Traffic Control and Infrastructure Organization Using Reinforcement Learning

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Introduction

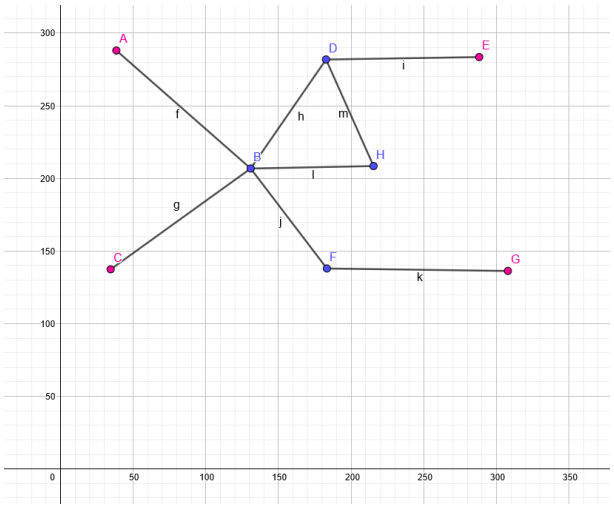
In recent years the traffic of cities became a rising topic with more and more city governments realizing that a motor-focused city design is unsustainable. Cities all around western Europe have started designing their cities around humans and public transit, and not around cars. E.g. Paris is planning to be a 15-minute city, Barcelona is incorporating the superblock design, the Dutch are using intelligent systems to manipulate traffic flow in order to make it faster.

If we take a look at how the Dutch infrastructure is designed, we will see that despite having less car lanes and overall less space for cars, the traffic flows more smoothly. This is thanks to the intelligent design of intersections, traffic lights and infrastructure. The know-how of this has been known ever since the 1970s, but the auto industry has been fighting against it ever since in order to gain more market. The basis of how to create walkable, human-centered and intelligent infrastructure that is optimal for both pedestrians and cars is written in the book by Strong Towns, an urban planning organization.

The aim for this research is to able to model a system of roads or city, and being able to pinpoint mistakes made by development engineers, with the goal in mind to make the city more humanly livable and liquidate urban highways that are like a scar on the face of a city.

Thesis work

My plan is to build an interface that models traffic flow in a graph-based structure, then train a reinforcement learning algorithm to find the optimal configuration of the roads in order to transport the most cars in the most effective way possible. Here's when the urban design principles come in: one can easily observe that the most effective way to transport as many cars as possible is if all roads are 8-lane highways. However it's also easy to see that it's miserable to live in a city where there are no quiet, auto-low streets and only 8-lane high-

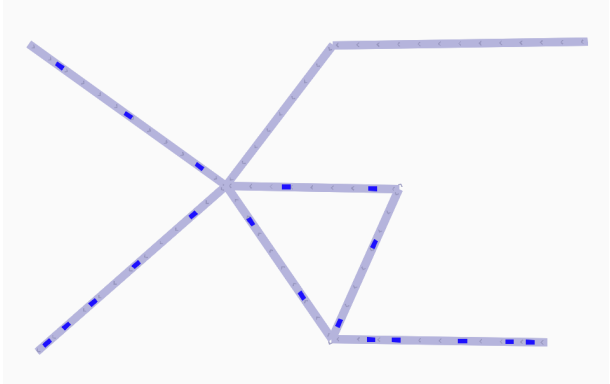
Figure 1: 

ways. This might be the best configuration for cars, but it would make the life of people living in the city absolutely horrible. The rewarding system of the reinforcement learning environment will be designed in order to reflect these principles: building cost, traffic light/roundabout tradeoffs, how humans would feel living next to the road. The agent will have to decide where to build, destruct, or make roads 1-way to make the city's transportation flow dynamic but also make it livable for humans. The rewarding scheme will reflect the principles laid down by Strong Towns and other urban planning organizations significant in the field like Happy Cities: Transforming Our Lives through urban design.

Methodology

The developed software will provide an interface where the user can make a graph, describing the intersections (nodes) and roads (edges) of the city in question. This for example can be done in GeoGebra and exported into a construction protocol in order to work as an input for the model. Below is an example simple city constructed:

The interface will read a construction protocol, construct a graph and all the possible pathways from it. And create a starting configuration with 2-way roads between all the nodes of the graph. The vehicle rate and distribution can be controlled before starting the simulation. A constructed "starting" city will look like as follows:

Figure 2: 

So far this is a simple configuration for demonstration. The vehicles are passing from one entry point to another, without necessarily choosing the shortest path, or being evenly distributed among all the roads, just as one would find in real life. The drivers' model will incorporate an intelligent behavior, like slowing down after the car in front is slowing down or gradually speeding up after a light has turned green with a comfortable acceleration parameter.

The road configuration will be examined with multiple methodologies like how many steps does it take for the roads to transport 100 cars or how much the road infrastructure would cost. If the agent is handed a road configuration it will be able to find the optimal one, with the least cost, least unnecessary roads and fastest transportation for a given amount of cars.