In this post I will be showing you how to write a code that fits the data-points to an exponential function, like:

$$y = Ae^{Bx} \qquad eq(i)$$

where, A & B are some constants that we will determine.

We will be using the Least Squares Method (also known as Chi square minimization) to achieve this.

Let's say you have *n* data points: x_i and y_i .
Then the fitted function can be calculated by minimizing the error(difference between the actual and fitted point):

minimize: $\boxed{err = \Sigma_{i=1}^{n}(Y_i - Ae^{Bx_i})^2}$

where $Y_i = Ae^{Bx_i}$

But this will give us alot of problem as doing that is not easy and a topic for another post, and very mathematical.
To cut the long story short, what we do instead is, we apply a trick, that is, we take the logarithm of eq(1) to get rid of the exponential

$$\ln(Y_i) = \ln(A) + Bx_i$$

and applying a quick change of variables as :

$$Yn_i = \ln(Y_i)$$
$$c = \ln(A)$$

we get,

$$Yn_i = Bx_i + c$$

which is exactly the equation of a straight line, and therefore, it becomes a problem of linear fitting. And we have already seen how to write a Linear Fitting program. We will use the following formulae from there:

$$\boxed{B = \frac{n\Sigma x_i y_i - \Sigma x_i \Sigma y_i}{n\Sigma x_i^2 - (\Sigma x_i)^2}}$$

$$\boxed{c = \frac{\Sigma x_i^2 \Sigma y_i - \Sigma x_i \Sigma x_i y_i}{n\Sigma x_i^2 - (\Sigma x_i)^2}}$$

You can refer to this link for a detailed proof.

From 'c' we calculate the value of A using:

$$A = e^c$$

So you will need to have some code for the user two enter the data-points or you could add them manually by initializing the arrays.

Once you have the data-points stored in the x and y arrays,
you can use the following code to find out the value of 'A' and 'B', which are the coefficients of exponential fitting funtion.

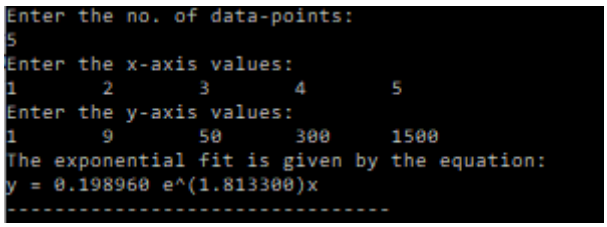
CODE:

```
/*******************************************************
*************Chi-square fitting**************
Exponential Fitting: y=Ae^bx
*******************************************************/
#include<stdio.h>
#include<math.h>
/*****
```

```
Function that calculates and returns the slope of the best fit line
Parameters:
N: no. of data-points
x[N]: array containing the x-axis points
y[N]: array containing the corresponding y-axis points
*****/
double slope(int N, double x[N], double y[N]){
        double m;
        int i;
        double sumXY=0;
        double sumX=0;
        double sumX2=0;
        double sumY=0;
        for(i=0;i<N;i++){
                sumXY=sumXY+x[i]*y[i];
                sumX=sumX+x[i];
                sumY=sumY+y[i];
                sumX2=sumX2+x[i]*x[i];
        }
        sumXY=sumXY/N;
        sumX=sumX/N;
        sumY=sumY/N;
        sumX2=sumX2/N;
        m=(sumXY-sumX*sumY)/(sumX2-sumX*sumX);
        return m;
}
/*****
Function that calculates and returns the intercept of the best fit line
Parameters:
N: no. of data-points
x[N]: array containing the x-axis points
y[N]: array containing the corresponding y-axis points
*****/
double intercept(int N, double x[N], double y[N]){
        double c;
        int i;
        double sumXY=0;
        double sumX=0;
        double sumX2=0;
        double sumY=0;
        for(i=0;i<N;i++){
                sumXY=sumXY+x[i]*y[i];
                sumX=sumX+x[i];
                sumY=sumY+y[i];
                sumX2=sumX2+x[i]*x[i];
        }
        sumXY=sumXY/N;
        sumX=sumX/N;
        sumY=sumY/N;
        sumX2=sumX2/N;
        c=(sumX2*sumY-sumXY*sumX)/(sumX2-sumX*sumX);
        return c;
```

```
}
main(){
        int N;
        printf("Enter the no. of data-points:\n");
        scanf("%d",&N);
        double x[N], y[N], Y[N];
        printf("Enter the x-axis values:\n");
        int i;
        for(i=0;i<N;i++){
                scanf("%lf",&x[i]);
        }
        printf("Enter the y-axis values:\n");
        for(i=0;i<N;i++){
                scanf("%lf",&y[i]);
        }
        for(i=0;i<N;i++){
                Y[i]=log(y[i]);
        }
        printf("The exponential fit is given by the equation:\n");
        double m=slope(N,x,Y);
        double c=intercept(N,x,Y);
        double A, b; //y=Ae^bx
        A=exp(c);
        b=m;
        printf("y = %lf e^(%lf)x",A,b);
}
```

OUTPUT:



Sample output 1

So that's it.
You now have the value of 'A' and 'B' and thus the exponential fit:

$$y = Ae^{Bx}$$

You can refer to the following links for more info:
Exponential Fitting – Lab Write-Up
Exponential Fitting – C++ Program
Exponential Fitting – Scilab Code
Curve Fit Tools – Android App (using the above code)
Curve Fit Tools – Documentation
Curve Fit Tools – Play Store
Curve Fit Tools – GitHub Repository
Curve Fitters – Scilab Toolbox

Hope you found this post useful.
If you have any questions/doubts drop them in the comments section down below.

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