Course Syllabus

ESI 4611: Advanced Data Analytics

Spring 2022

Instructed by Meserret Karaca and Aleksandr M. Kazachkov

Overview

Credits	3 (no pass/fail allowed)
Meetings	Tues. 8:30–10:25am ET (pds. 2–3) in Weimer 1064 and Thurs. 8:30–9:20am ET (pd. 2) in Weimer 1094
Website	Canvas through `elearning.ufl.edu`

Instructor:	Meserret Karaca (she/her/hers)
Email	`mkaraca@ufl.edu` (see Communication Guidelines below)
Office	Weil 401
Office hours	TBD, or by appointment
Phone	N/A

Instructor:	Aleksandr M. Kazachkov (he/him/his)
Email	`akazachkov@ufl.edu` (see Communication Guidelines below)
Office	Weil 401B or `https://ufl.zoom.us/j/91979933355`, password: 32611
Office hours	Tues. 10:30–11:30am ET, Thurs. 9:30–10:30am ET, or by appointment
Phone	+1.352.273.4902

Syllabus Contents

1 Course Description and Objectives

Catalog Description of ESI 4611 **3 Credits (Letter Grade)**

Second course in the data analytics ISE sequence that focuses on how and why algorithms work using an application-oriented approach. Studies advanced analytical and learning models that enhance decision making by converting data to information. Provides insights into how to choose the most effective tool for implementing a specific model.

Prerequisite: ESI 4610 (Introduction to Data Analytics) with a minimum grade of C.

Instructor's Description of the Class Our focus is on *prescriptive analytics* inside of a framework that relies on predictive and descriptive analytic tools. Specifically, through a variety of *matching problems* that arise in applications, we will learn to model and implement optimization problems within a broader process built on predictive insights, incorporate preferences and incentives into our algorithms, and critically evaluate the input (data) for and output of algorithms. To succeed in this class, students should already have experience writing Python code. It will also be helpful to have familiarity with basic concepts in optimization, such as the definition of *variable*, *constraint*, and *objective function*, and how to formulate a linear program.

Learning Outcomes By the end of this course, you will be expected to:

- Identify a matching problem in practice and formulate an optimization model with appropriate variables, constraints, and objective function for the problem.
- Implement Python code to solve prescriptive analytics problems while providing relevant input from predictive analytics methods.
- Model preferences and analyze incentives within analytics tasks.
- Evaluate algorithms via metrics relevant to all parties affected by the underlying task.
- Test and improve the performance of analytical models.

The course objectives will be pursued through exercises in various forms to help you understand and communicate these concepts, including assignments asking you to implement and analyze models of real-world phenomena and analytics algorithms, and a final project.

2 Guidelines on Communication and Class Meetings

Communication Guidelines

Canvas	Please use Canvas Discussions to ask all nonconfidential course questions.
Email	Emails regarding this course should have "[**ESI 4611**]" in the beginning of the Subject line, so your email can be answered more quickly.
Meetings	If you need to schedule a face-to-face meeting for any reason, please reach out over email. You will need to wear an appropriate face covering for the entirety of the meeting.

3 Tentative Course Schedule

Wk	Day	Topics*	Assignments
1	Jan 06	Intro to applied analytics for social good	HW 0 out (ungraded)
2	Jan 11	Prescriptive analytics: matching problems	HW 0 due, HW 1 out
3	Jan 18	Prescriptive analytics in Python	
4	Jan 25	Preferences and stable matchings	HW 1 due, HW 2 out
5	Feb 01	Incentives in decentralized markets	
6	Feb 08	Designing incentive-compatible mechanisms	HW 2 due, HW 3 out
7	Feb 15	Project selection and team formation	
8	Feb 22	Generating synthetic data	HW 3 due, HW 4 out
9	Mar 01	Predictive analytics: prediction and inference tasks	HW 4 due
10	Mar 08	Spring Break	
11	Mar 15	Overfitting and regularization	HW 5 out
12	Mar 22	TBD ML topic	HW 5 due, HW 6 out
13	Mar 29	TBD ML topic	
14	Apr 05	Algorithmic fairness considerations	HW 6 due, HW 7 out
15	Apr 12	Fair allocations of resources	
16	Apr 19 Apr 21	Project presentations Reading days	HW 7 due
17	Apr 25 Apr 29	Exam week Exam week	**Project due**

*Subject to change.

4 Class Materials

There is no required textbook or materials & supplies fee. I suggest the following references:

- Ani Adhikari, John DeNero, David Wagner, *Computational and Inferential Thinking: The Foundations of Data Science*, 2021, https://inferentialthinking.com/
- Avrim Blum, John Hopcroft, and Ravindran Kannan, *Foundations of Data Science*, 2018. https://www.cs.cornell.edu/jeh/book.pdf
- Felix Brandt, Vincent Conitzer, Ulle Endriss, Jérôme Lang, Ariel D. Procaccia, *Handbook of Computational Social Choice*, ISBN 9781107060432

  Free version: http://www.cambridge.org/download_file/898428, password `cam1CSC`.
- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, *An Introduction to Statistical Learning: With Applications in R, Second Edition*, 2021, DOI 10.1007/978-1-0716-1418-1, https://www.statlearning.com

