Decentralised Autonomous Intersection Management

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With advancement in Machine Learning, self-driving cars are becoming a reality. As self-driving cars become better they may eventually prove to be a safer option than having people drive cars.

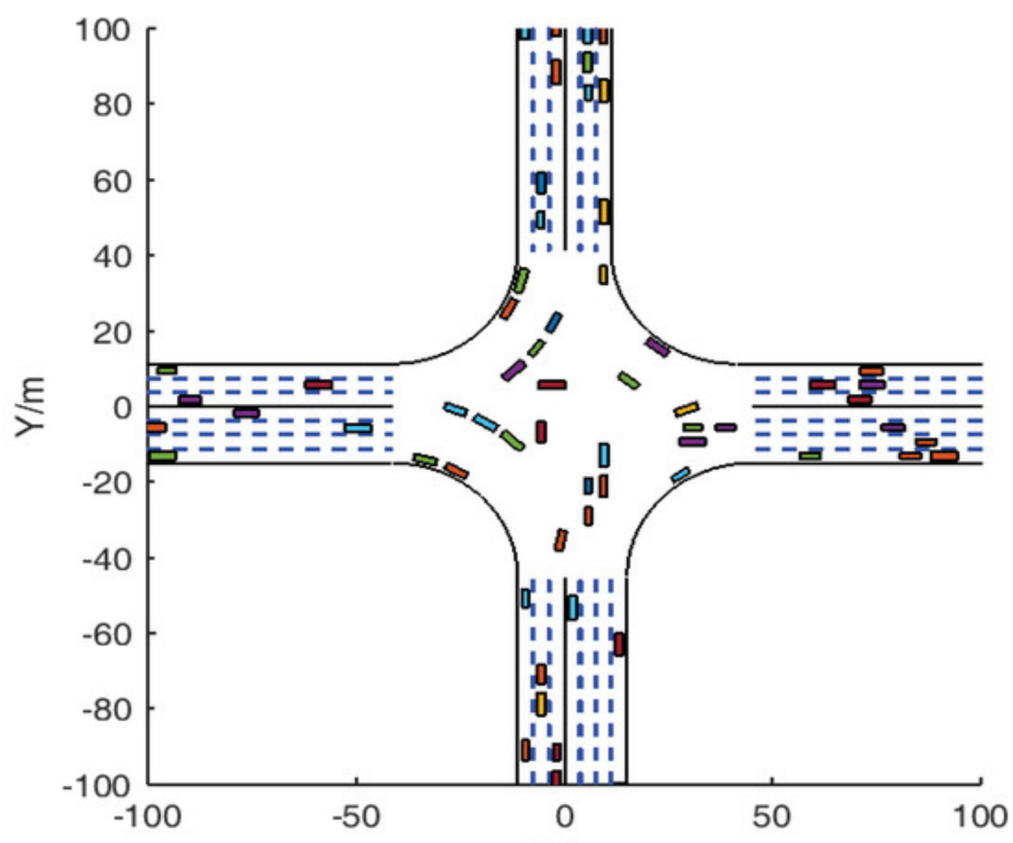
This can be attributed to a multitude of factors, including:
- Having a better understanding of their surroundings through use of a variety of sensors, which provide the car with a wealth of information to make decisions
- They are not susceptible to human error - such as lapses in attention, or tiredness
- Near instant reaction speeds

Additionally, self-driving cars may also benefit from the ability to communicate their intentions to one-another. They would be able to co-ordinate their decisions and trajectories in unison, working together to make the roads a safer place.

The road is full of many precarious situations that would be extremely chaotic to navigate without a commonly accepted set of rules. Take for example intersections. Currently intersection management is done using a multitude of methods such as roundabouts, stop signs, traffic lights, etc. These methods are inefficient, requiring stopping and slowing - and not to mention full of opportunities for lapses in judgment.

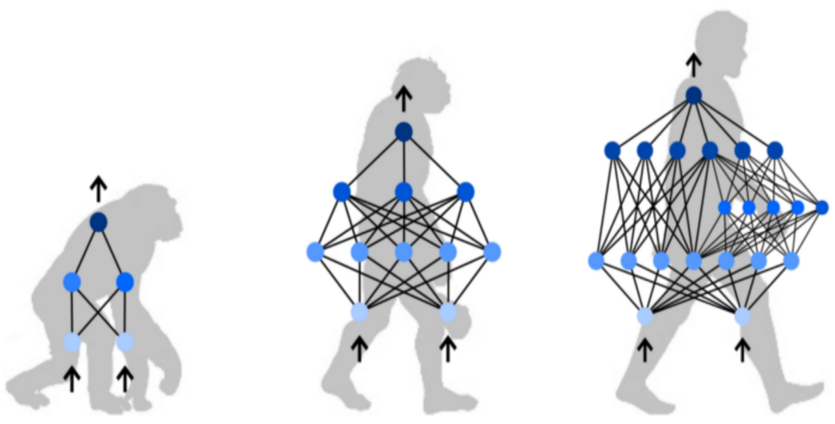
With the possibility of self-driving cars being able to communicate between each other, could it be plausible to create intersection management systems that require no stopping or significant changes in speed?

If executed correctly it would look like ordered chaos, with cars passing through busy intersections at speed but all without an accident. This is called Autonomous Intersection Management, and this masters proposes a potential implementation.



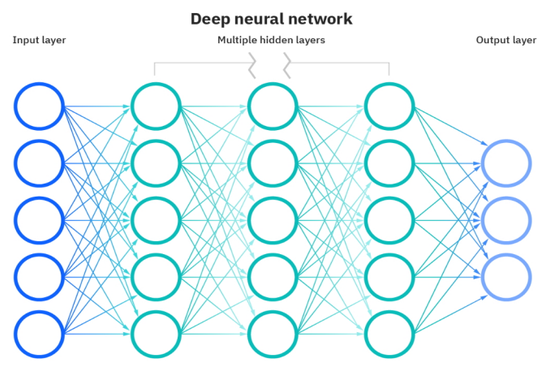
Evolutionary Algorithm

An Evolutionary Algorithm tailored to artificial neural networks will be used to train the vehicles, called Neuroevolution. Neuroevolution is a search algorithm which can be used to train Artificial Neural Networks inspired by mechanisms found within biological evolution, including mutation, selection, cross-over and reproduction. Individual generations of vehicles will undergo a simulated intersection where performance will be evaluated based on how successfully they traverse through.
The most successful vehicles will have aspects of themselves propagated into the next generation just as in nature.



Deep Learning

A sub-field of Machine Learning techniques that attempt to emulate the way biological neural networks of the brain process information and learn. In the context of the Autonomous Intersection Management System being proposed each individual car will have its own Artificial Neural Network that will be responsible for decision making on the road.



Binarized Neural Networks.

Binarized Neural Networks will be used for decision making in the vehicles. Traditionally Artificial Neural Networks use floating point values, usually between one and zero. However this has limitations, such as computer processing units not being optimized for performing mathematical operations. These mathematical operations are computationally expensive and, due to neural networks being what are called “black box” machines, are difficult or near impossible to verify. In other words, it is difficult to mathematically prove their robustness in consistently providing reliable decisions. However, Binarized Neural Networks use binary values, being one or zero, which are better tailored to computer processing units, and makes the neural network more verifiable.

Link to refernces:

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