



# Artificial Intelligence in Civil Engineering

## CE 7393

### Instructor Info —



Subasish Das, Ph.D.



Office Hrs: Thurs: 3:30-5:00 pm



Office: RFM 5210



[subasish.github.io/ait\\_lab](https://subasish.github.io/ait_lab)



[subasish@txstate.edu](mailto:subasish@txstate.edu)

### Course Info —



Prereq: CE 4361



Thurs



5- 8 pm



Room: RFM 5216

### Zoom Hours —



TBD by Email



TBD



<https://tinyurl.com/2p85vsyr>

### DIA Info —



Gauri Mahajan



Office Hrs: TBD



TBD

### At a Glance

This course explores the interface between artificial intelligence (AI) and civil engineering. The course covers foundational topics including civil engineering basics, AI fundamentals, matrix algebra, and data preprocessing. The curriculum also includes specific AI methodologies, like supervised, unsupervised, deep learning, and explainable AI, in addition to natural language processing. It highlights emerging technologies in civil engineering and the ethical and social implications of AI in the sector.

### Books/Materials

#### Textbook (Optional)

Bishop, C. *Pattern Recognition and Machine Learning*. Springer, 2006.

Goodfellow, I., Bengio, Y., and Courville, A. *Deep learning*. MIT press, 2016..

#### Other

I will provide supporting materials in Canvas/course website. Canvas will be used for lecture pdfs, HWs, and Exams. A quarto site (<https://subasish.quarto.pub/ce7393-fall24/>) will be used for interactive lectures.

### Grading

30% Homeworks 1-5, 6% each

50% Midterm Exam 1 & 2, 25% each

20% Term Paper

Will follow the standard scale: A = 89.5-100; B = 79.5-89.4; C = 69.5-79.4; D = 60-69.4; F <60. Curving is at the discretion of the professor.

### Term Paper

The term paper for requires students to explore the integration of AI in civil engineering practices, such as transportation, design, construction, and infrastructure management. Students will select a specific application area, conduct a literature review, develop AI models, and present their findings in a well-structured paper of 7,500-10,000 words. The paper must demonstrate originality, depth of analysis, and relevance to current engineering challenges. All codes should be released in GitHub. Students need to use Quarto to develop presentations and final papers.

### Learning Objectives

- Understand and explain the fundamentals of civil engineering and its applications.
- Understand the fundamental concepts of artificial intelligence (AI) and its different learning paradigms.
- Apply matrix algebra and probability concepts to understand and implement AI algorithms.
- Apply supervised, unsupervised, and deep learning techniques to solve civil engineering problems.
- Apply natural language processing concepts in the context of civil engineering.
- Understand the importance of and apply the principles of explainable AI.
- Evaluate the ethical and social implications of AI in civil engineering.

# FAQs

## ? What is AI?

! AI, according to Yann LeCun and Yoshua Bengio, can be defined as the development of systems that can perform tasks typically requiring human intelligence. These tasks include perception, reasoning, learning, and decision-making. AI systems are designed to interpret complex data, make informed decisions, and adapt their behavior based on experience, thereby mimicking cognitive functions traditionally associated with the human mind.

## ? What role does AI play in the development of smart cities?

! AI plays a crucial role in smart cities by optimizing traffic management, improving energy efficiency, enhancing public safety through real-time surveillance, and supporting the design of sustainable urban environments through data-driven decision-making.

## ? How can AI improve traffic safety?

! AI can improve traffic safety by optimizing traffic flow through real-time data analysis and predicting potential crashes, allowing for proactive measures to prevent collisions.

## ? What are the challenges of implementing AI in Civil Engineering?

! Challenges include the integration of AI with legacy systems, the need for large, high-quality datasets, the potential for algorithmic bias, the requirement for interdisciplinary expertise, and the resistance to change within the industry.

## Accommodations for Students with Disabilities

If you are a student with a disability who will require accommodation(s) to participate in this course, please contact me as soon as possible. You will be asked to provide documentation from the Office of Disability Services. Failure to contact the Office of Disability Services in a timely manner may delay your accommodations. Any accommodations for testing will be provided by ATSD only; everyone who tests in the classroom will test under the standard testing conditions. Please talk to me privately so that we can be sure your needs are met.

