## 6010 Special Topics in Data Science – Model Validation & Risk Management

The purpose of this syllabus is to set out policies and expectations for the course. Syllabus policies and expectations are intended to create a productive learning atmosphere for all students. The syllabus may change over the course of the semester; and all such changes will be noted in class and announced via Canvas announcements (which should go to your UNC Charlotte email).

Course Prerequisites:

STAT 3122 and STAT 3123, or by permission of department. DSBA 6156 (Applied Machine Learning).

Textbook:

There is no required textbook for this course.

Software:

You may use any software to begin the semester. However you are expected to be able to code everything in Python by the end of the semester. The group project must be coded in Python.

Course Description:

This course provides a comprehensive survey of the major risk elements in quantitative predictive modeling and the principles of model validation as a foundation for model risk management. It emphasizes methods to identify, evaluate, and mitigate model risk, covering topics such as causality, overfitting and underfitting, interpretability and explainability, sensitivity analysis, SHAP, robustness and reliability testing, fairness, resilience, and emerging issues in risk management for AI agents and large language models (LLMs). As a counterpart to model development, model validation is presented as a critical discipline for ensuring model soundness and compliance within a broadened risk environment. The overall objective is to equip students with the foundational concepts and practical tools necessary for effective model risk control and validation in modern data-driven organizations.

Course Objectives:

As a counterpart of model development, model validation takes on an increasingly important role in controlling quantitative model risks, in a broadened risk environment. Model risk management is a complex field of study consisting of concepts and techniques

across a wide spectrum. The primary objective of this course is to give students an introductory exposure to the foundation of model risk control via model validation.

Grades:

There are 1,000 points in this course, divided:

- 200 points for Participation
    - Attendance
    - In-class activities
    - Online activities / discussion
    - Points may be awarded for thoughtful questions or meaningful contributions when in class.
- 600 points for Individual Assignments
- 200 points for Final Project

Based on your points at the end of the class, your final grade will be:

| | |
|---|---|
| >= 900 | A |
| 800-899 | B |
| 700-799 | C |
| > 700 | D or Inc. |
| Academic Dishonesty | F |

Course Schedule:

| Date | Section |
|---|---|
| **Aug 17** | Intro to Model Validation & Model Risk Management (MRM)<br>• What is a model? (statistical, econometric, ML, AI)<br>• Why models fail: historical failures in finance, healthcare, tech<br>• Regulatory context (SR 11-7, Basel guidance, OCC, ECB TRIM)<br>• The model risk lifecycle and three lines of defense |

| | |
|---|---|
| **Aug 25** | Data: A Model's Foundation<br>• Missing Value Treatment<br>• Outlier Detection and Treatment<br>• Encoding, Scaling, and Transformation<br>• Dimensionality Reduction |
| **Sep 1** | **LABOR DAY -- NO CLASS** |
| **Sep 8** | Risks in Model Development<br>• Assumptions in Generalized Linear Models<br>• Data splitting, out-of-sample testing, cross-validation, bootstrap<br>• Multicollinearity: Checking and Mitigation<br>• Model Training and Performance Assessment |
| **Sep 15** | Advanced ML Algorithms & Algorithm Selection<br>Hyperparameter Optimization<br>Model Documentation |
| **Sep 22** | Conceptual Soundness: Model Explainability<br>Post hoc methods: Variable Importance (PFI)<br>Global Explainability, Local Explainability |
| **Sep 29** | Inherently Interpretable / Explainable Models<br>Model Robustness and Regularization<br>Bias and Variance |
| **Oct 6** | Model Diagnostics & Error Analysis<br>Performance Degradation and Model Weakness Identification<br>Model Segmentation and Improvement |

| | |
|---|---|
| **Oct 13** | Model Governance<br>Risk Management Strategies & Components |
| **Oct 20** | On-going Model Monitoring; Model Drift |
| **Oct 27** | Bias & Fairness |
| **Nov 3** | Introduction to Natural Language Processing & Embeddings<br>Introduction to Artificial Intelligence & Large Language Models |
| **Nov 10** | Information for AI: Knowledge Graphs<br>Artificial Intelligence & Agentic Systems |
| **Nov 17** | Metrics and Analysis / Evaluation of LLMs |
| **Nov 24** | LLMs: Risk Management and Governance |
| **Dec 1** | **NO CLASS**: Work on Final Project |
| **Dec 8** | Final Project Presentations<br>**LAST DAY OF CLASS** |

Office Hours:

No Teaching Assistant for Fall 2025

Instructor - Robert Fox (robert.fox@charlotte.edu): As needed, by appointment

Attendance:

Students are expected to attend every class and remain in class for the duration of the session. Failure to attend class or arriving late may impact your ability to achieve course objectives, which could affect your course grade. An absence, excused or unexcused,

does not relieve a student of any course requirement. Regular class attendance is a student's obligation, as is a responsibility for all the work of class meetings, including tests and written tasks. Any unexcused absence or excessive tardiness may result in a loss of participation points. The use of cell phones, smart phones, or other mobile communication devices is disruptive, and is therefore prohibited during class.

