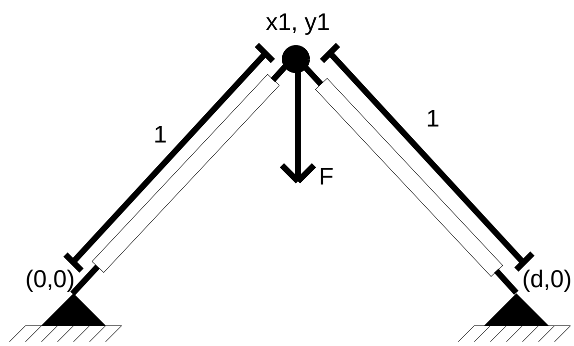
Introduction to Numerical Simulation (Fall 2003)
Problem Set #5 - due October 10th

Note: This problem set has only one problem, in order to give everyone a little time to catch up. It covers only the basics of the one-dimensional Newton method. We will cover multidimensional Newton methods in the next problem set.

1) In this problem, you will write a Newton algorithm for solving the struts and joints problem in the figure below. You will use that Newton solver to investigate a problem that has two correct solutions. Note, the problem is symmetric about the y-axis, so it can be treated as a one-dimensional problem.



For this problem, assume $EA_c = 1$ in the strut constitutive equation.

a) For the struts and joints example above, suppose the applied force F has nonzero x and y components (so you can not use symmetry). Give the nodal form for system of nonlinear equations which can be used to determine the values of x_1 and y_1 given d, F_x and F_y.

b) Suppose we now assume that the applied force F is only acting in the negative y direction. Give the one dimensional nonlinear equation for y_1 by eliminating the x_1 variable using the fact that by symmetry the horizontal forces must be in balance.

c)Suppose $d = \sqrt{3}$ in the example above, and assume F is acting in the negative y direction so that you can use the one-dimensional equation derived in part (b). Write a matlab script to use Newton's method to calculate the joint deflection as a function of F by starting with $F_x = 0, F_y = 0$ and then increasing the magnitude of the applied force in eight increments of $\Delta F_y = -0.02$. Use as the initial guess for Newton's method the solution of the previous load. For the $F = 0$ solve, use the initial guess $y_1 = \frac{1}{2}$.

c) Now that you know the solution for $F_y = -0.16$ (meaning the force is acting downward), work backwards by reducing the magnitude of the applied force in eight steps, $\Delta F_y = 0.02$. Once again, the initial Guess for the Newton iteration at each load step should be the solution of the previous load step.

d) Why is the solution you determined for $F_y = 0$, the last load step, of part (c) different from the solution you computed for the $F_y = 0$, the first load step, at the beginning of part (d)?