**How is lane following achieved?**

With the use of frenet coordinate system, the next\_d value stays constant allowing easy lane following.

**How to use spline to generate a smooth trajectory?**

Points on s-coordinates are fed to spline instances where interpolation will happen between them. Spline will give a smooth line which is sampled to create smooth trajectory. Hence we need to get a spline to sparse several waypoints.

Determine the x and y position for the distance horizon. Total horizontal distance is from the first waypoint to the last way point in x direction. Using trigonometry, calculate d using the formula x2 + y2 = d2. Using previously calculated d, velocity and time, calculate N using the formula: N = d / (0.02sec \* velocity). Find the corresponding y values on the splines for each N part. By following these steps, path points were determined for the ego car to traverse the spline.

**How to avoid collision with the car in front?**

Collision can be avoided by using the d value from the sensor fusion vector in frenet coord of each car. The d value is used to see if the car is in our lane. If the car is in front of our lane and is within the predetermined range of 18m in this case, we lower the reference velocity.

**How to avoid cold start?**

Cold start can be avoided by having incremental change in velocity, starting at 0.0 , instead of having a constant reference velocity.

**My Approach**

Car is initially not moving, and based on specified velocity increments the car moves forward at that given increment. This is to ensure the car is accelerating slowly and doesn’t violate threshold limits. Including spline and smooth trajectory is important behaviours to input to remove any jerk motions and avoid sharp turns.

Car accelerates until it reaches velocity of 49.7 mph, and this velocity is maintained unless there is a car in front that is closer than acceptable distance of 18 m. If there is a car in front that is going too slow and its violating the threshold distance, a flag is set indicating that there is a car ahead and is too close.

Next, the code checks both right and left lanes to find which lane is the closest car is in. The closest car in the rear is also checked. Again, the minimum distance of 18 m and 3 m must be maintained at all times between the ego car and car in the new lane, and in the rear side in the new lane, respectively. If all of these conditions are satisfied, then lane change is considered safe. In such situation where these criteria are satisfied for both the right and left lanes, the car will go to left lane over the right lane. This isn’t optimal since the car might go into lane with more congestion. However, if it is only safe to do lane change in one direction, then that lane will be chosen. In a case where is it unsafe to change the lane in either right or left lane, then the ego car will remain in its current lane and decelerate until a gap is established in front that is 18 m or greater.