

1 Example of 13 safety-violation types

Safety Violation 1: Wrong perceive two front vehicles emergently stopped on the front as one vehicle. As shown in Figure 1, ego vehicle is driving along the lane. Vehicle a is driving in the front of adjacent lane, and vehicle a is following vehicle b with a very short distance. When vehicle b and vehicle a are cutting into the lane of ego vehicle in the front at the same time, the perception module detects the two vehicles as one, leading to untimely braking.

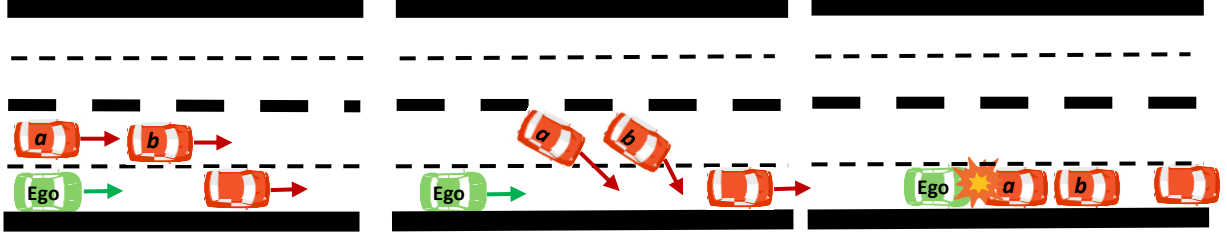


Figure 1: Example of 1st type of safety-violation scenarios

Safety Violation 2: Fail to detect the vehicle crossing from obstruction timely. As shown in Figure 2, when ego vehicle is crossing the intersection, vehicle b crosses the intersection. Perception module fails to perceive vehicle b due to the visual obstruction of vehicle a , leading to the collision.

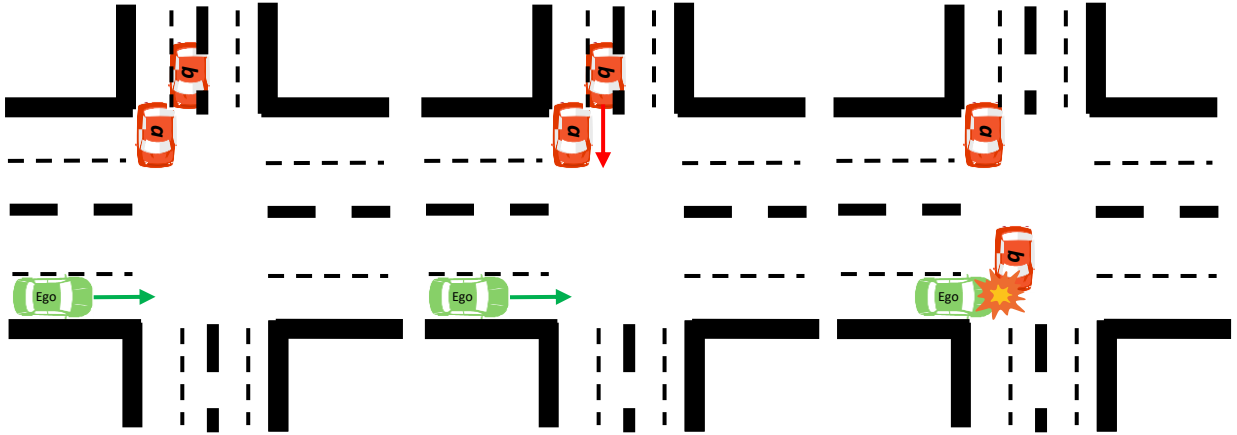


Figure 2: Example of 2nd type of safety-violation scenarios

Safety Violation 3: Fail to keep safe distance from vehicle suddenly cutting in ahead. As shown in Figure 3, ego vehicle is driving along the lane, and the vehicle a drives at a slow speed on adjacent lane. The planning module makes ego vehicle accelerate. Vehicle a changes to the lane of ego vehicle when ego vehicle is close to it. The perception module perceives the sudden lane changing of vehicle a timely, but the planning module fails to make ego vehicle decelerate or brake to keep safe distance from vehicle a .

