ILLINOIS
Economics
COLLEGE OF LIBERAL ARTS & SCIENCES

ECON 590 Course Syllabus
Applied Machine Learning

Credits: 4 graduate hours
Semester: Spring 2025
Meeting Times: TR 9:30 – 10:50 AM
Instructor: Yannis Bilias – **Room:** 28 DKH (Basement)
Email: bilias@illinois.edu
Office Hours: Tuesdays, Thursdays 3:30 – 4:30 PM, or by appointment.

Course Description

Machine learning, originally a development in computer science, combined with ideas of statistical analysis, offers the basis for a set of tools for modeling and understanding complex datasets. This introductory course gives an overview of different concepts, techniques, and algorithms in machine learning with a view towards applications in economics. We begin with topics such as Regression, Classification, Model Selection and we move to methods of improved predictive accuracy like Regularized Regression. Some more recent topics such as Decision Trees, Boosting, Support Vector Machines, and Neural Networks will be covered as time permits. The course will be delivered from the vantage point of user and provide the student with skills of implementation of the basic machine learning methods in economic problems.

Prerequisites: Knowledge of business statistics at an intermediate level will be sufficient for the smooth attendance of the course.

Learning Outcomes

Specialized Knowledge and Practical Application: ECON students will develop specialized machine learning techniques and quantitative skills that can be applied to a variety of empirical problems to real world situations.

Quantitative Reasoning: ECON students will learn how to analyze relevant data to obtain prediction of economic outcomes from analyzing complex datasets. Specifically, they may obtain datasets of very large size with excessively large number of variables, clean the dataset, apply and compare a menu of methods to predict the outcome of interest and decide on the important predictors using appropriate machine learning techniques.

Analytical Skills/Problem-Solving: ECON students will address problems that do not have a clear answer. Specifically, using statistical learning methods students learn how to predict outcomes and discover the few important predictors even in cases the economic theory does not offer clear guidance.

Learning Resources

The main text of the course is:

- (ISLR) An Introduction to Statistical Learning, (with Applications in R), 2nd ed, by James, Witten, Hastie, Tibshirani.
  The text is freely available at: https://www.statlearning.com/

  A version of the text with applications in Python is available:
- (ISLP) An Introduction to Statistical Learning, (with Applications in Python), by James, Witten, Hastie, Tibshirani, Taylor.

- (Optional) For a deeper treatment on the fundamentals of statistical machine learning you can consult:
  The Elements of Statistical Learning, by Hastie, Tibshirani, Friedman.
  It is available at https://hastie.su.domains/ElemStatLearn/index.html

Learning Management System – Canvas platform

Material (lecture notes, coding labs, assignments) is posted on canvas.

Computing

The course will make use of the R programming language. Previous experience with R is not required. For a detailed introduction to R language, you can consult:

- An Introduction to R, by Venables, Smith and the R Core Team.

The text is available at: https://cran.r-project.org/doc/manuals/R-intro.pdfOther resources/platforms

Grading

The final grade of the course will be based on:

- 20% Assignments
- 20% Midterm Exam (Thursday, March 6)
- 15% Class Project Proposals (Due March 30)
- 20% Class Project (Due May 4)
- 25% Final Exam

Course Policies

Lectures and R Labs:

Lectures explain theories and methodologies of machine learning methods. During the lectures, students will be exposed to the practical aspects of machine learning algorithms using the R language. R Labs are given during the lecture time.

In-class Quizzes:

Quizzes will be given randomly at the start of some lectures after we finish each topic. The quizzes will not be posted on Canvas and will not be graded, their purpose is to test your understanding of the material and give an idea on what to expect for the exams. In total, 7-8 quizzes will be administered.

Assignments and Exam Policy:

There will be one midterm exam and one final exam on theories, concepts, and applied aspects discussed during the lectures. Students are also expected to submit assignments and a class project on which they apply the practiced methods to a real data-based problem. The answers to assignments should be submitted on canvas class platform using Rmarkdown. In total, there will be 7-8 assignments.

Late Submission Policy:

Assignments and final projects should be submitted by the deadlines. Late submissions will not be accepted unless there is a well-documented and verified reason.

Class Project:

For the class project you should work as a group of no more than 4 individuals. You are strongly encouraged to form the research groups of size 4 as early as possible in the semester.

Each member of the group will receive the same points equal to the points given to the whole project report. The class project should involve the analysis of a relatively complicated data set (large number of observations, more than 5-6 variables) with the goal of investigating an interesting question using methods developed in class lectures.

Class Project Proposal:

By March 30 you are asked to submit a one-page proposal for the class project. The proposal should include the problem you will research on, some preliminary descriptive analysis of the dataset you will use, and the methods you intend to utilize for analysis.

