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Chaotic Dynamics – Proposal
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Introduction

In an effort to reduce travel time of cars and trucks traveling along the I-70 mountain corridor, I plan to study the chaotic properties of a Microscopic Traffic Flow Model (MTFM). I will make use of the several self-written tools for non-linear dynamics analysis and a few graphical tools in order to portray my results. While there has been quite a bit of research on the development of MTFMs, few have attempted to improve travel times. By analyzing the chaotic properties of such a model, I hope to gain insight on ways to improve the driving quality of cars and trucks on I-70.

Methods

In a MTFM, traffic is represented at the microscopic level[1]. Motion of an individual car is represented by a set of ordinary differential equations. Car-following models (CFM) are a type of MTFM where motion is dependent on the velocity and position of the car and the car ahead as well as a few input parameters, such as the vehicle length and maximum vehicle acceleration.

Lane-changing models attempt to model the behavior of drivers switching lanes. These models are dependent on the spacing and aggressiveness of cars in adjacent lanes. Integrating a Lane-changing model (LCM) with a CMF allows for the analysis of traffic flow in multiple lanes[2]. This will be beneficial as the portion of I-70 in analysis is a multi-lane highway, where lane changes will have an effect on the overall state of flow.

I plan to use a few numerical methods for analyzing these non-linear systems. To numerically solve the set of ODE's for the derived traffic flow model, I will use self-written Runge-Kutta method. From solving the ODE's over a range of initial conditions, I plan on generating bifurcation diagrams in order to view points where the flow of traffic bifurcates. My hope is that these bifurcation points will give insight into the underlying behavior of traffic flow and will help in developing techniques to improve driving quality.

I will attempt to identify parameters that will improve driving quality in two ways. The first will be improving the average driving time of all drivers on the portion of I-70. The second will be improving driving times for individual drivers. My hypothesis is that achieving these two types of improvement will require drastically different parameters.

Conclusion

The overall goal of my research will be to identify techniques to reduce the driving times of individual drivers as well as drivers as a whole. The area of focus will be along the I-70 mountain corridor, between Frisco and Denver. All analysis will be done through the use of self-written non-linear dynamics tools, written in Python.

Bibliography

1) Y. Luo and L. Bölöni. Towards a more accurate agent-based multi-lane highway simulation. In *Proc. of International Workshop on Agents in Traffic and Transportation (ATT10), in conjunction with the Conference on Autonomous and Multi-Agent Systems (AAMAS 2010)*, pp. 13–20, May 2010.

2) Kesting, Arne, Martin Treiber, and Dirk Helbing. "General Lane-Changing Model MOBIL for Car-Following Models." *Transportation Research Record: Journal of the Transportation Research Board* 1999 (2007): 86-94. Web.