Tracking Systems
Nonlinear Regression

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ECE 854
Lab 2 Report

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1 Introduction

This medtod is used to fit a non-linear model to a set of data. This is accomplished by implementing the root finding method.

The function is of the form:

$$y = \log(ax) \tag{1}$$

2 Derivation

To find the non-linear unknown we define an Error meteric, differentiate it and equate it to zero.

$$\mathrm{E} = \sum (\text{data} - \text{model})$$

For a function of the form (1) the error function can be written as:

$$E = \sum_{i=1}^{N} (y_i - \ln(ax_i))^2 \tag{2}$$

Where, x_i and y_i are the data points.

Taking the derivative of (2) with respect to the unknowns (here 'a'):

$$\frac{\partial E}{\partial a} = 2 \times \frac{\sum_{i=1}^{N} (y_i - \ln(ax_i))}{a}$$

Minimizing this function, we equate it to zero

$$\frac{\partial E}{\partial a} = 2 \times \frac{\sum_{i=1}^{N} (y_i - \ln(ax_i))}{a} = 0 \text{ [Where } a \neq 0]$$

$$f(a) = \sum_{i=1}^{N} (y_i - \ln(ax_i)) \tag{3}$$

Taking the derivative of (3) to get $f'(a)$

$$f'(a) = -\sum_{i=1}^{N} \frac{1}{ax_i} \times x_i \tag{4}$$

$$= \frac{-N}{a} \tag{5}$$

Now, iterating through values generated through the root finding method we use (3) and (5) in

$$a_{n+1} = a_n - \frac{f(a_n)}{f'(a_n)} \tag{6}$$

3 Implementation

Implementation of the root finding method in C

Listing 1: Non Linear Regression C Implementation

```
an=0.1;        /* initial guess; should be nearby true */
for (j=0; j<TOTAL_ITERATIONS; j++)
  {
  fan=fpan=0.0;
  for (i=0; i<total_data; i++)
        fan += (y[i]-log(an*x[i]));
  fpan = -total_data/an;
  an1=an-fan/fpan;
  printf("%lf %lf\n",an,an1);
  if (fabs(an-an1) < 0.0000001)
    break;
  an=an1;
  }
printf("%d iterations\n",j);
```

4 Results

4.1 Data File A

The initial guess used for this numerical method is 0.1 and in 7 iterations it approaches 6.71

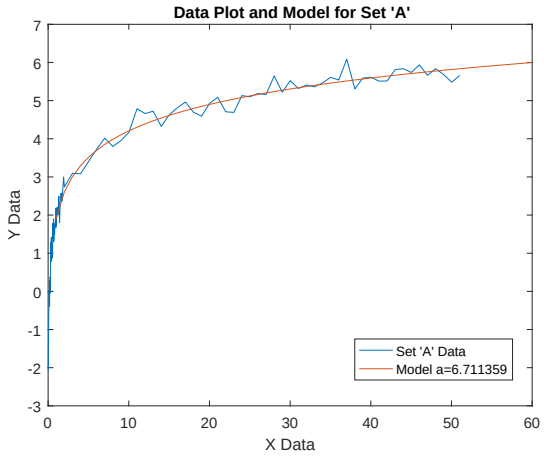

Figure 1: Model for Set A

```
Initial Guess:0.1

0.100000  0.520639
0.520639  1.851652
1.851652  4.236067
4.236067  6.185362
6.185362  6.690186
6.690186  6.711325
6.711325  6.711359
6.711359  6.711359
7 iterations
(END)
```

Figure 2: Iterations

4.2 Data File B

The initial guess used for this numerical method is 0.1 and in 8 iterations it approaches 18.996116

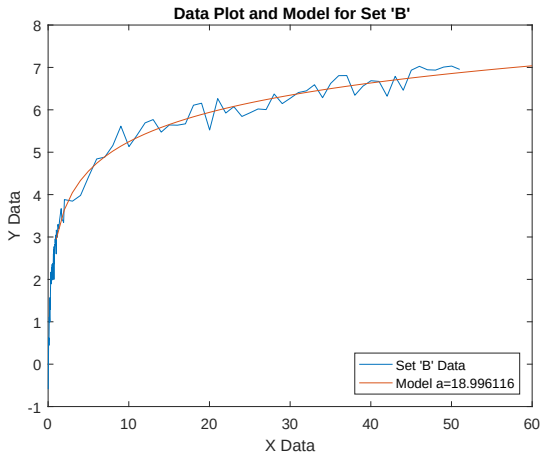

Figure 3: Model for Set B

```
Initial Guess:0.1

0.100000  0.624682
0.624682  2.757813
2.757813  8.079831
8.079831  14.986984
14.986984  18.539686
18.539686  18.990588
18.990588  18.996115
18.996115  18.996116
18.996116  18.996116
8 iterations
(END)
```

Figure 4: Iterations

4.3 Data File C

The initial guess used for this numerical method is 0.1 and in 5 iterations it approaches 0.289998

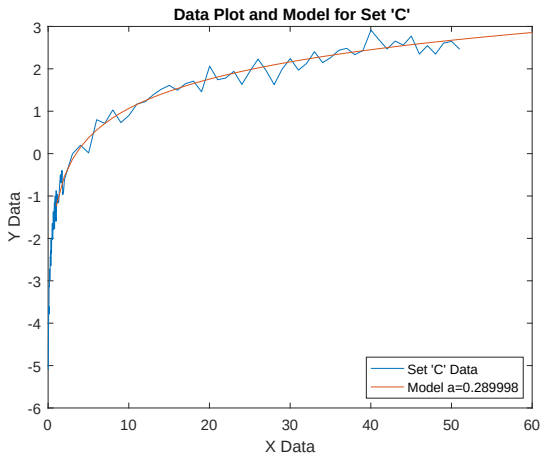

Figure 5: Model for Set C

Initial Guess:0.1

0.100000 0.206470
0.206470 0.276612
0.276612 0.289684
0.289684 0.289998
0.289998 0.289998
0.289998 0.289998
5 iterations
(END)

Figure 6: Iterations