24-311 NUMERICAL METHODS Fall 03

Carnegie Mellon University

PROBLEM SET 8

Issued: 10/16/2003
Due: 10/24/2003 Friday 1:00PM @ HH B127
Weight: 4% of total grade

PS8-1 2D Unconstrained Optimization--Equilibrium Position of a Spring System

Consider the simple two-spring system shown in the following figure. The springs are assumed to be linearly elastic, and the loads $p_1 = 5\,\text{N}$ and $p_2 = 5\,\text{N}$ are constant. This is a geometrically nonlinear problem because the resistance to the load is a function of the deformed position. The original length of the two springs are $l_1 = 10\,\text{cm}$ and $l_2 = 10\,\text{cm}$, and the two spring constants are $k_1 = 8\,\text{N/cm}$ and $k_2 = 1\,\text{N/cm}$.

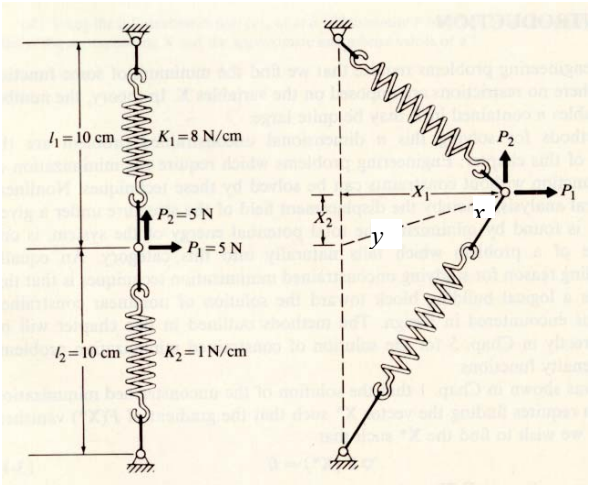


Figure 1: Spring system

The total energy of the system $E(x, y)$ can be written as a function of x and y, and its surface plot and the contour plot are shown in Figure 2.

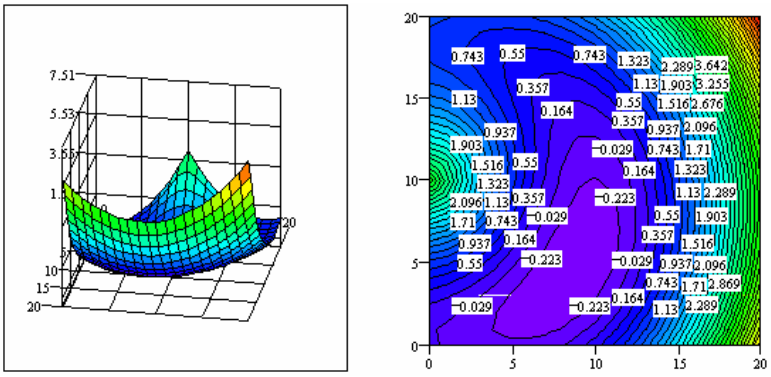


Figure 2: The surface plot and the contour plot

Write a program that determines the equilibrium position by minimizing the total energy $E(x, y)$ using the univariate search. In your univariate search start your search in the x direction. In each one-dimensional optimization run the golden section search ten times. Run the one-dimensional optimization five times in the x direction and y direction respectively. The convergence path thus consists of 10 line segments.

To show that your program is properly implemented, your program has to generate: (1) a text file, `output.txt`, that contains the numerical results showing the convergence process, and (2) a VRML files, `output.wrl`, that illustrates the surface plot of $E(x, y)$ and the paths of convergence. Your VRML files should look something like Figure 3, but the convergence path shown in the figure is not correct. To minimize your work to generate a VRML output the following subroutines and a sample code is available on the class web page.

In your hand-in directory on AFS, make a new directory called ps8 (in lower case). Hand in the following in your hand-in directory on AFS. Do not copy object files.

- Source code files and header files
- Executable file
- A text file named `output.txt`
- An output VRML file named `output.wrl`

Also hand in a printout of the following:

- Source code files and header files
- The output text file and the VRML file
- Two images of the VRML files that look like Figure 3

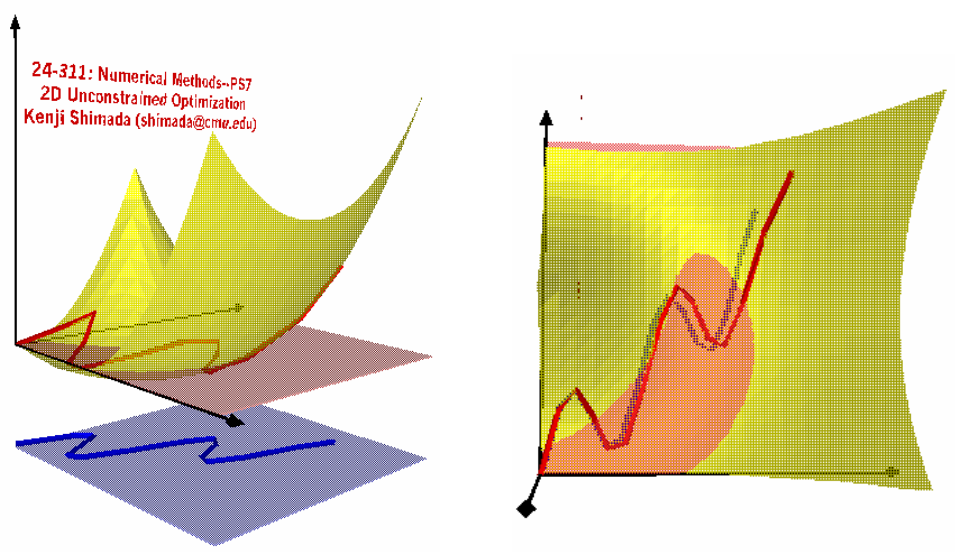
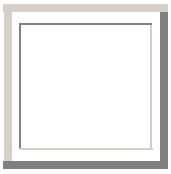


Figure 3: VRML file showing the surface plot and the convergence paths
(Note: the paths shown in the figure are not correct.)

PS8



The first letter of your LAST name

First Name _____ Last Name _____

PS8-1a (50 pts) Univariate search For handing in all the files and printouts (code, txt file, wrl file)	PS8-1b (50 pts) Univariate search For the correct algorithm and the results	Total (100 pts)

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