

# RMI 8450: Machine Learning Applications in Actuarial Science and Risk Management

## Syllabus for Spring 2025\*

Instructor: Xiangshi Yin<sup>†</sup>

March 31, 2025

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\*The course syllabus provides a general plan for the course; deviations may be necessary.

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# 1 Description

This course explores the application of machine learning algorithms in actuarial science and risk management. Students will learn theoretical foundations, model selection, evaluation techniques, and practical applications through case studies, preparing them to address real-world challenges in these fields.

## 1.1 Instructor

Name	Xiangshi Yin
Email	<a href="mailto:xyin@gsu.edu">xyin@gsu.edu</a>

## 1.2 Teaching Assistant

Name	TBD
Email	N/A

## 1.3 Lectures

We meet on every Monday evening at 7:15 PM (Eastern Time).

Days	Monday
Time	7:15 PM - 9:45 PM (Eastern Time)
Room	(Online) Webex@iCollege

To attend the online class, you need to:

- Go to the class home page on iCollege at <https://gastate.view.usg.edu/d2l/home/3259801>
- Click **Webex** tab→Click **Virtual Meetings**→Choose the corresponding class link and join.
- You could also click **Content** **Course Schedule** →Choose the corresponding class link and join

## 1.4 Office Hours

Days	Monday
Type	By Appointment
Time Slot 1	6:30 PM - 6:45 PM (Eastern Time)
Time Slot 2	6:50 PM - 7:05 PM (Eastern Time)
Room	(Online) Webex@iCollege

Please note that the office hours listed below are tentative and may be adjusted based on feasibility and student feedback. There are two 15-minute sessions available every Monday before our regular classes. To book a time slot, you need to:

- Go to the class home page on iCollege at <https://gastate.view.usg.edu/d2l/home/3259801>
- Click **Webex** tab→Click **Office Hours**→Choose the available time slot and click **Book**.
- After the meeting is booked, you'll receive Webex online meeting instructions in your school email address, and you can also add the meeting to your calendar so that you don't miss it.

## 1.5 Contact the instructor

During the term, it is highly recommended that you contact the instructor either during scheduled office hours or via email. The instructor is available to help you gain access to resources, focus your projects, and answer any questions you may have. Additionally, your classmates can also be a valuable source of assistance.

## 1.6 Course Website

All class information will be posted on the [iCollege](#) site. This includes lecture notes, assignments, key announcements, and links to additional websites with course-related materials. Additionally, source code, data, and other resources used in the class can also be found on our [GitHub repository](#).

# 2 Overview

In this course, we will explore the application of machine learning algorithms in actuarial science and risk management through common use cases such as:

- Time series modeling
- Marketing campaign predictions
- Insurance claim predictions
- Credit risk modeling
- Operational risk modeling and fraud detection
- Natural Language Processing (NLP) and information extraction

We will begin each topic with an overview of the theoretical foundations of relevant statistical and machine learning models. Discussions will cover the pros and cons of each model, best practices for model selection and evaluation, and case studies demonstrating their real-world applications. For some classical models, we will also implement key algorithms from scratch to deepen our understanding. This approach aims to provide students with a comprehensive grasp of both the theoretical and practical aspects of these models.

## **2.1 Intended Audience**

This course is designed for students who have a basic understanding of statistics and machine learning and are interested in applying these techniques to actuarial science and risk management. Basic knowledge of Python programming is required, and students should be comfortable with data manipulation and visualization using Python programming. We will do a quick survey of Python programming to ensure that everyone is on the same page but will not cover the basics in detail.

## **2.2 Learning Objectives**

Upon successfully completing this course, students will gain the following knowledge and skills:

- Understand the theoretical foundations of machine learning algorithms that could be applied in actuarial science and risk management
- Develop the ability to select and evaluate machine learning models for different use cases
- Apply machine learning algorithms to some real-world problems

## **3 Course Schedule**

The course schedule is shown below. However, the topics are subject to change based on the pace of the class and the feedbacks of the students. Please refer to the iCollege site for the most up-to-date information.

