

In this post I'm gonna show you how to calculate Laguerre polynomials using three different techniques: using recurrence relations, series representations, and numerical integration. The programs will calculate and plot the first few Laguerre polynomials.

Using Recurrence Relation

We will be using the following recurrence relation:

$$(n + 1)L_{n+1}(x) = (2n + 1 - x)L_n(x) - nL_{n-1}(x)$$

We would need two more relations, that is the relations for 0th and 1st order Laguerre polynomials:

$$L_0(x) = 1$$

$$L_1(x) = -x + 1$$

We will create a program that calculates the values of the Laguerre polynomial at various x values and for different n and store these values in a txt file. Then just plot it using Gnuplot.

We will create two functions called 'l0' and 'l1', that contain the definition of respectively.

Then we will create a function 'ln' that will use the first two functions and recursion to find the value of Legendre polynomial for different x,n.

NOTE: I am using a slightly modified form of the recurrence relation. To get the form I am using, just replace n by n-1.

CODE:

```

#include<stdio.h>
#include<math.h>

double l0(double x){
    return 1;
}

double l1(double x){
    return -x+1;
}
//The following is a general functoin that returns the value of the Laguerre Polynomial
for any given x and n=0,1,2,3,...
double ln(double x, int n){
    if(n==0){
        return l0(x);
    }
    else if(n==1){
        return l1(x);
    }
    else{
        return ((2*(n-1)+1-x)*ln(x,n-1)-(n-1)*ln(x,n-2))/n;
    }
}
}
main(){
    //We will create a data-file and store the values of first few Legendre
    polynomials for -1<x<5
    FILE *fp=NULL;
    //create data-file
    fp=fopen("laguerre1.txt","w");
    double x;
    //write the values of first 5 Lagurre polynomials to data-file
    for(x=-1;x<=5;x=x+0.1){
        fprintf(fp,"%lf\t%lf\t%lf\t%lf\t%lf\t%lf\n",x,ln(x,0),ln(x,1),ln(x,2),ln(x,3),ln(x,4));
    }
}

```

OUTPUT:

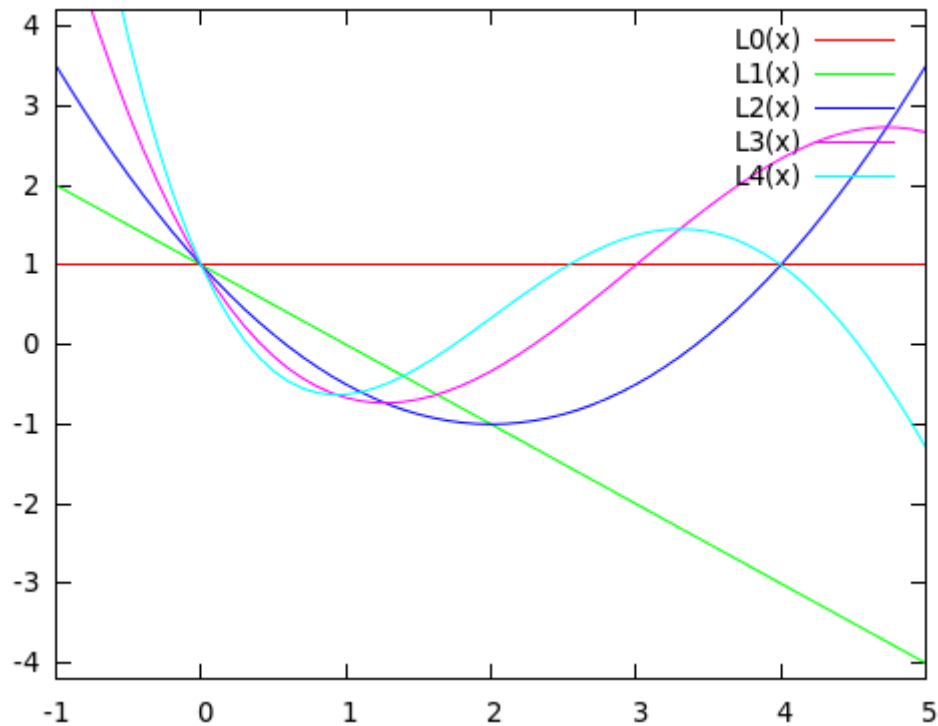
The above program will create a data-file called `laguerre1.txt` and store the values of the first 5 Legendre polynomials for $-1 \leq x \leq 5$. Now, you can just open the file and select the data and plot it using Excel, GnuPlot, Origin, etc.

