Write up Project MPC, Term 2.

I worked on main.cpp and MPC.cpp

My code is not working with the simulator. I spent days trying to figure out what's wrong with it. With the help of my mentor I found the section where the code breaks down. it's in MPC.cpp line 216 et. all. Here is the function that causes the issues:

```
CppAD::ipopt::solve<Dvector, FG_eval>(
    options, vars, vars_lowerbound, vars_upperbound, constraints_lowerbound,
    constraints_upperbound, fg_eval, solution);
```

I then checked all the variables and found them OK. My suspicion is that the ipopt is not working well on my Mac. Maybe there is an issue with ipopt.
My code compiles but when I run the simulator I get the following error message:

```
42["telemetry",{"ptsx":
[-32.16173,-43.49173,-61.09,-78.29172,-93.05002,-107.7717],"ptsy":
[113.361,105.941,92.88499,78.73102,65.34102,50.57938],"psi_unity":
4.12033,"psi":3.733651,"x":-40.62,"y":108.73,"steering_angle":
0,"throttle":0,"speed":0}]
cppad-20180000.0 error from a known source:
vector: index greater than or equal vector size
Error detected by false result for
    i < length_
at line 487 in the file
    /usr/local/include/cppad/utility/vector.hpp
Assertion failed: (false), function Default, file /usr/local/include/
cppad/utility/error_handler.hpp, line 206.
Abort trap: 6
```

I was hoping that maybe you can run my code on another setup which has been proven to work and see if the code works. Maybe you can help me find the problem. I tried on the forums and am getting no answers. My mentor is trying to help me but so far not results.

Here is an outline of my thoughts about how I code main.cpp and MPC.cpp

main.cpp

Here we take the data from the simulator and transform the data in the orientation space for easier fit. This happens in lines 97,98. The data is taken in from the simulator and we define the parameters like ptsx, ptsy, x,y, psi and v in lines 87 et.all.
The transformed data is run through plyfit in line 111.
We calucalte the cte and psi in lines 114 and 115.
We than define the state vector with positions, epsi, v and cte, with epsi being the psi error.
The state vector is run through the solver. We define 10 points variables poly_inc=2.5 and num_points=25.
The model predictive controller runs the data and predicts the new points in mpc_x_vals and mpc_y_vals.

MPC.cpp

Here the actual model is implemented.
First, I set size_t 10 and dt to 0.1, which gives me 100 data points per time step. I chose those numbers after checking with the lecture. Unfortunately I am not able to experiment since my code is not working with the simulator.
I decided for Lf=2.67 based on an approximation of the simulator car.
Then I initialize the variables in lines 24 et. all
Next I work on the eval function.
Here the important thing is to set the sensitivities for various variables by multiplying the variable as follows:

```
for (int i = 0;i<N;i++){
     fg[0]+=2000*CppAD::pow(vars[cte_start +i]-ref_cte,2);
     fg[0]+=2000*CppAD::pow(vars[epsi_start +i]-ref_epsi,2);
     fg[0]+=CppAD::pow(vars[v_start +i]-ref_v,2);
   }
   for (int i = 0;i<N-1;i++){
     fg[0]+=5*CppAD::pow(vars[delta_start +i],2);
     fg[0]+=5*CppAD::pow(vars[v_start +i],2);
   }
   for (int i = 0;i<N;i++){
     fg[0]+=200*CppAD::pow(vars[delta_start +i+1] -vars[delta_start +i],2);
     fg[0]+=10*CppAD::pow(vars[a_start +i+1]-vars[a_start +i],2);
   }
```

Next is the MPC solve function:
Here I set variable and constraint upper and lower bounds in lines 150-190.

Next is the function :

```
CppAD::ipopt::solve_result<Dvector> solution;

// solve the problem
  CppAD::ipopt::solve<Dvector, FG_eval>(
     options, vars, vars_lowerbound, vars_upperbound, constraints_lowerbound,
     constraints_upperbound, fg_eval, solution);
```

This is were my code shows the error message. I print the error message again:

```
42["telemetry",{"ptsx":
[-32.16173,-43.49173,-61.09,-78.29172,-93.05002,-107.7717],"ptsy":
[113.361,105.941,92.88499,78.73102,65.34102,50.57938],"psi_unity":
4.12033,"psi":3.733651,"x":-40.62,"y":108.73,"steering_angle":
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at line 487 in the file
    /usr/local/include/cppad/utility/vector.hpp
```

```
Assertion failed: (false), function Default, file /usr/local/include/
cppad/utility/error_handler.hpp, line 206.
Abort trap: 6
```

I checked all the variables:
options, vars, vars_lowerbound, vars_upperbound, constraints_lowerbound,
constraints_upperbound, fg_eval, solution

The look ok to me. I also cross checked with the Q&A video, where similar code is used and the same variables are used.

Please review my code and maybe you can see if it runs on another machine or maybe you can help me figure out what is wrong and why I am getting this error message.

Best, Krim