## CEE 8813 Syllabus

Data Analytics for Transportation Safety, Section A, 3 Credits

Fall 2026

## Instructor Information

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## General Course Information

### Description

About 1.35 million people die in roadway crashes each year worldwide and an additional 20–50 million suffer injuries. Furthermore, roadway fatalities represent over 2% of all deaths of all kinds. There are traffic engineers who specialize in reducing roadway crashes, and all engineers, planners, and other personnel working in transportation-related fields must consider roadway safety. Data science and analytics are utilized in roadway safety to predict crash locations, assess the effectiveness of safety treatments, and much more.

This course is recommended for those interested in data science/analytics or those who may work in transportation. This course will 1) introduce the history and fundamentals of transportation safety analysis, 2) teach the fundamental techniques for data analytics, 3) discuss crash data analysis and safety countermeasure prioritization, 4) teach students how to utilize predictive and systemic crash analysis, and 5) explore emerging technologies and emerging data sources that can be utilized in roadway safety.

### History and Fundamentals of Transportation Safety Analysis

Types of transportation safety hazards, including curve roadway departure, intersection, pedestrian and bicycle, distracted driving, and under-influence crashes, will be discussed.

Methods in transportation safety analysis that have become more data-driven and prioritize safety are mentioned.

**Fundamental Techniques for Data Analytics**

The basic techniques required to conduct data analytics in transportation safety, including data preprocessing, regression models, machine learning models, model validation techniques, and result evaluation methods.

**Crash Data Analysis and Countermeasures**

Methods to analyze and interpret crash data will be taught, including hot spot crash analysis, GIS visualizations, crash types, and crash severities. Then this crash data is utilized in benefit-cost analysis to prioritize safety treatment.

**Predictive and Systemic Crash Analysis**

Predictive models will be developed and utilized in this class where crashes are modeled as functions of various risk factors related to the roadway environment.

**Emerging Technologies to Improve Safety Analysis**

As sensor technologies advance, connected vehicles emerge, and computer vision improves, more data becomes available. Newly used data for safety analysis and potential data that could be utilized in the future will be taught in this class.

**Course Learning Outcomes**

**The goal of this course is to teach students to:**

1) Know what is and how to use basic data analytics techniques.
2) Effectively assess the safety of roadways with a data-driven approach.
3) Apply data analytics and science techniques in real-world applications.
4) Understand current and future potential data utilized to make informed decisions related to roadway safety.
5) Learn traffic safety analysis software known as Numetric and ArcGIS.

**Required Course Materials**

Learning material will be provided through Canvas.

**Grading Policy:**

| Criteria | Weight |
|---|---|
| Homework | 40% |

| | |
|---|---|
| Project Report/Presentation | 25% |
| Midterm | 15% |
| In-class Assignments | 10% |
| Class Participation | 10% |

**Grading Scheme:**

| Percentage | Grade |
|---|---|
| 89.5 – 100.0 | A |
| 80.0 – 89.5 | B |
| 70.0 – 79.5 | C |
| 60.0 – 69.5 | D |
| 59.5 or lower | F |

**Description of Graded Components**

**Homework:**

1) Identify and describe a safety hazard in the community. Students will discuss why a location is unsafe based on human factors and identify the fundamentals of traffic safety.
2) Analyze various crash and roadway fatality statistics and trends.
3) Conduct a crash data analysis on a selected site. The manners of collisions, vehicle maneuvers, crash severities, and more will be assessed to determine appropriate safety countermeasures in benefit-cost analysis.
4) Practice the fundamental data analytics techniques using examples, including the development of predictive models and further validation and evaluation for crashes.
5) Conduct a literature review on emerging technologies in the field of traffic safety.

**Lab:**

The lab sessions are designed to help students learn Python, statistical packages, and lab exercises, to better prepare and complete homework. They are designed to a) help students utilize Numetric to assess crash statistics, b) teach students how to assess the effectiveness of safety countermeasures, c) exercise basic Python coding, d) exercise basic data analytics techniques, e) visualize the transportation safety data on a map using GIS techniques, f) compute Crash Modification Factors, and g) explore the use of emerging technologies and data for crash predictors and safety improvement.

**Mid-Term Exam:**

The mid-term exam will cover content discussed in lectures and assignments throughout the course. This will be an in-class closed-book assignment.

**Course Project:**

The course project will utilize methods taught throughout the course in a network-level safety screening and crash analysis to determine effective safety treatments. Students will utilize a data-driven and systematic approach to identify a safety hazard, analyze crash types and risk factors, and determine appropriate safety treatments through benefit-cost analysis.

## Course Policies

**Attendance and/or Participation**

Regular attendance is expected. Each student is responsible for all material and administrative instructions given during the lecture period. Attendance will be taken periodically throughout the semester. The participation grade will be used to evaluate a student's level of attentiveness, preparation, and participation in class discussions.

**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 (https://catalog.gatech.edu/policies/honor-code/) and the student Code of Conduct (https://catalog.gatech.edu/rules/18/).

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.

**Accommodations for Students with Disabilities**

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (http://disabilityservices.gatech.edu/) at (404) 894-2563 as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter.

**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 (http://www.catalog.gatech.edu/rules/22/) articulate some basic expectations that you can have of me and that I have of you.

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

Homework will be assigned frequently throughout the semester. Late homework is not accepted unless specific arrangements are made with Dr. Tsai prior to the deadline. No credit will be given for late homework or assignments. Only medical reasons with verification will be considered for late assignments.

Exams will cover the material presented in the readings, in class, in homework, on field trips, and in projects. Exams are closed-book and closed-note. Exams must be taken as scheduled. Only university-excused circumstances will be considered. A grade of zero will be assigned for missed exams; there are no make-up exams.

## Campus Resources for Students

### Graduate Student Academic and Professional Success Resources

A list of resources for graduate students is given on the Office of Graduate and Postdoctoral Education (https://gradpostdoc.gatech.edu/) website.

- Academic Resources such as the Communications Center, Language Institute, Library, Catalog, Registrar, resources for conducting research, Advocacy and Conflict Resolution resources.
- Student Resources such as Campus Services, Child Care/Family programs, Health & Wellness, Career Services, and the Student Resource Guide.
- Professional Development such as the programming from the Career Center and other professional development resources and events.

**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, 11:00 AM – 11:50 AM.

Lab meets on Wednesdays, 3:30 PM – 5:25 PM.

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

**Course Topics**

- Course introduction & historical crash trends (FIRST, FARS)
- Fundamental traffic safety concepts - HSM, human factors, KABCO, predictive approach
- AASHTOware Safety / Numetric tools
- Historical safety practices - MUTCD, HSIP, Vision Zero, Safe System, systemic safety
- Safety data and sensing technologies - crash, near-miss, LiDAR, probe, smartphone
- Roadway safety management - network screening, diagnosis, countermeasure selection
- Project prioritization - economic analysis using EPDO
- Introduction to data analytics - fundamental concepts
- Fundamental data analytics - data cleaning, correlation, regression
- Predictive crash analysis - Safety Performance Functions / SPFs

- Spatial data analytics - ArcGIS data visualization and mapping, coordinate systems, LRS, GIS table operations, spatial query, join, and buffer (ArcGIS + GeoPandas)
- Crash Modification Factors (CMFs) - development and HFST application
- Emerging technologies, AI-based near-miss detection and crash diagrams

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