TER 2021-074 - Development
Deep Learning for Autonomous Cars / Federated learning, communication inter-objets

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1. Executive summary

Autonomous vehicles carry their own system in their entirety, which allows them to manage the events that come their way. In order to manage these events and react accordingly, they are equipped with different kinds of sensors, like cameras, LiDAR etc, which relay the information to the vehicle's "brain".

This on-board system must process all the data accordingly to decide and react accordingly based on the environment and all the sensor data.

Computational resources are usually limited in the vehicles and real-time reactions are needed as well. Therefore This system is generally quite heavy to carry, which is quite limiting in terms of power and calculation time.

Two autonomous vehicles following each other will therefore have to sense and analyse the same things.

To avoid the overhead of multiple computations of the same scene, one solution is to consider the communication between these vehicles so the information is shared between vehicles. If a vehicle receives an event notification from another, he could know how to react accordingly.

This would make it possible to avoid certain repetitive tasks for each of the vehicles on a given road event.

Obviously, this communication of information between vehicles can be used to plan its route, this would avoid losing time if we know this Traffic jam/obstacle information on one of the possible paths to get from point A to point B.

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2. Project Description

Technological Context

- There is no communication between vehicles as there is no standard protocol for communication between vehicles.
- And for the moment we don’t have solutions for the federated learning applied to vehicles.

Motivations

- Avoiding being surprised when arriving at an obstacle/event
- Avoiding that two vehicles make the same computation for the same information/event
- Reducing the overall computation across a pool of vehicules (efficient energy usage)
- Increasing the confidence and robustness of detections thanks to federated learning

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Goals

- To be able to communicate between several vehicles.
- Learn and anticipate in real time by taking into account information from several vehicles.

Risks (and measures taken against)

- The lack of meaningful computing power associated with the power envelope that we use

  To tackle this issue we plan to use appropriated software techniques to reduce the size of our models, this will come with technological restrictions that we have to be chosen (i.e. real time federated learning)

- The lack of meaningful software solutions associated with inter-car communications

  To tackle this issue we plan to consider the different software solutions associated with federated learning and use the most appropriate one even if it comes with technological restrictions.

Scenarios

1. The user is at point A;
   He wants to go to point B;
   He plans his trip to go to this point B, which involves a highway road with no near exit;
   The other vehicles informs everyone on the same direction and specified radius that on his route there is an obstacle;
   Thus, the car can take the appropriate measures .

2. The user is in his vehicle;
   He drives 100 meters behind another vehicle;
   The vehicle in front of him sees a speed limit signalisation;
   This vehicle informs everyone on the same direction and specified radius of this speed limit;
   The user's vehicle is able to use less computation and/or lower the confidence threshold.

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3. Concrete application

Tasks done before the full time period

- Understand the basics of federated learning.
- Research the software solutions associated with federated learning.
- Visit the MiA to see the track.
- Meet the professors and discuss our subject.

Tasks to be done during the full time period

- Further research about the technical aspects of federated learning.
- Cloud environment deployment.
- Basic mock/POC of federated learning.
- First implementation in the cars.

Project & Team management

- Create tasks that are divided in User/Tasks/Subtasks according to the specifications
- Use standard development techniques, write documentation
- Assign tasks according according to our speciality