Fall 2022 Webinar Series – 12/01/2022

CREST MECIS

Presentation 1: Dr. Jia Chen and Dr. Vagelis Papalexakis, University of California-Riverside (UCR)

Title: Tensor Methods with Graphs and Deep Learning

Abstract:

In this presentation, we will explore a number of topics involving low-rank factorization, tensor methods, and learning with graphs. Firstly, we will discuss a novel framework for learning a super-resolution tensor from different compressed views with the help of graph side information, which improves the robustness and the fidelity of the reconstruction of a high-resolution tensor from two complementary disaggregated views. Subsequently, we will present new and exciting preliminary results on leveraging deep learning for approximating the singular value spectrum of a dataset; we will discuss our initial proposed architecture and preliminary results as well as implications for future work.

Presentation 2: Dr. Bo Zhou, University of Illinois-Chicago (UIC)

Title: Optimal Deployment of CAV Lanes: An Efficiency-Equity Bi-Objective Consideration

Abstract:

Connected and autonomous driving is one of the key technologies shaping future mobility. As the transition from human-driven vehicles (HVs) to connected autonomous vehicles (CAVs) will not be completed overnight, the road environment is expected to have coexistence of HVs and CAVs in the many years to come. In such a mixed traffic environment, we consider deploying dedicated CAV lanes in a transportation network on which CAVs can travel with reduced headways and therefore enhanced road capacity. While previous works focus on optimizing system efficiency while deploying CAV lanes, the implications for equity among travelers have not drawn research attention. In this paper, we tackle CAV lane deployment problem by explicitly accounting for both efficiency and equity objectives. A bi-level bi-objective optimization model with multi-class user equilibrium is developed to determine the optimal CAV lane deployment in a generic transportation network. To solve this bi-level model, a new approach that integrates hybrid metaheuristics encompassing non-dominated sorting genetic algorithm and variable neighborhood search, and the Frank-Wolfe algorithm is proposed. Numerical experiments are conducted on small and large networks to demonstrate the application of the model and effectiveness of the solution approach. The results provide insights about considering both efficiency and equity in CAV lane deployment.

<u>Presentation 3:</u> Alberto Velazquez, Master's Student, UTRGV

Title: Quadcopter Control Using Single Network Adaptive Critics

Abstract:

Quadcopter drones are nonlinear, underactuated systems with complex dynamics consisting of twelve states and four controls. The states are defined using two related reference frames: the earth frame, which describes the position and angles, and the body frame, which describes the linear and angular velocities. Splitting the dynamics into the position and the attitude (angles) simplifies the system and reduces computational loads when training approximate dynamic programming (ADP) algorithms. These algorithms can derive the optimal trajectory-tracking control for input-affine nonlinear systems. Finite-Horizon Single Network Adaptive Critics, or Finite-SNAC, can provide a controller that applies online optimal feedback control, minimizes control effort, can handle all initial conditions within the domain of training, and works for all times within the finite-horizon. Finite-SNAC controllers can track reference trajectories for both the position and attitude systems, with a neural network estimating the desired angles corresponding to the desired position. In Finite-SNAC, the optimal control for the system is derived by solving a discrete-time recursive Hamilton-Jacobi-Bellman equation using a linear in-parameter neural network. The neural network trains to find a mapping between the gradient of the optimal cost-to-go function with respect to the current states, also known as the costate vector, and the current states. The network's weights iteratively train using the least-squares approximation method until convergence, and training begins at the final time and proceeds back to the initial time. The result is an optimal, trajectory tracking control scheme for quadcopter drones.

<u>Presentation 4:</u> Randy Chapa, Master's Student, UTRGV

Title: Safety-Aware Longitudinal and Lateral Control of Autonomous Vehicles

Abstract:

Safety is undoubtedly the most critical design requirement regarding autonomous vehicle controllers. This research considers an autonomous vehicle to keep a desired distance from the leader vehicle, as well as stay centered within the lane. To achieve this, the lateral control problem and the combined longitudinal and lateral control problem were studied. Adaptive control laws were proposed with the aid of the backstepping technique and the barrier function technique. Simulation was done to verify the effectiveness of the proposed control laws.