Selected Topics in Intelligent Driving Systems
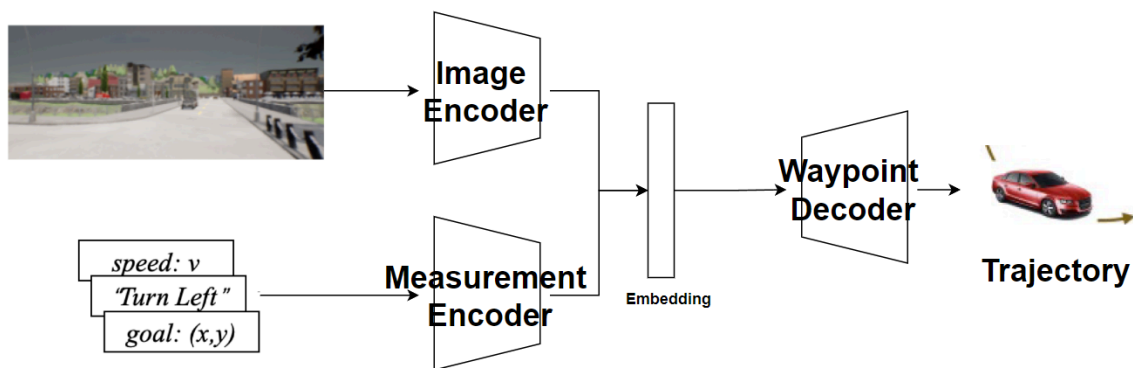
Spring 2024 Homework #2:

Announce: 4/18, Deadline: 5/5 23:59

Introduction

This homework will guide you through the process of training an end-to-end driving model and assessing its performance using the Town 05 Long benchmark in CARLA.

Implementation

In this homework, we use imitation learning to train a vision-based driving model. The system takes in various inputs such as a front-view image, ego vehicle speed, high-level command (like turn left, turn right, go straight), and a goal location, and then predicts the future trajectory of the ego vehicle. The figure above illustrates the overall architecture.

You have to complete (TODO, End TODO) blocks with the following requirements:

1. You don't need to collect data by yourself, but prepare a data loader for training.
   - data.py
     - Setup ground-truth future waypoints (TODO 1)
     - How to use high-level command as input (TODO 2)

2. Implement some components of the driving model.
   - model.py
     - Forward the inputs to get some latent embedding (TODO 3)
     - Predict the ego's speed (TODO 3)
     - Predict the waypoints (TODO 4)
3. Create an agent using the trained model that can be evaluated in CARLA.
   - vision_agent.py
     - Tick input data from CARLA (TODO 5)
     - Converts waypoints into vehicle control with a PID controller (TODO 6)
     - Apply control to your vehicle (TODO 7)

Dataset & Commands

Please check README.md on the HW2 github page.

Grading: Report (100%)

Your report should include the following content:

1. Implementation (10%)
   a. Code screen shot & Detailed explanation of each TODO section

2. Discussion (45%)
   a. Use **e2e_driving/statistics.py** to parse results in the results_VA.json (10%)
      For example:

```
score_composed = 60.38049586660488
score_penalty = 0.6044178031147422
score_route = 99.74683301636148
collisions_layout = 0.5478799014140817
collisions_pedestrian = 0.0
collisions_vehicle = 0.40868251265397354
red_light = 0.09131331690234695
stop_infraction = 1.2057313469901592
vehicle_blocked = 0.06374543601634708
outside_route_lanes = 0.4724279486703206
```

    b. In which aspects does the model perform poorly? (15%)
       Please don't answer with "the score is not high enough.
       Please provide evidence (image, video, …)

    c. How would you enhance the explainability of the models (20%)
    d. Anything you want to discuss

3. Question Answering (45%)
    a. What else can we do to improve the performance of the driving model? (10%)

       If you implement them, please explain the codes and analyze the results

       You can get bonus points up to 10 pts!

    b. Besides imitation learning, how would you train the end-to-end driving models? What are the pros and cons of each paradigm? (15%)

       Check section 2 in this paper

    c. In HW2, we predict the future trajectory and convert it into control through a PID controller. However, there are some works that predict control directly [1,2,3,4]. What do you perceive as the challenges or limitations of each of these methods? (20%)
    d. Did you encounter any problems with this assignment?
4. Please provide any reference you take

Submission

You only need to submit the report file in this homework, please include the section titles in the report and submit **{student_id}_HW2.pdf** to E3 before 5/5 23:59.
Late submission would have a -20 penalty per day.