CS 238 Final Project Proposal

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Concept: Autonomous Driving a Stanford Bus Route

Introduction:

The goal of this project is to develop an autonomous self-driving system for a school bus for the Stanford campus. The bus will be able to transport students and staff between different buildings and locations on campus, providing a safe and efficient mode of transportation. This project will focus on the sequential decision-making capabilities of the self-driving bus, as well as addressing potential sources of uncertainty.

Background:

Self-driving technology has advanced significantly in recent years and has the potential to revolutionize transportation. However, one of the main challenges in developing autonomous vehicles is the ability to make safe and efficient decisions in a complex and dynamic environment. This is particularly true for a self-driving school bus, which must navigate busy streets and interact with pedestrians, bicyclists, and other vehicles.

Decision-Making Problem:

The autonomous self-driving school bus must be able to make a wide range of decisions, such as predicting the behavior of other road users and reacting to unexpected events. The bus must also be able to handle different weather conditions, traffic patterns, and road closures. Explicitly, the bus operates in a continuous loop of sequential tasks that form the basis of its autonomy: gather information (sensors), determine appropriate action at time t (control logic), and implement action (actuators). The project will focus on a predetermined route to reduce the complexity of the problem.

Sources of Uncertainty:

- Sensor data: The self-driving bus relies on a variety of sensors, such as cameras, lidar, radar, and ultrasonic sensors, to gather information about its surroundings. However, these sensors can be affected by weather, lighting conditions, and other factors, which can lead to uncertainty in the data they provide.
- Model uncertainty: The bus may incorrectly account for the implication of weather conditions on the road surface, and therefore, traction. Our bus will operate under some level of uncertainty about the ground’s coefficient of friction in off nominal conditions such as heavy rain or icing in very rare cases. The bus’ belief of the road’s conditions has implications on control actions the bus implements such as stopping distance and forward acceleration.
- Interaction uncertainty: The bus must interact with other road users, such as pedestrians, bicyclists, and other drivers. However, human behavior can be unpredictable and difficult to anticipate, which can lead to uncertainty.

Potential solution methods

We would like to optimize our bus' behavior over a finite set of design variables. We may train our bus' decision making using a reinforcement learning framework, which rewards positive behavior like passenger comfort and low fuel economy while punishing negative behavior like crashing into a pedestrian (obviously). Below is a list of behaviors that we consider as positive and negative.

Positive:

- Passenger comfort
  - Possibly defined in terms of changes in bus acceleration
- Timeliness
  - Rewarded for arriving to bus stops on schedule

Negative:

- High control actions
  - We would like to punish the bus using high, potentially dangerous control efforts outside of emergency situations
  - Low control actions also reward fuel efficiency
- Injury
  - To passengers or pedestrains