Syllabus - ECON490

Applied Machine Learning in Economics

Fall 2020

Logistics

- **Credits:** 3 Undergraduate
- **Class Time:** MW 9:30am - 10:50am
- **Class Location:** Your Computer

Instructor: Julian Wade (jjpwade2@illinois.edu)

Teaching Assistants

- **OMITTED**

Please give advanced notice that you will be attending office hours. Otherwise, you might find yourself in an empty Zoom room.

This is a flipped course. Lecture videos will be posted on compass after each meeting. The course time is intended to be used for clarifying questions on lecture videos, readings, and supplementary materials and help on homework assignments and final projects. In general, I will neither lecture during the course time nor record the meeting.

If advanced notice is given for reasons such as extreme time zone difference or extenuating circumstances, I will provide recordings to these students only.

Learning Objectives

Academic

By the end of the course, students should be able to describe what is in the "black box" of machine learning. Students should have a solid understanding of when to apply specific techniques, how to validate these models, and how to compare across different methods. Furthermore, students should have an intuitive understanding of the bias-variance tradeoff for each technique.

Students should also feel comfortable programming in `R`. This includes implementing the statistical techniques learned in class and dealing with data, from loading and saving, cleaning and wrangling, exploratory data analysis, and presenting results.

Personal

Since this is a senior level course, it is my goal to help prepare you for entering the work force. If **procrastination** has been an issue in the past, this course provides ample opportunity to train good habits, much like a muscle. My general advice–that has worked wonders for me–is to buy a physical planner, allocate specific chunks of time to work on assignments for all courses, and heavily scratch off completed tasks. It is quite cathartic! Importantly, don't forget to schedule to for fun.

In the labor force, there a fewer, but larger deadlines with greater consequences for missing them. This course is intended to provide habits of self-help (see Coding Assistance Checklist). The general process is to try to

solve the problem yourself. If you cannot solve it on your own, ask a coworker. And if all else fails ask your boss. That being said, I will not leave you out in the cold when problems arise.

Teaching Philosophy

I never want to give work that is just busy work or irrelevant. If you find some assignments are a pain, know that I have assigned it for a reason. My goal is to help you learn and become a professional. This primarily a coding class, but there will be some important theory all data scientists should know.

I believe asking questions and communicating early paired with putting in the effort is the key to success not limited to this course. Remember, I will not try to overwhelm you in this course.

Any sort of discrimination is strictly prohibited and unacceptable. I will follow up with the university about any cases. Everyone is, and should feel, included.

Expectations

Of you

I expect you to start on course work early, to follow the Coding Assistance Checklist, to be prepared with questions for course time (such as questions on the muddiest point), to attend the synchronous portion, to communicate about inability about deadlines ASAP, and to ask for help when you need it.

Of me

I will only give assignments if I believe they will help you understand the material and/or be applicable in future life. I am most likely available by email from 9:00am-5:00pm central time. I will always do my best to respond within 24 hours. I will ask for periodic anonymous feedback on the course and adjust accordingly. I am teaching to help you learn.

The Course

This is an introductory applied machine learning course with applications in economics. We will discuss a wide variety of data science techniques covering using a statistical programming language `R`, data wrangling and cleaning, exploratory data analysis, inference, and prediction. Preidction constitutes the bulk of the course, where we will predict continous variables, binary variables, and multiclass variables.

Requirements

Prerequisites

- **Courses:** ECON 203, MATH 220/221
- **Programming:** None

Textbooks

- **Required** - An Introduction to Statistical Learning: with Applications in R by by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani
- **Not Required** - The Elements of Statistical Learning: Data Mining, Inference, and Prediction by Trevor Hastie, Robert Ribshirani, and Jerome Friedman

Program Downloads

- `R` - The software
- `RStudio` - The GUI
- `VS Code` - For remote real-time coding assistance

Grading

GPA	Letter	Percentage
4.0	A	[93%, ∞)
3.7	A-	[90%, 93%)
3.3	B+	[87%, 90%)
3.0	B	[83%, 87%)
2.7	B-	[80%, 83%)
2.3	C+	[77%, 80%)
2.0	C	[73%, 77%)
1.7	C-	[70%, 73%)
1.3	D+	[67%, 70%)
1.0	D	[60%, 67%)
0.0	F	[0, 60%)

I reserve the right to positively adjust grades at the end of the semester.

