AMAT 502—Modern Computing for Mathematicians—Fall 2024 Syllabus

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Course Objectives: *Modern Computing for Mathematicians (AMAT 502)* is designed to take a student with no previous background in computer science or programming to a basic level of competency in programming in Python so that they can carry out the fundamental tasks of a data scientist. Specifically, by the end of the semester the student should be able to: define functions, assign values to variables, work with basic data types such as lists and dictionaries, understand concepts from object oriented programming (OOP) such as inheritance and polymorphism, create a class from as well as subclasses, call methods on objects, control the flow of a program via good programming principles such as abstraction, create scatter plots and plots of mathematical functions using Matplotlib, simulate random phenomena such as flipping a coin, apply machine learning methods such as regression, KNN, K-Means, PCA, logistic regression, SVM, and naive Bayes classifiers. The student will be able to load a data set (provided as a CSV file) as a Pandas data frame and perform basic data cleaning, feature engineering, and apply scikit-learn libraries to analyze said data set.

Description of the Course: *Modern Computing for Mathematicians (AMAT 502)* is meant to be the core requirement of the Data Science Masters program here at UAlbany. This course will provide an introduction to programming for students who have never coded before as well as a refresher for more experienced programmers. We will also provide a theoretical and practical introduction into machine learning. At a high-level, this course has three parts:

- 8 lectures on Programming Fundamentals in Python
- 4 lectures on Numpy, SciPy and Statistics
- 11 lectures on the machine learning using Pandas and Scikit-Learn as well as its mathematical and conceptual foundations.

The remaining time is for group projects and presentations. A lecture outline is on Page 2.

Pre-Requisites: Basic undergraduate mathematics such as calculus, linear algebra, probability and stats.

Lecture Place and Times: This is a HYBRID course. You must watch lecture videos and work through the lecture notebooks at a fixed pace. We will meet IN-PERSON on alternating Wednesdays (see calendar below) to make sure you're on track and TEST your comprehension of the material in BB0119 (Massry Center for Business). You will need to download the Global Protect VPN (link below) to access the JupyterHub server when you're off campus. Your login is your netID **all lower case** and your usual password.

- YouTube Lectures: https://www.youtube.com/@amat5022
- Our JupyterHub Server: https://amat502-9397-fa24.its.albany.edu/
- Link for the VPN: https://albany.atlassian.net/wiki/spaces/askit/pages/52333741/VPN+Virtual+Private+Network
- ZOOM Class Meetings: https://albany.zoom.us/my/jmcurry

Office Hours: Mondays 2:30-4 PM in CK391 (Catskill) and by appointment.

Grading Schema:

- 5% for participation and demonstrated effort on coding exercises.
- 20% for your best 2 out of 3 Quizzes (45 minutes, in person), denoted ♠.
- 20% for an in-person 90-minute Midterm 1, denoted ♢.
- 25% for an in-person 90-minute Midterm 2, denoted ♢.
- 30% for an in-person 3-hour FINAL EXAM, denoted ♣.

Academic Integrity: Please familiarize yourself with UAlbany's *Standards of Academic Integrity* page: https://www.albany.edu/studentconduct/standards_of_academic_integrity.php

Talking, using your phone, ChatGPT or similar LLMs, or any material not on our servers during in-person class assessments is strictly prohibited.

(1) For the first offense, **you get a warning.**
(2) For the second offense, **a zero for the assessment and I file a Violation of Academic Integrity Report (VAIR).**
(3) For the third or later offense, **you get a letter grade reduction (or possibly fail) and I refer you to community standards, which could result in expulsion from UAlbany.**

Course Materials: Jupyter Notebooks cover all the necessary material for this class as well as videos for each lecture. Please watch these ahead of time.

- YouTube lectures: https://www.youtube.com/@amat5022
- GitHub Back-Up of Lectures: https://github.com/jmc42/AMAT502/
- Required Text: *Introduction to Computation and Programming Using Python* by Guttag, 3rd ed.
- Additional Free Text: https://github.com/jakevdp/PythonDataScienceHandbook

Attendance and Missed Work Policy:

This is a hybrid online/in-person course. Attendance to in-person class meetings is MANDATORY. Attendance to online course meetings is optional, but strongly encouraged.

