Tactical decision-making in dynamic uncertain traffic situations

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Description:

This research project considers how to design a tactical decision making system for autonomous driving. A fully autonomous vehicle needs to be able to replace the high level decision making of a human driver. Such decisions concern, for example, how to merge into traffic from a highway ramp, whether or not to overtake a slower vehicle, or how to negotiate a crossing. These decisions also need to consider uncertainties in traffic situations, both from sensor limitations and in the intention of other road users.

Background & Motivation

There is a strong motivation for building safe autonomous commercial vehicles, such as trucks, since removing, or allowing the driver to perform other tasks, would significantly increase the vehicle's productivity.

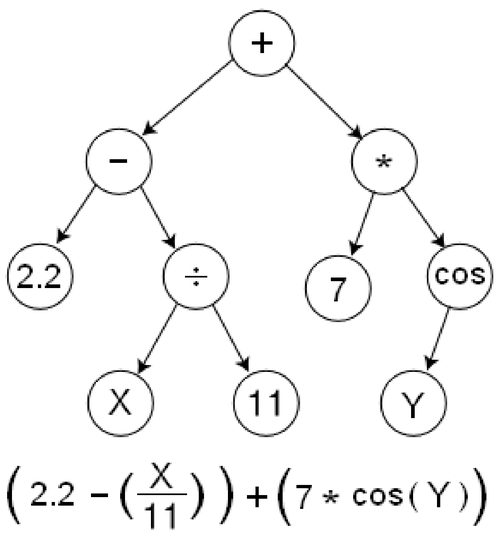
The basic building blocks of a fully autonomous vehicle already exist, but some major questions still remain to be solved before a human can be replaced. One such question is how to make tactical decisions, involving potentially conflicting demands when balancing safety and efficiency.

Research Goal & Questions

The goal of the research project is to develop a prototype of the previously mentioned decision making system. In the process, the following research questions should be answered:

- How can the quality of decision making be measured? How can it be formulated mathematically?
- How can machine learning be used to create a decision making system, integrating traffic rules, human driving behaviour and safety?
- How can a decision making system be guaranteed to be safe?

Methods & Preliminary Results



Example of genetic programming.

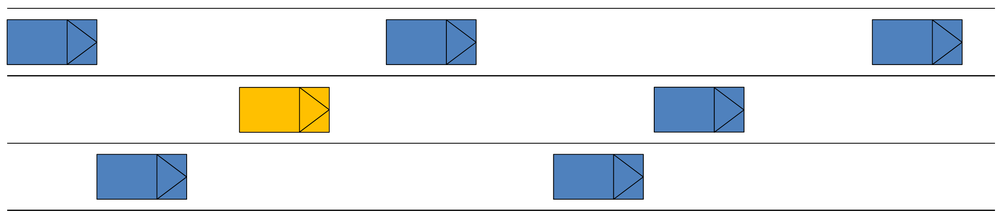
The first studied type of decision making scenario is choosing when to change lane during highway driving.

Initially two different machine learning methods, Linear Genetic Programming and Deep Reinforcement Learning, are applied to the problem. Simulations are used for training the system, returning an automatically generated decision making algorithm.

Roadmap & Milestones

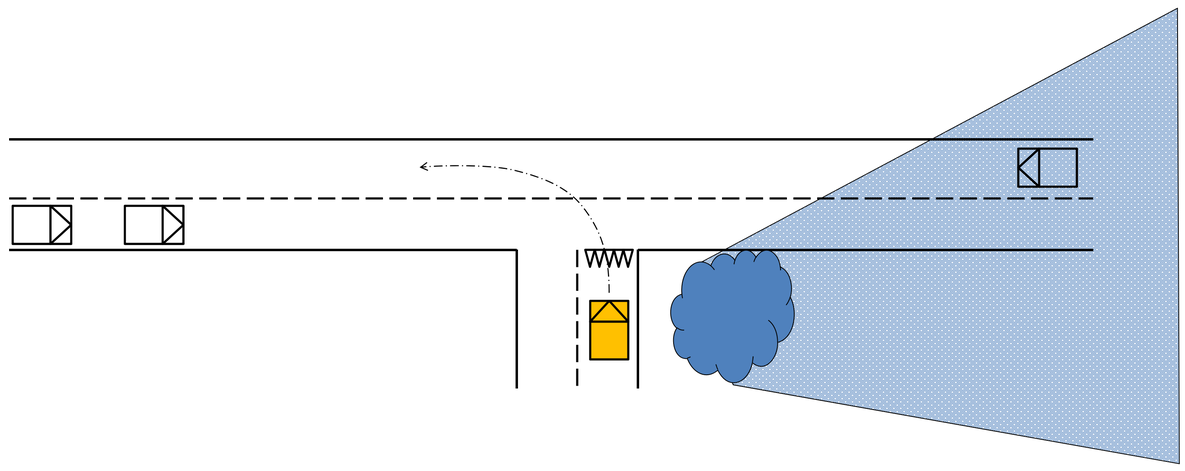
A rough road map for the short- to medium-term future:

- Investigate simple solutions for a highway lane changing scenario.
- Develop solutions, apply to a more realistic highway scenario.
- Compare with human drivers at VTI driving simulator.
- Apply to more complex scenarios, such as a crossing.
- Investigate alternative, more complex, solutions.



Highway lane changing scenario.

Example of a traffic situation, including uncertainties in other vehicles' intentions and sensor occlusion. Here a decision needs to be taken, simplified, whether to stop or go at the intersection.



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