ECE 411 Introduction to Machine Learning
Course Syllabus (Fall 2023)

Time & Location:

Lecture: MW4:30–5:45 pm, 2236 EB3.

Discussion: F12:50–1:40 pm, 1005 EB1.

Instructor: Dr. Chau-Wai Wong

Office hour: [See course webpage for most up-to-date information]

Email: [Use Piazza]

Course webpage: https://ncsu-wong.org/ece411_23Fall/
[or Google instructor's name]

Teaching Assistant: Mr. Prasun Datta and Ms. Chanae Ottley

Office hour: [See course webpage for most up-to-date information]

Email: [Use Piazza]

Course Description: Deep learning progressed remarkably over the past decade. This course introduces fundamental concepts and algorithms in machine learning that are vital for understanding state-of-the-art and cutting-edge development in deep learning. This course exposes students to real-world applications via well-guided homework programming problems and projects. Topics include, but are not limited to regression, classification, support vector machines, crossvalidation, and convolutional neural networks (CNN), long short-term memory (LSTM), and transformers.

Learning Outcomes: By the end of this course, the students should be able to:

1. Explain basic concepts and underlying working principles of machine learning algorithms such as linear and logistic regressions, maximum likelihood estimation, and expectation-maximization.
2. Derive and implement from scratch basic machine learning algorithms such as linear and logistic regressions.
3. Explain the pros and cons of common classical machine learning algorithms.
4. Identify the correct machine learning tool for solving a particular kind of problem.
5. Use off-the-shelf machine learning packages to address real-world machine learning problems, e.g., examples adapted from Kaggle competitions.
6. Gain an appreciation for ongoing advances in the field by explaining the key merits and application domains of a few exemplar cutting-edge algorithms like deep neural networks.

Prerequisites: ST 300-level or above, and ECE301/CSC316/ISE361/MA341. Talk to the instructor if prerequisites can be waived.

Course Structure:

The course consists of two 75-min lectures and one 50-min discussion section per week. A teaching assistant will lead the discussion section, covering practice problems and answering questions from students. There will be weekly homework assignments (30%) that contain both written problems and programming problems, two midterm exams (20%×2), and one term project (30%). Programming will be in Python, R, or Matlab. Students are expected to be able to write computer programs and have mathematical maturity in probability theory (e.g., have taken a 300-level statistics course) before taking the course. A linear algebra course such as MA305/405 is recommended while taking the course.

Topics: Linear statistical models, Bayesian classifiers, support vector machine (SVM), clustering, principal component analysis (PCA), naive Bayes, topic model, hidden Markov model (HMM), convolutional neural networks (CNN), long short-term memory (LSTM), and transformers.

Textbooks:

G. James, D. Witten, T. Hastie and R. Tibshirani, Introduction to Statistical Learning with Applications in R, 1st edition, Springer, 2013. [Online]

T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning, (12th Printing, 2017), 2nd Ed., Springer. [Online]

I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016. [Online]

Reference Books:

M. P. Deisenroth, A. A. Faisal, and C. S. Ong, Mathematics for Machine Learning, 2020. [Online]

S. H. Chan, Introduction to Probability for Data Science, 2021. [Online]

J. L. Devore, Probability and Statistics for Engineering and the Sciences, Ed. 9.

A. Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, Ed. 3, 2008.

C. E. McCulloch, S. R. Searle, Generalized, Linear, and Mixed Models, Wiley & Sons, 2001.

K. P. Murphy, Machine Learning: A Probabilistic Perspective, 2012. [Online via NC State library]

R. O. Duda, P. E. Hart, D. G. Stork, Pattern Classification, 2nd Ed., Wiley, 2001.

E. Alpaydin, Introduction to Machine Learning, 2nd Ed., MIT Press, 2009.

Letter Grades:

This Course uses Standard NC State Letter Grading:

97 ≤ **A+** ≤ 100
93 ≤ **A** < 97
90 ≤ **A-** < 93
87 ≤ **B+** < 90
83 ≤ **B** < 87
80 ≤ **B-** < 83
77 ≤ **C+** < 80
73 ≤ **C** < 77

70 ≤ **C-** < 73
67 ≤ **D+** < 70
63 ≤ **D** < 67
60 ≤ **D-** < 63
0 ≤ **F** < 60

Requirements for Credit-Only (S/U) Grading: To receive a grade of S, students are required to take all exams, complete all assignments, and earn a grade of C- or better. Conversion from letter grading to credit only (S/U) grading is subject to university deadlines. Refer to the Registration and Records calendar for deadlines related to grading. For more details refer to http://policies.ncsu.edu/regulation/reg-02-20-15.

Auditing Policy: Students must register this course for auditing. Auditing students must turn in all homework assignments. However, they are not required to take the exams. More information about and requirements for auditing a course can be found at
http://policies.ncsu.edu/regulation/reg-02-20-04

Late/Missed Assignments/Exams:

All assignments must be turned in at the beginning of class on the date they are due. A penalty of 20 pts out of 100 pts per day will be assessed for all homework assignments turned in late. You are expected to turn in your assignments on time for any anticipated absences that you will have so please plan accordingly. Emergency or unanticipated absences will be handled on a case-by-case basis. There will be no make-up homework assignment, project, or exam. Grades for a missing item with valid excuses and documentation will be estimated using the grades of other available items in the same category. Students who believe they have valid excuses to miss an assignment, project, or exam must comply with University Attendance Regulations REG 02.20.03 on NC State's website.

Attendance Policy: Students must attend the class in person. For a detailed Attendance/Absence Policy, see Attendance Regulation NCSU REG 02.20.03 at http://policies.ncsu.edu/regulation/reg-02-20-03.

Absences Policy: Excuses for unanticipated absences must be presented to the instructor within one week after the return to class.

Academic Integrity:

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at http://policies.ncsu.edu/policy/pol-11-35-01

Violations of academic integrity will be handled per the Student Discipline Procedures (NCSU REG 11.35.02).

Honor Pledge: Your signature on any test or assignment indicates "I have neither given nor received unauthorized aid on this test or assignment."

Digital Course Components: Students may be required to disclose personally identifiable information to other students in the course, via digital tools, such as email or web postings, where relevant to the course. Examples include online discussions of class topics and posting of

student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

Digital access: Discussions board on Piazza.

Accommodations for Disabilities:

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG02.20.01) (https://policies.ncsu.edu/regulation/reg-02-20-01/).

Non-Discrimination Policy:

NC State provides equal opportunity and affirmative action efforts, and prohibits all forms of unlawful discrimination, harassment, and retaliation ("Prohibited Conduct") that are based upon a person's race, color, religion, sex (including pregnancy), national origin, age (40 or older), disability, gender identity, genetic information, sexual orientation, or veteran status (individually and collectively, "Protected Status"). Additional information as to each Protected Status is included in NCSU REG 04.25.02 (Discrimination, Harassment and Retaliation Complaint Procedure). NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at http://policies.ncsu.edu/policy/pol-04-25-05 or https://oied.ncsu.edu/divweb/. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 919-515-3148.

Course Evaluation: Students will be notified during the last week of the class to complete course evaluations. All evaluations are confidential; instructors will never know how any one student responded to any question, and students will never know the ratings for any particular instructors.