ECE523: Engineering Applications of Machine Learning and Data Analytics

1 Course Details

Instructor	Gregory Ditzler *Assistant Professor* *Department of Electrical & Computer Engineering*
Instructor Email	ditzler@arizona.edu
Course Websites	https://d2l.arizona.edu piazza.com/arizona/spring2021/ece523
Lecture Times	MWF 10-10:50AM
Lecture Room	Steward Observatory, Rm N210 Zoom (see D2L for a link)
Instructor Office Hour	via Zoom F 12PM-1PM
Grader	TBD

2 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.

Prerequisite ECE 503 (Probability and Random Processes for Engineering Applications) and knowledge of linear algebra.

3 Course Materials

3.1 Textbook

Recommend (and reference)

- "*Introduction to Machine Learning*," E. Alpaydin, MIT Press, 2010, 2nd Ed. [***Free through UArizona Libraries***]
- "*Elements of Statistical Learning Theory*," T. Hastie, R. Tibshirani, and J. Friedman, Springer, 2008. [***Free online***]
- "*Deep Learning*," I. Goodfellow, Y. Bengio and A. Courville, MIT Press, 2016. [***Free online***]
- "*Machine Learning: A Probabilistic Perspective*," K. Murphy, MIT Press, 2012.
- "*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.

3.2 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 unlikely that computers in the campus labs will have it installed. Python is automatically installed with most operating systems (e.g., Linux and OSX); however, we do not recommend using the default installation of Python. We highly recommend using the Anaconda distribution of Python since it will install several different machine learning, data manipulation, data visualization, and many other packages that will be useful in this course. There are other packages that we will use throughout the semester that are not included in Anaconda (e.g., Tensorflow, Keras, PyTorch, etc), but these can easily be installed. You can also use Google Colab if you would like to run your code on Google's cloud without installing Python on your computer.

4 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.

5 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).

5.1 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. *Assignments must be submitted as a zip file with code and a pdf document with your solutions*!

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 and pdf should be named as follows `LastFirst-HW-X.zip` and `LastFirst-HW-X.pdf`, 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.

5.2 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.

5.3 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).

6 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.

7 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.

8 COVID-19 Notes

- Remain flexible: If pandemic conditions warrant, the University may require that we return to remote operations. If that is the case, we will notify you by D2L Announcement and email that we are moving to remote operations.
- Meeting times for remote teaching: We will be meeting remotely until the University notifies us that in-person meetings may commence.
- Classroom attendance
  - If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
  - Notify your instructors if you will be missing an in person or online course.
  - Campus Health is testing for COVID-19. Please call (520) 621-9202 before you visit in person.
  - Visit the UArizona COVID-19 page for regular updates.

8.1 Face Coverings are Required in Our Classroom

Per UArizona's Administrative Directive, face coverings that cover the nose, mouth, and chin are required to be worn in all learning spaces at the University of Arizona (e.g., in classrooms, laboratories and studios). Any student who violates this directive will be asked to immediately leave the learning space, and will be allowed to return only when they are wearing a face covering. Subsequent episodes of noncompliance will result in a Student Code of Conduct complaint being filed with the Dean of Students Office, which may result in sanctions being applied. The student will not be able to return to the learning space until the matter is resolved.

8.2 Physical Distancing is Required in Our Classroom

During our in-person class meetings, we will respect CDC guidelines, including restricted seating to increase physical distancing and appropriately-worn face coverings. Per UArizona's Administrative Directive, face coverings that cover the nose, mouth, and chin are required to be worn in all learning spaces at the University of Arizona (e.g., in classrooms, laboratories and studios). Any student who violates this directive will be asked to immediately leave the learning space, and will be allowed to return only when they are wearing a face covering. Subsequent episodes of noncompliance will result in a Student Code of Conduct complaint being filed with the Dean of Students Office, which may result in sanctions being applied. The student will not be able to return to the learning space until the matter is resolved.

8.3 Academic Advising

If you have questions about your academic progress this semester, or your chosen degree program, please note that advisors at the Advising Resource Center can guide you toward university resources to help you succeed.

8.4 Life Challenges

If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or DOS-deanofstudents@email.arizona.edu.

9 Physical and mental-health challenges

If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520-621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

10 Subject Change

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