Interpolation & Curve Fitting Exercises

1)

The file "weatherinistanbul.txt" in Ninova contains 12 temperature values of Istanbul. The first column is the number of the day and the second column is the temperature value measured on that day.

Using this data set, find the temperature values for the whole year (365 days) using the Lagrange interpolation. Write the new data into a file called "wholeyearweather.txt" and plot the known and interpolated-extrapolated data on the same graph.

2)

A physicist cannot sleep in hot summer days and there is a cricket living in a nearby tree.

Our physicist counts the number of cricket chirps per minute in several nights and measures the temperature outside, then writes them in a file called "sleeplessnights.txt" and uploads it to Ninova.

The first column in the file is the number of chirps per minute and the second column is the temperature in degrees Fahrenheit. (Don't ask why, our subject is a physicist!)

Read the data from the file, convert the temperature values to Celcius using:

Celcius=(Fahrenheit-32)*5/9.

There is a theory which claims that the temperature is a linear function of the number of chirps per second (this is not a joke).

a. Find this function using the least squares curve fitting method,

b. Plot the given data and the fitting function on the same graph.

3)

SpongeBob SquarePants and Patrick are hunting jellyfish.

Squidward is counting the number of jellyfish that has been caught in each minute while playing his clarinet and then he prepares a data file "jellyhunt.txt" with the minutes in the first column and the number of the jellyfish in the second column and uploads this file to Ninova.

According to Squidward, the number of jellyfish is related with time (in minutes) as

$f(t) = At^3 + B$.

a. Find the constants A and B in his theory.

b. Plot the original table and fitting function on the same graph.

4)

P (kN/m^2)	T (K)	v (m^3/kg)
9000	700	0.031980
9000	800	0.037948
9000	900	0.043675
10000	700	0.028345
10000	800	0.033827
10000	900	0.039053
11000	700	0.025360
11000	800	0.030452
11000	900	0.035270

The specific volume [v (m^3/kg)] of steam, corresponding to the van der Waals equation of state, as a function of pressure [P (kN/m^2)] and temperature [T (K)] in the neighborhood of P=10000 kN/m^2 and T=800 K is given in the table.

Find the coefficients of the fitting polynomial $v=a_1+a_2T+a_3P+a_4PT$

5)

i. Solve the differential equation,

$$\frac{dy}{dx} = y$$

using Euler's method ($y_{n+1}=y_n+h*y_n$). Take y(0)=1 and solve the equation from x=0 to x=1. Take the increment h=0.01.

ii. The analytic solution of this ODE is y=e^x. Therefore, if we fit the values found in the previous question to the function $y = Ae^{Bx}$ by using the least squares approach, then we expect to find *A*=*B*=*1* (for the theoretical, exact values). Departures from these values can be related to the error of the ODE integration scheme. Find the *A* and *B* values for the data table found by the Euler's method.

HINT: You can define the data table using the results in the first question as,

x	y(x)
0	1
0.01	...
0.02	...
...	...
...	...
1	...

After finding this table, it is easy to fit to a given function using the least squares approach. Remember how we fitted to an exponential function by linearization.

6)

The file "*einstein.txt*" in the homework directory of Ninova contains the number of articles by Albert Einstein that are published in the years between 1901 and 1954. The first column is the year and the second column is the number of article(s) published in that year.

There are four claims by four Muppet characters:

Kermit the Frog claims that Einstein's productivity (number of the published article(s) in a year) can be given by a **Lagrange interpolation polynomial**.

Miss Piggy claims that Einstein's productivity can be given by **linear least squares fitting** (ax+b).

Gonzo claims that Einstein's productivity can be given by **second-order polynomial least squares fitting** (ax^2+bx+c).

Fozzie Bear claims that Einstein's productivity can be given by **third-order polynomial least squares fitting** (ax^3+bx^2+cx+d).

Find the curves for all claims between 1901-1954 and plot them along with the given data points.

NOTE 1: It is encouraged (but not obligatory) that you use functions or subprograms.

NOTE 2: http://www.youtube.com/watch?v=8N_tupPBtWQ