Safety Violation 4: Wrongly compute the safe distance from vehicle with a large size stopping in the front. As shown in Figure 4, ego vehicle is driving along the lane. The vehicle a on adjacent lane accelerates to the front of ego vehicle. Vehicle a is a truck. It cuts into the lane of ego vehicle and then stops. The perception module perceives the movement of vehicle a , and ego vehicle brakes to stop behind vehicle a . The planning module computes the safe distance that ego vehicle should keep from vehicle a when it stops. However, the planning module does not

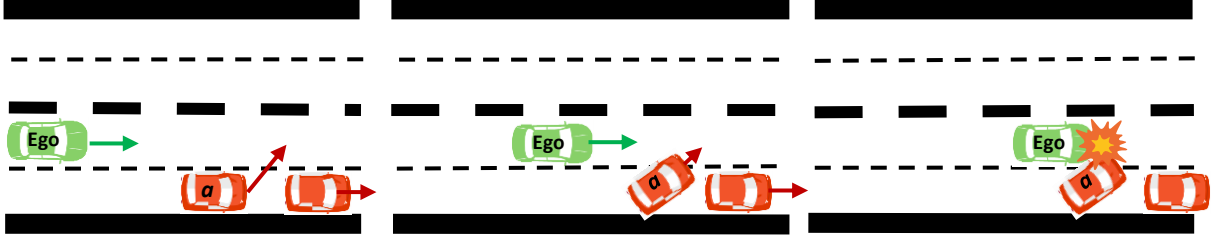


Figure 3: Example of 3rd type of safety-violation scenarios

consider the large size of vehicle a when computing the safe distance, causing ego vehicle to stop too close to and then rear end vehicle a .

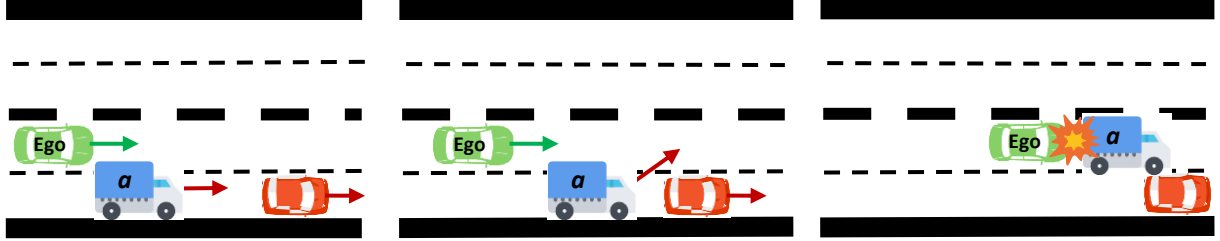


Figure 4: Example of 4th type of safety-violations

Safety Violation 5: Fail to make a response to the retrograding vehicle. As shown in Figure 5, ego vehicle is following lane and the vehicle a retrogrades in the front of the lane. The perception module has perceived the retrograding vehicle. There is enough time and road space for ego vehicle to change to adjacent lane so that it can avoid the collision. However, planning module fails to make a response to avoid retrograding vehicle.

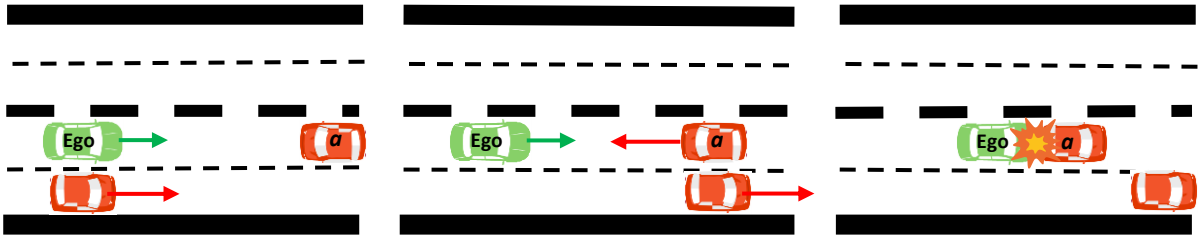


Figure 5: Example of 5th type of safety-violation scenarios

Safety Violation 6: Fail to avoid the pedestrian that follows a crossing vehicle to cross the road. As shown in Figure 6, vehicle a is crossing the intersection, and the pedestrian is running to follow a to cross the intersection. Perception module has perceived the two participants crossing the intersection, and planning module makes ego vehicle wait for vehicle a to pass, but not waiting for the pedestrian to pass.

Safety Violation 7: Fail to avoid the vehicle suddenly interrupting it. As shown in Figure 7, ego vehicle is following vehicle b and keeping a safe distance from vehicle b . When vehicle a is cutting into the lane of ego vehicle, the safe distance is interrupted. The perception module have perceived the cutting from a , and prediction module have predicted the interruption. However, planning module does not immediately make ego vehicle decelerate to leave a safe distance for a .