  Repository with related Python code: https://github.com/JWarmenhoven/ISLR-python.
- Michael Kearns, Aaron Roth, *The Ethical Algorithm*, 2019, ISBN 9780190948207
- Brady Neal, *Introduction to Causal Inference from a Machine Learning Perspective*, 2020 https://www.bradyneal.com/causal-inference-course#course-textbook
- Cathy O'Neil, *Weapons of Math Destruction*, 2016, ISBN 9780553418835
- Alvin E. Roth, *Who Gets What — and Why: The New Economics of Matchmaking and Market Design*, 2016, ISBN 9780544705289
- Wes McKinney, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython*, 2nd Edition, 2018, ISBN 9781491957660

  Repository with related Python code: https://github.com/wesm/pydata-book.
- Supplemental reading and lecture notes may be provided.

You are expected to take your own class notes, but any slides that are prepared for the course will be made available to you. These are not intended to replace the actual lecture, but rather to serve as an outline. *Any material I distribute to the class should be kept strictly within this class; without my express permission, you cannot share course content (aside from this syllabus) to anyone not enrolled in the class.*

Software Use We will use the coding language Python. It will be required to learn to use Jupyter notebooks. All faculty, staff, and students of the University of Florida are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

5 Professional Component (ABET)

This course supports the ISE undergraduate program educational objectives of producing graduates who

- "will be successful professionals using industrial and systems engineering skills",
- "can acquire advanced knowledge through continuing education or advanced degree programs", and
- "can become active leaders in their profession and/or community".

Relation to Program Outcomes (ABET)

Outcome	*Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	
3. An ability to communicate effectively with a range of audiences	
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Medium
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	High
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	High

6 Grading Policy, Assignments, Exams, and Effort

Your course grade will be based on these criteria:

Participation	10%
Homework	60%
Project	30%

You should expect to spend ~6 hours on this class per week, on average, outside of lectures.

The (tentative) grading scale is: A = $[93.\bar{3}, 100]$, A⁻ = $[90, 93.\bar{3})$, B+ = $[86.\bar{6}, 90)$, B = $[83.\bar{3}, 86.\bar{6})$, B⁻ = $[80, 83.\bar{3})$, C+ = $[76.\bar{6}, 80)$, C = $[73.\bar{3}, 76.\bar{6})$, C⁻ = $[70, 73.\bar{3})$, D+ = $[66..\bar{6}, 70)$,

D = $[63.\bar{3}, 66.\bar{6})$, D$^-$ = $[60, 63.\bar{3})$, E = [0,60). Some assignments or exams may be curved if the average is too low. See also the Undergraduate Academic Regulations on Grading at catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx.

6.1 Attendance & Participation

Attendance is mandatory, but will not be directly recorded. Participation will be based on in-class activities and Canvas discussions; active involvement in both is highly encouraged. In-class activities will include ungraded work in small groups approximately once a week to reinforce class concepts and gain hands-on experience. You will be able to use your notes.

6.2 Homework

You must submit your own homework. You *are* allowed to discuss problems with other students in the class, such as on Canvas, but you *cannot* share complete answers with each other. If you have attempted a problem on your own but could not find a solution, your next step should be to talk to your classmates, the TA(s), or me. You may also refer to online resources, but do not abuse this policy: if you find a solution or partial solution to a problem, leave it aside and only refer to it as a last resort, after exhausting the options of seeking help via Canvas, the TA(s), and me. Even at that point, the best thing to do is to use that outside resource partially, to get a sense of a path to the solution, and then to attempt the problem on your own again. If you do read a solution from an external source, I advise you to internalize *how* and *why* the solution works, possibly with the help of the TA(s)/me. In that situation, you should write your own solution while not looking at the external source, to ensure you really understood it.

You *must* properly attribute your sources at the start of your solution to each problem, even if it is yourself (via "Attribution: self"). For example, if Bob asks Alice for advice on question 3, then Bob would write at the beginning of their solution to question 3: "Attribution: Discussed with Alice". You will not lose points for telling the truth.

Late Assignment Policy For all but the last homework, late submissions are allowed with no penalty for up to a week after the official due date, but their grading may be substantially delayed. Any assignments submitted more than 7 days after the due date will not be graded. Special arrangements will be made in the event of an *excused absence*. Excused absences must be in compliance with University policies in the Undergraduate Catalog (catalog.ufl.edu/UGRD/academic-regulations) and require appropriate documentation.

6.3 Exams

There is no exam scheduled for this course.

6.4 Project

You will work on a data analytics team project to practice the skills learned during the class. The goal of the project is to go through the complete data analytics process to answer questions about a topic of your own choosing. The project work consists of the following stages: data acquisition, data analysis, visualization, and presentation of results. The project is a team assignment; you will be a part of a group of 2 to 4 students. There are several graded deliverables that will make up your final project score:

1) Project proposal (PDF file)

2) Final project report (PDF file)

3) Project presentation (file or link from your favorite presentation software)

4) Code (Python and/or Jupyter notebook files)

Projects teams will be formed in the middle of the semester. Each team will develop a proposal that will be due in week 8. Students will be provided with a template for the final report and rubrics for each deliverable.

