ELEG/FSAN 815 - Analytics I: Statistical Learning

Credits: 3, Section(s):
Semester: Fall, Year: 2024
Tuesday & Thursday, 8:00am - 9:20am, Location and Room: Gore Hall 204
Lecture: In person

Table of Contents

1. Instructor Information

Instructor Contact Information

Instructor name: Gonzalo R. Arce
Email address: arce@udel.edu
Office location: 312 Evans Hall
Office hours: By appointment

Teaching Assistant(s) Contact Information

Instructor name: Carlos Galeano
Email address: rgaleano@udel.edu
Office location: Evans Hall 210
Office hours: Wednesday 4:00pm – 5:00 pm Evans Hall 210

2. Course Description

Description

A first course in machine learning, covering the theory, algorithms, and practice. The fundamental concepts in learning theory are described and an overview of the types of learning. Training and testing are described as they relate to the generalization problem. Several hypothesis class models are considered including the linear model and its nonlinear transformation. Regression and classification problems are described. The overfitting problem is formulated, and various regularization methods are introduced including Ridge and LASSO. Support vector machines are introduced as well as neural networks including convolutional neural networks, graph neural networks, and transformers.

Prerequisites

First course in linear algebra (eigen decomposition, matrix algebra, and determinants). First course in probability and statistics (probability density functions, conditional density functions, moments, Bayes theorem), calculus (derivatives, partial derivatives, integrals). Basic Python or MATLAB programming skills.

Course Delivery

In person, Classroom: Gore Hall 204

3. Learning Outcomes

At the conclusion of this course, you should have learned about:
1. Probability and Stationary processes
2. The Learning Problem
    2.1. Problem Setup
    2.2. The Perceptron
    2.3. Types of Learning
    2.4. Is Learning Feasible?
    2.5. Error and Noise
3. Training vs Testing
    3.1. Theory of Generalization
    3.2. The VC Dimension
4. The Linear Model
    4.1. Optimization
    4.2. Nonlinear Transformation and Logistic Regression
5. Overfitting and Regularization
6. Lasso regression

7. Support vector machines
8. Neural Networks
9. Convolutional Neural Networks
10. Graph Neural Networks
11. Transformers
12. Deep Autoencoders and Generative Models
13. Epilogue

4. Learning Resources

Required Learning Materials

Textbook 1: Learning from Data, Yaser S. Abu-Mostafa, Malik Magdon-Ismail, and Hsuan-Tien Lin, AMLbook 2012.

Lecture slides available at [Analytics I: Statistical Learning (udel.edu)](udel.edu)

Technology

[Canvas](): In this class, Canvas, UD's online learning management system, will be used for all course activities and communication channels. <u>All assignments will be posted through the Canvas course site</u> unless otherwise directed.

Information on how to use Canvas is available through the [Canvas Student Guide]().

Canvas can also be accessed via [MyUD]().

[Python/Matlab:]() We will be using Python/Matlab in this class for homework.

5. Learning Assessment

Final Grade Breakdown

The final course grade will be calculated using the following components:

Course Component	Percentage of Total
Homework	25%
Midterm 1	25%
Midterm 2	25%
Final Exam	25%

7. Course Policy Document

Course Specific Policies

All re-grade requests must be submitted within one week after the assignment or exam was returned.

Attendance

Students are expected to attend all their scheduled classes and laboratories and not to be absent without adequate reason. Further information may be found at **UD's attendance policy.** Absences from graded activities need to be approved by the primary instructor beforehand, or with appropriate documentation to the instructor for urgent health, personal, or family matters.

Absences on religious holidays listed in university calendars are recognized as an excused absence. Nevertheless, students are urged to remind the instructor of their intention to be absent on a particular upcoming holiday. Absences on religious holidays not listed in university calendars, as well as absences due to athletic participation or other extracurricular activities in which students are official representatives of the university, shall be recognized as excused absences when the student informs the instructor in writing during the first two weeks of the semester of these planned absences for the semester.

