Compilation

Your code should compile.

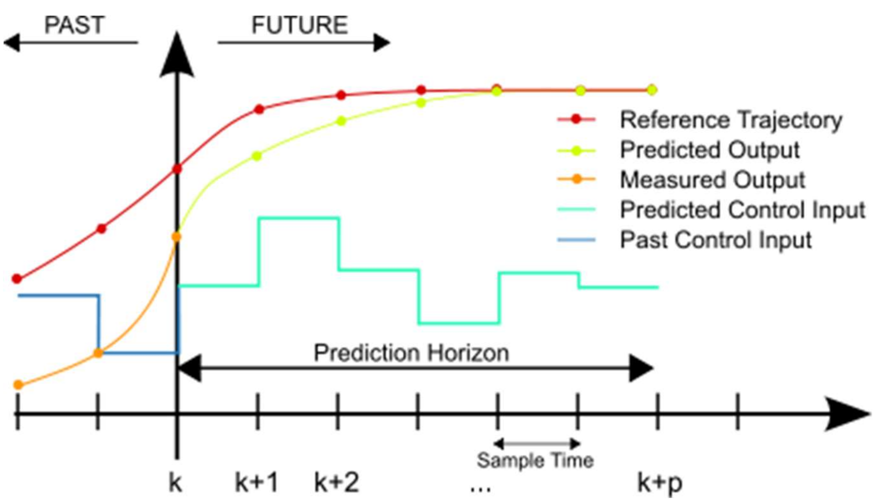
Code must compile without errors with cmake and make.

Given that we've made CMakeLists.txt as general as possible, it's recommend that you do not change it unless you can guarantee that your changes will still compile on any platform.

Implementation

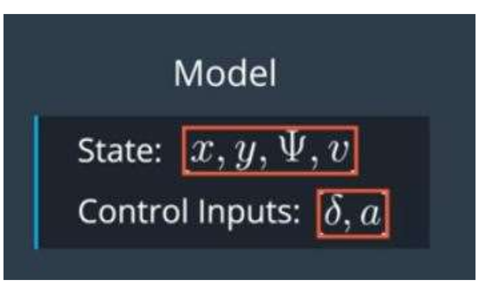
The Model

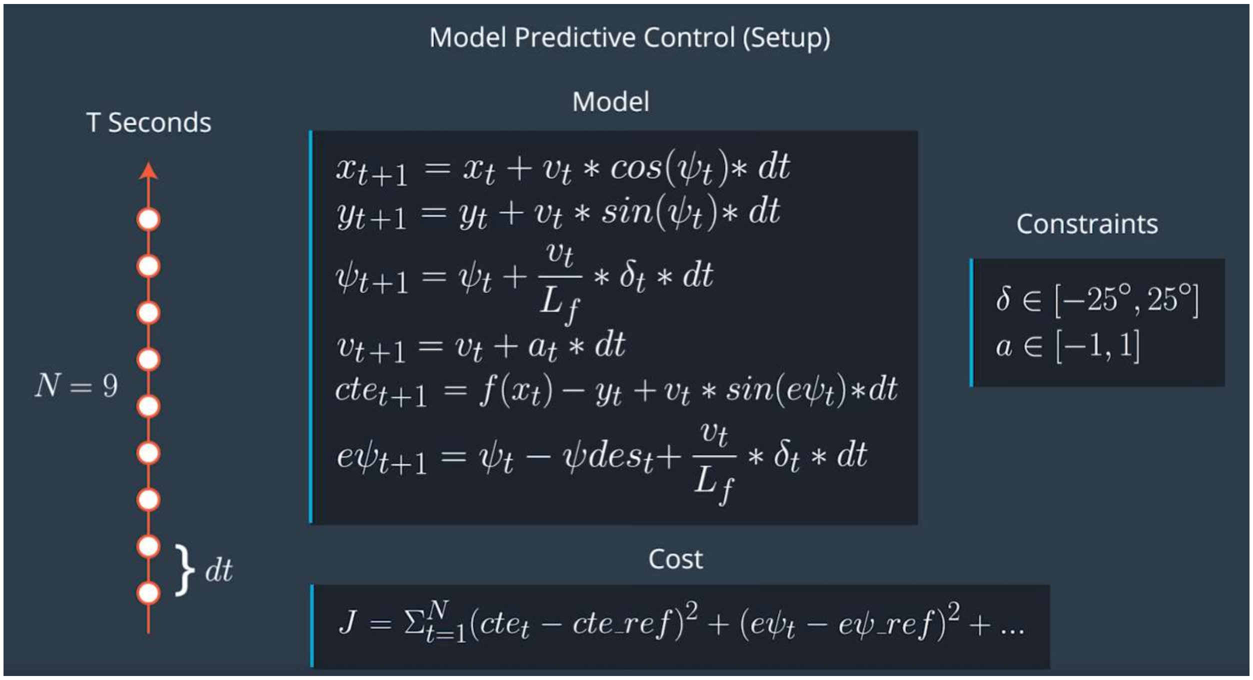
https://en.wikipedia.org/wiki/File:MPC_scheme_basic.svg