## Conduct

Civility in the classroom is very important for the educational process and it is everyone's responsibility. If you have questions about appropriate behavior in a particular class, please address them with your instructor first. Disciplinary procedures may be implemented for refusing to follow an instructor's directive, refusing to leave the classroom, not complying with social distancing or sneeze and cough etiquette, and refusing to implement other health and safety measures as required by the university. Additionally, the instructor, in consultation with the department chair/school director, may refer the student to the Dean of Students Office for further disciplinary review. For more information regarding conduct in the classroom, please review the following policies at Section 03: Courteous and Civil Learning Environment, and number II, Responsibilities of Students, Section 02.02: Conduct Prohibited.

## Drop Policy

The automatic "W" deadline for dropping individual classes is on the calendar. After that date, you may not drop any single course. If you withdraw from the University, you may do so until withdrawal date on the calendar. If you are intending to withdraw from the class or University, feel free to meet with me to discuss your grade in the course. You should also talk to your academic advisor. All academic deadlines can be found here.

## Emergency Management

In the event of an emergency, students, faculty, and staff should monitor the Safety and Emergency Communications web page. This page will be updated with the latest information available to the university, in addition to providing links to information concerning safety resources and emergency procedures. Faculty, staff, and students are encouraged to sign up for the TXState Alert system.

## Honor Code

Every item that you submit for grading must be the result of your own intellectual effort. Otherwise, you have committed academic dishonesty, whether intentional or not. All students are expected to follow the Texas State University Honor Code. In general, the penalty for academic misconduct in my class is a zero for the assignments in question. A second instance of cheating by a student will result in a grade of F for the class. The Honor Code can be found on the Texas State website at [here](#) and [here](#).

## Sexual Misconduct Reporting (SB 212)

Effective January 2, 2020, state law (SB 212) requires all university employees, acting in the course and scope of employment, who witness or receive information concerning an incident of sexual misconduct involving an enrolled student or employee to report all relevant information known about the incident to the university's Title IX Coordinator or Deputy Title IX coordinator. According to SB 212, employees who knowingly fail to report or knowingly file a false report shall be terminated in accordance with university policy and The Texas State University System Rules and Regulations.

## Class Schedule

### MODULE 1

Week 1	08/29	Session 1	Introduction on AI in CE, and discussion on syllabus
		Session 2	Introduction R, Rstudio, and Quarto
Week 2	09/05	Session 1	Data Wrangling
		Session 2	Feature Importance
Week 3	09/12	Session 1	Matrix Algebra
		Session 2	Probability [HW1 Due on 09/06]
Week 4	09/19	Session 1	Supervised Learning
		Session 2	Challenge Lab: Data and Solution
Week 5	09/26	Session 1	Unsupervised Learning
		Session 2	Challenge Lab: Data and Solution [HW2 Due on 09/27]
Week 6	10/03	Session 1	Deep Learning
		Session 2	Challenge Lab: Data and Solution [HW3 Due on 10/04]
Week 7	10/10	Session 1	Reinforcement Learning
		Session 2	EXAM 1

### MODULE 2

Week 8	10/17	Session 1	Natural Language Processing
		Session 2	Challenge Lab: Data and Solution
Week 9	10/24	Session 1	Explainable AI
		Session 2	Challenge Lab: Data and Solution [HW4 Due on 10/25]
Week 10	10/31	Session 1	Ethical and Social Implications of AI in CE
		Session 2	Challenge Lab: Data and Solution
Week 11	11/07	Session 1	AI Tools
		Session 2	Case Studies [HW5 Due on 11/08]
Week 12	11/14	Session 1	Large Language Models
		Session 2	Towards World Model
Week 13	11/21	Session 1	Disruptive AI Technologies in Transportation
		Session 2	EXAM 2

### MODULE 3

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Week 14	<a href="#">11/28</a> Thanksgiving	No class
Week 15	<a href="#">12/05</a> Session 1	Pitch on term papers (20 min. each)
	Session 2	Pitch on term papers (20 min. each)

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Note: Course contents can be slightly modified.