6.5 Regrade Policy

Every student may request a regrade of their assignments and exams. Only one regrade will be considered per assignment/exam. The deadline for requesting a review is two weeks after the graded work is returned to the class, even if you were not present that day. The request for regrading must be done in writing together with a detailed description of the reasons why you believe there was a mistake in your grade. Note that requesting a regrade implies that the *entire* assignment may be reviewed. This means points could actually be *deducted*.

7 Honor Code

All course participants (myself and students) must abide by the requirements and spirit of the University of Florida Student Honor Code, which can be found at

https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/.

Every University of Florida student is subject to the following Honor Pledge:

> We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity by abiding by the Student Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment."

You are obligated to report any condition that facilitates academic misconduct to appropriate personnel. Any honor code violations will be handled by the University's honor code process.

In this course, collaboration on exams is expressly forbidden, as is the exchange of complete answers to homework assignments prior to submission. Please ask if at any point you need clarification regarding the honor code expectations, or you need assistance in any way in complying with the honor code.

8 Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback is available at gatorevals.aa.ufl.edu/students. Students will be notified when the evaluation period opens, and can complete evaluations through the

email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via ufl.bluera.com/ufl. Summaries of course evaluation results are available to students at gatorevals.aa.ufl.edu/public-results.

9 Course Recording

Instructor Recording of Class Sessions
Class sessions may be audiovisually recorded and made available for private review. **If you participate in class, you acknowledge that your voice and potentially your image, such as your video or profile picture, may be captured on this recording. If you do not consent, you must inform the instructor(s) as soon as possible, to discuss alternatives.** As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited. In particular, you are not permitted to distribute recordings of this class to anyone not enrolled.

Student Recording of Class Sessions
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are: (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

10 Special Accommodations

If you require special accommodations, you should reach out as early as possible in the semester to discuss how we can ensure accessibility for you, and you should connect with the Disability Resource Center by visiting disability.ufl.edu/students/get-started.

11 Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see the Notification to Students of FERPA Rights and visit registrar.ufl.edu/ferpa.

12 Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. We aspire to educate students to become future leaders capable of creating diverse and inclusive work cultures wherever their careers may take them.

It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. If you feel like your performance in class is being impacted by discrimination or harassment of any kind please contact your instructor or any of the following:

- Your academic advisor or Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@ufl.edu

13 Land Acknowledgement

A Land Acknowledgement is a formal statement that recognizes and respects Indigenous Peoples as traditional stewards of this land, as well as their enduring relationship with it. Specifically, the University of Florida is located on the traditional territory of the Timucua and Seminole tribes. It is important to recognize and reflect on the context in which our (land grant) institution of higher learning exists, and that we are not only acknowledging the history, but also identifying an ongoing process of marginalization and colonialism. I encourage you to read the history of Indigenous Peoples in Florida and the rest of the United States, and consider what you can do to support current indigenous populations.

14 Campus Resources

14.1 Health and Wellness

Take care of yourself by paying attention and devoting time to your physical and mental wellbeing. Do not hesitate to reach out to me or a qualified professional if you are ever in need of support. Resources that are available to you include:

- University Police Department: 352-392-1111 (call 911 for emergencies).
- U Matter, We Care: If you or someone you know is in distress, please contact umatter@ufl.edu or call 352-392-1575 (a nighttime and weekend crisis counselor is available). The U Matter, We Care Team can help connect students to many other helping resources

available including, but not limited to, Victim Services, Housing Staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. https://umatter.ufl.edu

- Counseling and Wellness Center: Visit the center or call 352-392-1575 for information on crisis and non-crisis services. https://counseling.ufl.edu
- Student Health Care Center: Visit the SHCC website or call 352-392-1161 for 24/7 information to help you find the care you need. https://shcc.ufl.edu
- UF Health Shands Emergency Room / Trauma Center: For immediate medical care call 352-733-0111 or go to the emergency room at 1515 SW Archer Road, Gainesville, FL 32608. https://ufhealth.org/uf-health-shands-emergency-room-trauma-center
- **Sexual Discrimination, Harassment, Assault, or Violence** If you or someone you know has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence, contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, 352-273-1094, title-ix@ufl.edu. https://titleix.ufl.edu
- Sexual Assault Recovery Services (SARS): Sexual assault counseling available through the Student Health Center, 352-392-1161.

14.2 Academic Resources

- e-Learning Technical Support: 352-392-4357 (option 2) or learning-support@ufl.edu.
- Career Resource Center: Career assistance and counseling, Reitz Union, 352-392-1601.
- Library Support: Receive assistance with using the libraries or finding resources.
- Teaching Center: General study skills and tutoring, Broward Hall, 352-392-2010 or 352-392-6420.
- Writing Studio: Help brainstorming, formatting, and writing papers, 302 Tigert Hall, 352-846-1138.
- The Care Area: Address student complaints, create success plans and ongoing support for students in distress, and help students complete necessary medical petition paperwork for all courses or medical withdrawals from a course.
- Distance Learning Complaints: Student complaints for online distance learning programs.