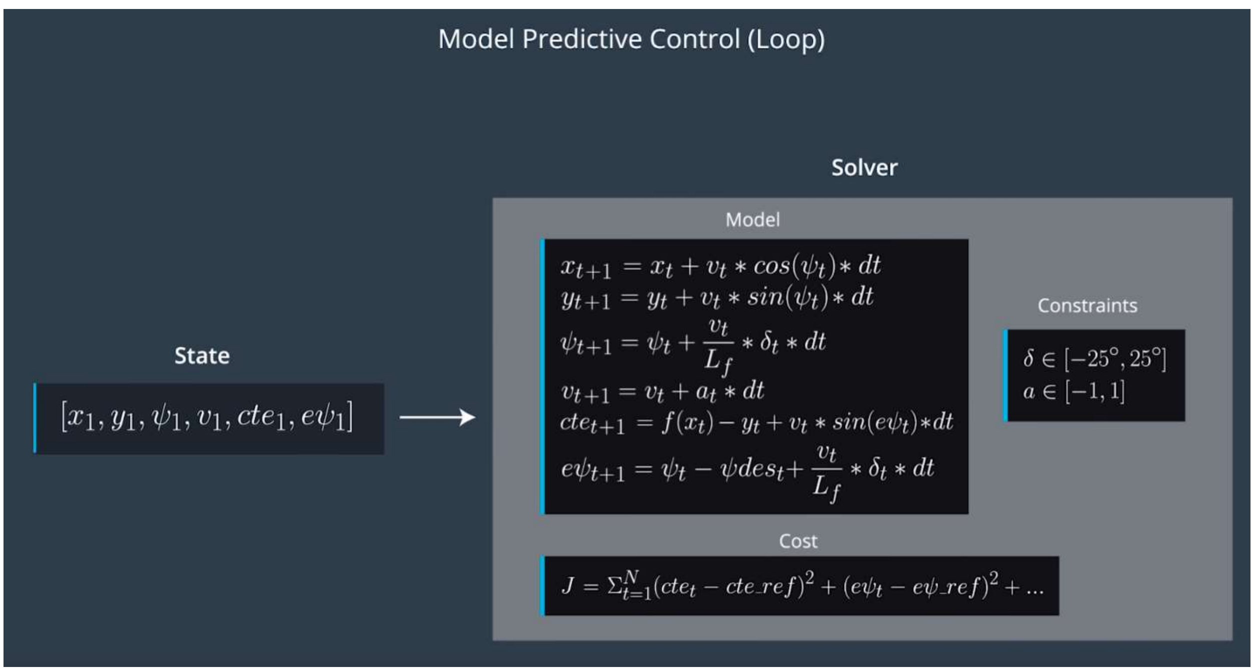
Student describes their model in detail. This includes the state, actuators and update equations.

Model consists of input state vector consisting of the GPS coordinates x & y , yaw(psi) and velocity. Also model is given the control input steering angle delta and acceleration.

