

## Network Analytics and Machine Learning

CIS4930/6930

**Class Periods:** Tues T 10:40 AM – 11:30 AM (Period 4), Thurs R 10:40AM – 12:35 AM (Period 4 – 5)

**Location:** Tues LIT 109 / Thurs LIT 205 (Little Hall)

**Academic Term:** Spring 2022

### Instructor:

Name: Prof. Ahmed Helmy

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Office Phone Number: (352) 294-6652

Office Hours: Days of week: TBA, hours available: TBA, office location: CSE426 & virtual

### Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Please contact through the Canvas website

- Name, email address, office location, office hours: TBA

### Course Description

(3 credits) *Overview:* The overarching theme of this course is the application of data analytics, statistical, and machine learning techniques to problems in various networked systems. Example target networks include computer, mobile and sensing networks, as well as social, transportation, and health networks and systems (such as disease spread, infection and epidemics).

*Who is this class for?* It is meant for graduate students (CIS6930), and undergraduate students at junior and senior levels (CIS4930) with deep interest in the areas of networks and networked systems, as well as applied machine learning and data analytics.

**Prerequisites:** Programming skills (using Python, Java, or other) at the level of COP 3502 or 3503 or above. Knowledge of data analysis & statistics, machine learning, and computer networks is a plus, but not required.

*Topics Description:* This course covers topics of data-driven network analytics and applied machine learning techniques to the area of networked systems. The first half focuses on computer, mobile (and human-related) networks measurements, disease infection networks, contacts/encounter modeling and contact tracing technologies. Related methods of graph models, encounter graphs, small world networks, contact estimation, analysis and simulation techniques are discussed and applied to real-world datasets. The second half focuses on advanced data mining and applied machine learning techniques, including classification, clustering, prediction/forecast, and generative modeling. A practical project is conducted to apply such techniques to a large library of network traces and use them in the design of intelligent networked systems.

### Focus:

- What this course *is*: The focus throughout this class is on networking related problems and applications, with careful attention to concepts of analysis, modeling, and design of systems and services, as driven (and informed) by the data interpretation and its analytical insights (as obtained by statistical and machine learning tools).
- What this course *is not*: The focus is *not* on the mathematical derivations and proofs of machine learning algorithms, probability, or related optimization theory.

Skills acquired in this class should emphasize and supplement deep understanding of two main areas: 1- networked systems analysis, modeling, and design, and 2- data analytics, and *applied* machine learning (ML).

Deep understanding of concepts, coupled with practical analytical and machine learning skills, are essential for future networking research and industry, that would greatly help in understanding today's networks, and designing networks of the future.

A major semester-long group project is required (described below).

*Lecture progress:* The lecture series starts by a set of lectures on fundamentals, concepts, and practical problems of networked systems. The lectures shall discuss several datasets and applications in the areas of networks in general, including computer and mobile networks, vehicular and transportation networks, disease spread networks, among others. Then, tools and packages for statistical analyses and machine learning (ML) will be used and applied to understand trends in the data, establish models and simulations, and design and improve applications and services. The material in this course is *not* intended to go deep into the mathematics of ML or deep networks unless necessary, and *no* proofs will be needed. It is an *applied* course with focus on systems and applications. The lectures are designed to be interactive and engaging. Throughout the semester, related experiments shall be assigned (to be submitted in groups), to build familiarity with the statistics and ML tools and packages used. Especially in the second half of the semester, heavy student engagement is necessary and needed in the form of topic presentations, project presentations and demos. These presentations and demos are conducted in groups.

*Groups:* During the initial weeks, the students will form groups for the project and experiments. Every group gets to choose a topic to formulate a problem for the project. Also, each group is assigned a project presentation and demo slots. The weeks that follow cover specific topics and problems based on lists of readings (provided by the instructor and proposed by the students) and based on the projects progress. The last lecture of class usually includes slots for students to demo their projects and results.

*Projects:* This course relies heavily on students' own effort and experimentation. It is a hands-on course where assignments and experiments are conducted by the students. The students are also involved in working in teams/groups on a semester project.

Students shall carry out a semester-long project with a group, in addition to several assignments to build the required skills and get familiar with several datasets (e.g., of network and mobility measurements, contacts/encounter traces, etc.). There will be presentations with the group towards the 2nd half of the semester and a demo session at the end to showcase the outcome/output of the various projects. Typically, each group consists of 3-5 students, but details to be further discussed with the instructor in the first few weeks.

All projects are expected to be practical and conducted to apply the skills and techniques acquired to a large library of network traces, and use them in problem solutions, understanding and modeling of existing systems, and/or the design of future intelligent networked systems.

*Project Milestones:* The term project has four main milestones: (1) an initial project proposal (~2 pages) due around the first ¼ of class, (2) a final project proposal (3~4 pages) due around the mid point of the semester, (3) an initial draft of the project report (~8 pages) due around the ¾ point of class, and (4) the final project report (~12 pages) due during the last lecture.