Communication

Course announcements will be posted using Canvas.

UD Policies

Academic Integrity

Please familiarize yourself with UD policies regarding academic dishonesty. To falsify the results of one's research, to steal the words or ideas of another, to cheat on an assignment, to re-submit the same assignment for different classes, or to allow or assist another to commit these acts corrupts the educational process. Students are expected to do their own work and neither give nor receive unauthorized assistance. Complete details of the university's academic integrity policies and procedures can be found at sites.udel.edu/studentconduct/sgup/ Office of Student Conduct, 218 Hullihen Hall, (302) 831-2117. E-mail: student-conduct@udel.edu

Harassment and Discrimination

The University of Delaware works to promote an academic and work environment that is free from all forms of discrimination, including harassment. As a member of the community, your rights, resource and responsibilities are reflected in the non-discrimination and sexual misconduct policies. Please familiarize yourself with these policies at www.udel.edu/oei . You can report any concerns to the University's Office of Equity & Inclusion, at 305 Hullihen Hall, (302) 831-8063 or you can report anonymously through UD Police (302) 831-2222 or the EthicsPoint Compliance Hotline at www1.udel.edu/compliance. You can also report any violation of UD policy on harassment, discrimination, or abuse of any person at this site: sites.udel.edu/sexualmisconduct/how-to-report/

Faculty Statement on Disclosures of Instances of Sexual Misconduct

If, at any time during this course, I happen to be made aware that a student may have been the victim of sexual misconduct (including sexual harassment, sexual violence, domestic/dating violence, or stalking), I am obligated by federal law to inform the university's Title IX Coordinator. The university needs to know information about such incidents to, not only offer resources, but to ensure a safe campus environment. The Title IX Coordinator will decide if the incident should be examined further. If such a situation is disclosed to me in class, in a paper assignment, or in office hours, I promise to protect your privacy--I will not disclose the incident to anyone but the Title IX Coordinator.

For more information on Sexual Misconduct policies, where to get help, and reporting information, please refer to www.udel.edu/sexualmisconduct. At UD, we provide 24/7/365 crisis assistance and victim advocacy and counseling. Contact 302-831-1001 to get in touch with a sexual offense support advocate, as well as confidential and anonymous counseling services for other concerns.

Accommodations for Students with Disabilities

Any student who thinks he/she may need an accommodation based on a disability should contact the Office of Disability Support Services (DSS) office as soon as possible. Students who have documentation of their need for accommodation should register via the SAM platform: andes.accessiblelearning.com/UDEL/. Reach DSS in the following ways: Phone: 302-831-4643, fax: 302-831-3261, DSS website. Email: dssoffice@udel.edu or visit at 240 Academy Street, Alison Hall Suite 130.

During COVID-19, Disability Support Services staff are available remotely. Please call 302-831-4643 during business hours (8-5 M-F) or email dssoffice@udel.edu for assistance.

Non-Discrimination

The University of Delaware does not discriminate against any person on the basis of race, color, national origin, sex, gender identity or expression, sexual orientation, genetic information, marital status, disability, religion, age, veteran status or any other characteristic protected by applicable law in its employment, educational programs and activities, admissions policies, and scholarship and loan programs as required by Title IX of the Educational Amendments of 1972, the Americans with Disabilities Act of 1990, Section 504 of the Rehabilitation Act of 1973, Title VII of the Civil Rights Act of 1964, and other applicable statutes and University policies. The University of Delaware also prohibits unlawful harassment including sexual harassment and sexual violence.

For inquiries or complaints related to non-discrimination policies, please contact: Office of Equity & Inclusion-oei@udel.edu, 305 Hullihen Hall Newark, DE 19716 (302) 831-8063

For complaints related to Section 504 of the Rehabilitation Act of 1973 and/or the Americans with Disabilities Act, please contact: Office of Disability Support Services, dssoffice@udel.edu, Alison Hall, Suite 130, Newark, DE 19716 (302) 831-4643 OR contact the U.S. Department of Education - Office for Civil Rights