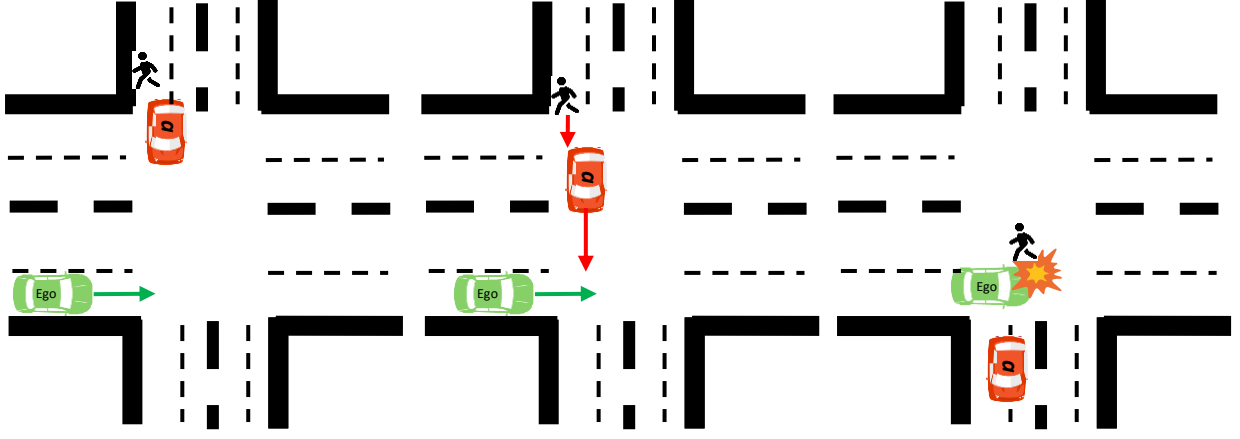


Figure 6: Example of 6th type of safety-violation scenarios

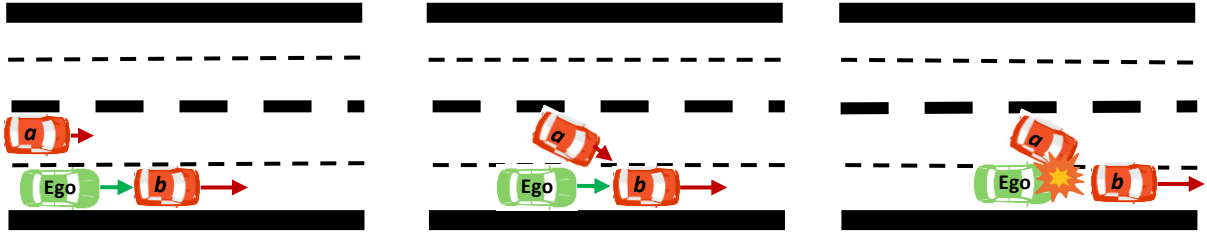


Figure 7: Example of 7th type of safety-violations

Safety Violation 8: Fail to generate the route of lane changing vehicle from behind. As shown in Figure 8, ego vehicle is following the vehicle a on the lane. The vehicle b is driving on the adjacent lane. When planning module plans to change to the adjacent lane, prediction module predicts the trajectory of b as driving straight on adjacent lane, so the planning module is waiting for b to pass by. However, b changes to the lane where ego vehicle is located, prediction module fails to generate the new route of b , so planning module still makes ego vehicle waits, leading to the rear-end.

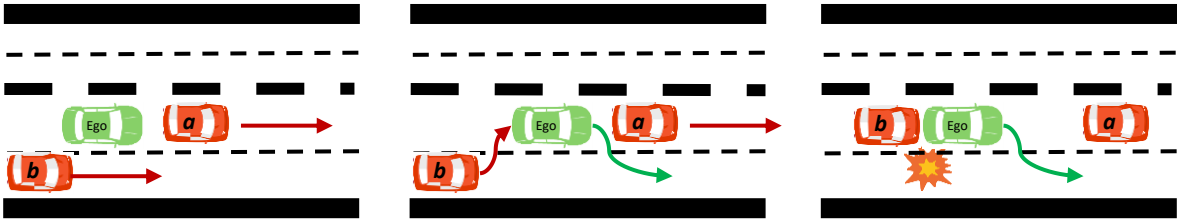


Figure 8: Example of 8th type of safety-violation scenarios

Safety Violation 9: Fail to compute the acceleration of vehicle from behind on the side lane. As shown in Figure 9, ego vehicle tries to overtake the slow participant vehicle b ahead on the lane. The trajectory is planned as a curvy trajectory by planning module. When ego vehicle is entering the adjacent lane, the vehicle a with the right of the lane is accelerating from behind, which is not computed by prediction module.

