Computer Systems Project Proposal

A Traffic Simulation Model Allowing For Wide-ranged Vehicle Communication

Timmy Galvin

1. Traffic is an ever-growing problem as population around the world increases exponentially and with it, the number of drivers. Previously, fluid flow models have been used in an attempt to model traffic, but as has been recently discovered, only agent based models can accurately model a traffic scenario as small perturbations can have a butterfly effect and change the entire system.
2. The purpose of this project is to create a functioning agent based traffic simulation model. The main goal for my project is to see if traffic conditions can be lessened through the availability of information. This goal goes hand in hand with creating a working model that accurately shows traffic behavior as is now generally accepted. The overall goal of this is to see if the spread of information to all the agents in a traffic model can lessen bad traffic situations. This would best modeled by a computer simulation and the results could further research into whether things such as variable speed limits would be beneficial to high traffic areas.

3. To create a realistic and reasonable agent based traffic simulation, research will need to be done on how to correctly or more accurately model human driving behavior. The facts that will need to be researched are braking equations, tendencies to tailgate, and driver aggressiveness and how it affects their driving. An algorithm will need to be written beyond that of a simple linear system for the vehicle's braking method as humans don't break steadily with knowledge of just what extent to brake. However, while a more realistic model is trying to be constructed, it will follow the general rule of traffic models of a collision-free system. For the environment to have useful across the system communication, an algorithm will need to be written that relates traffic flow versus traffic density and that tries to optimize this by altering the limitations on the traffic.

   The first main portion of this project will be creating a generic accurate traffic model with multiple lanes, stoplights and stop signs, and turning. Once this is created, the focus will be moved towards having the program assess the flow of the traffic and alter traffic laws as to better alleviate and handle traffic situations. I don't know if this method will work how I plan it, but I want to test the validity and impact of the whole system knowing the condition of the rest of the system.

4. When I first began research into traffic simulations and models, I found two main theories for how best to simulate traffic. The long-held mostly American conception of fluid flow models that treat traffic using advanced math equations for flow and the newer European view of agent based modeling systems. From what I found, agent based models seem to be the prevailing method with scientists such as Kai Nagel leading current research. Models have moved from a top-down approach and macro models to more recent bottom-up approach and a compilation of micro models as per research by Steen Rasmussen. Results from this new method have been more accurate and better able to simulate traffic flow.

   For the sake of computational speed, all models to date are based on linear systems, as such they deal with instantaneous lane changing. My model will go past this by shrinking the

number of cars in the system to allow for more mathematical operations and a 2d system that will better depict true lane changing behavior.

5. As for my procedure, I have already done extensive research into agent based modeling systems and any further research I conduct will be in how to best capture individual human driving characteristics. My program is at a state where it models a two-lane system with a speed trap that initiates a traffic jam. My progress will be building upon this current model, adding more features and human-like behavior to move past the simpler models. Once I have graphical analysis in place I can conduct tests on new versions of my simulation to see if it correctly models known traffic patterns with a single optimum.

   I will use Java to develop this model and will most likely use previously conducted research, formulas, or pseudo-code to incorporate more humanization of the cars. Although, when I am coding these things, I need to first have my model working with the basic elements that I have already included. I might run into an issue with my 2d system, for when my cars are turning, their detection method will be extremely complicated to code. This will be a major hurdle that I will have to overcome in doing my project.

   For data input, I can have everything hard-coded into the program, or as I plan, I can leave certain values for the user to input, such as traffic density, speed limit, acceleration, and such. With these data values, my program's test will mainly include observing the traffic behavior and the graphical analysis to see if it fits with accepted and actual behavior. Also, I will use varying numbers of cars in the model to have a graph of cars versus run speed to see how much the 2d calculations will slow the program when the number of cars is vastly increased. Essentially this program will be tested with process modeling as the results will be compared to mathematically derived graphs in other reports and articles.

   I will use a simple time-based structure to plan out my work. I will divide my project chronologically in what needs to be founded on previous work. I will then attack these divided sections and progress to my goals for my project.

6. I expect to see find from my project that an agent based modeling can accurately describe a traffic situation. I also am expecting to find that a spread of information across the system will alleviate and help bad traffic situations.

   The data that I collect will be presented by graphs. The two graphs I have planned are a flow versus density graph and a run speed versus density. I think these will depict the purpose of my program well. My results can be used to design more detailed systems that can be tested to alter physical traffic setups. This could result in an adaption of sensors and variable speed limits to help deal with traffic situations that occur regularly.