Lecture Outline:

The lectures are pre-recorded and available on YouTube. Search for "AMAT502". The following is the link to the channel. Please Like and Subscribe!

https://www.youtube.com/@amat5022

- Lec 1 = Introduction to Data Science + Basic Numerical Operations,
- Lec 2 = Conditionals and Loops,
- Lec 3 = Bisection Search and Functions, Quick Discussion of Big-O Notation
- Lec 4 = Functions and Recursion,
- Lec 5 = More Recursion, Strings and Lists
- Lec 6 = Data Types and Edit Distances
- Lec 7 = "One Liners" and Intro to Object Oriented Programming
- Lec 8 = More OOP and Data Structures
- Lec 9 = OOP for Mortgages and Matplotlib
- Lec 10 = NumPy Array Operations + Intro to Randomness
- Lec 11 = Basic Probability Distributions Review
- Lec 12 = Hypothesis Testing and the CLT
- Lec 13 = Into to Machine Learning: Regression
- Lec 14 = Intro to ML: Classification and Clustering Overview,
- Lec 15 = Catch-Up Lecture + Intro to Pandas
- Lec 16 = K-Means Clustering
- Lec 17 = Principal Component Analysis
- Lec 18 = MNIST via K-means and K-Nearest Neighbors
- Lec 19 = Model Validation and Bias-Variance Tradeoff
- Lec 20 = Naive Bayes Classifier
- Lec 21 = Maximum Likelihood and Logistic Regression
- Lec 22 = SVM: From Hyperplanes to Kernels
- Lec 23 = Decision Trees and Entropy
- Lec 24 = Data Science Reconsidered + Intro to TDA

Look above for the approximate content of the lectures listed below.

In-Person Class Meetings are in the Massry Business Center BB0119.

Monday	Wednesday
Aug 26th Lecture 1	**Aug 28th** Lecture 2 In-Person: Intro + Review of Lectures 1 & 2.
Sep 2nd Lecture 3 NO Office Hours due to ♡ Labor Day ♡	**Sep 4th** Lecture 4 ZOOM: Review of Lectures 3 & 4
Sep 9th Lecture 5	**Sep 11th** In-Person: Review + ♠ **Quiz 1** ♠ on Lectures 1-4.
Sep 16th Lecture 6	**Sep 18th** Lecture 7 ZOOM: Review of Lectures 6 & 7
Sep 23rd Lecture 8	**Sep 25th** In-Person: Review + ♠ **Quiz 2** ♠ on Lectures 5-7.
Sep 30th Lecture 9	**Oct 2nd** Lecture 10 ZOOM: Review of Lectures 9 & 10
Oct 7th Lecture 11	**Oct 9th** In-Person: ♢ **Midterm 1** ♢ on Lecture 1-9
Oct 14th Lecture 12	**Oct 16th** Lecture 13 ZOOM: Review of Lectures 11-13
Oct 21st Lecture 14	**Oct 23rd** In-Person: Review + ♠ **Quiz 3** ♠ on Lectures 10-12
Oct 28th Lecture 15	**Oct 30th** Lecture 16 ZOOM: Review of Lectures 14-16
Nov 4th Lecture 17	**Nov 6th** In-Person: Review of Quizzes + Midterm 2 Prep
Nov 11th Lecture 18	**Nov 13th** Lecture 19 ZOOM: Review of Lectures 17-19
Nov 18th Lecture 20	**Nov 20th** In-Person: ♢ **Midterm 2** ♢ on Lectures 1-19
Nov 25th Lecture 21	**Nov 27th** Lecture 22 ZOOM: Review of Lectures 20-22
Dec 2nd Lecture 23	**Dec 4th** Lecture 24 In-Person: Review of Midterms + Final Prep
Dec 9th ♡ Last Office Hours ♡	**Dec 11th** ♡*NO MORE CLASSES*♡

WE WILL HAVE AN IN-PERSON FINAL ON MONDAY DECEMBER 16TH!