Selected Topics in Intelligent Driving Systems

Spring 2024 Homework #1: Occupancy Map Forecasting

Announce: 3/21, Deadline: 4/2 23:59

Introduction

In this homework you will learn to perform basic occupancy forecasting from ground truth bounding boxes with a constant velocity hypothesis and a learning-based model. You need to implement some critical functions used in data preprocessing, validation, and visualization.

Implementation

We have implemented the learning-based model and training pipeline for you. All you need to do is filling in the TODO blocks in **utils.py**, the TODOs include the implementation of following aspects:

1. **Constant velocity**

   Forecast the future locations of other vehicles with constant velocity hypothesis:

   $$Loc_{t+1} = Loc_t + speed_t * \Delta t$$

2. **Coordinate Transformation**

   Carla coordinate system: x-front, y-right, z-up

   BEV Image coordinate system: x-back, y-right

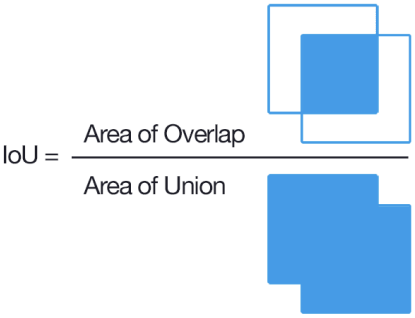
   a. Global-to-Ego

      Please check Lecture 2 - Coordinate Systems - release.pptx page 38~46.

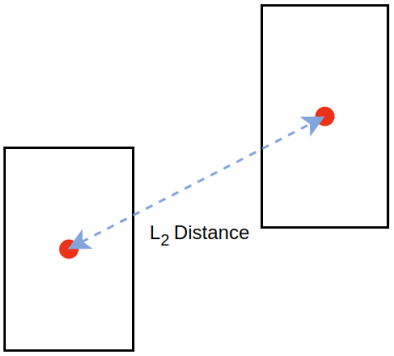
   b. Ego-to-BEV

3. Metric

a. IOU

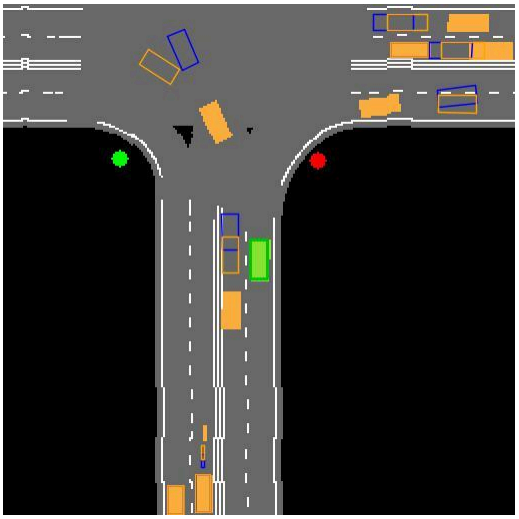


b. L_2 distance



4. Visualization

The following figure is the example of the visualization result, **yellow**/**blue** boxes denoting the ground truth/predicted future bounding boxes respectively.



Usage

```
bash run.sh $MODEL $ROOT_DIR $FORECAST_TIME $VALIDATE
# e.g. bash run.sh learn ./HW1_dataset 0.5 0
# $MODEL == constant setting is automatically run on validation set.
```

1. `$MODEL`: select forecasting model between [constant, learn]
2. `$FORECAST_TIME`: define forecasting time: n*0.5
3. `$VALIDATE`: whether to validate [1, 0]

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. Compare the result of constant velocity and learning-based forecasting models at different forecasting steps.
        i. Quantitative result (Metric: IOU and L_2 distance) (5%)
            - Constant velocity & Learning-based
        ii. Qualitative result (Visualization) (5%)
            - Constant velocity & Learning-based
        iii. Which one is better, why? (20%)
        iv. Your conclusion (15%)
    b. Anything you want to discuss

3. Question Answering (45%)
    a. We quantize the label when training the learning-based forecasting model, converting the task into a classification problem. What would this design affect the performance of the model? (20%)
    b. What else can we do to improve the performance of the forecasting model? (10%)

If you implement them, please explain the codes and analyze the results (IOU, L_2 distance, visualization)

You can get bonus points up to 10 pts!

c. How would you use this representation to facilitate planning? (15%)
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}_HW1.pdf** to E3 before 4/2 23:59.

Late submission would have a -20 penalty per day.