

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

## Syllabus for Spring 2025\*

Instructor: Xiangshi Yin<sup>†</sup>

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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/d21/home/xxxxxxxtbd>
- 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/d21/home/xxxxxxxtd>
- 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	Introduction to Risk Management
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
09	2025-03-10	Insurance Claim Predictions
10	2025-03-17	(No Class) <sup>2</sup>
11	2025-03-24	Fraud Detections
12	2025-03-31	Marketing Campaign Predictions
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

#### 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
- **Deep Credit Risk: Machine Learning with Python**
  - Published June 2020
  - Publisher(s): Independently published
  - ISBN: 9798617590199

## 4.2 Other books and resources

- 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.
- *An Introduction to Statistical Learning, with Application in Python* <https://hastie.su.domains/>
- 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.

### 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>3</sup> by the deadline.

### 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

TBD

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<sup>3</sup>Instructions on homework submission will be posted on the class home page on iCollege