Labs for September 30th, 2015

**Exercise 0.1.** Try to implement as many ways of computing $\sqrt{a}$ as possible and plot the convergence:

- halving of intervals
- dividing intervals proportionally
- $x_k := \frac{x_{k-1} + \frac{a}{x_{k-1}}}{2}$
- $x_k := x_{k-1} - \frac{x_{k-1}^2 - a}{2x_{k-1}} = \frac{1}{2} \left( x_{k-1} + \frac{a}{x_{k-1}} \right)$

**Hint:** You may want to consult [https://en.wikipedia.org/wiki/Methods_of_computing_square_roots](https://en.wikipedia.org/wiki/Methods_of_computing_square_roots). You may want to use matplotlib as in the previous homework, e.g.,

```python
import matplotlib.pyplot as plt
plt.plot([1,2,3,4], [1,4,9,16], 'ro', [1,4,1,4], 'g^')
plt.axis([0, 6, 0, 20])
plt.show()
```

**Exercise 0.2.** Look at the methods above, try to compute the iterates with very high precision using Decimal, and then using the default precision. Plot the error across the iterations, for all the methods.

**Exercise 0.3.** Calculate the two roots of $ax^2 + bx + c = 0$. This has the solution $x_1, x_2 = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. Specifically, try to improve upon the following code, which you have seen in the lecture:

```python
import math
def roots(a, b, c):
    s = math.sqrt(b*b - 4.0*a*c)
    x1 = (-b + s) / (2.0*a)
    x2 = (-b - s) / (2.0*a)
    return (x1, x2)
```

by using

$b = -a(x_1 + x_2)$  and  $c = ax_1x_2$. 