Homework 2: Numbers

You know the `math` module contains the function `math.sqrt` for computing the square root of a number. Instead, in this lab, you are to write an algorithm for computing square roots through *iterative refinement* using the *secant method*.

The Secant Method

Suppose A is a number from which we want its square root. Your algorithm should first make two initial, and completely naive "guesses" about the square root of A, called x_0 and x_1:

- $x_0 = A/5$
- $x_1 = A/10$

With these two guesses, the square root approximation can be calculated using the following formula.

$\text{aprox} = x_0 - (x_0^2 - A)/(x_0 + x_1)$

However, it may not be correct when applied only once. It will need to be calculated repeatedly using iterative refinement (i.e. a `for` loop). To refine the approximated square root of A, aprox:

1. Update x_0 to be the value of aprox,

2. Update x_1 to be the value of x_0

3. Run the secant method calculation again.

Hint: Python's simultaneous assignment ability (see *Writing Programs* slides) can make things a little easy for you.

Your Assignment

Write a `main` function, that when run, implements the secant method, with the required steps:

1. Print a short introduction about the program's purpose.

2. Prompt the user for the value A to find $\sqrt{A}$.

3. Prompt the user for the number of times to improve the guess.

4. Calculate the guesses x_0 and x_1, described above.

5. Loop the specified number of times, applying the secant method, described above.

6. After the loop ends, do two things:

    1. Print a *simple* table showing the guess number (starting at 1!), the current estimate, and the difference between the current estimate and the true value of square root of A.

    2. Then, report the final value of your calculation, and subtract your final estimate from the value of `math.sqrt(A)` to show how accurate is your final estimate.

Output

If you wanted to find the square root of 16 using 10 iterations of secant method, it should appear like this:

```
This program calculates the square root of a given number using the secant method.
What is the number for which you want to calculate the square root? 16
How many iterations do you want to use? 10
1 4.3999999999999995 0.39999999999999947
2 3.957894736842105 0.04210526315789487
3 3.997984886649874 0.00201511335012583
4 4.000010664675927 1.0664675927252176e-05
5 3.9999999973130103 2.6869897418180244e-09
6 3.9999999999999964 3.552713678800501e-15
7 4.0 0.0
8 4.0 0.0
9 4.0 0.0
10 4.0 0.0
My guess for the square root of 16.0 is 4.0
The difference between my guess and the real result is 0.0
```

Note: All printed strings **must** match the above output. Obviously, the numbers may differ. To otherwise deviate will cause the Gradescope autograder to deduct points.

If you're failing the tests but your solution seems to match up with this:

1. **Make sure after your input statement you have a space**

    - input("What is the number for which you want to calculate the square root? ")

      will pass

    - input("What is the number for which you want to calculate the square root?")

      will fail

2. **Make sure you don't have extra spaces in your print statements.**

    - print("My guess for the square root of", a, "is", aprox) will pass

- print("My guess for the square root of ", a, " is ", aprox)

  will fail

3. **Make sure the decimal points line up**

   Printing 4.0 will pass, printing 4 will fail

Submission Requirements

The title for this lab is *hw2*. Your submitted file is **required** to be named `hw2.py`.

At the top of your code, be sure to include a *docstring* that includes your name, see an example below.

```
'''Andrew Read-McFarland, Homework 2: Numbers. Takes as input A and outputs estimated square root of A'''
```

Submit your `hw2.py` file to gradescope for grading.