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Multi Agent Traffic Planning - Team 12

Self driving cars are quickly becoming a reality, and they're soon going to take over our streets. Electronic component companies and car companies, like Nvidia and Tesla, among others, are pairing up to deliver self driving car technology to the world. With this new future coming into the light, intersections can become a thing of the past because these cars can, collectively, form a multi agent system that can communicate with each other while driving and can simultaneously slow down and speed up to account for each other in intersections. With this motivation, we look at these precise planning problems: how do we decide the best plan for cars approaching an intersection at the same time? Given a large amount of traffic, how do we make sure that the cars each pass the intersection without collisions and trying to slow their speeds as less as possible?

The problem has to be formulated formally. For that, we are going to use PDDL language to represent it. Our problem clearly depends on time, so probably we will need to take it into account when doing the PDDL representation. To do this we will have to discretize the speeds of cars and assume that they can instantly switch between them. Then we will use constraint programming to determine at what speed cars have to drive in order to safely cross the intersection, where the constraints are based on both the speed and location of the cars. It is going to be a multi-agent system, where communication between cars is also important.

We will look at these cases (sequentially):

1. One intersection with only two cars approaching perpendicular at a time.
2. One intersection with multiple cars coming from each direction, making sure to account for traffic not only from the left and the right, but also slowing down for cars that have not crossed the intersection.
3. A city grid (probably a simple one with no more than 6 intersections) with various cars and different starting and ending points.

The literature we are going to read before starting are the following:

- Maria Fox and Derek Long. Pddl2. 1: An extension to pddl for expressing temporal planning domains. J. Artif. Intell. Res.(JAIR), 20:61–124, 2003. (https://helios.hud.ac.uk/scommv/IPC-14/repository/fox-long-jair-2003.pdf)
- Kurt Dresner and Peter Stone (2004) *Multiagent Traffic Management: A Reservation-Based Intersection Control Mechanism* (https://dl.acm.org/citation.cfm?id=1018799)
- Arnaud Doniec, René Mandiau, Sylvain Piechowiak and Stéphane Espié (2008) *A behavioral multi-agent model for road traffic simulation* (http://www.sciencedirect.com/science/article/pii/S0952197608000456)

We aim for the following combination of evaluations:
Technical depth: 2, Technical breadth: 3, Implementation: 2, Analysis/Discussion: 3

The tasks we hope to get done at 50% completion:

- Build a simple one-intersection model as a graph, and
- Have two agents
- Agents are only allowed to go in straight
- Agents are allowed to drive at 0 km/h, 20 km/h, 40 km/h and 60 km/h
- Write "Related Work", "Our Approach", "Case Studies" in the report

The tasks we hope to get done at 100% completion:

- Build a more complex multi-intersection model where agents want to travel from any entrance points to any predetermined exit point, and
- Have agents across multiple intersections safely as they will (inevitably) approach intersections simultaneously
- Complete the report with an abstract, introduction and summary

The tasks we hope to get done at 125% completion:

- Allow cars to "change their mind" while driving, i.e. they change their exit location
- Allow cars to take turns on an intersection and allow them to drive with different speeds
- Scale the problem to an actual city grid like Chicago

We have 4 group members so we will spend around 100 ph for the whole group. The work breakdown is as follows:

Task	**Person(s)**	**Time (ph)**
Find literature and do project proposal	ALL	15
Read the literature	ALL	10
Implement framework for traffic simulation	Peter, Eric	5
Design constraints for case 1	Julia, Jaime	5
Test case 1 with different configs	Eric	2
Extend constraints for case 2,3	ALL	15
Test case 2 with different configs	Julia	3
Extend framework to include city grid	Peter	2
Test case 3 with different configs	Jaime	5
Suggest possible improvements	ALL	5
Write Report	ALL	25
Prepare Presentation	ALL	5