University of Oklahoma Gallogly
College of Engineering
School of Industrial and Systems Engineering
ISE/DSA 5503: Healthcare Analytics
Mondays/Wednesdays, 3:00 pm - 4:15 pm.
Location: Carson Engineering Center, room 123
Spring 2022

Instructor: Dr. Talayeh Razzaghi
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Email: talayeh.razzaghi@ou.edu
Office Hours: Wednesdays, 4:25 p.m.- 5:25 p.m. [or by appointment].
Zoom Link: TBA

Meeting ID: TBA
Passcode: TBA

Learning Management System: https://learn.ou.edu

Course Description:
Over the last decade, Artificial Intelligence (AI) and Machine Learning (ML) have made numerous success stories of developing decision support tools for problems arising in robotics and automation, manufacturing, energy, and defense. At the same time, healthcare sector has had a slower pace in adopting AI-based techniques even with the advent of massive-size data repositories (e.g., electronic health records) due to several reasons including but not limited to its inherent complexity, high degree of heterogeneity in the data, and strict privacy concerns. Over the past few years, ML/AI-based decision support systems fueled by healthcare data have become successful in offering insights for improving care delivery, mitigating adverse health outcomes, and reducing unnecessary costs. Nonetheless, the increasing growth of heterogeneous healthcare data from various healthcare organizations has posed great challenges in analysis and mining massive and multi-modal data in a practical clinical environment. This course gives an overview of the primary concepts and methods towards developing AI-enabled healthcare systems. We will focus on studying foundational methods in machine learning and data analytics for prediction and pattern recognition, and apply them to specific areas in medicine and healthcare including, but not limited to, disease diagnosis, patient treatments and their outcomes prediction, clinical risk stratification, healthcare insurance fraud detection, and disease progression modeling.

Prerequisites: Graduate standing or permission of instructor; ISE 3293 or ISE/DSA 5013.

A basic foundation in linear algebra, probability and statistics, and data structures are recommended for this course. In addition, students should be open to learning new computing tools and technologies. Tutorials or primers will be provided for most prerequisite topics and tools. This course is generally suitable for graduate students in industrial and systems engineering, applied math, biomedical engineering, computer engineering, mechanical engineering, statistics, computer science, information science, and management information systems. If you are a student from outside of these disciplines, please talk to the instructor to discuss your interests and obtain consent to enroll.

Course Goals:

Upon successfully finishing the course, students will:
1. understand basic concepts of analytics with an emphasis on machine learning related to their applications in medicine and healthcare;
2. know how to perform critical tasks such as data preprocessing, data mining, and data visualization;
3. identify and apply appropriate intelligent system models and computational tools to specific problems in biomedicine and healthcare; and
4. know how to investigate recent research topics in healthcare, analyze the performance of specific models as applied to healthcare problems, and explain their advantages and limitations.

Course Reference Textbooks:

There are no required textbooks for this course. Notes of the instructor will be provided in class via Canvas.

- Hastie, T., Tibshirani, R., and Friedman, J. The elements of statistical learning, 2009.
- Stuart Russell and Peter Norvig. 2009. Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall Press, Upper Saddle River, NJ, USA.
- M. Bishop. Pattern recognition and machine learning, 2007.
- Data Mining and Machine Learning: Fundamental Concepts and Algorithms Second Edition, Mohammed J. Zaki and Wagner Meira, Jr, Cambridge University Press, March 2020.
- Foundations of Machine Learning, M. Mohri, A. Rostamizadeh and A. Talwalkar, MIT Press, 2018.
- Toby Segaran. 2007. Programming Collective Intelligence (First ed.). O'Reilly.
- Deep Learning, I. Goodfellow, Y. Bengio and A. Courville, MIT Press, 2016.
- Tony J. Cleophas and Aeilko H. Zwinderman. 2015. Machine Learning in Medicine - a Complete Overview. Springer. • Sunila Gollapudi, S. 2016. Practical Machine Learning. Packt Publishing Ltd.
- Peter Harrington. 2012. Machine Learning in Action. Manning Publications Co., Greenwich, CT, USA.
- Selected seminal and contemporary readings from peer-reviewed literature such as Proceedings of Machine Learning in Healthcare, Artificial Intelligence in Medicine, IISE Transactions on Healthcare Systems Engineering, IEEE Transactions on Biomedical and Health Informatics, and other relevant venues.

