Undergraduate Research Opportunity:
AI for Sustainability and Resilience to Natural Disasters

Instructors: Arlei Silva (arlei@rice.edu) and James Doss-Gollin (jdossgollin@rice.edu)

Spring 2023

Program description

The IFCE-Rice-SENAI Program on Artificial Intelligence for Urban Sustainability and Resilience to Natural Disasters in the Americas is a tripartite alliance integrating research and development (R&D), education, and local partnerships to improve infrastructure systems to better handle hydroclimate extremes. The program is funded by the *100K Strong in the Americas Innovation Fund*[1] with the goal of strengthening higher education partnerships between the US and other countries in the Americas. This is a US-Brazil collaboration with the other institutions being the Instituto Federal do Ceará (IFCE) and the Instituto de Inovação para Tecnologia da Informação e Comunicação (SENAI).

This is a project-based course where a few intro lectures and homework activities will be combined with a semester-long project where students will have hands-on experience in applying Artificial Intelligence, Machine Learning, and Data Science for increasing sustainability and resilience to natural disasters. The students will be invited to present their project (as a talk or poster) at a research workshop to be held in Houston in October 2023. There will be also opportunities for participating in other activites of the IFCE-Rice-SENAI program, such as online seminars and a short (one week) visit to Brazil.

The enrollment for this course is capped at 4 students.

Credit Hours: 1

Participating students should register for one credit of COMP 290 (Computer Science Projects) for Spring 2023. The expected dedication time is 2 hours per week.

Mission

Introduce students to applications of Artificial Intelligence to sustainability and resilience to natural disasters.

[1] https://www.100kstrongamericas.org

Target Audience

Undergraduate students in Computer Science, Civil Engineering, Electrical and Computer Engineering, Statistics, and Computational and Applied Math.

Recommended Prerequisites

Linear algebra, probability and statistics, intro-level machine learning or data science, basic Python programming.

Course Materials

All the reading materials will be made available to the students online. Computational resources will be made available via Google Colab credits.

Format

The course will start with eight recorded hour-long intro lectures on AI, resilience, and sustainability. Each lecture will be followed by a brief programming homework problem (in Python). The instructor will be available during office hours to answer questions. The remainder of the course will be focused on a research project. Office hours will also be available for providing guidance on the projects. Students will submit a brief mid-term report and also present their project results at the end of the course.

Grading

Grades will be based on the following.

- Homeworks (40%)
- Project mid-term report (30%)
- Project presentation (30%)

Logistics

Lecture recordings will be made available to the students weekly. Communication with the instructor will be through Piazza or email.

Projects

A list of projects will be recommended by the instructor and students will be able to select their projects. Students will also be able to suggest project ideas as long as they fit the topic of the course. The plan is for projects to be done individually but team projects will also be considered. Here are some examples of projects that would fit the course:

1. Efficient flood prediction: how to efficiently predict water depths over time given rainfall and terrain data (e.g., elevation, friction, water streams)? Different models can be applied, including CNNs, RNNs, and GNNs.
2. Large-scale traffic simulations: given partially observed traffic data from a large urban area (e.g. Harris County), how to simulate traffic and estimate the impact of interventions, such as increasing the number of lanes in a freeway?
3. Evacuation route recommendation: given water depth predictions from a flood simulation model, how to recommend evacuation routes from regions likely to be flooded to safe ones?
4. Pollution prediction: given partially observed traffic data from sensors, how to predict the amount of pollution emitted by vehicles in different areas??

Rice Honor Code

Students are expected to adhere to the Rice Honor Code.[2] This is an individual project, so all the reports should be based on individual effort. Research integrity, according to university policy, is also expected.[3]

Students with Disabilities

If you have a documented disability that may affect academic performance, you should: 1) make sure this documentation is on file with Disability Support Services (Allen Center, Room 111 / adarice@rice.edu / x5841) to determine the accommodations you need; and 2) meet with me to discuss your accommodation needs.

Schedule

Week 1-8	Intro and logistics, lectures
Week 9	Projects
Week 10	Spring break (March 11-18)
Week 11-14	Projects
Week 14	Mid-term report (April 14)
Week 15-16	Projects
Week 16	Final presentation (April 28)

[2]Honor System Handbook: http://honor.rice.edu/honor-system-handbook/
[3]Rice Research Integrity Policy: https://policy.rice.edu/324