LAB 2 -NON LINEAR REGRESSION

ECE8540

MADHUMITA KRISHNAN

Introduction

In this lab we develop a code to calculate a nonlinear regression fit for the give data sets by using root finding methods. The function we use to fit the data is

$$y = \ln(ax)$$

For the data we use the given datasets logdataA, logdataB and logdataC.

Derivation

The error function can be written as:

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

where x_i and y_i are given data points

Taking the derivative of the above equation with respect to a we get:

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

Minimizing the above equation by equating to zero we get:

$$\frac{\partial E}{\partial a} = 2 * \frac{\sum_{i=1}^{n} (y_i - \ln(ax_i))}{a} = 0$$

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

Taking the derivative of $f(a)$:

$$f'(a) = -\sum_{i=1}^{n} \frac{1 * x_i}{a * x_i}$$

$$f'(a) = -\frac{N}{a}$$

Now we use the given formula for the root finding method

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

Code for fitting the model

```
N=height(logdataA)
x=logdataA{:,1};
y=logdataA{:,2};
plot(x,y,'o')
hold on
A=[log(x) x.^0];
b=[y];
X=inv(transpose(A)*A)*transpose(A)*b;
g=X(1,1)
truea=X(2,1)
totaliterations=50000;
an=1.5;  %initial value of an should be near true value
i=0;

while i<500000
    fan=0;
    fpan=0;
    j=1;
    while j<N+1
        fan = fan + ( (y(j)- log(an.*x(j))));
        j=j+1;
    end

    fpan = -(N/an);
    i=i+1;
```

```
    an1=an-(fan/fpan);       %using root finding method
    fprintf('an: %f an1: %f \n',an,an1)
    if (abs(an-an1) < 0.0000001)
        break;
    end
    an=an1;

end
fprintf('iterations %i',i);      %no of iterations

Y=log(an.*x);
plot(x,Y)
title('y=ln(ax) model for logdataA')
legend('Given dataset','nonlinear model',
'Location','southeast')
xlabel('xi')
ylabel('yi')
hold off
```

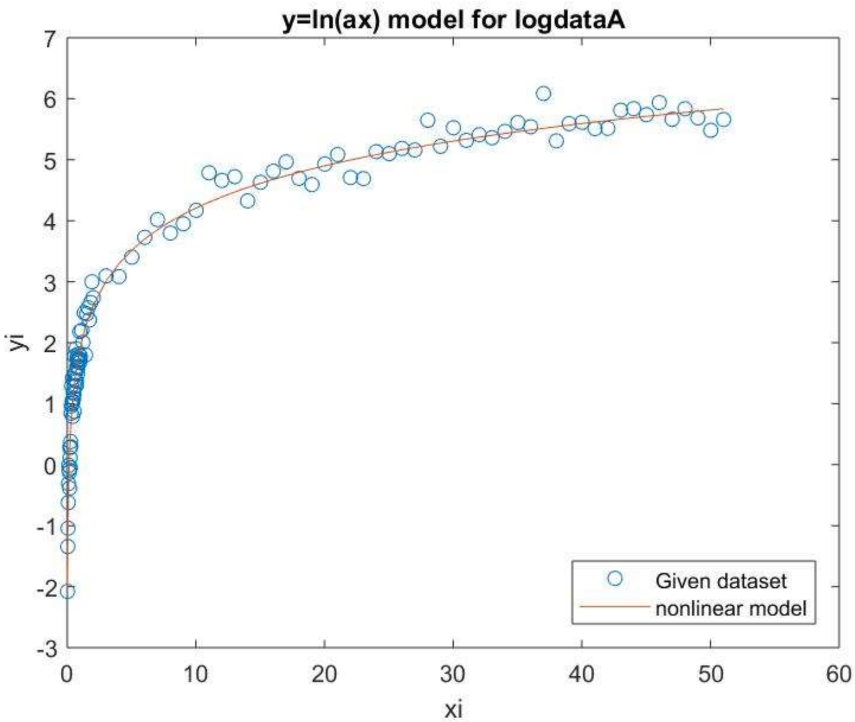
OUTPUT

DATA FILE A

For logdataA we find the value of an by assuming the initial value an=1.5 which is close to the true value of a .We retrieve the number of iterations and the final value of $an = 6.711359$

```
Command Window
an: 1.500000 an1: 3.747504
an: 3.747504 an1: 5.931217
an: 5.931217 an1: 6.664149
an: 6.664149 an1: 6.711192
an: 6.711192 an1: 6.711359
an: 6.711359 an1: 6.711359
fx iterations 6>>
script    Ln 27  Col 25
```

