

# CS 1200 FS20 Homework 2 (Paper)

Due 9/29/2020 (Tuesday) at 11:59 PM

## Submit your assignment to Canvas:

1. A PDF file that contains all the answers to the individual questions. If the problems require to write Python or C++ codes, you need to put the codes and all code output in the pdf file as well. This should all be well organized. Points will be deducted for sloppy or disorganized work.
2. All the Python or C++ codes.

If you need a program that helps, you put PDF files together into a single PDF file, try <http://www.pdfsam.org/>. The program there is open source and available for free.

## Homework 2 problems:

(1)(20pts) Write programs in Python or C++ to solve the following problem:

- Bob, John and Smith make their living as carpenter, painter and plumber, though not necessarily respectively.
- The painter recently tried to get the carpenter to do some work for him, but was told (heard) that the carpenter was out doing some remodeling for the plumber.
- The plumber makes more money than the painter does.
- Bob makes more money than John does.
- Smith has never heard of Bob.

What position does each man fill? Submit a listing and a run of your program. (Note: For your reference, see the Bank Employee example in Lecture 10 and the code lecture10.py)

(2) (15pts) A positive integer is “magic” if, and only if, it can be reduced to 1 by repeatedly dividing it by 2 if it's even or multiplying it by 3 and then adding 1 if it's odd. So, for example, 5 is magic because 5 reduces first to 16 ( $5*3+1$ ), then to 8 ( $16/2$ ), then to 4 ( $8/2$ ), then to 2 ( $4/2$ ), and finally to 1 ( $2/2$ ). Let us see another example. 3 is magic because 3 reduces first to 10 ( $3*3+1$ ), then to 5 ( $10/2$ ), then to 16 ( $5*3+1$ ), then to 8 ( $16/2$ ), then to 4 ( $8/2$ ), then to 2 ( $4/2$ ), and finally to 1 ( $2/2$ ). The magic numbers hypothesis states that all positive integers are magic, or, formally:  $\forall x, \text{MAGIC}(x)$  where **MAGIC(x) is the predicate “x is magic”**. This problem is known as Collatz Conjecture. (For your reference, see [https://en.wikipedia.org/wiki/Collatz\\_conjecture](https://en.wikipedia.org/wiki/Collatz_conjecture))

Write a C++ or Python program to check that 93571393692802302 is a magic number and print the step numbers. (For example,  $x=12$  we get the step numbers: 12, 6, 3, 10, 5, 16, 8, 4, 2, 1)

(3) (15pts) Variation on Ch4-4.4 #16&#17

Prove that for all integers  $a, b, c, d$  and  $a \neq 0, b \neq 0$ , if  $a \mid b, a \mid c$ , and  $b \mid d$ , then  $a \mid (7c^2d - 3bc + 5d)$ .

**Extra Bonus Points (10pts):**

For problem 2, write a C++ or Python program to automate the search for a counter example to the magic numbers hypothesis for user definable ranges of positive integers (may be as simple as asking for an upper limit and searching from 1 through that limit).