UAS4T Competition Overall Report

[Submitted by: GUC – MRS Team]

Overview:

The problem being addressed in this competition is a highly challenging problem. In this report, a summary of the work done in addressing this problem would be presented.
The area of attention in this study is mainly composed of three roads meeting at a T-intersection, with lots of details to each road of them.

Some general assumptions are adopted throughout the work conducted by the team:

1. **Queue**: a queue is defined as the combination of vehicles that exist between two consecutive traffic lights, and accordingly in a single road, there might be different queues that can belong to the same road.
2. **Lane:** a lane is defined as the region that exist between two road lines.
3. **Traffic:** The vehicles that exist in a certain lane **NOT** necessarily be in a single line, as several small vehicles such as motorcycles can stand still beside each other.
4. **Traffic Lights: NO** information was provided in the data about the status of the traffic lights, so the adopted methodologies were mainly driven by the behavior of the vehicles instead of having them based on the cycle times of the traffic lights.

Methodology:

The adopted methodology in this study was based upon understanding the behavior of the vehicles during their motion. The following steps cover the main part of the adopted methodology until the analysis of queues stage in which two different approaches were used. The steps go as follows:

1. The information provided about the vehicles and their motion was extracted from the provided data csv file.
2. The region in which the data was provided (longitude and latitude ranges) were identified from the min and max values throughout the time interval.
3. From Open Street Map (OSM) the specified region was extracted.
4. Visualization of the data was carried to analyze (with eyes at the beginning to understand) the behavior of the vehicles during their motion in the environment.
5. The 3 roads under study are divided into different regions; where the widths of the streets were extracted from the OSM file and the analysis of the view from google earth enabled us to count the available number of lanes in each road. (N.B.: in some cases, there was change in the number of lanes between the different segments of the road). Also between each consecutive traffic lights, lanes were defined.
6. At each time step, detection of the location of each vehicle and its corresponding assigned road is conducted, based upon the overall dimensions of the road. (N.B.: in cases where the vehicles left the main roads under study such as side roads, or were in the intersection zone, they become not assigned to any of the roads).
7. After this, it was time to move on to the stage of counting the vehicles that are forming queues and to assess the presence of the spillbacks.

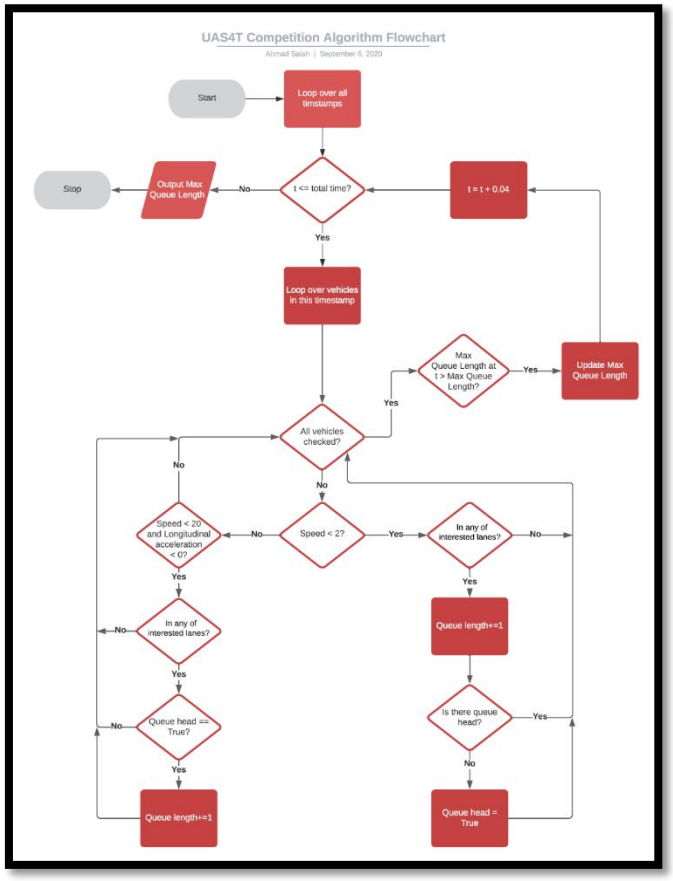
In addressing the problem of queue formation and spillbacks effect, two main approaches are adopted. The details of both approaches that are used along with their corresponding details and later on results are presented below.

