Bioengineering 499C: Systems and Synthetic Biology

April 17, 2008
Homework Assignment #2B; Due: 22th April 2008

Points awarded for each question are indicated in square brackets. Return assignment with your name clearly indicated at the top of your answer sheet. [Total points: 50]

[15] **Question 1**

Implement the Newton-Raphson method to determine the square root for a value entered by the user. Implement the method using is a tool of your choice. Show the code you used and three examples illustrating it in operation. Show the intermediate results as the iteration proceeds and converges to the solution in your answer.

[35] **Question 2**.

Implement the Newton method for multiple variables and use it to find the steady state for the following model:

$$X_o \rightarrow S_1; \quad k_1\ X_o - k_2\ S_1$$

$$S_1 \rightarrow S_2; \quad k_3\ S_1 - k_4\ S_2$$

$$S_2 \rightarrow X_1; \quad k_5\ S_2$$

You will need to derive the differential equations for this model in order to use the Newton method.

Let Xo and X1 be boundary species. Let S1 and S2 be state variables, that is species that are allowed to change during the simulation. Set the values of the kinetic constants and boundary species to:

$$X_o = 10; X_1 = 0;\ k_1 = 0.1;\quad k_2 = 0.2;\ k_3 = 0.3;\ k_4 = 0.4;\ k_5 = 0.2;$$

Note: Many software tools have built-in capabilities to evaluate the inverse of a matrix, see the table below:

Software Tool	How to Specify a Matrix	Command to Compute the Inverse
Matlab/SciLab	A = [1.2 4.5; 7.8 9.8]	inv (A)
Jarnac	A = {{1.2, 4.5}, {7.8, 9.8}}	1/A
R	A = matrix (c(1.2, 4.5, 7.8, 9.8), nrow = 2)	solve (A)
Mathematica	A = {{1.2, 4.5}, {7.8, 9.8}}	Inverse[A]
Excel	Enter values into cells A1 to C3, use Shift-Ctrl-Enter to enter the command. For details, see: http://www.math.iupui.edu/~momran/m118/matrices3.pdf	=MINVERSE(A1:C3)