Academic Assistance

Students are encouraged to utilize the many resources we have throughout campus to assist with academics. We recommend that you seek them out starting early in the semester, not just in times of academic need, in order to develop good study habits and submit work which represents your full academic potential. Many resources are found on the Economics Website including details about the Economics Tutoring Center, Academic Advising, and other academic support options:
https://economics.illinois.edu/academics/undergraduate-program/academic-student-support

Academic Integrity
According to the Student Code, `It is the responsibility of each student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions.' Please know that it is my responsibility as an instructor to uphold the academic integrity policy of the University, which can be found here: https://studentcode.illinois.edu/article1/part4/1-401/

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policies. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity. **Read the full Student Code at** https://studentcode.illinois.edu/

Students with Disabilities
To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TTY), or e-mail a message to disability@illinois.edu. DRES Website: www.disability.illinois.edu/

Community of Care
As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (217-333-0050 or http://odos.illinois.edu/community-of-care/referral/). Based on your report, the staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe. Further, we understand the impact that struggles with mental health can have on your experience at Illinois. Significant stress, strained relationships, anxiety, excessive worry, alcohol/drug problems, a loss of motivation, or problems with eating and/or sleeping can all interfere with optimal academic performance. We encourage all students to reach out to talk with someone, and we want to make sure you are aware that you can access mental health support at the Counseling Center (https://counselingcenter.illinois.edu/) or McKinley Health Center (https://mckinley.illinois.edu/).
For mental health emergencies, you can call 911 or walk into the Counseling Center, no appointment needed.

Disruptive Behavior
Behavior that persistently or grossly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. Such behavior inhibits other students' ability to learn and an instructor's ability to teach. A student responsible for disruptive behavior may be required to leave class pending discussion and resolution of the problem and may be reported to the Office for Student Conflict Resolution for disciplinary action.

Emergency Response Recommendations
Emergency response recommendations can be found at the following website: http://police.illinois.edu/emergency-preparedness/. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. http://police.illinois.edu/emergency-preparedness/building-emergency-actionplans/.

Religious Observances
The Religious Observance Accommodation Request form is available at https://odos.illinois.edu/community-of-care/resources/students/religious-observances/. Submit the form to the instructor and to the Office of the Dean of Students (helpdean@illinois.edu) as soon as possible.

Family Educational Rights and Privacy Act (FERPA)
Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy

Act (FERPA) should self- identify to the instructor to ensure protection of the privacy of their attendance in this course. See http://registrar.illinois.edu/ferpa for more information on FERPA. Student information and records will not be released to anyone other than the student unless the student has provided written approval or as required by law.

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: http://www.wecare.illinois.edu/resources/students/#confidential.
Other information about resources and reporting is available here: http://wecare.illinois.edu/.

Student Support

The Counseling Center is committed to providing a range of services intended to help students develop improved coping skills in order to address emotional, interpersonal, and academic concerns. Please visit their website to find valuable resources and services: https://counselingcenter.illinois.edu/.
Counseling Center Information: 217-333-3704
Location: Room 206, Student Services Building (610 East John Street, Champaign IL)
McKinley Mental Health Information: 217-333-2705
Location: 3rd Floor McKinley Health Center 1109 South Lincoln, Urbana, IL
Emergency Dean: The Emergency Dean may be reached at (217) 333-0050 and supports students who are experiencing an emergency situation after 5 pm, in which an immediate University response is needed and which cannot wait until the next business day. The Emergency Dean is not a substitute for trained emergency personnel such as 911, Police or Fire. If you are experiencing a life threatening emergency, call 911. Please review the Emergency Dean procedures: http://odos.illinois.edu/emergency/

Academic Dates and Deadlines

Students should make note of important academic deadlines for making changes to their courses (add, drop, credit/no-credit, grade replacement, etc.). https://registrar.illinois.edu/academic-calendars
Please check with your academic department regarding specific procedures and policies.

Course Schedule (subject to change with advance notice)

Week	Date	Topic
1	Jan 21	Introduction to course, introduction to R (ISLR, chapter 1)
		Assignment 1
2	Jan 28	Introduction to Statistical Learning (ISLR, chapter 2)
		Assignment 2
3	Feb 4	Linear Regression (ISLR, chapter 3)
		Assignment 3
4	Feb 11	Classification (ISLR, chapter 4)
		Assignment 4
5	Feb 18	Resampling Methods (ISLR, chapter 5)

6	Feb 25	Linear Model Selection, Regularization, PCA (ISLR, chapter 6), **Review** - Prepare for the Midterm Exam
7	Mar 4	**Review -** Prepare for the Midterm Exam. **MIDTERM EXAM (Thursday March 6)**
8	Mar 11	Linear Model Selection, Regularization, PCA (ISLR, chapter 6) Assignment 5
9	Mar 18	SPRING BREAK
10	Mar 25	Tree-based Methods (ISLR, chapter 8) **Class Project proposal is due March 30**. Assignment 6
11	Apr 1	Tree-based Methods (ISLR, chapter 8) Assignment 7
12	Apr 8	Support Vector Machines (SVM) (ISLR, chapter 9)
13	Apr 15	Support Vector Machines (SVM) (ISLR, chapter 9 Assignment 8
14	Apr 22	Unsupervised Learning with Clustering (ISLR, chapter 12)
15	Apr 29	Deep Learning (ISLR, chapter 10) - if time permits. **Review** - Prepare for the Final Exam. Class Project is due May 4.
16		**Review** - Prepare for the Final Exam.