Week	Date	Topic
01	2025-01-13	Introduction to Python for Machine Learning
02	2025-01-20	(No Class) <sup>1</sup>
03	2025-01-27	Machine Learning Basics
04	2025-02-03	Actuarial Science and Machine Learning
05	2025-02-10	Data Exploration and Feature Engineering
06	2025-02-17	Evaluating Model Performance
07	2025-02-24	Time Series Modeling
08	2025-03-03	Credit Risk Modeling (part I)
09	2025-03-10	Credit Risk Modeling (part II)
10	2025-03-17	(No Class) <sup>2</sup>
11	2025-03-24	Ensemble Learning Methods
12	2025-03-31	ML Model Serving
13	2025-04-07	NLP and Information Extraction (part I)
14	2025-04-14	NLP and Information Extraction (part II)
15	2025-04-21	GPT Models and Prompt Engineering
16	2025-04-28	Final Project Presentation

## 4 Readings

We don't have a required textbook for this course. However, the following books are recommended for students who want to dive deeper into the topics covered in this course. I'll also highlight the chapters that are relevant to the topics we cover in class while we progress through the semester.

### 4.1 Primary References

- **Hands-On Machine Learning with Scikit-Learn and Tensorflow** by Aurélien Géron
  - Released October 2022
  - Publisher(s): O'Reilly Media, Inc.
  - ISBN: 9781098125974
- **An Introduction to Statistical Learning, with Application in Python**
  - Published July 2023 [[link](#)]

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<sup>1</sup>Martin Luther King Jr. Day

<sup>2</sup>Spring Break

- Publisher(s): Springer
- ISBN: 9783031387463
- [Lab Resources](#)
- **Machine Learning for Financial Risk Management with Python**
  - Published December 2021
  - Publisher(s): O'Reilly Media, Inc.
  - ISBN: 9781492085256

## 4.2 Other books and resources

- Daniel Roesch *Deep Credit Risk: Machine Learning with Python* Independently published, 2020.
- Fabrizio Romano *Learning Python: Learn to code like a professional with Python - an open source, versatile, and powerful programming language* Packt Publishing, 2015.
- Charles Severance *Python for Everybody: Exploring Data in Python 3* CreateSpace Independent Publishing Platform, 2016
- Joel Grus *Data Science from Scratch: First Principles with Python* O'Reilly Media, 2015.
- Foster Provost *Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking* O'Reilly Media, 2013.
- Technical blogs posted on [www.medium.com](http://www.medium.com).
- Last but not least, [Google](#) and [StackOverflow](#) are always your BEST FRIENDS to learn special coding skills.

## 5 Software

- All programming activities will be performed on the your own laptop. Your laptop should have Python 3 and Jupyter Notebook installed. Using the Anaconda installation (<https://docs.anaconda.com/anaconda/install>) is a good start to have most of the packages we need for the class in one shot. Detailed installation instructions will be posted on the class home page on [iCollege](#) and [our course GitHub repository](#)

- If you are interested to explore new tools, you could also try Google Colab ([colab.research.google.com](https://colab.research.google.com)). It is an online Jupyter Notebook environment with Python and free computing resources backed by Google. You may need to install certain packages yourselves if they are not available in the notebook environment.

## 6 Homework/Quizzes/Final Project

Homework are assigned once every 2 weeks. There will be 2 online quizzes and 1 final group project over the whole semester<sup>3</sup>.

Date	Note	Quiz	Homework	Due (EST)
2025-01-13	First class		Y	2025-01-27 19:15
2025-01-20	(No Class)			N/A
2025-01-27		Y		2025-02-03 19:15
2025-02-03			Y	2025-02-17 19:15
2025-02-10				N/A
2025-02-17			Y	2025-03-03 19:15
2025-02-24		Y		2025-03-03 19:15
2025-03-03	Team proposals		Y	2025-03-24 19:15
2025-03-10	Team finalized			N/A
2025-03-17	(No Class)			N/A
2025-03-24	Suggested project topics		Y	2025-04-07 19:15
2025-03-31				N/A
2025-04-07	Project topics finalized		Y	2025-04-21 19:15
2025-04-14				N/A
2025-04-21				N/A
2025-04-28	Final Project Presentation			2025-05-01 23:59

### 6.1 Homework

Homework assignments are the continuation of a hands-on activities in class. Detailed information about the activity and expectation for successful completion are provided with the instructions. See the web site for the most recent and detailed information on these assignments. **Homeworks are individual assignments!** You may discuss the assignment with your classmates, but your final answers should reflect your individual effort. Completed assignments must be uploaded<sup>4</sup> by the deadline.

<sup>3</sup>Schedule here is subject to change based on the pace of the class

<sup>4</sup>Instructions on homework submission will be posted on the class home page on iCollege



## 6.2 Quizzes

Quizzes will be given out after the regular class and comprise only a few questions. However, some questions may need some thinking and calculations.