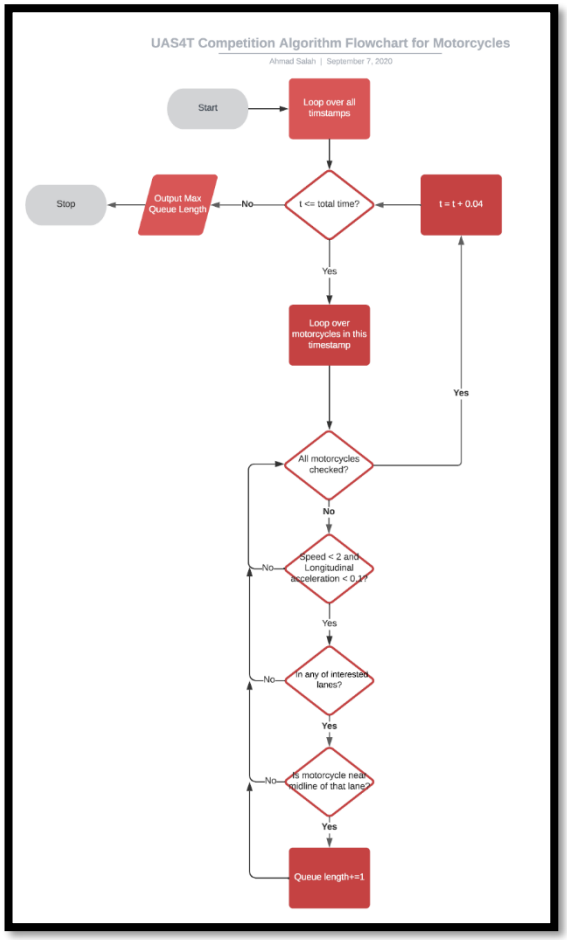
1. Queue-based Approach:

[**Hint**: Detailed information about this approach, and separate report are available in the corresponding zipped file, along with screenshots and results csv files]

The behavior of both vehicles and motorcycles is monitored to identify whether the target vehicle is accelerating or decelerating and accordingly a specific behavior could be triggered. In case of noticing that a vehicle is decelerating and then coming to stop, while the following vehicles are also slowing down, this indicates that a queue is being formed. Accordingly the queue calculations are started. This algorithm is based mainly on the concept of **Decision Trees**. It divides the dataset into subsets using a single feature or features and a single threshold or thresholds and continue doing the same idea to reach the purest subsets.

The approach can be summarized by these flow charts (left: vehicles, right: motorcycles):





