ECONOMIC MODELING & SIMULATION

IE University
Professor: **JAVIER CEREZO LAFUENTE**
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Academic year: 23-24
Degree course: SECOND
Semester: 2º
Category: COMPULSORY
Number of credits: 3.0
Language: English

PREREQUISITES

DATA SCIENCE FOR ECONOMICS

SUBJECT DESCRIPTION

The goal of this course is to explore the intersection between data science and economics, with a focus of exploring economic problems with Python. The course will therefore have a pragmatic spirit, and will build upon the Programming I, Programming II, and Data Science courses.

The course will be organized along three areas of knowledge: Bayesian inference, Time Series, and Exploratory analysis and regression, plus a few additional minor topics. These broad fields have broad applications in Economics, and Python counts with powerful libraries to tackle them. We will cover examples ranging from demographics, to forecasting of economics, to finance, although the tools that the students will be equipped with after the course can be applied to numerous fields.

OBJECTIVES AND SKILLS

The main objective of this course is to understand how to apply econometrics and data science to the study of economic modelling and how Data Science can help to better understand economic and simulation models on a theoretical and practical level.

METHODOLOGY

This course does require basic mathematical knowledge (essential calculus and algebra) and basic programming experience (an introductory course to Python and some knowledge of NumPy and Pandas). Because the nature of the material is mostly practical, it is required from the students to follow the classes, to put some effort in practicing the examples shown, and to devote some time to the homework.

Students are welcome to schedule a meeting with the professor or to communicate with him via email / message in case they require help.

Since the course involves a lot of programming, students should bring their computers to every class. The recommended IDE (integrated development environment) for the class will be Repl.it, although students are welcome to use more traditional IDEs such as VSCode, Pycharm, Spyder, or even a classic editor (vim, emacs, etc.) and a terminal if they wish. All these alternatives are free, so students need not spend any money on any commercial product.

Teaching methodology	Weighting	Estimated time a student should dedicate to prepare for and participate in
Lectures	26.67 %	20 hours
Discussions	6.67 %	5 hours
Exercises	33.33 %	25 hours
Group work	6.67 %	5 hours
Other individual studying	26.67 %	20 hours
TOTAL	100.0 %	75 hours

PROGRAM

SESSION 1 (LIVE IN-PERSON)

Presentation and exploratory analysis

We will describe the contents of the program, as well as the aims and guidelines of the course. We will walk through the tools, the development environment and the programming language.

We will learn how to load data into Python and explore the variables of a dataset. We will learn how to construct new variables and derive insights from data with the tools that Pandas provides us with.

SESSION 2 (LIVE IN-PERSON)

Linear least squares

We will write our own least squares fit and explore the properties of the linear regression. We will also write functions to plot the results and the residuals and estimate the goodness of the fit.

SESSION 3 (LIVE IN-PERSON)

Regression

We will cover the theory and practice behind multiple linear regression, using statsmodels and other standard Python libraries.

SESSION 4 (LIVE IN-PERSON)

Logistic regression

Logistic regression is a variation on the regular regression that is used mostly in classification problems.

SESSION 5 (LIVE IN-PERSON)

Time Series (1/3)

We will cover a quick history of time series and its applications. We will see where to find time series and which issues are typically found in time series datasets. We will also learn how to construct synthetic time series.

SESSION 6 (LIVE IN-PERSON)

Time Series (2/3)

We will cover simulations of time series with random generators, including a random walk and examples from science. We will learn statistical models for time series, starting with autoregressive models, moving average models, and ARIMA models.

SESSION 7 (LIVE IN-PERSON)

Time Series (3/3).

We will cover state space methods, such as the Kalman filter applied to a linear Gaussian model. We will also see how to generate and select features for a time series.

SESSION 8 (LIVE IN-PERSON)

Midterm

SESSION 9 (LIVE IN-PERSON)

Bayesian inference (1/4)

We will cover probabilities in Python, including conditional probabilities, laws of probability, and several examples with real datasets.

SESSION 10 (LIVE IN-PERSON)

Bayesian inference (2/4)

We will cover Bayes's Theorem, with Python applications to several classic problems in probability, including the Monty Hall Problem. We will also learn about distributions and how to update our priors.

SESSION 11 (LIVE IN-PERSON)

Bayesian inference (3/4)

We will cover the binomial distribution, bayesian estimation, the binomial likelihood function, and bayesian statistics. We will also study the train problem, which includes topics such as sensitivity to prior and power laws.

SESSION 12 (LIVE IN-PERSON)

Bayesian inference (4/4)

We will cover a few more advanced topics on Bayesian inference.

SESSION 13 (LIVE IN-PERSON)

(Only if we progress fast enough) Graphs

If we progress fast enougth we will cover the definition of graphs, their visual representations, the package NetworkX, generation of graphs, connected graphs, and Erdos-Rényi graphs.

SESSION 14 (LIVE IN-PERSON)

Wrap up session

We will use this session to review topics that are not clear or that need further clarification before the final.

SESSION 15 (LIVE IN-PERSON)

Final exam

BIBLIOGRAPHY

Compulsory

- Aileen Nielsen. *Practical Time Series Analysis: Prediction with Statistics and Machine Learning.* O'Reilly Media, Inc, USA. ISBN 1492041653 (Printed)
- Allen Downey. *Think Bayes: Bayesian Statistics in Python.* O'Reilly Media, Inc, USA. ISBN 9781492089469 (Printed)

EVALUATION CRITERIA

Criteria	Percentage	Comments
Class Participation	10 %	
Individual Work	30 %	
Intermediate Tests	30 %	
Final Exam	30 %	

PROFESSOR BIO

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JAVIER CEREZO LAFUENTE

Javier Cerezo is an adjunct professor at IE University. He holds an MSc in aerospace engineering from UPM and an MBA from The University of Chicago. He has developed his career in Airbus, where he worked in aeroelasticity and structural dynamics, McKinsey, where he led strategy and operations projects in Latin America, and Amazon, where he was product manager. He now works as Associate Director of Data Science in Novartis.

