

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.

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 = Intro 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 BB 119.

MONDAY		WEDNESDAY	
Aug 26th	Lecture 1	Aug 28th	Lecture 2 In-Person: Intro + Review of Lectures 1 & 2.
Sep 2nd NO Office Hours due to ♡ Labor Day ♡	Lecture 3	Sep 4th	Lecture 4 ZOOM: Review of Lectures 3 & 4
Sep 9th	Lecture 5	Sep 11th	In-Person: Review + ♠ Quiz 1 ♠ on Lectures 1-3.
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 4-7.
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 NO OH due to ♡ Indigenous Peoples' Day ♡		Oct 16th	Lecture 12 ZOOM: Review of Lectures 11-12
Oct 21st	Lecture 13	Oct 23rd	Lecture 14 In-Person: Review of Lectures 13 & 14
Oct 28th	Lecture 15	Oct 30th	Lecture 16 ZOOM: Review of Lectures 15-16
Nov 4th	Lecture 17	Nov 6th	In-Person: ♠ Quiz 3 ♠ on Lectures 10-14+Lec17
Nov 11th	Lecture 18	Nov 13th	Lecture 19 ZOOM: Review of Lectures 18-19
Nov 18th	Lecture 20	Nov 20th	In-Person: ◇ Midterm 2 ◇ on Lectures 1-17
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	♡ <i>NO MORE CLASSES</i> ♡

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