CEE 3090 Syllabus

Data Analytics in CEE, Section A, 3 Credits

Fall 2026

Instructor Information

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General Course Information

Description

Over the last several years, large quantities of raw and processed data have become available. Combined with advancements in sensor and information technologies, large quantities of high-quality raw data and processed data are now available. These data include, but are not limited to, thermal data, sea level data, air quality data, infrastructure health condition data, traffic data, and roadway safety evaluation data. Civil and environmental engineers (CEE) and researchers often need to work on data collection, data preparation (e.g., cleaning and filtering), data processing, data analysis, and forecasting. Therefore, it is important for students to learn and understand basic data analytics skills.

This course will introduce students to the framework under which data-driven assessments in CEE are conducted. More specifically, the course will discuss (1) a systems approach to problem-solving using data analytics; (2) how data is accessed, processed, and assessed (e.g., exploratory data analyses); (3) data analytic tools for regression and classification problems (e.g., multiple linear regression, random forest classifiers, artificial neural networks). The course also addresses the skills required to communicate the results of data-driven assessments and

the value of working in teams that pursue a common goal. These aspects will be emphasized during the course project.

This course introduces students to the value of data in CEE and the use of data analytics tools that can provide valuable insights when engineers face real-world data and events. This course adopts a systems approach, employing systematic data analytics procedures to holistically address CEE-related issues with a problem-solving mindset.

Course Learning Outcomes

Understanding Data Analytics in CEE Contexts

- Systems Approach in Data Analytics: Learn the systematic data analytics procedures, emphasizing a holistic perspective and problem-solving skills to address CEE-related issues.
- Objective of Data Analytics: Learn to define and articulate CEE-related research questions and purposes in data analytics.
- Value of Data: Understand the crucial role data plays in CEE-related applications.
- Real-world Problem Solving: Utilize data analytics for real-world problem-solving in CEE.

Technical Skills for Data Analytics

- Managing Data Quality: Understand how to handle raw data, deal with missing data, and clean data.
- Processing and Presenting Data: Master the techniques to filter, process, visualize, describe, analyze, and convey data effectively.
- Programming for Data Analysis: Build skills in utilizing popular programming languages, like Python, to conduct thorough data processing, analysis, and visualization.
- Creating Forecasting Models: Learn how to establish effective forecasting models to deal with CEE-related problems.

Communication and Collaboration

- Effective Communication: Communicate the concepts learned in this class to technical and non-technical audiences, fostering interdisciplinary dialogue.
- Teamwork: Apply collaboration strategies and techniques to a team project, highlighting the importance of teamwork in contemporary engineering projects.

Pre-requisites

Basic-to-intermediate MATLAB, R, or Python skills for data analysis will be helpful with midterm and final project deliverables. Tutorials discussing the tools required for completing the course project will be provided in the course.

Required Course Materials

The textbook utilized for this course is An Introduction to Statistical Learning with Applications in Python, authored by Gareth James et al. Textbook Link: https://www.statlearning.com/

Grading Policy:

Course grading will be based on homework (20%), midterm and final presentations (20% each), a final report (25%), midterm exam (10%), and class reflections (5%). Students will present their projects at mid-term and at the end of the course; students will submit a final written report. Homework will equip students with skills for project-related data analysis and interpretation.

Assessment	Allocation
Homework	20%
Midterm Presentation	20%
Final Presentation	20%
Final Report	25%
Midterm Exam	10%
Class Participation	5%

Grading Scale: A: 90–100%, B: 80–89.9%, C: 70–79.9%, D: 60–69.9%, F: below 60%

Description of Graded Components

Homework: Homework for this semester will be group-based, aligning with the topics and groups assigned for the course project. There will be four homework assignments (HW) throughout the semester. Each HW is due by 11:59 PM on the specified due date and must be submitted via CANVAS.

In-class and Lab Exercises: The lab sessions are designed to help students learn Python, statistical packages, and lab exercises. These exercises are not assessed based on correctness or completion. Full credit will be awarded for simply submitting the exercise.

Course Project: Students will work in groups on a semester-long course project involving real-world CEE data analytics problems. Projects will be presented at mid-term and at the end of the course.

Midterm Exam: The midterm exam will cover content discussed in lectures and assignments.