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OTHER INFORMATION

GENERAL OBSERVATIONS

Each student has four attempts over two consecutive academic years to pass this course. Dates and location of the final exam will be posted in advance and will not be changed. Students must attend at least 70% of the sessions. Students who do not comply with the 70% attendance rule will receive a 0.0 on their first and second attempts and go directly to the third one (they will need to enroll in this course again the following academic year). Students who are in the third or fourth attempt should contact the professor during the first two weeks of the course.

ATTENDANCE

Attendance is mandatory at IE University, as it is an essential factor of IE ?s learning methodology. While we do closely monitor attendance in each course, we also consider our students responsible for their own agenda and commitments, as adult university students. With that in mind, each student may miss up to 30% of the sessions within a given course and still maintain the possibility of passing that given course. This 30% "buffer" is to be used for any absences, such as: illnesses, personal emergencies, commitments, official/governmental matters, business and/or medical appointments, family situations, etc. Students should manage their various needs, and situations that may arise, within that 30% buffer. If a student is absent to more than the allowed 30% of the sessions (regardless of the reason), s/he will obtain a 0.0 grade for that course in both the ordinary and extraordinary calls of the current academic year, and s/he will have to retake the course during the following academic year. Having established the rule, we strongly discourage to use this buffer as granted, we highly recommend to attend 100% of the classes as it will improve your learning outcomes, it will increase the class performance and it might improve your participation grade. Extreme cases involving emergencies such as: extended hospitalizations, accidents, serious illnesses and other contexts involving force majeure, are to be consulted with the Program Management team for assessment of the situation and corresponding documentation, so that Program Management can support and guide each student optimally.

CODE OF CONDUCT IN CLASS

1. Be on time. Students arriving more than 5 minutes late will be marked as "Absent". Only students that notify in advance in writing that they will be late for a specific session may be granted an exception (at the discretion of the professor). Students attending online must always have their cameras on during the session or risk being marked absent.
2. If applicable, bring your name card and strictly follow the seating chart. It helps faculty members and fellow students learn your names.
3. Do not leave the room during the lecture: Students are not allowed to leave the room during lectures. If a student leaves the room during lectures, he/she will not be allowed to re-enter and, therefore, will be marked as "Absent". Only students that notify that they have a special reason to leave the session early will be granted an exception (at the discretion of the professor).
4. Do not engage in side conversation. As a sign of respect toward the person presenting the lecture (the teacher as well as fellow students), side conversations are not allowed. If you have a question, raise your hand and ask it. If you do not want to ask it during the lecture, feel free to approach your teacher after class. If a student is disrupting the flow of the lecture, he/she will be asked to leave the classroom and, consequently, will be marked as "Absent".
5. Use your laptop for course-related purposes only. The use of laptops during lectures must be authorized by the professor. The use of Social Media or accessing any type of content not related to the lecture is penalized. The student will be asked to leave the room and, consequently, will be marked as "Absent".
6. No cellular phones: IE University implements a "Phone-free Classroom" policy and, therefore, the use of phones, tablets, etc. is forbidden inside the classroom. Failing to abide by this rule entails expulsion from the room and will be counted as one absence.
7. Escalation policy: 1/3/5. Items 4, 5, and 6 above entail expulsion from the classroom and the consequent marking of the student as "Absent." IE University implements an "escalation policy": The first time a student is asked to leave the room for disciplinary reasons (as per items 4, 5, and 6 above), the student will incur one absence, the second time it will count as three absences, and from the third time onward, any expulsion from the classroom due to disciplinary issues will entail 5 absences.

RETAKE POLICY

Any student whose weighted final grade is below 5 will be required to sit for the retake exam to pass the course (except those not complying with the attendance rules, who are banned from this possibility). Grading for retakes will be subject to the following rules:

The retakes will consist of a comprehensive exam. The grade will depend only on the performance on this exam; continuous evaluation over the semester will not be taken into account.
The exam will be designed bearing in mind that the passing grade is 5 and the maximum grade that can be attained is 8 out of 10.
Dates and location of the retakes will be posted in advance and will not be changed.

PLAGIARISM / ACADEMIC HONESTY

Plagiarism is the dishonest act of presenting another person's ideas, texts or words as your own.

This includes in order of seriousness of the offense:

providing faulty sources;
copy-pasting material from your own past assignments (self-plagiarism) without the instructor's permission;
copy-pasting material from external sources even while citing them;
using verbatim translations from sources in other languages without citing them;
copy-pasting material from external sources without citing them;
and buying or commissioning essays from other parties.
IEU students must contact the professor if they don't know whether the use of a document constitutes plagiarism. The professor will advise the student on how to present said material. All written assignments have to be submitted through Turnitin, which produces a similarity report and detects cases of plagiarism. Professors are required to check each student's academic work in order to guarantee its originality. If the originality of the academic work is not clear, the professor will contact the student in order to clarify any doubts. In the event that the meeting with the student fails to clarify the originality of the academic work, the professor will inform the Director of the Bachelor Program about the case, who will then decide whether to bring the case forward to the Academic Ethics Committee. Very high similarity scores will be automatically flagged and forwarded to the Academic Ethics Committee. Plagiarism constitutes a very serious offense and may carry penalties ranging from getting a zero for the assignment to expulsion from the university depending on the severity of the case and the number of times the student has committed plagiarism in the past.