Safety Violation 10: Fail to predict the acceleration of vehicle that follows a crossing vehicle to cross road. As shown in Figure 10, ego vehicle plans to pass the intersection. Vehicle a is crossing the intersection at a high speed, and vehicle b behind a is crossing the intersection at a low speed. The perception module has perceived the two vehicles. Ego vehicle waits for a

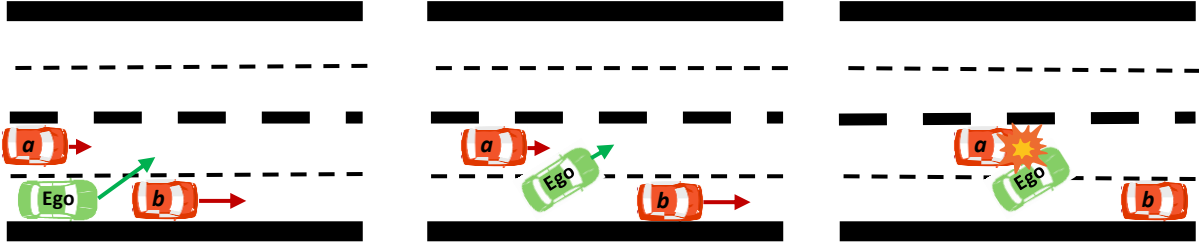


Figure 9: Example of 9th type of safety-violation scenarios

moment to let vehicle a pass by, and then starts to drive. However, b is accelerating when crossing the intersection, which is not predicted by the perception module. So when ego vehicle restarts to drive, b is driving close to ego vehicle at a high speed, leading to the collision.

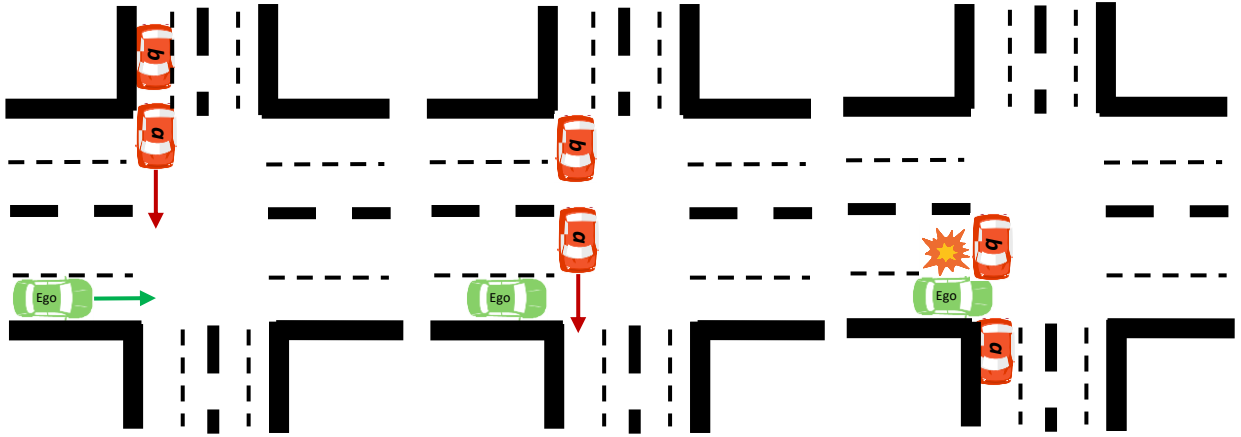


Figure 10: Example of 10th type of safety-violation scenarios

Safety Violation 11: Fail to predict the route of pedestrian who is walking to a parked vehicle. As shown in Figure 11, the ego vehicle is driving on the lane and vehicle a is parked in the front on the lane. When ego vehicle is planning to overtake vehicle a , a pedestrian is walking to vehicle a . The prediction module wrongly predicts the route of the pedestrian, leading to the collision with pedestrian.

