CAP5610: Machine Learning

Room: CB2 O206, MoWe 4:30PM-5:45PM

Instructor: Dr. Yanjie Fu, Assistant Professor of Computer Science
E-mail: yanjie.fu@ucf.edu; Phone: (407)823-4993; Blackboard: CAP5610@Webcourses
Office: HPAII-238B
Office Hours: Monday Wednesday 3:30PM-4:30PM

Lead TA: Wangyang Ying; Email: yingwangyang@knights.ucf.edu
Lead TA Office hours: Tuesday Thursday 2:45PM-4:00PM (in person)
Lead TA's Office: Health and public affairs 2, Room: 0238L

Grader TA: Soumik Ghosh, soumikghosh@knights.ucf.edu
Grader TA Office hours: TBD
Lead TA's Office: Health and public affairs 2, Room: 0238L

Prerequisite(s): 1) CAP 4630 Introduction to Artificial Intelligence or registration is contingent upon the Consent of the Instructor.; 2) programming skills in python

Suggested Preparation Before Classes: 1, practice your python programming skills, for example, use python to implement the bubble sorting algorithm and use python to develop a course registration system. 2, get familiar with some machine learning libraries (e.g., pandas, scikit-learn, pytorch); 3, review your probability, statistics, hypothesis testing, and Baysian methods course materials; 4, review your database, data structure, algorithm course materials; 5, review your linear algebra, discrete math, linear regression course materials; 6, if you have learned optimization or operation research, review various optimization methods, such as, maximized likelihood estimation, maximize a posterior, MCMC, expectation-maximization. 7, select and practice a machine learning competition in Kaggle.com

Text Book: There is no required textbook. Most of the material (slides and handwritten notes) for the course will be provided on the course webpage.

Recommended Readings:
- ``Pattern Recognition and Machine Learning'', by Christopher M. Bishop, Springer, ISBN: 0-387-31073-8. (A statistical perspective. Fundamental yet challenging.)
- ``Introduction to Data Mining'', by Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Addison Wesley, ISBN: 0-321-32136-7, 2005. (A CS algorithmic perspective. Easy to read.)

- ``Deep Learning'', by Ian Goodfellow, Yoshua Bengio, and Aaron Courville. Available for free online (http://www.deeplearningbook.org/) or available for purchase. 2016.
- ``Reinforcement Learning: An Introduction'', by Richard S. Sutton and Andrew G. Barto. Second Edition. MIT Press, 2018

Course Description and Objectives:

(1) To introduce the ideas, intuitions, methodologies, algorithms, strengths, weaknesses, improvements, applications of classical machine learning tasks including supervised learning (e.g., regression, classification, ranking) and unsupervised learning (e.g., clustering)
(2) To discuss emerging machine learning topics, such model regularization, recommender systems, reinforcement learning, deep learning

Learning Programming Languages before Classes:

Python is a major language for AI and data science. To learn Python, check out: https://www.programiz.com/python-programming/first-program.

Grading Policy:

3-6 Homework Assignments:	20%
2 Exams	30%
1 Course Project	25%
1-2 ML Competitions	20%
Attendance/paper reading/discussion:	5%

All grading will be determined based on a scale of: A: [93-100%], A-: [90-93%), B+: [87-90%), B: [83-87%), B-: [80-83%), C+: [77-80%), C: [70-77%), D: [60- 70%), F: [0-60%). Final grades in the course may be curved at the instructor's discretion.

Class Policies:

1. Face-to-face lectures: this is required by UCF and the face-to-face mode is more informative and interactive.

2. **To protect student privacy, UCF has an official mechanism (student caring) to handle your requests (e.g., need more time for exams, notices of absence) due to your health, family, and personal issues**. Please contact UCF student service office (*https://scs.sdes.ucf.edu*) for your requests. UCF student service office will send an official notice email to the course instructor and TA/graders once your request is approved.

However, you should make every effort to attend each lecture. Without the approval email, there will be:

- One point penalty (out of a maximum of 5) for each class missed beyond three (regardless of the reason).

To make up a missed exam, you need to contact the student service office to notify the instructor about your absence <u>before</u> the exam.

3. Your participation points will be reduced if you are found playing your electronics, sleeping, chatting, being significantly late, etc.

4. The Late Submission policy is set to deduct 1/4 per day for late submissions.

5. The reading materials (PPT files) for the lecture (if any) should be available on Webcourses before about 11:59 PM on the day before the lecture. Please read these slides and print it out in Handouts format and bring to the classroom and take notes on them.

6. Assignments must be completed independently. While discussions and collaborations during class time are encouraged, homework and examination problems must be solved independently. Plagiarism in any assignment and examination is strictly prohibited. A score of zero will be given to **all involved parties**, and more actions may be taken which may result in dismissal from the university.