Class Recordings:

Class sessions will all be audio- and/or video-recorded for the purposes of student-participant reference and access by other students enrolled in the same course (including students enrolled in different class sections or break-out groups). Students are not permitted to make their own recordings of class sessions or to share or distribute University recordings of class sessions. NOTE: Students with specific electronic recording accommodations authorized by the Office of Disability Services may record classes; however, the instructor must be notified of any such accommodation prior to recording. Any distribution of such recordings is prohibited.

Class Absence(s):

The instructor has the authority to excuse a student's class absence(s) and to grant a student an academic accommodation (turn in a late assignment, provide extra time on an assignment, reschedule an exam, etc.). However, under Academic Affairs Policy on Course Attendance and Participation, University-sanctioned events or activities are considered excused absences. A University-sanctioned event or activity is one in which a student formally represents the University to external constituencies in athletic or academic activities. This policy does not supersede individual program attendance and/or participation requirements that are aligned with accreditation or licensure. For more information and student responsibilities to account for such an absence, see provost.charlotte.edu/policies-procedures/academic-policies-and-procedures/course-attendance-and-participation.

Students are encouraged to work directly with their instructors regarding class absences for **medical appointments, military/court orders, and/or personal and family emergencies**, such as a death in the immediate family, where a student is able to provide an instructor with appropriate supporting documentation of the absence. The final decision for approval of absences and missed work or make-up work is determined by the instructor.

For absences due to **religious observances**, students must provide the instructor with written notice of requested accommodations no later than the 10th day of instruction for the semester. The instructor and the student should then discuss what a reasonable

accommodation should be in the given case and then document this agreed-upon accommodation. University Policy 409 provides more details about this procedure. The Office of Civil Rights and Title IX is available as a resource if students or faculty have questions about the process.

The Office of Student Assistance and Support Services (SASS) can provide notification to faculty of **emergency situations**, when a student is unable to do so and when the office has been made aware of such emergencies. In such situations, the SASS office may also be able to assist with verification of such emergencies, once a student is able to return to classes. The SASS office does not provide verification of absences for car trouble, weather issues, personal activities, work, weddings, vacations, or University-sponsored events. Absences related to such activities should be discussed directly with the faculty member.

Should a student need assistance from the SASS office in verifying an emergency situation, they can submit an online request form (sass.charlotte.edu/services/absence-verification) and attach supporting documentation. Please note that students are not required to go through the SASS office at any time regarding absence verification, and the SASS office does not have the authority to excuse absences, allow for make-up work, or provide other academic accommodations.

In cases of absence due to **pregnancy or parenting** (pregnancy, childbirth, false pregnancy, termination of pregnancy, or recovery from any of these conditions), students should contact the Office of Civil Rights and Title IX to obtain absence verification by completing the online form

Links to an external site. at http://bit.ly/332eaGd

Links to an external site..

Disability Accommodations:

Students in this course seeking accommodations to disabilities must first consult with the Office of Disability Services and follow the instructions of that office for obtaining accommodations.

Non-discrimination:

All students and the instructor are expected to engage with each other respectfully. Unwelcome conduct directed toward another person based upon that person's actual or perceived race, actual or perceived gender, color, religion, age, national origin, ethnicity, disability, or veteran status, or for any other reason, may constitute a violation of University Policy 406, The Code of Student Responsibility. Any student suspected of engaging in such conduct will be referred to the Office of Student Conduct.

Academic Integrity:

All students are required to read and abide by the Code of Student Academic Integrity. Violations of the Code of Student Academic Integrity, including plagiarism, will result in disciplinary action as provided in the Code. Definitions and examples of plagiarism are set forth in the Code and on the Student Accountability & Conflict Resolution website. The Code is available from the Dean of Students Office or online at legal.charlotte.edu/policies/up-407. Additional resources are available on the Student Accountability & Conflict Resolution website.

Faculty may ask students to produce identification at examinations and may require students to demonstrate that graded assignments completed outside of class are their own work.

Copyright:

Lectures and course materials, including presentations, tests, exams, outlines, and similar materials, are protected by copyright. The creators of the material are the exclusive owners of copyright of those materials. I encourage you to take notes and make copies of course materials for your own educational use. However, you may not, nor may you knowingly allow others to reproduce or distribute lecture notes and course materials publicly without express written consent. This includes providing materials to commercial course material suppliers such as CourseHero, Chegg, and other similar services. Students who publicly distribute or display or help others publicly distribute or display copies or modified copies of an instructor's course materials may be in violation of University Policy 406, The Code of Student Responsibility, or University Policy 407, Code of Student Academic Integrity. Similarly, you own copyright in your original papers and exam essays. If I am interested in posting your answers or papers on the course web site, I will request your written permission.