The final grade is borken down into **nine homework assignments** to apply the concepts learned in class, at least weekly **quizzes** to ensure the assigned reading has been read, and a **final project** to creatively apply the techniques learned in class to an individually chosen (approved by instructor) research question.

Homework	Total Percent	Final Project	Total Percent
HW 1 - Yeehaw! Data Wrangling	8%	Research Proposal	3%
HW 2 - EDA, Regression, & You	8%	Compass2g Proposal Post	3%
HW 3 - Getting Classy	8%	EDA of Selected Proposal	4%
HW 4 - Finding Validity:I Choose you!	8%	Draft of Preliminary Results	7%
HW 5 - Basis for Local Spline Time	8%	Presentation	10%
HW 6 - Forest Through the Trees	8%	Final Draft	10%
HW 7 - Rise of the Machines	8%		
HW 8 - LearNNing Deeply	8%		
Total	64%		37%

Topics

The following is an outline of topics intended to be covered in the course, time permitting. The content is subject to change due to the instructors discretion. Any changes will be announced in class, via email, and/or the course website.

1. Programming
    a. R, RStudio
    b. RMarkdown - Homework write-up
    c. VS Code - Remote assistance
    d. GitHub - Collaboration
2. Machine Learning Fundamentals
    a. Data wrangling and cleaning
    b. Bias-variance tradeoff
3. Linear Regression
    a. Multivariate
    b. Logistic
4. Classification
    a. KNN, LDA, QDA
5. Resampling & Model Selection
    a. Cross-validation

    b. Bootstrap
    c. Subset selection
    d. Shrinkage estimators
    e. PCR
6. Nonlinearities
    a. Splines
    b. Local regression
7. Regression Trees
    a. Bagging, boosting, gradient boosting
    b. Random forests
8. Support Vector Machines
9. Neural Networks
10. Unsupervised Learning
    a. Point, longitudinal
11. ML strengths and weaknesses
12. GitHub

Policies

Course Policies

There will be no make-up exams, because there are no exams.

Attendance is not mandatory. However, it is highly encouraged. Classmates may ask questions you haven't considered. You will need to use the many of the techniques discussed in the course for your final project. Hopefully, you will use these techniques throughout your career. Being as knowledgable as you can will help you on the job market.

Because homework solutions will be posted after submission, late-assignments will not be accepted without a university excuse. If you have any concerns about missing work ahead of time, please let the instructor know so accommodations can be considered.

Attendance Policy: Not Required

Student Code pertaining to student attendance

Office of the Dean of Students helps to assist students navigate the Student Code and course policies. If students will be absent for an extended period of time, they should discuss with this office.

Coding Assistance Checklist

1. Read error, check code for typos, and/or `?the_function_you_are_using` if applicable
2. Check lecture notes or video
3. Google/YouTube issue or error code
4. Check or post on HW discussion board

If completed steps 1-4 without resolve, email a TA about problem/office hours or email instructor.

Regrading Policy

All regrade requests must be submitted in writing to the instructor no more than one week after the assignment has been graded. The request must be written and include a detailed summary of why you believes the grade they received was incorrect. I will regrade the entire assignment, so the grade may go up or down. Consequently, students should only request a regrade if they are very confident that the original grade they received was incorrect.

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 may be located on the Economics Website, including information about the Economics Tutoring Center, other tutoring centers.

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.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policies. Ignorance is not an excuse for any academic dishonesty. 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.

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

Emergency Response Recommendations

Emergency response recommendations.

I encourage you to review this website and the campus building floor plans website within the first 10 days of class.

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 the registrar's website 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. More information may be found here.

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. Other information about resources and reporting is available here.

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:

Counseling Center

- Information: 217-333-3704
- Location: Room 206, Student Services Building 610 East John Street, Champaign, IL
- Appointment: Scheduled for same day, recommend calling at 7:50 a.m.

McKinley Mental Health Information:

- 217-333-2705
- **Location:** 3rd Floor McKinley Health Center 1109 South Lincoln, Urbana, IL
- **Hours:** 8 a.m. – 5 p.m., Monday through Friday Appointment: Scheduled in advance.

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.

Academic Dates and Deadlines

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