Farhad Ramezanghorbani 20131758 – HW9

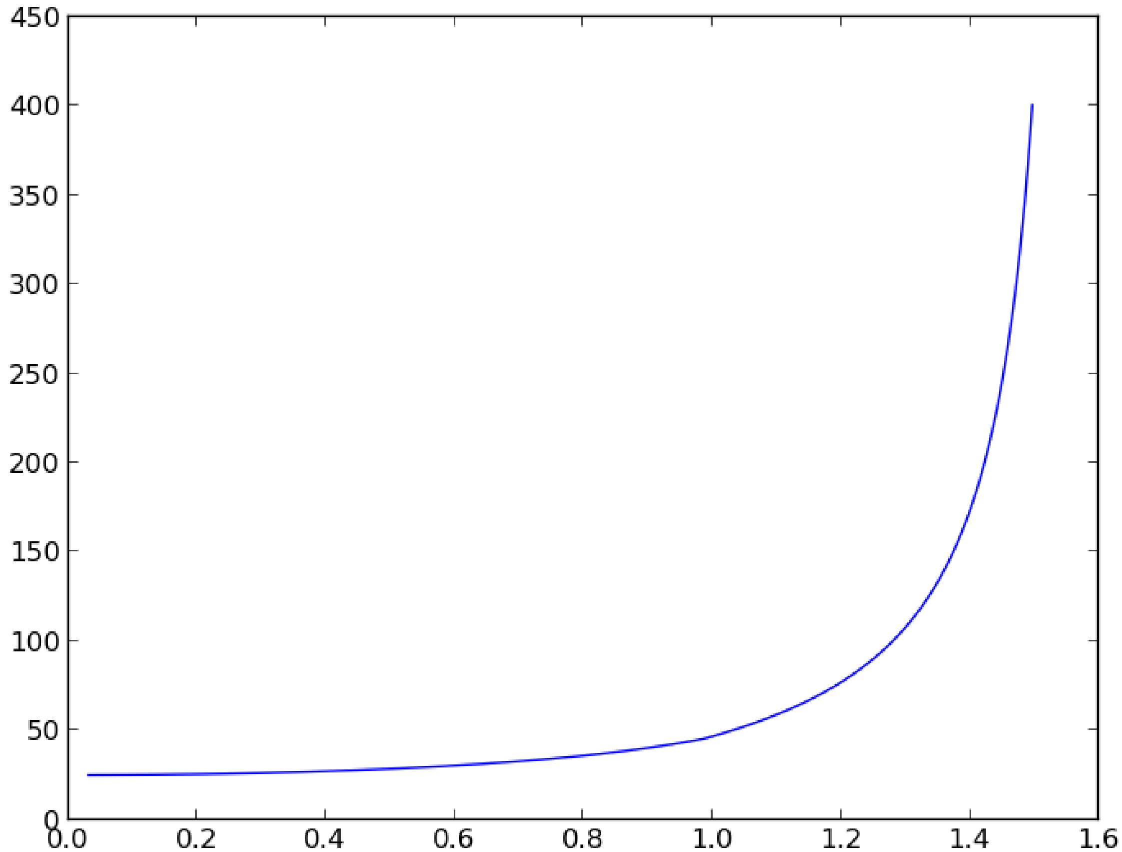
In AX = B:
X is matrix of forces from f1 to f13
A is matrix of coefficient
B is matrix of constant

A:
```
[[ 0.      1.      0.      0.      0.     -1.      0.      0.      0.      0.      0.      0.      0.]
 [ 0.      0.      1.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.]
 [ 0.7071  0.      0.     -1.     -0.7071  0.      0.      0.      0.      0.      0.      0.      0.]
 [ 0.7071  0.      1.      0.      0.7071  0.      0.      0.      0.      0.      0.      0.      0.]
 [ 0.      0.      0.      1.      0.      0.      0.     -1.      0.      0.      0.      0.      0.]
 [ 0.      0.      0.      0.      0.      0.      1.      0.      0.      0.      0.      0.      0.]
 [ 0.      0.      0.      0.      0.7071  1.      0.      0.     -0.7071 -1.      0.      0.      0.]
 [ 0.      0.      0.      0.      0.7071  0.      1.      0.      0.7071  0.      0.      0.      0.]
 [ 0.      0.      0.      0.      0.      0.      0.      0.      0.      1.      0.      0.     -1.]
 [ 0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      1.      0.      0.]
 [ 0.      0.      0.      0.      0.      0.      0.      1.      0.7071  0.      0.     -0.7071  0.]
 [ 0.      0.      0.      0.      0.      0.      0.      0.      0.7071  0.      1.      0.7071  0.]
 [ 0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.7071  1.]]
```

