Project: Regression Analysis

The project is concerned with **curve fitting** (or **regression analysis**) for data arising in various scientific experiments. We will explore the *least-squares method*: for given data $\{(x_i, y_i)\}_{i=1,\cdots,n}$, find a representation f which is parameterized by m variables ($m < n$) and minimizes

$$\sum_{i=1}^{n} |f(x_i) - y_i|^2 \tag{1}$$

Differentiating (1) with respect to each of the variables and setting the result to be zero, one can get the so-called *normal equation* which is an $m \times m$ algebraic system. For the current project, we will consider

$$f(x) = f_1(x) + f_2(x), \tag{2}$$

where

$$f_1(x) = c_0 + c_1 x + c_2 x^2 + c_3 x^3, \quad f_2(x) = \frac{x^2}{d_0 + d_1 x^2}.$$

The scope of the project:

1. Download the modelcode: `Curve_Fitting.CC.tar`
2. Design an algorithm (and modify the code) which includes the following components
   (a) a routine which reads the data
   (b) a routine for the Gauss-Elimination (you may download one from web sites or utilize a module built in the system as in MATLAB)
   (c) a routine for the construction of algebraic system arising from

$$\min_{f_1} \sum_{i=1}^{n} \left| f_1(x_i) - \left(y_i - f_2^{\text{old}}(x_i)\right)\right|^2 \tag{3}$$

   (d) a routine for the construction of algebraic system arising from

$$\min_{f_2} \sum_{i=1}^{n} \left| f_2(x_i) - \left(y_i - f_1^{\text{old}}(x_i)\right)\right|^2 \tag{4}$$

   (You have to apply the linearization for this routine.)
   (e) combine (b)-(d) to get an alternating iterative solver, and test the data

Remarks:

- Implement routines in separate files. When your program is in C, FORTRAN, or JAVA, you may compose a makefile for a convenient compiling; try `mkmk`.
- The alternating iterative solver may be implemented separately such that it can be called from the main routine.
- You should initialize either c_i's or d_i's (depending on your iteration strategy) before the iteration begins.

Report:

- Your code (the soft copy) in a disc
- The corresponding hard copy of your code, along with a small documentation explaining your experiment.

The project may be hard for some students; reasonable degrees of efforts and performance are expected from you.