Generating Path for the cars to follow

Approach

The class **PathPlanner**, implemented in **path_planner.cpp** and **path_planner.h,** contains the major part of the code which generate the path for the car at each timestep. The code is based on the approach from the Q&A video session with more features added (change lane, speed up, slow down) in order to complete the path planning pipeline.

Details

First, we need to initialize the PathPlanner with some important parameters: number of points on the trajectory will be generated each time, safety distance (distance from ahead car that we need to consider to slow down or change lane)

All steps below are in order with how the Path Planner take to generate new path at every timestep:

1. Estimate car heading angle with the current car state like: yaw, x, y coordinates.
2. Checking if car is in changing lane mode or just finished changing lane.
3. If the car is NOT in changing lane mode:
    a. Check if we need to slow down or change lane. The logic is as below:
        i. If there is a slow moving car ahead within safety distance, we only change lane if :
            1. There is enough space on the neighborhood lanes
            2. There is no car is driving too slow ahead in the candidate lane.
            3. There is no car is driving too fast behind in the candidate lane.
            4. Speed of the car is at least 45 mph (otherwise the car might change lane at low speed and cause collision)
        ii. Else: stay in the current lane and slow down until our car maintain a safe distance with the car in front.
    b. If the car does not have to slow down / or change lane, then we check if we can increase the speed to the speed limit.

    Else: keep the car running in the same previous conditions.

4. Generate the anchor points to fit a cubic function with spline and use it to generate the trajectory later on.
5. Push previous trajectory point to the new trajectory list so we can keep the transition smooth.
6. Generate the new trajectory based on new information obtained from above steps:
    a. New target speed if we can increase speed
    b. New lane if we decide to change lane
    c. New trajectory fit function if we decide to change lane and new anchor points from different heading angles.