In the previous exercise, the computer problem involved using a graph to find the “roots” of an inconveniently-complex algebraic function. A root of function f(x) is an x value for which f(x)=0. Manually zooming into a graph works, but there are more convenient methods of numerical root-finding. One of the better alternative methods is the brentq() function.

Brentq() requires three parameters: the function for which to find a root, and two starting guesses of where the answer might be. The two guesses must be on either side of a solution. Brentq() then returns the value of the solution between the two guesses.

Let’s use the problem from that set as an example:

from pylab import \* # get mathematical tools

from scipy.optimize import brentq # get the brentq() root-finder

R = 2.5

h = 1.2

v = 4.8

g = 9.8

def F(theta):

output = v\*cos(theta)/g \* (v\*sin(theta) + sqrt(v\*\*2\*sin(theta)\*\*2 + 2\*g\*h)) - R

return output

answer1 = brentq(F, 0.0, 0.4)

answer2 = brentq(F, 0.8, 1.2)

print(answer1, answer2)

The function definition shown is just the one from part A1 of the previous exercise. From a plot of that function (you know how to do this) you can see that the plot crosses zero somewhere between x=0 and x=0.4, then crosses again between x=0.8 and x=1.2. You can probably make better guesses than that, but there is no need: any reasonable guesses will work as long as there is one root between the two guesses you give brentq(). If you run this code, you’ll probably recognize the results; they’re answers to part B of the previous exercise.

You can use this technique for solving many numeric problems: you just have to write a python function that returns zero at the desired solution. For example, to solve sin(x) = exp(-x) you would write the function like this:

def something(x):

return sin(x) - exp(-x)

print brentq(something, 0, pi/2.0)

Note that the value returned by the function is just the difference between the right and left sides of the equation, which is zero for a solution.

Brentq() has more options: if you want to learn more google “Python brentq”, but the simple options shown here work for 99% of problems.

**ASSIGNMENT**

Redo exercise 3B, with the following parameters:

1. R = 1 m, other parameters unchanged.
2. R = 5 m, other parameters unchanged.
3. R = 5 m, h = 3.2 m, v = 6.8 m.