## 6.3 Final Project

The project has to showcase a subset of the methodologies and techniques covered in the course. Teams can comprise up to 3 students, and should form by the expected date. **Teams are free to choose a data set for their project** (the instructor will also release a list of suggested topics as a reference). The use of proprietary or classified data sets is not allowed. **Project deliverables include a detailed report, functioning code, and a presentations.** Details about requirements and evaluation criteria will be posted on the class homepage on iCollege.

Key dates to remember (also marked in the schedule above):

- **2025-03-03:** Team proposals due
- **2025-03-10:** Team finalized
- **2025-03-24:** Suggested project topics due
- **2025-04-07:** Project topics finalized
- **2025-04-28:** Final project presentation
- **2025-05-01:** All project submissions due

Teams will submit one assignment for all team members. In most cases, each member of the team will get the same score. Each team assignment must also include a list of tasks completed by each member.

## 7 Evaluation

Students will be evaluated by the deliverables summarized below:

Assignment	Percentage
Quizzes	10%
Homework	45%
Final Project	45%
Total	100%

Grade	Percentage
A+	$\geq 97$
A	$\geq 90$
A-	$\geq 87$
B+	$\geq 83$
B	$\geq 80$
B-	$\geq 77$
C+	$\geq 73$
C	$\geq 70$
C-	$\geq 67$
D	$\geq 60$
F	$< 60$

## 8 Make-up Examinations

Generally, make-up exams are not allowed. Whether or not a student will be allowed to take a make-up examination is within the discretion of the instructor. Notice of intended absence from an announced examination with a fully documented explanation of a compelling reason must be given prior to the examination to be missed in order to qualify for a make-up examination.

## 9 Workload Expectations

Students should plan for 2 - 3 hours of work outside of class each week for each course credit hour. Thus, a 3-credit course averages between 6 and 9 hours of student work outside of the classroom, each week.

**Arbitration:** There will be a one-week arbitration period after graded activities are returned. Within that one-week period, you are encouraged to discuss any assumptions and/or misinterpretations that you made on the activity that may have influenced your grade.

**Attendance:** If you are unable to attend a class session, it is your responsibility to acquire the class notes, assignments, announcements, etc. from a classmate. The instructor will not give private lectures for those that miss class.

**Submission of Deliverables:** Unless specific, prior approval is obtained, no deliverable will be accepted after the specified due date. If you have a legitimate personal emergency (e.g., health problem) that may impair your ability to submit a deliver-

able on time, you must take the initiative to contact the instructor before the due date/time (or as soon after your emergency as possible) to communicate the situation.

## 10 Sharing of Instructor-Created Materials

The selling, sharing, publishing, presenting, or distributing of instructor-prepared course lecture notes, videos, audio recordings, or any other instructor-produced materials from any course for any commercial purpose is strictly prohibited unless explicit written permission is granted in advance by the course instructor. This includes posting any materials on websites such as *Chegg*, *Course Hero*, *OneClass*, *Stuvia*, *StuDocu* and other similar sites. Unauthorized sale or commercial distribution of such material is a violation of the instructor's intellectual property and the privacy rights of students attending the class and is prohibited.

## 11 Use of AI Tools

Generative AI tools, such as ChatGPT, are designed to assist in creating and analyzing text, code, video, audio, and other multimedia. Use of these resources in your coursework comes with benefits and risks. Any unapproved use within the course might be considered a breach of academic honesty. While exercising responsible and ethical engagement with AI is a skill you may hone over time, your unique human insights, critical thinking, and creative contributions remain pivotal to your learning experiences and success. In this course, the rules for AI usage are as follows:

- You are not allowed to use AI tools to complete assignments and quizzes.
- You are not allowed to use AI tools to generate ideas, text, code, or presentation for your project work.
- You may use generative AI tools like ChatGPT only when explicitly permitted<sup>5</sup>.

## 12 General GSU Policies

### 12.1 Students with Disabilities or Special Needs

Students who wish to request accommodation for a disability may do so by registering with the [Access and Accommodation Center](#). Students may only be accommodated upon issuance by the Access and Accommodation Center of a signed Accommodation

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<sup>5</sup>We will discuss topics on GPT models later in this course

Plan and are responsible for providing a copy of that plan to instructors of all classes in which accommodations are sought.

## 12.2 Religious Accommodation and Holidays

Students must provide instructors with reasonable notice of the dates of religious holidays on which they plan to be absent and must be given an equivalent opportunity to make up missed work according to an agreed-upon schedule. Such accommodations might include rescheduling an exam or giving the student a make-up exam, allowing an individual or group presentation to be made on a different date, letting a student attend a different section for the same class that week, adjusting a due date or assigning the student appropriate make-up work that is no more difficult than the original assignment. Students wishing to have an excused absence due to the observation of a religious holiday of special importance must provide **“advance written request to each instructor by the end of the first week of classes.”**

## 12.3 GSU Policy on Withdrawing from Classes

The semester midpoint (March 04, 2025) is the last day to voluntarily withdraw from a full semester class and receive a possible grade of W. Withdrawals appear on the student’s permanent record and count toward their attempted hours.

