ECE523: Engineering Applications of Machine Learning and Data Analytics

§ Course Details

Instructor	Gregory Ditzler (Dept. of ECE)
Instructor Email	ditzler@email.arizona.edu
Course Websites	https://d2l.arizona.edu piazza.com/arizona/spring2019/ece523
Lecture Times	MWF 10-10:50AM
Lecture Room	César E. Chavez Bldg. 301
Instructor Office Hour	ECE Bldg 556D F 4–5PM

§ Catalog Description

Machine learning deals with the automated classification, identification, and/or characterizations of an unknown system and its parameters. There are an overwhelming number of application driven fields that can benefit from machine learning techniques, such as self-driving cars, practical speech recognition, and teaching a computer to play a game. This course will introduce you machine learning and develop core principles that allow you to determine which algorithm to use, and/or design a novel approach to solve your engineering task. This course will also use software technology to supplement the theory learned in the class with applications using real-world data.

§ Textbook

Required

- "Introduction to Machine Learning," E. Alpaydin, MIT Press, 2010, 2nd Ed.

Recommend (and reference)

- "Machine Learning: A Probabilistic Perspective," K. Murphy, MIT Press, 2012.
- "Elements of Statistical Learning Theory," T. Hastie, R. Tibshirani, and J. Friedman, Springer, 2008.
  http://web.stanford.edu/~hastie/ElemStatLearn/
- "Pattern Classification," R. Duda, P. Hart, and D. Stork, Wiley-Interscience, 2000.
- "Pattern Recognition and Machine Learning," C. Bishop, Springer, 2007.

I will supply lecture notes that are specific to the course content that may not be covered in the textbook. Students should use both the text and the lecture notes as reading material for the course.

§ Software

You will be required to use Python to work on assignments throughout the course. Python is freely available for your local computer; however, it is very unlikely that computers in the campus labs will have it installed. It is recommended that you install the Anaconda distribution of Python (www.continuum.io). We will also use Google's TensorFlow

(www.tensorflow.org) for implementing different types of artificial neural networks.

§ **Grading**

Your final numerical grade will be computed as follows.

Homework (≈5)	35 points
Mid-term Exams (2)	35 points
Project	30 points
Total	100 points

Your course letter grade will be assigned based on your final numerical grade as follows.

90	100	A
80	89	B
70	79	C
60	69	D
0	59	E

The above scale represents a minimum guarantee. At my discretion, I may curve course grades up (but not down). My intent with grading is to reward fair effort with fair credit, in short, I aim to be reasonable. Exams missed by the students cannot be made up unless prior arrangements have been made with the instructor. Make-up exams are evaluated on a case-by-case basis. It is impossible for me to answer the question "what grade will I get" at the week of the withdraw deadline, please do not ask me this.

§ **Course Expectations**

This course is a fast-paced, mathematically and computationally intensive graduate level course. You will be learning a substantial amount of material, and you will be writing simulations Python. Expertise (not just familiarity) some other programming language is essential. Because this is a graduate level course, you will also be expected to do a substantial amount of reading – not only from the text but also from scientific magazines and journals. Successful completion of this course will demand significant amount of time commitment from you, a good portion of which may be spent on reading and algorithm implementation.

If you miss a class, you are responsible for any missed material, and given the pace and level of this course, even a single missed lecture will be difficult to catch up. So don't miss class! Finally, grades must be disputed within one week of the assignment being return (note this is not the same as the day you pick it up during an office hour).

§ **Homework Submission Policy**

You **must** submit all of the code, data, and pdf files in a zip folder (i.e., not rar, 7z, etc) on D2L. *Assigments must be submitted as a zip file*! Furthermore, each homework will have a theory and practice section. You must include a single pdf file (not doc, docx, or multiple JPEG figures of the pages from your homework) with the solutions to both the theory and practice components to the homework. Failure to follow any/all of these policies leaves the instructor the option to not grade the homework based on a failure to follow the homework submission policy. Your zip file should be named as follows `LastFirst-HW-X.zip`, where `Last` is your last name as it appears on D2L, `First` is your first name as it appears on D2L

and `X` is the homework number.

§ **Topics (subject to change)**

Week	Topic	Assignment
#0	Linear Algebra & Probability Refresher / Python https://developers.google.com/edu/python/	
#1	Introduction / Foundations	HW 1 Assigned
#2	Bayes Decision Theory / Discriminate Functions	
#3	Logistic Regression / Density Estimation	HW 2 Assigned HW 1 Due
#4	Dimensionality Reduction / Feature Selection	
#5	Optimization / Multi-Layer Perceptrons	HW 3 Assigned HW 2 Due
#6	Neural Networks / Deep Learning	
#7	Support Vector Machines / Risk Minimization	HW 4 Assigned HW 3 Due
#8	Exam / Mixture Models	Project Proposal
#9	Clustering / Unsupervised Learning	HW 5 Assigned HW 4 Due
#10	Decision Trees / Ensemble Classifiers	
#11	Boosting / PAC Models	HW 5 Due
#12	Online Learning / Multi-Arm Bandits	
#13	Exam / Applications	
#14	Big Data & Map-Reduce	
#15	Convolutional & Recurrent Neural Networks	
#16	Advanced Topics & The Future of ML	Final Report

§ **Course Project**

A final project to help you put all course-developed skills to work will be assigned. You will have a minimum of one month to work on the project. All project ideas must be pre-approved by the instructor for appropriate scope and depth. Groups of two are welcome.

Graduate students are expected develop a novel technique, either from scratch, or by suitably modifying an existing technique for a specific problem of your interest; test it on at least five standard benchmark databases available at the UCI Machine Learning Repository or Kaggle. If the student chooses to do an application specific project, then it should be tested on the data generated by that application. Many data sets are available through a link in this paper: http://jmlr.org/papers/v15/delgado14a.html.

Projects are expected to be of conference submission quality (i.e., some level of novelty is required). Many machine learning related conferences have deadlines after the semester ends and you're encouraged to submit your work with your advisor and you do not need to include me on the publication. My hope is that this project helps you with your research and degree.

§ **Academic Integrity**

Students are responsible for completing homework assignments by themselves, but may work

on strategies to complete the assignments with other students. You are encouraged to work in teams on homework assignments, but copying a completed assignment of another student and submitting it as your own is considered a violation of academic integrity—and it will hurt you when it comes to the exams. Any take-home examinations *may not consist of any group work, even for problem strategies.*

Additional exceptions to this policy will be plainly marked in the requirements for that exercise or project. Any violations of this policy will be dealt with to the full extent permitted by the University of Arizona, and *may result in suspension or expulsion from the university, in addition to a failing grade.* Please familiarize yourself with the Code of Academic Integrity if you have any questions (see http://deanofstudents.arizona.edu/codeofacademicintegrity).

§ **Threatening Behavior by Students**

The University seeks to promote a safe environment where students and employees may participate in the educational process without compromising their health, safety, or welfare. The Arizona Board of Regents (ABOR) Student Code of Conduct, ABOR Policy 5-308, prohibits threats of physical harm to any member of the University community, including to one?s self. Threatening behavior can harm and disrupt the University, its community, and its families. Threatening behavior is prohibited.

§ **Accessibility and Accommodations**

At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520-621-3268) to explore reasonable accommodation.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

§ **Subject Change**

The contents of this syllabus are subject to change at the instructor's discretion.