It is expected that the students utilize the tools and themes below in their experiments and projects.

*Tools and Themes:* (may differ from one semester to another)

*Tools:* Most assignments and projects will be using Python and related tools, packages and libraries. These may include Numpy, Pandas, Matplotlib, Scipy, Scikit-learn, TensorFlow, among others, and will depend largely on the choice of projects by the various groups. In general, knowledge/usage of Anaconda and Jupyter notebooks is a plus.

*Themes:* Although student groups are free to choose their own topics for their projects, the projects need to be closely related to the class topics and get the instructor's approval. Also, it is highly recommended to choose from the 'themes' if possible. The themes include: – multi-dimensional classification of campus users using network measurements – analysis of disease (e.g., Covid-19) spread networks data – distance estimation using Bluetooth data – design of shared transportation services using trip data.

### ***Materials and Supply Fees***

N/A

### ***Required Textbooks and Software***

*Textbooks and readings:* There are no required textbooks for this course. The main readings will come from reading lists provided by the instructor on network measurements, analytics, modeling, simulation and applications. In addition, to cover some background on statistical tools, packages, and concepts, students can make use of the following books: [these books are not the main source of lecturing on networks, but are partly used for ML, and are useful references for students]

### ***Recommended Materials***

- Recommended book: S. Raschka, V. Mirjalili, "Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2", 3rd Edition, 2019, ISBN 9781789955750
- Optional (but not required) book: C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006. ISBN 0387310738.
- More readings (mainly on mobility modeling and networked systems) and references to resources (software and datasets) shall be provided by the instructor.

### ***Student responsibilities:***

- Attendance, class discussions, weekly meaningful posts (on Canvas discussion boards), paper readings as/if needed
- Participate in two group presentations: topic presentation, project presentation
- *High quality* final project report and demo
- Team work, assignment and experiments evaluation

The experiments are carried out in groups of students with combined reports. Each individual should understand and be able to perform the experiments on his/her own (there may be random pop quizzes to test this ability). Students will also be required to design parts of new experiments. The students will also be asked to write reviews for some papers that will be presented in class.

Instructions for the project proposal and report will be posted on the web in as much detail as possible. Similarly, instructions for performing experiments and samples of reviews will be posted.

### ***F2F Course Policy in Response to COVID-19***

We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email [covid@shcc.ufl.edu](mailto:covid@shcc.ufl.edu)) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

### ***Class Expectations, Make-Up Policy, and Attendance***

**Make-Up Policy** – There is a 10% penalty for submissions that are late (maximum 48 hours after the initial deadline). Requests for extreme circumstances must be requested in writing preferably before the due date. Excused absences must be consistent with university policies in the [Undergraduate Catalog](#) and the [Graduate Catalog](#) and require appropriate documentation. Additional information can be found in [Attendance Policies](#).

### ***Evaluation of Grades***

<b>Assignment</b>	<b>Total Points</b>	<b>Percentage of Final Grade</b>
Paper Discussions & Quizzes	100	13%
Assignments (3)	100 each	27%
Topic Presentation	100	15%
Project Presentation	100	20%
Project Report	100	25%
		100%

### ***Grading Policy***

<b>Percent</b>	<b>Grade</b>	<b>Grade Points</b>
91.5 - 100.0	A	4.00
89.5 - 91.4	A-	3.67
87.5 - 89.4	B+	3.33
81.5 – 87.4	B	3.00
79.5 - 81.4	B-	2.67
77.5 - 79.4	C+	2.33
71.5 – 77.4	C	2.00
69.5 - 71.4	C-	1.67
67.5 - 69.4	D+	1.33
61.5 - 67.4	D	1.00
59.5 - 61.4	D-	0.67
0 - 59.4	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

### ***Students Requiring Accommodations***

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

### ***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 in a professional and respectful manner is available at <https://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 <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

### ***University Honesty Policy***

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the 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.” The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### ***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. 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 Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, [rbielling@eng.ufl.edu](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

### ***Software Use***

All faculty, staff, and students of the University 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.

### ***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: <https://registrar.ufl.edu/ferpa.html>

### ***Campus Resources:***

#### ***Health and Wellness***

##### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**Counseling and Wellness Center:** <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

##### **Sexual Discrimination, Harassment, Assault, or Violence**

If you or a friend 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](mailto:title-ix@ufl.edu)

##### **Sexual Assault Recovery Services (SARS)**

Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

## Academic Resources

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.  
<https://lss.at.ufl.edu/help.shtml>.

**Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling.  
<https://www.crc.ufl.edu/>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.  
<https://teachingcenter.ufl.edu/>.

**Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers.  
<https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus**: <https://care.dso.ufl.edu>.

**On-Line Students Complaints**: <http://www.distance.ufl.edu/student-complaint-process>.