B:
```
[[ 0]
 [10]
 [ 0]
 [ 0]
 [ 0]
 [ 0]
 [ 0]
 [15]
 [ 0]
 [20]
 [ 0]
 [ 0]
 [ 0]]
```

X:
```
[[-28.2845425 ]
 [ 20.        ]
 [ 10.        ]
 [-30.        ]
 [ 14.14227125]
 [ 20.        ]
 [  0.        ]
 [-30.        ]
 [  7.07113562]
 [ 25.        ]
 [ 20.        ]
 [-35.35567812]
 [ 25.        ]]
```

Part two results:



horizontal axes: angle (1-3-2) - rad
vertical axes: maximum force in truss

In part one: with solve() function – which provides a linear solution for Ax = B, we can obtain X elements which are forces (f1 to f13).
In the second part of question, we cannot see optimum in 45 degree. If we decrease the 1-3-2 angle from 90 degree to zero or truss will be shaped vertically and in that case we can approximately say that 1 and 2, also 8 and 7 are the same, and maximum force goes to a constant value near alpha = 0.

for alpha values near 90, truss shape would be horizontal, and it make sense to have an infinite value for maximum force of the truss.

```
from math import *
from numpy import *
import pylab as pl
from numpy.linalg import *

######################################## coefficient matrix of forces:
A=matrix('0 1 0 0 0 -1 0 0 0 0 0 0 0 ; 0 0 1 0 0 0 0 0 0 0 0 0 0 ; 0.7071 0 0 -1 -0.7071 0 0 0 0 0 0 0 0 ; 0.7071 0 1 0 0.7071 0
0 0 0 0 0 0 0 ; 0 0 0 1 0 0 0 -1 0 0 0 0 0 ; 0 0 0 0 0 0 1 0 0 0 0 0 0 ; 0 0 0 0 0.7071 1 0 0 -0.7071 -1 0 0 0 ; 0 0 0 0 0.7071 0 1
0 0.7071 0 0 0 0 ; 0 0 0 0 0 0 0 0 0 1 0 0 -1 ; 0 0 0 0 0 0 0 0 0 0 1 0 0 ; 0 0 0 0 0 0 0 1 0.7071 0 0 -0.7071 0 ; 0 0 0 0 0 0 0 0
0.7071 0 1 0.7071 0 ; 0 0 0 0 0 0 0 0 0 0 0 0.7071 1')
######################################## constant matrix in AX = B:
B=matrix('0 ; 10 ; 0 ; 0 ; 0 ; 0 ; 0 ; 15 ; 0 ; 20 ; 0 ; 0 ; 0')
############################################# soloution of AX = B:
x = solve(A,B)
print "fi values for i in [1,13]\n", x
###############################################################
n = linspace(pi/100,pi/2.1,1000)                    #list of 1000 number in [pi/100,pi/2.1]

List = []
for t in n:                                         #change alpha in coefficient matrix
                                                    #considering the angle of 1-3-2
        A[2,0] = sin(t)
        A[2,4] = -sin(t)

        A[3,0] = cos(t)
        A[3,4] = cos(t)

        A[6,4] = sin(t)
        A[6,8] = -sin(t)

        A[7,4] = cos(t)
        A[7,8] = cos(t)

        A[10,8] = sin(t)
        A[10,11] = -sin(t)

        A[11,8] = cos(t)
        A[11,11] = cos(t)

        A[12,11] = sin(t)

        y = solve(A,B)
        List.append(abs(y).max())


pl.plot(n,List)
pl.show()
```