Schedule:

The following table is a tentative list of topics for the class. This list might be revised on a yearly basis based on the pace of the class, trends, and updates in the methodological domain, application areas, and/or tool.

Topic
Introduction: (i) Intelligent and expert systems in healthcare, (ii) healthcare data challenges and issues
Supervised, semi-supervised, and unsupervised learning
Linear and logistic regression
Decision Trees, Support vector machine, Deep learning
Feature selection and dimensionality reduction
Time series prediction and temporal models
Support vector machine for big data
Offline and online learning
Model evaluation and performance metrics, cross-validation, model interpretability
Ethics of AI: bias, fairness, accountability, and transparency in machine learning; ethical, legal, and social issues of ai in medicine and healthcare
Privacy-preserved machine learning, and transfer learning
Disease Diagnosis
Risk stratification, patient outcome prediction
Disease progression modelling
Optimize healthy aging/life span
Healthcare insurance fraud detection

Predicting, preventing, and responding to emergent pathogenic threats
Project presentations

Expectations:

1. Attendance to the class sessions is mandatory. This is a graduate-level course; the students are responsible for all material covered in the lectures as well as reading assignments and are expected to actively participate in class discussions.

2. Students are supposed to bring their laptops to class to work on class problems.

3. The course will encourage the use of R or Python-based tools and libraries. Students are not required to have prior experience with R or Python and machine learning libraries, but are encouraged to get accustomed with such tools during the course of the semester. Prior experience with computing tools such as MATLAB can be easily transferred/applied to this course.

4. By no means, the purpose of this class is to teach R and Python. The main goal is to teach the techniques of data analysis and machine learning for healthcare applications, and the students are responsible to spend a good amount of time to learn about the syntax codes and resolve the issues with errors in R and Python by themselves.

Final Grade:

- *Assignments: 25%*
  - There will be 5-6 assignments in this class. The details about the due-date and late-submission penalty will be announced in the homework description. Late submission is accepted for only some homework, please read the instructions for each homework carefully before starting to work on the assignments. The assignments may include both written and programming problems. Students must perform the majority of statistical and analytic work in R/Python; however, the work can be supplemented with other tools (e.g., Microsoft Access, Microsoft Excel, LaTeX, etc.).
  - Some assignments will be in the research critique format that are meant to allow for critical thinking around specific methods and their connection and relevance to applications. This will involve in-class demonstration and discussion sessions based on research and written critiques prior to the session.

- *Midterm Exam: 30%*

The actual exam date/time will be announced throughout the semester.

- *Discussion Quizzes: 10%*
  Quizzes will be taken in-class and should take around 15-20 minutes to be completed. They will usually be administered at the end of Discussion Sessions, so plan your attendance accordingly. Be prepared for articles assigned for discussion during class time.

- *Final Project (35%):*
  - *Project Team Selection and Proposal (10%)*
  - *Final draft and presentation (90%)*

    ✓ This course project will involve identification of method(s) and a healthcare problem of interest, selection of appropriate tools and datasets, systematic review of pertinent

literature, application and evaluation of the methodology, interpretation of results, and development of a comprehensive research manuscript. Detailed milestones and guidelines will be available on Canvas at the beginning of the semester.

- ✓ The student(s) can select a topic for the project from other topics (other than listed topics in the table above) and other methods in healthcare and biomedical applications such protein-protein interactions, optimization of treatment protocols, and scheduling of clinical visits.

Grading Scale

There is a grade guarantee of 90% = A, 80% = B, 70% = C, 60% = D. Grades may be curved at the end of the semester.