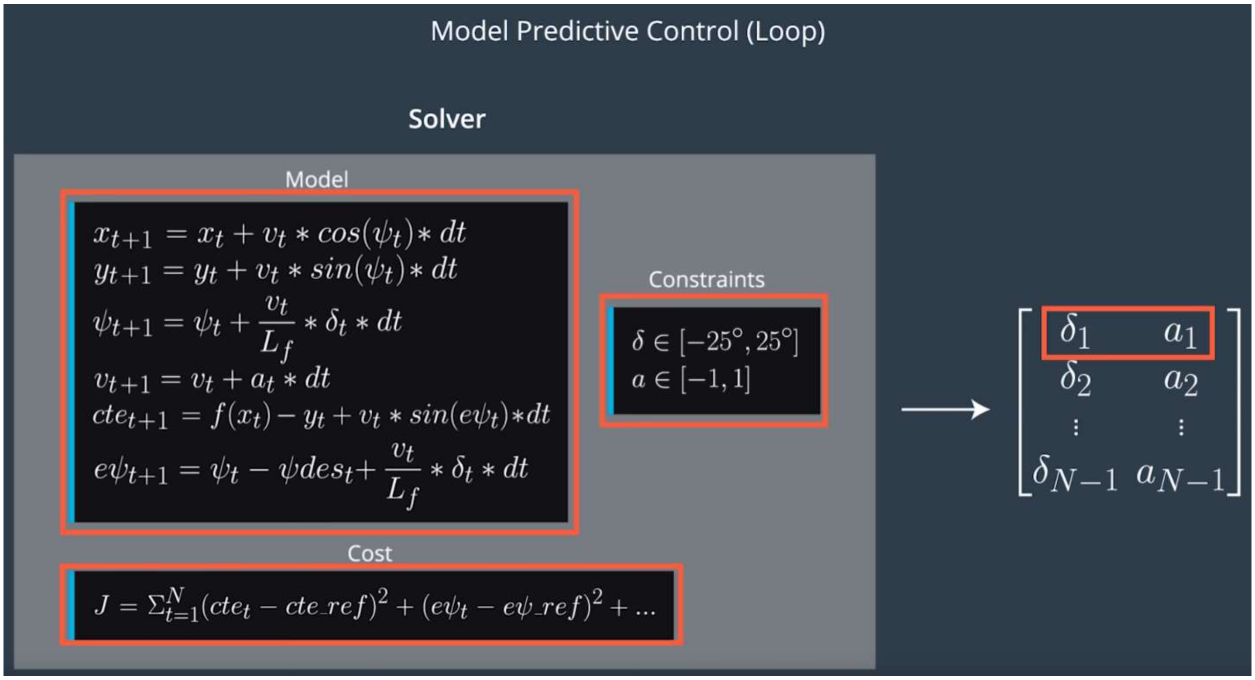




Model Predictive Control (Setup)
T Seconds
$N = 9$
dt
Model
$x_{t+1} = x_t + v_t * cos(\psi_t) * dt$
$y_{t+1} = y_t + v_t * sin(\psi_t) * dt$
$\psi_{t+1} = \psi_t + \frac{v_t}{L_f} * \delta_t * dt$
$v_{t+1} = v_t + a_t * dt$
$cte_{t+1} = f(x_t) - y_t + v_t * sin(e\psi_t) * dt$
$e\psi_{t+1} = \psi_t - \psi des_t + \frac{v_t}{L_f} * \delta_t * dt$
Constraints
$\delta \in [-25°, 25°]$
$a \in [-1, 1]$
Cost
$J = \Sigma_{t=1}^{N}(cte_t - cte\_ref)^2 + (e\psi_t - e\psi\_ref)^2 + ...$



Model Predictive Control (Loop)
State
$[x_1, y_1, \psi_1, v_1, cte_1, e\psi_1]$
Solver
Model
$x_{t+1} = x_t + v_t * cos(\psi_t) * dt$
$y_{t+1} = y_t + v_t * sin(\psi_t) * dt$
$\psi_{t+1} = \psi_t + \frac{v_t}{L_f} * \delta_t * dt$
$v_{t+1} = v_t + a_t * dt$
$cte_{t+1} = f(x_t) - y_t + v_t * sin(e\psi_t) * dt$
$e\psi_{t+1} = \psi_t - \psi des_t + \frac{v_t}{L_f} * \delta_t * dt$
Constraints
$\delta \in [-25°, 25°]$
$a \in [-1, 1]$
Cost
$J = \Sigma_{t=1}^{N}(cte_t - cte\_ref)^2 + (e\psi_t - e\psi\_ref)^2 + ...$



Timestep Length and Elapsed Duration (N & dt)

Student discusses the reasoning behind the chosen N (timestep length) and dt (elapsed duration between timesteps) values. Additionally the student details the previous values tried.

After trial and error I decided on a N value of 8 and dt of 0.725

Previous value of N =5 didn't resolve error quickly enough and N = 12 led to many osciallations

Polynomial Fitting and MPC Preprocessing

A polynomial is fitted to waypoints.

The waypoints are fitted to a polynomial and projected forward from the reference point of the vehicle by 25 timsteps.

If the student preprocesses waypoints, the vehicle state, and/or actuators prior to the MPC procedure it is described.

The waypoints are first converted from the world reference frame to the vehicle's frame of reference

Model Predictive Control with Latency

The student implements Model Predictive Control that handles a 100 millisecond latency. Student provides details on how they deal with latency.

Model predicts the parameter values at timestep t+1 before optimization

Simulation

The vehicle must successfully drive a lap around the track.

No tire may leave the drivable portion of the track surface. The car may not pop up onto ledges or roll over any surfaces that would otherwise be considered unsafe (if humans were in the vehicle).

The car can't go over the curb, but, driving on the lines before the curb is ok.