For GnuPlot, the command is:

```

plot './laguerre1.txt' u 1:2 w l t 'L0(x)', ' ' u 1:3 w l t 'L1(x)', ' ' u 1:4 w l t 'L2(x)', ' ' u
1:5 w l t 'L3(x)', ' ' u 1:6 w l t 'L4(x)'

```



First few Laguerre polynomials using recurrence relation

Using Series Representation

Using Numerical Integration

References:

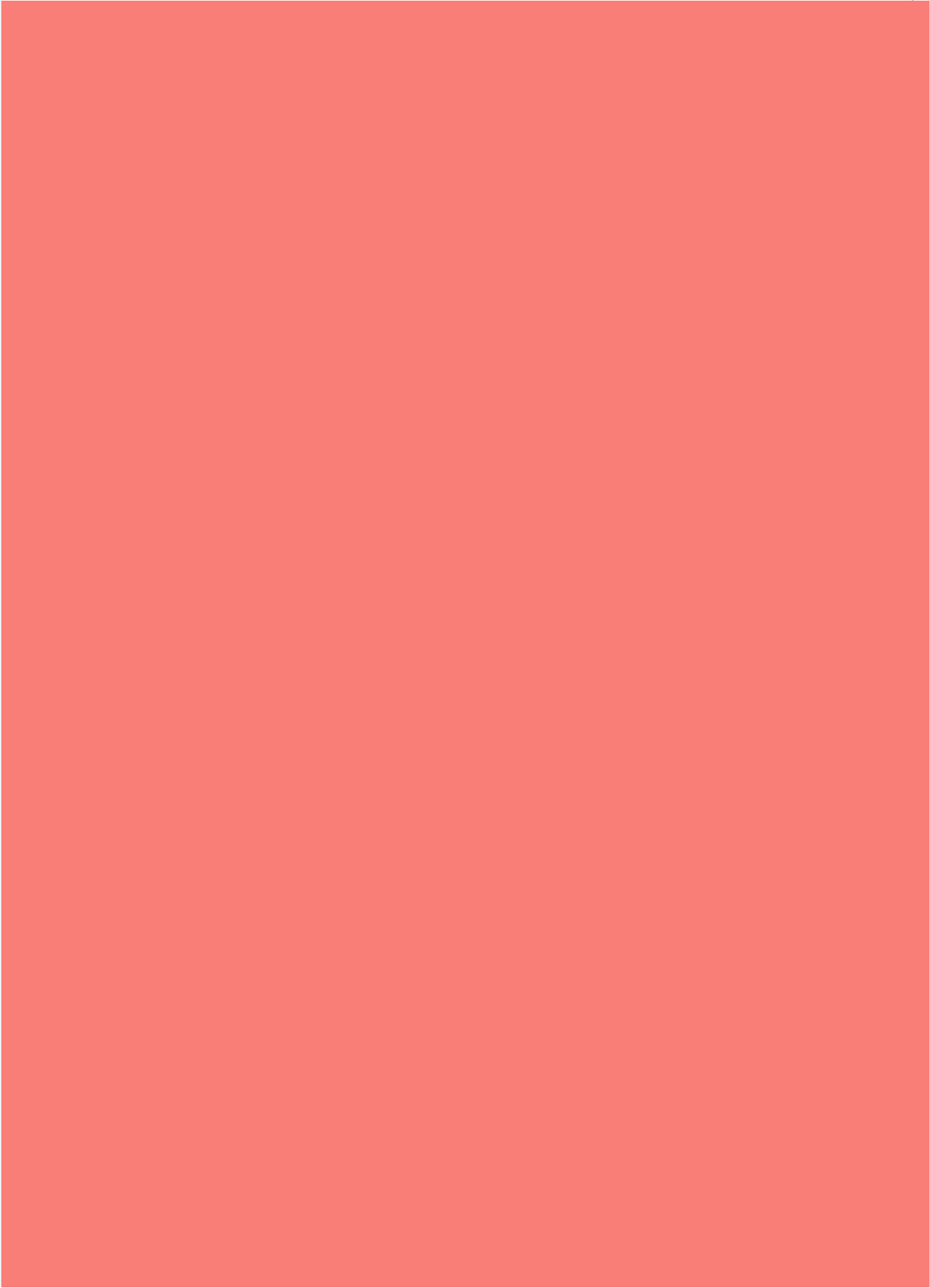
<http://mathworld.wolfram.com/LaguerrePolynomial.html>



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I'm a physicist specializing in computational material science with a PhD in Physics from Friedrich-Schiller University Jena, Germany. I write efficient codes for simulating light-matter interactions at atomic scales. I like to develop Physics, DFT, and Machine Learning related apps and software from time to time. Can code in most of the popular languages. I like to share my knowledge in Physics and applications using this Blog and a YouTube channel.

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