7. Issues related to a grade must be raised within 3 days after the grade is posted on the UCF Webcourses. Keep calm (not angry) and be polite when writing your emails.

8. The midterm exam covers supervised learning and unsupervised learning I & II. The midterm exam is scheduled after finishing the discussion of unsupervised learning II.

9. If you copy and past materials from existing papers and Kaggle posts to your final project reports with (>20% detection rates), I will file a claim to the UCF student service office and initialize **the student misconduct investigation**.

10. Please be honest with your written emails when you request an extension of due day, modification of scores, etc. In the past, I observed fake materials (e.g., a later modified & manipulated picture of homework submission), and dishonest or non-verified reasons (e.g., unreliable network connectivity right at 11:50pm, operation system crash right at 11:55pm). More importantly, according to Florida sunshine law, all your written documents/emails will be evidence of your violation of rules or laws. I will file a claim to the UCF student service office and initialize **the student misconduct investigation**.

Anonymous Feedback/Comments/Suggestions?

Feel free to leave any comments and suggestions about how the instructor/grader can do better to help you learn this course, such as whether the lectures are clear, examples are helpful, questions are answered timely, etc. Please check [this anonymous form](). Your input is highly appreciated.

Schedule (non-restrictive):

Week 1 (01/9): Introduction (Tutorial of Python Programming by TA)
Week 2 (01/16): Understanding Data & Data Preprocessing (Tutorial of Pandas by TA)
Week 3 (01/23): Supervised Learning I: Rule-based Classification, Decision Trees,
Week 4 (01/30): Supervised Learning II: Ensemble Learning, Bagging, Random Forest
Week 5 (02/06): Supervised Learning III: Generative Models & Naïve Bayesian Learning, Discriminative Models & Logistic Classification, KNN Nearest Neighbor
Week 6 (02/13): Supervised Learning IV: Hard Margin, Soft Margin, Non-linear SVM, Kernel Tricks, Boosting, AdaBoosting
Week 7 (02/20): Unsupervised Learning I: Clustering Basics, K-means, Hierarchical Clustering
Week 8 (02/27): Unsupervised Learning II: Density Based Clustering, Fuzzy Set & Fuzzy Logic, Fuzzy K-means
Week 9 (03/06): Unsupervised Learning III: EM, Mixture Model, GMM
Week 10 (03/13): Spring Break
Week 11 (03/20): Learning with Matrix Data I: RecSys, Content based Recommendation and Collaborative Filtering
Week 12 (03/27): Learning with Matrix Data II: Latent Factor Models and Factorization
Week 13 (04/03): Learning to Rank
Week 14 (04/10): Deep Learning I: Deep Reinforcement Learning (reading: [comparison of onpolicy, offpolicy, offline RL](#), [inverse RL](#), [Waterloo CS IRL](#))
Week 15 (04/17): Deep Learning II: Deep Sequential Learning
Week 16 (04/24): Deep Learning II: Deep Representation/Graph Learning
Week 17 (05/01): Final Exam Week

Important Dates (non-restrictive):

Project pitch due date: Week 5 Monday (Deliverables: a video)
Project progress check point 1 due date: Week 7 Monday (Deliverables: a video & a peer evaluation)
Form project team due date: Week 5 Monday after project pitch due day
Project progress check point 2 due date: Week 12 Monday (Deliverables: a video & a peer evaluation)
Final project report due date: Week 15 Thursday (Deliverables: a paper & a peer evaluation)
Exam 1: Week 9 Monday/Wednesday after finishing unsupervised learning II
Exam 2: the Monday of the UCF final exam week, face to face mode

Project:

Check project description

Homework:

Check homework descriptions

My Recommended Learning Strategy:

1, Attend the classes instead of being a home-stay student watching videos. Classrooms are more interactive and informative.

2, Read the slides and sometimes textbook chapters provided in the Modules before every lecture. Attend the face to face lectures. Watch the video recording after the lecture, combined with reading the notes.

3, During the learning, you need to create a checklist of your learning outcomes. For each ML algorithm:

- Understand the general idea and motivation?
- Understand key definitions/measures/concepts that are used the algorithm?
- Understand the key steps/components/calculation procedures of the algorithm?
- Understand the underlying optimization objective of the algorithm?
- Uderstand the strengths and weaknesses of the algorithm? In which case it work well or doesn't work?
- Understand the improvement of the algorithm?
- Play a toy data with the algorithm using ML programming libraries (e.g., Python, Scikit Learn, open source code in the Gittub)
- Read the open-resource code of the algorithm to see if you can understand the code and then reproduce the algorithm from scratch by yourself?
- Try to use this algorithm or the problem-solving philosophy behind the algorithm to solve a challenge in your full-time/part-time job, your current Ph.D. research, or a data competition.

