Saving Time and Life: A Model of Self-Driving Vehicles

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Problem: Every day, an average of over 3,000 people dies due to world-wide vehicle-related accidents. Throughout a person's life, we can estimate that approximately five years of real time will be spent waiting in line, with 6 months of that due to red traffic lights. The advent of more sophisticated vehicle safety features has led to the development of completely autonomous driving systems and this has positive implications for our lives. Our team is looking to model a small system of two-way streets filled with self-driving cars and measure how well the behavior of these cars, governed with a small amount of basic rules, is able to adapt to increasingly dense traffic. The measure of success of our autonomous fleet will be in terms of traffic flow throughput and how robust our system is when subjected to less-than-ideal newcomers (cars that behave badly).

Approach: To solve the problem of modeling self-driving cars, we are going to establish a small amount of rules and objectives which will be used to govern the behavior decisions of the cars. We will start out by creating our streets using a 2-dimensional grid. After that, we will create functions which randomly assign starting locations for our cars and restrict them to unidirectional travel, changing location on the street at one point a time step. The cars should 'loop' back to the opposite end of the street once they've hit the end to ensure the system is continuous. Once that is successful, we will randomly assign unique destinations for all the cars and give them ways to continue avoiding collision while also progressing towards their goal. Once this system is running and we have also created a satisfactory way to visualize it, we will test its robustness by adding 'bad drivers' to the streets. These bad cars are cars that are not going to attempt to avoid crashing (although they should avoid hitting the boundaries of our grid). We'll create a way to measure traffic flow throughput. Given this approach, we would then be able to start to put more realistic constraints on our system and see if it could hold up (acceleration, cars with shared destination goals, limits on speed, etc.). Employing these different challenges might even allow us to test our model on a real city's streets. At that point, we could compare our results with real life data!

Objectives:

1) Create rules for vehicles that self-govern behavior on a small grid network of virtual streets with cars either going north or east.

2) Have these rules result in increased Traffic flow throughput without crashes or traffic jams.

3) Test robustness of design by slowly introducing unsafe drivers and reporting how long the system was resistant to accidents.

4) Assign destinations for cars and allow for multi-directional travel. Find the capacity of the system to hold self-driven cars before destinations prove to be unreachable.

5) (Stretch) Apply realistic boundaries and constraints to our model to more accurately represent traffic in real life.

6) (Stretch) Use updated model to compare our traffic flow throughput with a real city.