# PID Controller Parameter selection.

PID Some of my observations.

I initially approached the problem through a little bit of trial and error with the various numbers - at least for the P and D control parameters until I got it go around the track albeit not very smoothly.

Just using Proportional (0.6 factor) I would get a fast reaction but it would overshoot quite a bit. As we went faster on the track this oscillation would get worse and eventually leave the track. You can see that in action in this [video](#).
This is a chart capturing the CTE per iteration - for Proportional control only - as the car accelerates to towards 30mph the oscillations get worse as a function of speed and end up driving off the track.

cte - Proportional Control only.
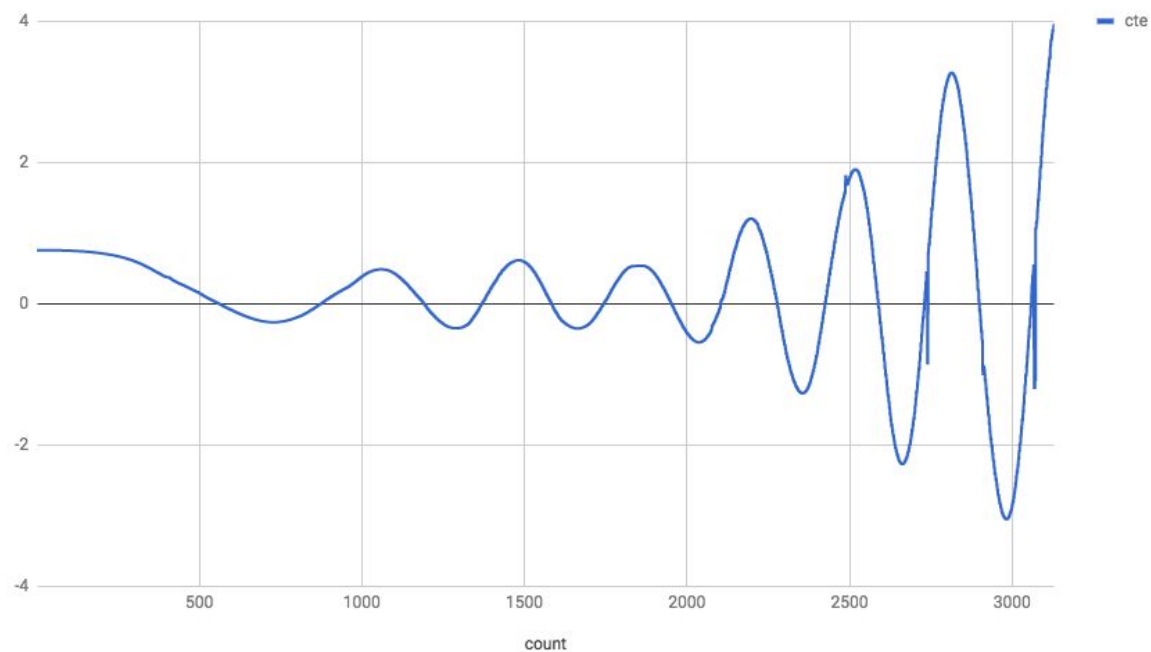
Adding proportional plus derivative dramatically improved the situation ([video](#)). In these cases the derivative portion significantly reduced the overshooting. However from the chart below which again plots CTE over Time, notice there is a bias towards the positive.

