Multi Agent Systems for Emergency Response

Duration: Half-Day

Contact: Ayan Mukhopadhyay (Vanderbilt University, ayan.mukhopadhyay@vanderbilt.edu), Sayyed Mohsen Vazirizade (s.m.vazirizade@vanderbilt.edu)

Short biography of the organizer(s):

AM: Dr. Ayan Mukhopadhyay is a research scientist at Vanderbilt University, USA. His research interests are multi-agent systems, robust machine learning, and decision-making under uncertainty. Prior to this, he was a post-doctoral research fellow at the Stanford Intelligent Systems Lab at Stanford University, USA. He was awarded the 2019 CARS post-doctoral fellowship by the Center of Automotive Research at Stanford (CARS). He finished his doctorate in Computer Science at Vanderbilt University's Computational Economics Research Lab, and his doctoral thesis on robust decision-making for emergency response was nominated for the Victor Lesser Distinguished Dissertation Award 2020. He works on multi-agent systems to tackle societal problems, and was recently awarded the Google AI Impact Scholar Award 2021.

SM: Dr. Sayyed Mohsen Vazirizade is a post-doctoral research fellow at Vanderbilt University, Department of Electrical Engineering and Computer Science. As a member of SCOPE (Smart and resilient Computing for Physical Environment), he works on multiple projects including developing Artificial Intelligence agents for integrated data-driven technologies for smart cities. He earned his Ph.D. in Civil Engineering from the University of Arizona in 2020. His main research focuses are on risk and reliability engineering, statistical modeling and prediction, and machine learning.

Audience expectation and prerequisites:

- Basic Knowledge of Machine Learning.
- Some knowledge about decision-making under Uncertainty (Markov-Decision Processes)
    - We will provide introductory material on both. While some prerequisite knowledge will certainly be helpful, we welcome participants with no prior knowledge in these domains.

Speakers

- Ayan Mukhopadhyay (Vanderbilt)
- Sayyed Mohsen Vazirizade (Vanderbilt)
- Hemant Purohit (GMU)
- Tina Diao (Stanford) ~ Tentative

Abstract

Emergency response to incidents such as accidents, crimes, and wildfires is a major problem faced by communities. Emergency response management (ERM) comprises several stages and sub-problems like forecasting, detection, allocation, and dispatch. The design of principled approaches to tackle each problem is necessary to create efficient ERM pipelines. This talk will go through the design of principled decision-theoretic and data-driven approaches to tackle emergency incidents. It will discuss the data collection, cleansing, and aggregation as well as some models and methods we used to solve an imbalanced classification problem. Further, we will explain how large multi-agent systems can be used to tackle emergency scenarios under dynamic environments and communication and state uncertainty. We will go through fundamental modeling paradigms like Markov decision processes, semi-Markov decision processes, and partially-observable Markov decision processes and how promising actions can be found for stochastic control problems. As case studies, we will specifically look at emergency incidents like wildfires and road accidents. We will also go through two open-source datasets that we have created for the research community to use regarding traffic accidents and wildfires.

Schedule

Topic	Total Duration	Description
Introduction and Tutorial Overview	20 minutes	Introduction to Emergency Response. How does the problem manifest itself? What are open challenges? What are the challenges faced by practitioners? Relevant Papers: https://arxiv.org/abs/2006.04200
Forecasting Spatial-Temporal Incidents.	60 minutes	Introduction to data-driven learning. Description of challenges like learning under sparsity. We will discuss

		how synthetic resampling, clustering, statistical and algorithmic approaches to learning, and inference can help emergency response. We will also discuss robustness of learning in the context of game-theoretic scenarios. Relevant Papers: https://arxiv.org/abs/2106.08307 https://ayanmukhopadhyay.github.io/files/UAI.pdf https://arxiv.org/pdf/1902.08274.pdf
Invited Talk 1: Hemant Purohit (GMU)	20 minutes	Disaster Informatics using Real-Time Social Media Analytics Methods.
Decision-Making	60 minutes	Introduction to decision-making under uncertainty. How can we model sequential decision-making problems as Morkov (and semi-Markov) decision making processes? What are some approaches to solve such problems? How can such approaches scale to real-world scenarios? https://dl.acm.org/doi/pdf/10.5555/3237383.3237471 https://ayanmukhopadhyay.github.io/files/aamas20.pdf https://ayanmukhopadhyay.github.io/files/iccps21.pdf
Implementation Tutorial	30 minutes	Description of implementation for forecasting methods. https://statresp.ai https://wildfire-modeling.github.io
Invited Talk 2: Tina Diao (Stanford)	20 minutes	Response to Wildfires using Partially Observable Markov-Decision Processes
Open Challenges, Future Directions of Work, and Conclusion	20-30 minutes	Conclusion and discussion regarding open challenges, followed by an open discussion sesion.