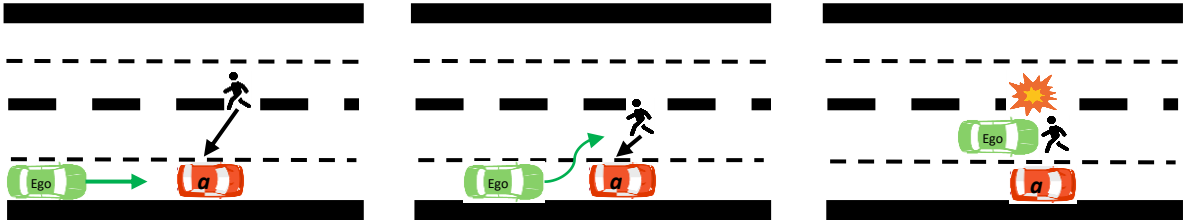


Figure 11: Example of 11th type of safety-violation scenarios

Safety Violation 12: Fail to predict crossing pedestrian (another vehicle stops emergently on the side lane). As shown in Figure 12, ego vehicle and vehicle a are driving on two adjacent lanes. When the pedestrian is crossing the road, vehicle a stops and the pedestrian starts to cross the road. The perception module perceived the sudden stop of vehicle a . In real traffic, the emergency stop of a vehicle on the side lane is a typical sign that a sudden dangerous situation

occurs. However, the prediction module fails to predict the high-potential dangerous situation, leading to ego vehicle not avoiding the pedestrian.

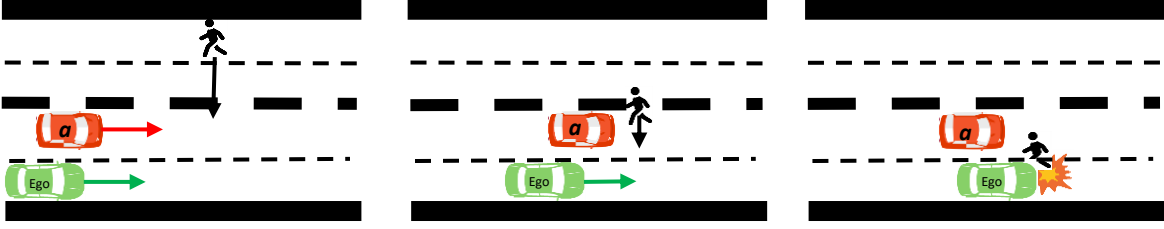


Figure 12: Example of 12th type of safety-violation scenarios

Safety Violation 13: Fail to predict the moving pedestrian at intersection (the traffic light of the pedestrian direction is green). As shown in Figure 13, when ego vehicle is turning around, perception module perceives the pedestrian standing by the intersection, and planning module decelerate a little for safety driving on intersection. Perception module perceives the traffic light change to green, but prediction module fails to predict the pedestrian starting to walk, leading to the collision with pedestrian.

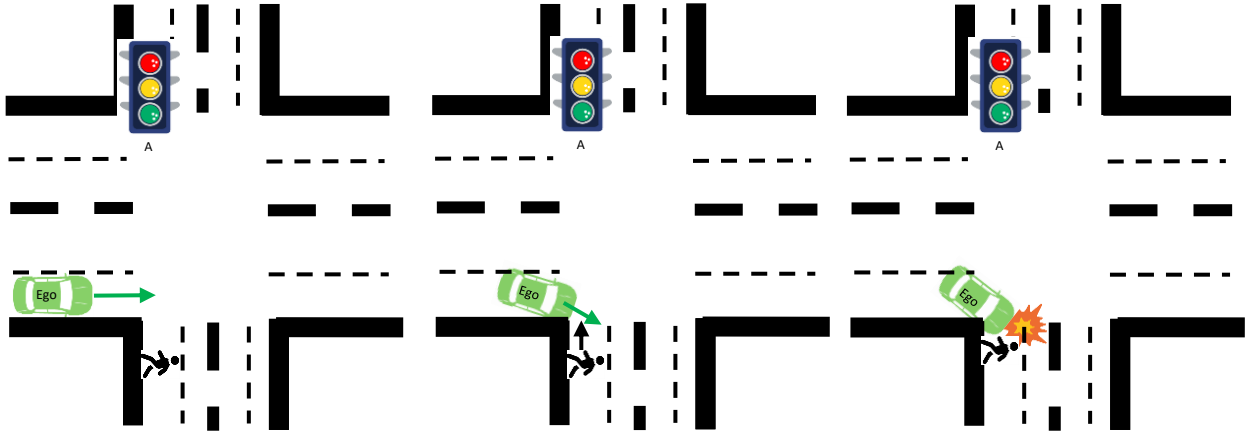


Figure 13: Example of 13th type of safety-violation scenarios