Students can use PAWS to withdraw before the midpoint; after that date, voluntary withdrawals cannot occur. Students are allowed only 6 withdrawals during their academic careers at GSU. If they withdraw from your course after drop-add and before the midpoint, they receive a W (unless they already have 6 withdrawals); if they withdraw after the midpoint, they will automatically receive a WF. After 6 withdrawals, withdrawal at any point in the course results in an automatic F.

While Voluntary Withdrawals are the most common, GSU policy also permits Involuntary Withdrawals, Emergency Withdrawals, Military Withdrawals, and Non-Academic Withdrawals, and explains when and how students can initiate a withdrawal. You are responsible for understanding and adhering to the GSU Revision of Class Schedule (Add/Drop and Withdrawal) policy explained in [Section 1332](#) of the Undergraduate Catalog.

## 12.4 Campus Safety APP ([Livesafe Mobile App](#))

Georgia State University values the safety of all university community members. To promote campus safety, the university is providing the LiveSafe app free for all stu-

dents, faculty, and staff. This app provides a quick, convenient, and discrete way to communicate with the GSU police. I strongly recommend that you download the app from either the Apple App Store or Google Play. You can sign-up for Panther Alerts and learn more about LiveSafe by visiting the GSU [LiveSafe webpage](#).

## **12.5 Campus Police Numbers**

**Please make sure you have these campus police numbers in your phone**

- For emergencies call 404-413-3333
- For non-emergencies and to request a safety escort call 404-413-2100
- If you are hearing impaired call 404-413-3203

## **12.6 Family Educational Rights Privacy Act (FERPA)**

In keeping with USG and university policy, this course website will make every effort to maintain the privacy and accuracy of your personal information. Specifically, unless otherwise noted, it will not actively share personal information gathered from the site with anyone except university employees whose responsibilities require access to said records. However, some information collected from the site may be subject to the Georgia Open Records Act. This means that while we do not actively share information, in some cases we may be compelled by law to release information gathered from the site. Also, the site will be managed in compliance with the Family Educational Rights and Privacy Act (FERPA), which prohibits the release of education records without student permission. For more details on FERPA, go [here](#).

## **12.7 Course Assessment**

Your constructive assessment of this course plays an indispensable role in shaping education at Georgia State. Upon completing the course, please take the time to fill out the online course evaluation.

## **12.8 Academic Honesty**

As members of the academic community, students are expected to recognize and uphold standards of intellectual and academic integrity. The [Policy on Academic Honesty](#) assumes as a basic and minimum standard of conduct in academic matters that students be honest and that they submit for credit only the products of their

own efforts. The ideals of scholarship and the need for fairness require that all dishonest work be rejected as a basis for academic credit. They also require that students refrain from any and all forms of dishonorable or unethical conduct related to their academic work.

The Policy on Academic Honesty is published in the [Student Code of Conduct](#) and the [Student Handbook](#) and is available to all members of the university community. The policy represents a core value of the university, and all members of the university community are responsible for abiding by its tenets. Lack of knowledge of this policy is not an acceptable defense to any charge of academic dishonesty. Members of the academic community, students, faculty and staff, are expected to report violations of these standards of academic conduct in accordance with the procedures articulated in this Policy on Academic Honesty.

## **12.9 Student Code of Conduct**

The [Georgia State Student Code of Conduct](#) contains policies and procedures to both promote the university mission and protect the rights of students, faculty and staff. The Office of the Dean of Students is responsible for upholding the university's established policies and procedures that comprise the Student Code of Conduct. The Student Code of Conduct articulates the types of actions that infringe upon the campus' climate of civility and the academic integrity of the university. An overarching philosophy of the student conduct process is to provide students with the opportunity to reflect upon their actions, take responsibility for the outcomes of their life and develop ethical approaches to their decision-making process. Students are obligated to be knowledgeable of and to comply with the university's rules, policies and procedures. Students are also individually responsible for understanding and exercising their rights, fulfilling their obligations and respecting the rights of others. A copy of the most current Student Code of Conduct may be accessed on the web.

For more information, visit the Office of the Dean of Students in the Student Center East, Suite 303, or call 404-413-1515.