# Notations

Spline Function

Abscissas Vector

Ordinates Vector

Knot Vector

Control Vector

Data Matrix

# Problem Formulation

Find that minimizes s.t. (clamped)

# Solution

Throughout, denote as the vector with the first and last elements removed.

We want to solve for , since we know the values for already.

The solution is given by:

Details below.

## Approach 1

A math equations and numbers

Description automatically generated with medium confidence

Note that can be multi-dimensional (and not vectors) to solve the 2D problem simultaneously for x and y.

### Clamped

## Approach 2

## MSE

## Smoothness

## Putting it together

## Unclamped:

# Curvature Fixing Algorithm

Given path :

1. Construct clamped smooth B spline with midway points and set new s.t. (total control points  
   Implementation details below
2. Follow 2-peak solution scheme

Where

Same solution, just with :

### Enforce Clamping

sually

# Enforce Initial Heading

Find comprised of 2D control points that fit data with the initial heading constraint:

(find and use it to construct )

Enforce clamping using as before.

# Finding given data

Note that is the number of control points, where is the interior knot length (can derived directly from ).



Set where r is defined as the ratio of maximum twists per unit of length (meter).  
  
Advantage is that we can work with a smaller number of control points – can make computations faster and more importantly, guarantee max curvature algorithm validity.  
Parameter:

1. Redefine loss as MSE instead of SE (add average), define as maximum and have some constant

Parameter:

1. Take inspiration from dierckx to define as the maximum allowed MSE value to search for i.e. search for largest that fits MSE constraint  
   Parameter:
2. My preferred - combine 1 and 2:  
   Set to be very lenient, and not a ratio that determines the minimum control points needed, but something that ‘makes sense’. Then use constant .  
   Parameter:

Check validity: take some trip(s) and measure MSE and roughness for each frame. Take largest MSE frames and analyze them. A good parameter for each method is one that ensures a maximum MSE along the entire trip