Homework Plans (Weeks 3–15)

1. HW 1: Data Analytics (DA) Task Definition and DA Problem Formulation
2. HW 2: Data Description, Data Cleaning, and Exploratory Data Analysis
3. HW 3: Model Selection, Training and Validation Design
4. HW 4: Model Comparison, Validation, and Results Interpretation

Homework Format Requirements:

1) HW must be neat, legible, and organized.
2) The students' names, the HW number, and the date must be on all assignments.

3) All graphs must be computer generated. Hand-drawn graphs will not be graded.
4) Any assumptions students make in interpreting the datasets analyzed must be clearly stated.

Course Policies

Attendance and/or Participation

Attendance at all lectures is encouraged. In accordance with the Institute's requirement, verification of participation in the class will be reported to the Registrar's Office and the Office of Scholarships and Financial Aid.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct.

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Core IMPACTS

Core IMPACTS is the University System of Georgia's General Education curriculum. If you are teaching a course that counts towards Core IMPACTS, you should include a syllabus statement about the Core area and associated career competencies. This resource developed by the Center for Excellence in Teaching and Learning and Online Education at Georgia State University includes template syllabus statements for each of the Core IMPACTS areas that you may adapt for your course.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions

will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

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Extensions, Late Assignments, & Re-Scheduled/Missed Exams

Late assignments will only be accepted without penalty if students have asked for permission (with a GT-approved excuse or for other extenuating circumstances) at least 48 hours before the assignment is due; a proposed submission date is required. Under other circumstances, homework scores will be reduced by 25% per day late (including weekend days). This applies to all late homework, for any reason, in the absence of an official GT excused absence.

Collaboration, Group Work, and Use of Generative AI

Students are expected to perform class activities according to the standards outlined in the Georgia Tech Academic Honor Code. Cheating of any kind is unethical and unacceptable; students should quote and attribute any words/ideas that are not their own. The use of Generative AI tools must be explicitly authorized by the instructor for specific assignments.

Campus Resources for Students

Undergraduate Student Academic Success Resources:

A list of resources for undergraduate students' academic success and information about advising can be found at Success at Tech (https://www.success.gatech.edu/).

- Academic Support: Academic Success and Advising (a unit in the Office of Undergraduate Education & Student Success) provides free support for your courses. Students can attend scheduled supplemental review (PLUS) sessions, stop by Drop-In Tutoring, or schedule a one-on-one appointment through Knack. To explore what options work best for you, please visit us online at success.gatech.edu/tutoring, email us at tutoring@gatech.edu, or come see us at Clough Undergraduate Learning Commons, Suite 283.

Student Well-Being:

At Georgia Tech, we are concerned about your overall physical, social, and mental well-being. A comprehensive list of wellness related resources has been compiled and maintained by the Office of the Vice President for Student Engagement and Well-being (student-resource-guide (gatech.edu)

Tentative Schedule

Classes begin August 24, 2026 and end December 8, 2026.

Lectures are held Mondays and Wednesdays, 2:00 PM – 2:50 PM.

Lab sections meet on Fridays (A01, 12:30 PM – 2:25 PM), or Thursdays (A02, 3:30 PM – 5:25 PM; A03, 8:25 AM – 10:20 AM).

No classes on September 7 (Labor Day), October 5 (Fall Break), November 25–27 (Thanksgiving).

Course Topics

- Course Introduction
- Systems Approach in Data Analytics
- Strategies to Communicate with Non-technical Audiences
- Introduction to Data Analytics and Machine Learning
- Data Analytics in DOT Pavement Asset Management (Invited Talk)
- General Concepts in Data Analytics (Statistical Learning)
- Pavement Infrastructure Maintenance and Rehabilitation (M&R)
- Linear Regression

- Classification Models
- Resampling for Model Validation
- Automated Roadway Condition Evaluation Using AI and Smartphones (Invited Talk)
- Linear Model Selection and Regularization
- Spatial Data Analytics Using GIS
- Data Display for Non-technical Audiences
- Spatial Data Analytics Using Python (GeoPandas)
- Tree-based Models
- Sensing Technologies in Smart City Infrastructure
- Introduction to Deep Learning
- Fundamentals of Report Writing and Oral Presentations
- Geostatistical Analysis and Its Applications (Invited Talk)
- Student Course Project Presentations

*The schedule will be provided at the beginning of the semester on Canvas.