CTE over Time using P and D only
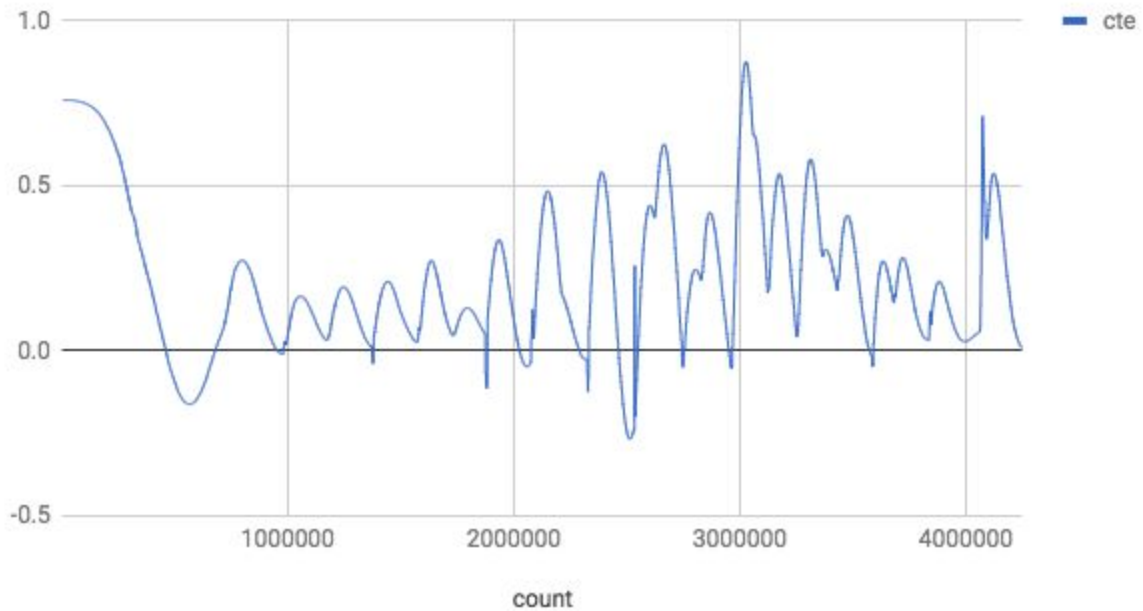
Finally adding in the integral portion resulted in the following type of driving.([video](#))
The integral portion was less noticeable when observing the driving visually.
However in the chart below you can see it converging towards 0 pretty clearly.
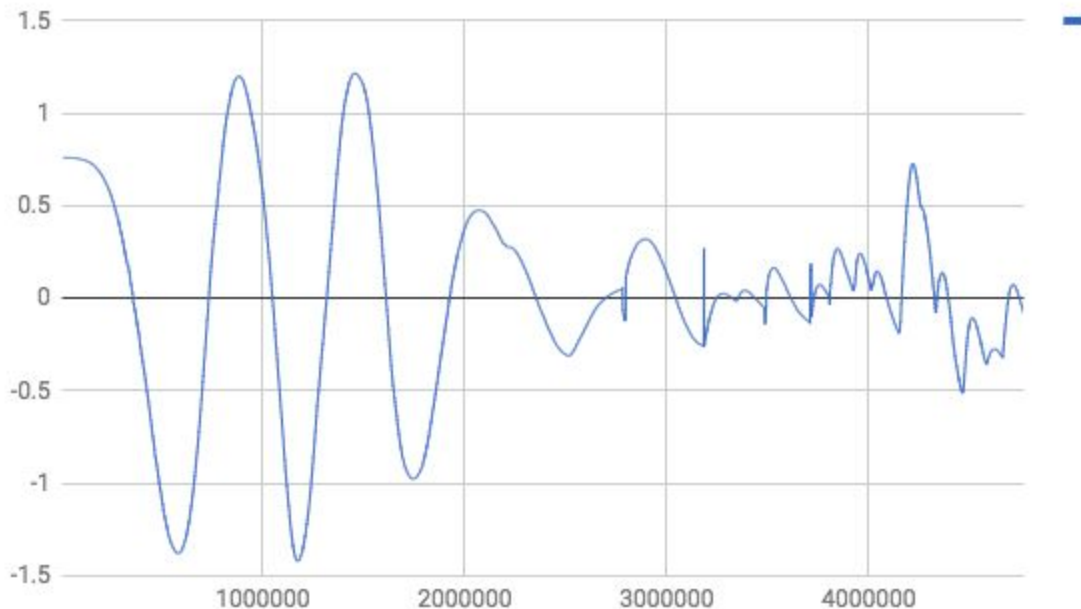
Final weights selection.

My approach to optimizing the control parameters was to first find a set of parameters that could drive completely around the track and then use an online continuous Twiddle implementation to tune those params.

I implemented a version of the Twiddle algorithm that measured the average squared error over N iterations while driving around the track.
I tried various sample sizes, but realized that turns especially at speed would cause a rapid increase in CTE and so it was important to include these turns in the sample size, so I increased the sample size to cover the entire track at least once. This captured all errors during turns as well as the straight sections.

I ran this version for approx 200 laps to let the twiddle algorithm converge on a good set of weights.

This is a screen capture video of a lap with the final control parameter settings.
[Full track video.](#)