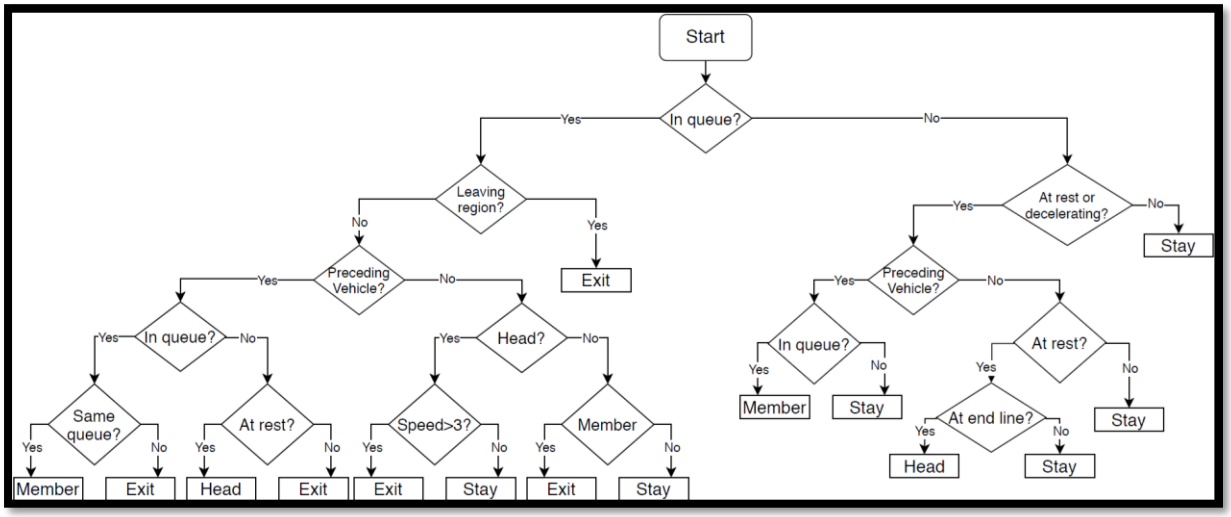
2. Lane-based Approach:

[**Hint**: Detailed information about this approach, and separate report are available in the corresponding zipped file, along with screenshots and results csv files]

Unlike the previous queue-based approach, this approach focuses more on assigning the vehicles during their motion to their corresponding lanes. Where based on the position and heading of a specific vehicle, it is assigned to a certain lane, and accordingly a queue is calculated based on the formation of several vehicles that belong to the same lane.

It is worth to mention that there are two versions of this approach. One that is conservative and another that is not conservative. The main difference between both would be in the definition of the zone around each lane in which a vehicle is considered to belong to certain lane or not. The less this zone is, the more conservative the code becomes, and accordingly, less vehicles are considered to belong to this lane.

This approach can be summarized as shown in the following flowchart:



* Several details for both the mentioned algorithms are not mentioned in this report due to the constraint of space. Yet they are arranged and well commented inside the code. Moreover, different information can be found inside each zip folder.

Results:

For both tested approaches in the detection of the queues and the maximum queue occurring, the spillbacks, and their corresponding time steps, the results achieved are almost the same (for the overall max. queue). It is worth to mention that for the lane-based approach, the variation of the algorithm mode between conservative to non-conservative will have minor effect on the results, yet the main findings remain the same. (More details are in the results report available in the zip file).

The **main** results of both approaches are summarized in the table below:

Parameters	**Queue-based Approach**			**Lane-based Approach**		
	28i Ok-Leo Con. Road	*Leof Alex Road*	*Oktovriou Road*	*28i Ok-Leo Con. Road*	*Leof Alex Road*	*Oktovriou Road*
Max Queue	14 (lane 2) @ 501.52 s	**20 (lane 5) @ 804.72 s**	7 (lane 1) @ 431.36 s	7 (lane 1) @ 423.48 s	**21 (lane 3) @ 802.36 s**	13 (lane2) @ 342.32 s
M. Q. length	0.05288 km	0.123743 km	0.04964 km	--	--	--
Start of Max Queue	[23.732163, 37.991564]	[23.732473, 37.991596]	[23.731334, 37.991967]	[23.731129, 37.990736]	[23.736487, 37.99098]	[23.731536, 37.992773]
End of Max Queue	[23.731579, 37.991445]	[23.733857, 37.991377]	[23.731436, 37.992406]	[23.731121, 37.990746]	[23.736492, 37.990993]	[23.731535, 37.992793]
Spillbacks	Few Spillbacks occur, details in results file.	Many Spillbacks occur, details in results file.	None	Few Spillbacks occur, details in results file.	Many Spillbacks occur, details in results file.	None

As can be seen from the results, there are some discrepancies between the results achieved in the roads, and this is attributed mainly to the difference of mentality in tackling the problem between the two adopted approaches.

On the other hand, both approaches yielded the **same result** in terms of the maximum queue in all the data provided in approximately the same time. (Note: **lane of max. queue is same**, but have different number in the two implementations).