perform comparative assessments of their performance in terms of accuracy, generalization, scalability, and other key application-oriented metrics.
- Work on biweekly projects in small teams with heterogeneous knowledge and skills to bring projects to completion.
- Write detailed project reports commenting on approach and results obtained for each project.
- Make formal oral presentations of projects.
- Perform live demonstrations of projects.

Reference Materials: Technical papers will be provided for references

Prerequisites: minimum grade of 1.0 in E E 242; and either MATH 136, AMATH 352, or MATH 126 and MATH 208; and either E E 391, IND E 315, MATH 394/STAT 394, or STAT 390.

Topics:

- Introduction and Lab Usage Tutorial
- Unsupervised Machine Learning
- Supervised Machine Learning
- From MLP to CNN Deep Learning
- Generative Adversarial Learning
- Open Long-Tailed Recognition
- Object Detection and Segmentation
- Deep Learning for Image/Video Applications

Course Structure: The class meets for two two-hour lectures a week. The whole class is divided into small groups (2-3 students). There are 4 warm-up homework (group based Lab projects) assignments that include some CPU/GPU design projects to get students familiar with the cloud-based resource system on the machine learning algorithms based on the related signal and image data that will be covered in the class, and on how to write Python code in the Pytorch environment which is based on Google Colab. Students are required to demo their results and answer questions on each question of the homework/Lab assignments. Every homework/Lab report will be required to contain experimental results, code (online registered) and interpretations of the results. In addition, there will be a team-based final project assignment, which contains some open-ended projects ,given some specially provided signal and image data, and requires students to read some reference papers and propose their own solutions, the final project requires a submitted final project report and should be presented to the whole classroom in the final week about the adopted methods and performance.

Computer Resources: Colaboratory (Colab) is a Google research project created to help disseminate machine learning education and research. It is a Jupyter notebook environment that requires no setup to use and runs entirely in the cloud. It allows you to use virtual machines with a GPU (or TPU) to accelerate machine learning workloads for up to 12 hours at a time. It is free to use! There is a paid option called “Colab Pro” which gives access to faster GPUs, more RAM, more CPU cores, more disk space, and longer runtimes, but the paid version won’t be necessary for this course.

Laboratory Resources: None

Grading: 4 team-based homework/Lab assignments (15% each), one final project assignment (10% for group presentation, 30% for project report).

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

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

(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.* **(L)**

(3) *An ability to communicate effectively with a range of audiences.* **(M)**

(4) *An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.* **(L)**

(5) *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.* **(M)**

(6) *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.* **(H)**

(7) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* **(M)**

Religious Accommodations:

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/). Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodations-request/).

Accommodations & Access:

If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 206-543-8924 or uwdrs@uw.edu or disability.uw.edu. DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between the student, instructor, and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning

environments consistent with federal and state law.

Academic Integrity:

It is required by CEP for course approval that you include a statement about academic integrity in your syllabus. There may be guidelines you want to add that are specific to your class. For example, are students encouraged, or prohibited from, collaborating on homework solutions, lab assignments, or reports? The syllabus should state how academic misconduct in the class is defined by the instructor. The syllabus should state the effect on the student's grade if the student is found responsible.

Engineering is a profession demanding a high level of personal honesty, integrity and responsibility. Therefore, it is essential that engineering students, in fulfillment of their academic requirements and in preparation to enter the engineering profession, adhere to the College of Engineering Statement of Principles. Any student in this course suspected of academic misconduct (e.g., cheating, plagiarism, or falsification) will be reported to the College of Engineering Dean's Office and the University's Office of Community Standards and Student Conduct to initiate the student conduct process. *Any student found to have committed academic misconduct may receive a zero for their grade on the impacted academic work (e.g., assignments, project, or exams), and academic consequences, with the possibility of expulsion.*

Title IX:

"UW, through numerous policies, prohibits sex- and gender-based violence and harassment, and we expect students, faculty, and staff to act professionally and respectfully in all work, learning, and research environments. For support, resources, and reporting options related to sex- and gender-based violence or harassment, visit UW Title IX's webpage (https://www.washington.edu/titleix/), specifically the Know Your Rights & Resources guide (https://www.washington.edu/titleix/files/2020/08/KYRR-guide-8-10-2020-LINKED.pdf).

If you choose to disclose information to me about sex- or gender-based violence or harassment, I will connect you (or the person who experienced the conduct) with resources and individuals who can best provide support and options. You can also access those resources directly:

- Confidential: Confidential advocates (https://www.washington.edu/sexualassault/support/advocacy/) will not share information with others unless given express permission by the person who has experienced the harm or when required by law.
- Private and/or anonymous: SafeCampus (https://www.washington.edu/safecampus/) provides consultation and support and can connect you with additional resources if you want them. You can contact SafeCampus anonymously or share limited information when you call

Please note that some senior leaders and other specified employees have been identified as "Officials Required to Report." (https://www.washington.edu/titleix/title-ix-officials-required-to-report/) If an Official Required to Report learns of possible sex- or gender-based violence or harassment, they are required to call SafeCampus and report all the details they have in order to

ensure that the person who experienced harm is offered support and reporting options (https://www.washington.edu/titleix/resources/)."

Prepared by: Jenq-Neng Hwang

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Prerequisite Updates: 02/26/2025 (Chris Overly)