Metrics for the Closed Loop Track of the INTERPRET Challenge

The metric for the closed-loop track is based on the closed-loop performance of the "prediction $\rightarrow$ planning" pipeline on the ego agent. Let $d_i \in \{sim_i, gt_i\}$ represent the source of data for scenario i, where sim_i is the close loop simulation and gt_i is the ground truth. For all testing scenarios, with the total number as n_s, We consider the following five metrics:

1. The number of collision scenarios, represented by n_{col}, quantifies safety performance of the testing perdition method.

2. "Efficiency" of the ego agent, represented by S_{eff}, quantifies how efficient the ego agent is. Let Δs^{d_i} be the distance that the ego agent traveled along the reference at the end of corresponding data for scenario i, We measure the efficiency via the ratio of Δs^{d_i} in the simulation and in the ground-truth.

$$S_{eff} = \frac{1}{n_s} \sum_{i=1}^{n_s} \frac{\Delta s^{sim_i}}{\Delta s^{gt_i}} \tag{1}$$

3. "Jerk" of the ego agent, represented by S_{jer}, is the average jerk of the trajectory of the ego agent. Let $v \in \{ego, target\}$ represent the agent that is evaluated, where ego is the ego agent, $target$ is the reactive agent. Then, let $j_k^{d_i,v}$ be the jerk of the evaluated agent at time step k in corresponding data for scenario i. Assume that $t_s^{d_i}$, $t_e^{d_i}$ are the starting time step and the ending time step of corresponding data. The "Jerk" score of a evaluated agent is defined as

$$s_{jer}(d_i, v) = \sqrt{\frac{1}{t_e^{d_i} - t_s^{d_i}} \sum_{k=t_s^{d_i}}^{t_e^{d_i}} (j_k^{d_i,v})^2} \tag{2}$$

   Thus, the S_{jer} is defined as

$$S_{jer} = \frac{1}{n_s} \sum_{i=1}^{n_s} s_{jer}(sim_i, ego) \tag{3}$$

4. "Velocity" of the trajectory of the ego agent, represented by S_{vel}, is the average difference between the current speed and the desired speed, represented by v_d, if the current speed is smaller than the desired speed.

Assume $v_k^{d_i,v}$ represent the speed of the evaluated agent at time step k in corresponding data for scenario i. The "Velocity" score of a evaluated agent is defined as

$$s_{vel}(d_i, v) = \sqrt{\frac{1}{t_e^{d_i} - t_s^{d_i}} \sum_{k=t_s^{d_i}}^{t_e^{d_i}} (\min\{v_k^{d_i,v} - v_d, 0\})^2} \tag{4}$$

Thus, the S_{vel} is defined as

$$S_{vel} = \frac{1}{n_s} \sum_{i=1}^{n_s} s_{vel}(sim_i, ego) \tag{5}$$

5. "Courtesy" of the trajectory of the ego agent, represented by S_{cou} is considering cases if the ego agent does not have the "right-of-way". The "Courtesy" is defined as the increased cost (in terms of the jerk cost and velocity-related cost) of the other agents due to the actions of the ego agent compared to the ground-truth cost. Hence, the "Courtesy" score of scenario i for the ego agent without "right-of-way" is given by

$$s_{cou}(i) = s_{jer}(sim_i, target) - s_{jer}(gt_i, target) + s_{vel}(sim_i, target) - s_{vel}(gt_i, target) \tag{6}$$

note that the ground-truth score terms of the target agent are same for all different predictors, Therefore, we will ignore them from the metric,i.e.,

$$s_{cou}(i) = s_{jer}(sim_i, target) + s_{vel}(sim_i, target) \tag{7}$$

If the ego agent in a test case has the right-of-way, we define its "courtesy" score as zero. Thus, the S_{cou} is defined as

$$S_{cou} = \frac{1}{n_s} \sum_{i=1}^{n_s} s_{cou}(i) \tag{8}$$

The final score, represented by S, of one prediction method is defined as sum of the weighted score of the above metrics. It is given as follows:

$$Score = w_{eff}\ S_{eff} + w_{jer}\ S_{jer} + w_{vel}\ S_{vel} + w_{cou}\ S_{cou} \tag{9}$$

where $w_{eff} = 10$, $w_{jer} = -1$, $w_{vel} = -1$, $w_{cou} = -1$ are the weights.