4, interactive learning by attending lectures, interacting with classmates, TA, and lectures, reading external materials, practicing programming

- Before asking a question, you are suggested to firstly recall what your learned in the classroom and check whether the related knowledge was discussed in the lecture or not.
- If your question was not discussed in the lecture, you are suggested to exploit what you learned in the lecture to perform inference to solve the question creatively.
- You can leverage Google and your external reading skills to find your answer to the question.
- You can ask your classmates and TA.
- In the face to face in-classroom learning, you can ask questions during the lecture, the break, or the office hours.

Email Policy:

This document sets forth guidelines for email communication in this course. Excessive emails are problematic for our fellow students, and the instructor. Please be sure you have a legitimate need to send an email.

- The instructor will answer email covering the following:

> a. Questions that arise from difficulty in understanding course material or content
> b. Requests for feedback on graded work
> c. Private issues related to your participation and progress in the course
- The instructor will NOT answer emails for the following:
  > a. Questions already answered in the course information and contents on Webcourses (please look on Webcourses first)
  > b. Lack of clear purpose of why the email was sent
  > c. Questions unrelated to the course or of an inappropriate nature
  > d. No signature that indicates who send the email
- The instructor will respond to emails sent on a given day no later than close of work on the NEXT WORKDAY.
- If the subject of the question would be of general interest, the instructor will copy all other members of the class.
- You will be expected to have daily access to the internet and e-mail, since I will be e-mailing you constantly about assignment updates, additions and changes. YOU MUST USE KIGHTS E-MAIL FOR ALL CORRESPONDENCE RELATED TO THIS CLASS. The Professor will not communicate with you via e-mail addresses outside the University system. If you do not have a Knights E-mail account, you need to activate one immediately.
- If you do not own a computer, there are computers accessible to you in all UCF computer labs, and most computer labs have computers connected to the internet. For further information on computer labs, please see the following website: http://registrar.sdes.ucf.edu/webguide/index_quickfind.aspx.

Academic Integrity:

Receiving a work product (e.g., a homework paper or code submitted in response to an assignment) from other individuals (other students in the course, former students, tutors, etc.) is considered "Unauthorized assistance". Giving such a work product to other individuals, either willfully or through negligence, is considered "Helping another violate academic behavior standards." Copying a work product from submissions from past semesters or copying from an online repository is considered "Plagiarism." You are allowed to discuss class materials and high-level concepts related to the assignment with others. However, you must work individually when creating the work product. For programming assignments, you must design algorithms, data structures, and develop code individually. Any violation to the above is considered Academic Integrity Violation. Students found to be in violation of academic integrity will be reported to the Office of Integrity and Ethical Development, in addition to receiving a zero grade on their assignments. Following the report, The Office may conduct hearing, and if found in violation, a student may receive penalties, up to and including dismissal from the university.

Students should familiarize themselves with UCF's Rules of Conduct at: http://osc.sdes.ucf.edu/process/roc. According to Section 1, "Academic Misconduct," students are prohibited from engaging in: 1. Unauthorized assistance: Using or attempting

to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating. 2. Communication to another through written, visual, electronic, or oral means: The presentation of material which has not been studied or learned, but rather was obtained. through someone else's efforts and used as part of an examination, course assignment, or project. 3. Commercial Use of Academic Material: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc. 4. Falsifying or misrepresenting the student's own academic work. 5. Plagiarism: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own. 6. Multiple Submissions: Submitting the same academic work for credit more than once without the express written permission of the instructor. 7. Helping another violate academic behavior standards.

Responses to Academic Dishonesty, Plagiarism, or Cheating

Students should familiarize themselves with the procedures for academic misconduct in UCF's student handbook, The Golden Rule:
http://goldenrule.sdes.ucf.edu/docs/goldenrule.pdf
UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and when necessary respond to academic misconduct. Penalties can include a failing grade in an assignment or in the course, suspension or expulsion from the university, and/or a "Z Designation" on a student's official transcript indicating academic dishonesty, where the final grade for this course will be preceded by the letter Z. For more information about the Z Designation, see http://goldenrule.sdes.ucf.edu/zgrade

"The Golden Rule"

Violations of student academic behavior standards are outlined in the Golden Rule, the University of Central Florida's Student Handbook (http://www.ucf.edu/goldenrule/). As a UCF student, you are held responsible for knowing what is listed in "The Golden Rule" handbook. As reflected in the UCF creed, integrity and scholarship are core values that should guide our conduct and decisions as members of the UCF community. Plagiarism and cheating contradict these values, and so are very serious academic offenses. Penalties can include a failing grade in an assignment or in the course, or suspension or expulsion from the university. Students are expected to familiarize themselves with and follow the University's Rules of Conduct (see http://www.osc.sdes.ucf.edu/).