Plot for data file A:



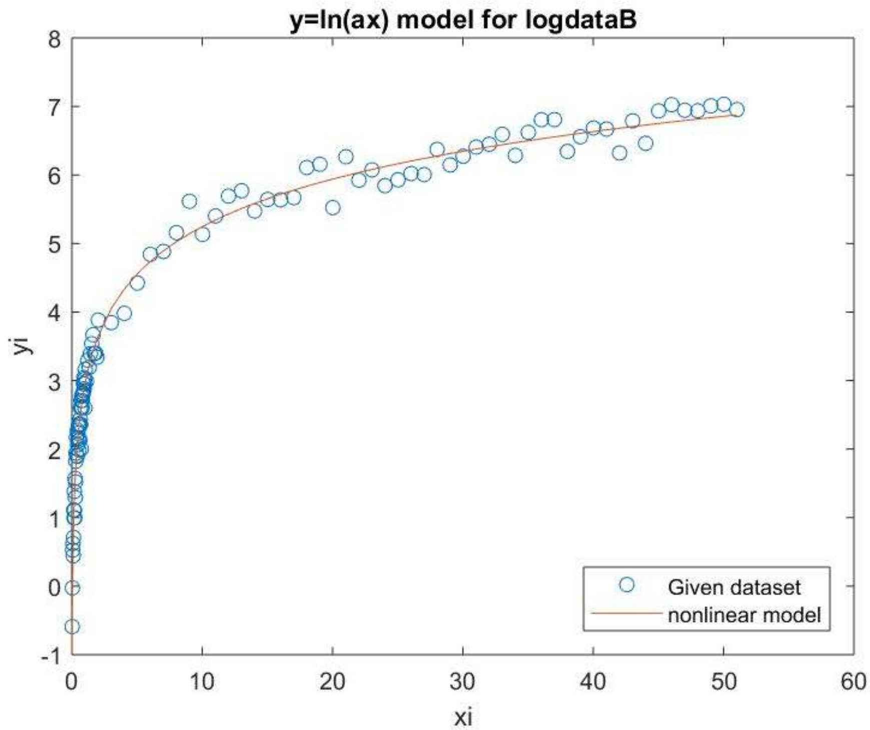
DATA FILE B

For logdataB we use the initial value of an=2 which is close to the true value and we find the number of iterations and the final value of an=18.996116

```
Command Window
an: 2.000000 an1: 6.502175
an: 6.502175 an1: 13.473142
an: 13.473142 an1: 18.101656
an: 18.101656 an1: 18.974719
an: 18.974719 an1: 18.996104
an: 18.996104 an1: 18.996116
an: 18.996116 an1: 18.996116
fx iterations 7>>
script    Ln 12 Col 5
```

Using this value of an we plot the nonlinear mode $y = \ln(ax)$ given

Plot for data file B:



DATA FILE C

For logdataC we find the value of an by assuming the initial value an=0.1 which is close to the true value of a .We retrieve the number of iterations and the final value of $an = 6.711359$

```
Command Window
   -1.2293

 an: 0.100000 an1: 0.206470
 an: 0.206470 an1: 0.276612
 an: 0.276612 an1: 0.289684
 an: 0.289684 an1: 0.289998
 an: 0.289998 an1: 0.289998
 an: 0.289998 an1: 0.289998
fx iterations 6>>
                                                   script        Ln 12 Col 6
```

Using this value of an we plot the nonlinear mode $y = \ln(ax)$ given:

Plot for data file C: