Homework 3

cs249
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Due:
The reading for this assignment is
These questions are adapted from Faires and Burden, Section 2.4.

3.1 More scary numbers

Now that you have a plan to pay for your children's college education, it's time to think about buying a house! If you get a mortgage, the following formula shows the relationship of your monthly payments to the interest rate.

$$a = \frac{p}{i}[1 - (i+1)^{-n}] \tag{1}$$

where a is the cost of the house, p your monthly payment, n is the number of months you keep this up, and i is the interest rate per period.

The median cost of a house in Wellesley is $640,000. Assume that you can afford a payment of $1800 per month and you get a 30-year mortgage.

1. What is the maximum (monthly) interest rate that will allow you (and your two kids) to live in Wellesley?

   Write your answer in the form of a function named `interest2`. You should turn in a printout of the program as well as the answer (you can write the answer on the printout or include it as a comment at the end of the function).

2. Run the program again with a payment of only $1700 a month? What happens? What does this mean? Again, you can write your answer on the printout or add it in a comment.

Here are some suggestions about how to proceed:

- Type in the code from the book and run it. Make sure you understand how it works, and check that you get the same answer as in the book. Try it out with some different values.
- Comment out the body of the top-level function and add a line that just invokes `func`. Test `func` in isolation.
- Change `func` to compute the new function and test it.
- Compute the derivative of the new function on paper. Change `deriv` to compute the new derivative and test it.
- Gradually uncomment the statements in the top-level function and test as you go.

4 Can of Coke

Suppose you want to design a can to enclose a volume of 1000 cm^3. You have to choose the radius, r, and the height, h, that minimize the amount of material needed to build the can.

You might have seen a problem like this in a calculus class. If we assume that the area of the top and bottom is $2\pi r$ and the area of the cylinder is $h2\pi r$, then the amount of material we need is

$$m = 4\pi r^2 + h2\pi r \tag{2}$$

and it is straightforward to find the solution analytically.

More realistically, though, we might have to provide extra material to form the seams. If the extra material, s, is 0.25 cm, then the area of the top and bottom is $\pi(r+s)^2$ and the area of the cylinder is $h2\pi(r+s)$.

1. Formulate the new problem as a root finding problem.
2. Write a MATLAB program, similar to `interest.m` that finds the values of h and r that minimize m.

   Hint: solve for h in terms of r and then write $m(r)$ entirely as a function of r.