Course Accessibility Statement

The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need disability-related access in

this course must be officially registered with Student Accessibility Services (SAS) (http://sas.sdes.ucf.edu/) (Ferrell Commons 185, sas@ucf.edu, phone 407-823-2371) in order to receive accommodations. Through Student Accessibility Services, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential access and accommodations that might be reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student.

Make-Up Assignments for Authorized University Events or Co-curricular Activities

Students who represent the university in an authorized event or activity and who are unable to meet a course deadline due to a conflict with that event must provide the instructor with documentation in advance to arrange a make-up. No penalty will be applied. For more information, see UCF policy at: http://policies.ucf.edu/documents/4-401.1MakeupAssignmentsForAuthorizedUniversityEventsOrCocurricularActivities.pdf

Religious Observances

Students must notify their instructor in advance if they intend to miss class for a religious observance. For more information, see the UCF policy at: http://regulations.ucf.edu/chapter5/documents/5.020ReligiousObservancesFINALOct17.pdf

Deployed Active Duty Military Students

Students who are deployed active duty military and/or National Guard personnel and require accommodation should contact their instructors as soon as possible after the semester begins and/or after they receive notification of deployment to make related arrangements.

Disruptive Behavior Policy

Behavior disruptive to the continued success of this course and other students may result in one or more of the following actions:
- Academic Action – Taken by the Professor, Chair, or Dean of the College: 1. Removal from the class session and loss of credit for a specific assignment, examination or project. 2. Referral to Counseling 3. Removal from the course with a grade of "F", and/or
- Conduct Review Action – Taken by the Office of Student Conduct 1. Warning 2. Probation 3. Suspension 4. Expulsion 5. Permanent conduct record with UCF accessible by other Institutions upon request

Title IX

The University of Central Florida will not tolerate sexual misconduct or harmful behavior which occurs on or off the UCF campus. Sexual misconduct and other harmful behavior

include sexual harassment, stalking, dating violence, domestic violence, and sexual assault. Any disclosures of sexual misconduct will be taken seriously. This website describes reporting options, resources and rights for students who have been victims of sexual misconduct or harmful behaviors. The information contained on this web page have been provided to explain the options and resources following a sexual assault or relationship violence. These include access to safety planning, reporting, counseling, and long-term healing. The purpose of the resource guide is to provide a roadmap of different offices on campus, as well as local and national organizations that can assist you as you make informed decisions. Know your rights. Know your options. Know our resources.

For student-on-student sexual misconduct, contact: Dana Juntunen | Dana.Juntunen@ucf.edu Deputy Title IX Coordinator 407-823-4683; Sarah Laake | Sarah.Laake@ucf.edu Lead Title IX Investigator 407-823-4683

For University-employee-on-student sexual misconduct, contact:
Dawn Welkie | Dawn.Welkie@ucf.edu Title IX Coordinator 407-823-1354

Required Statement Regarding COVID-19

To protect members of our community, everyone is required to wear a facial covering inside all common spaces including classrooms (https://policies.ucf.edu/documents/PolicyEmergencyCOVIDReturnPolicy.pdf). Students who choose not to wear facial coverings will be asked to leave the classroom by the instructor. If they refuse to leave the classroom or put on a facial covering, they may be considered disruptive (please see the Golden Rule for student behavior expectations). Faculty have the right to cancel class if the safety and well-being of class members are in jeopardy. Students will be responsible for the material that would have been covered in class as provided by the instructor. Depending on the course of the pandemic during the semester, the university may make changes to the way classes are offered. If that happens, please look for announcements or messages in Webcourses@UCF or Knights email about changes specific to this course.

COVID-19 and Illness Notification – Students who believe they may have a COVID-19 diagnosis should contact UCF Student Health Services (407-823-2509) so proper contact tracing procedures can take place.

Students should not come to campus if they are ill, are experiencing any symptoms of COVID-19, have tested positive for COVID, or if anyone living in their residence has tested positive or is sick with COVID-19 symptoms. CDC guidance for COVID-19 symptoms is located here: (https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html)

Students should contact their instructor(s) as soon as possible if they miss class for any illness reason to discuss reasonable adjustments that might need to be made. When possible, students should contact their instructor(s) before missing class.

In Case of Faculty Illness – If the instructor falls ill during the semester, there may be changes to this course, including having a backup instructor take over the course. Please look for announcements or mail in Webcourses@UCF or Knights email for any alterations to this course.

Course Accessibility and Disability COVID-19 Supplemental Statement – Accommodations may need to be added or adjusted should this course shift from an on-campus to a remote format. Students with disabilities should speak with their instructor and should contact sas@ucf.edu to discuss specific accommodations for this or other courses.