Course Policies

Make-up Policy

There will be no make-up homework in case a student cannot submit his or her own homework before the due date (although extension may be given based on the situation). Make-up exams will be administered only to students with a documented health/family emergency. Students with an extreme, unavoidable circumstance that will prevent them from attending a scheduled exam must appeal to the instructor (via email) at least one week before the exam date. Each appeal will be considered on a case-by-case basis. Again, no alternative exam scheduling arrangements are guaranteed for non-emergency non-documented reasons (such as (but not limited to) conflict with your schedule).

University Policies

Academic Integrity

Academic integrity means honesty and responsibility in scholarship. Academic assignments exist to help students learn; grades exist to show how fully this goal is attained. Therefore, all work and all grades should result from the student's own understanding and effort. Accordingly, cheating, plagiarism, or any act of dishonesty is strictly prohibited at the University of Oklahoma. To name a few examples, copying from another student's paper, from one of previous semesters or other courses, or from published writings are all treated as violation of academic integrity. If occurred, the disciplinary consequences are applied to all parties involved. Again, as a member of the OU community, it is your responsibility to protect your educational investment by knowing and following the rules and by reporting any violations of those rules that you witness.

Non-Discrimination Policy

OU guarantees equality of opportunity in education and strives to provide an academic environment that is free from any form of discrimination. Discrimination or harassment of any person based on race, color, religion, creed, gender, national origin, age, disability, veteran status, sexual orientation, or gender identity is a violation of state and federal laws and/or OU policies and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. Be advised that all students, faculty, and staff are required to report instances of sexual harassment, sexual assault, or discrimination to the appropriate offices within the university. Information regarding non-discrimination policies and reporting guidelines can be found at http://www.ou.edu/eoo.

Pregnancy/Childbirth

Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact your instructor as soon as possible. Also, see http://www.ou.edu/eoo/faqs/pregnancy-faqs.html for answers to commonly asked questions.

Religious holidays

It is the policy of the University to excuse absences of students that result from religious observances and

to provide without penalty for the rescheduling of examinations and required class work that may fall on religious holidays. Notification must be provided sufficiently in advance, and every effort should be made to submit required work in advance.

Reasonable Accommodation Policy

Any student in this course who has a disability that may prevent him/her from fully demonstrating his/her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities.

Title IX Resources and Reporting Requirement

For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/domestic violence, or stalking, the university offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at smo@ou.edu. Incidents can also be reported confidentially to OU Advocates at 405/615-0013 (24 hours a day, 7 days a week). Be advised that an instructor/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office.

Accommodations for Disabilities

Reasonable accommodations will be made for students with disabilities. To take advantage of available resources, please contact the Disability Resource Center for detailed information and procedures. Registration instructions are available at http://www.ou.edu/drc/drc-registration. Please inform the instructor if you have a disability that may prevent you from fully demonstrating your abilities so that accommodations can be made to ensure your full participation in the course and safeguard your educational opportunities at OU.

Masking Policy and Protocol

The university encourages masking indoors. The university strongly encourages masking for all individuals in high-density settings, such as classrooms and at special events. The university strongly encourages the entire OU community to get vaccinated, particularly those residing in congregate housing. More information is available at: https://ou.edu/coronavirus/masking-policy

Communication

All enquiries should be sent through Canvas (at http://Learn.ou.edu) and I will reply back your questions in Canvas. I will send urgent and regular communication to all students using the Announcements tool in Canvas. It is a requirement in this class that you set your New Announcements in Notifications to "Right Away" to ensure that you receive any announcements. (Go to Profile>Notifications, find for new announcements and set to Right Away).

Announcements

I will use Announcements to send time sensitive information to the entire class. Because you can set your own notification preferences in Canvas, you will need to make sure you receive announcements daily. You are required to set your notifications for New Announcements to be Right Away.

Students are responsible for any changes/additions to this syllabus announced in class.