**Name: Session:**

**Programming I**

**Lab Exercise 12.19.2023**

**List Comprehension**

Python supports a concept called "list comprehensions". It can be used to construct lists in a very natural, easy way, like a mathematician is used to do.

The following are common ways to describe lists (or sets, or tuples, or vectors) in mathematics.

|  |  |
| --- | --- |
|  | S = {x² : x in {0 ... 9}} V = (1, 2, 4, 8, ..., 2¹²) M = {x | x in S and x even} |

In Python, you can write these expressions almost exactly like a mathematician would do, without having to remember any special cryptic syntax.

This is how you do the above in Python:

|  |  |
| --- | --- |
|  | S = [x\*\*2 for x in range(10)] V = [2\*\*i for i in range(13)] M = [x for x in S if x % 2 == 0] |
|  |  |

**## List Comprehension Demo**

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# Create a list of words

words = 'The quick brown fox jumps over the lazy dog'.split()

print words

print

print

# Create a list of the words in upper case, lower case and their length

# using list comprehension

stuff = [[w.upper(), w.lower(), len(w)] for w in words]

for i in stuff:

print (i)

Write the following programs **using List Comprehension**. Print out the source code, attach to this assignment and turn in.

1. Write a program that prints out a table with x = 1 to a 10 and x2, x3, x4, and sqrt(x).
2. Write a program that prints out a table with degree = 0 to 90 degrees and the sine, cosine, and tangent of that angle.
3. Write a program that will take a list of words and print them out from shortest word to longest word.

**Solving Systems of Equations**

In your Algebra class, one of the common tasks you have is the solving of systems of equations. As you know, to solve a system with two unknowns, you will require two independent equations. For example, a simple system:



Can be solved using basic Algebra. This is fine but in the real world, systems of equations can involve numbers that are not as convenient. In you education, you will take a course called Linear Algebra. Linear Algebra can be a pretty tough course but you will learn new tools that will make it easier. Solving a system of equations such as the one above involves using matrices. In your high school Algebra course you will learn the basics of matrices but probably not to the depth required to solve systems that are very involved. The above system and be represented with the following matrix equation:



To solve for x and y, the equation can be rearranged as such:



The part of this equation that makes it difficult is finding the inverse of the 2x2 matrix. Actually a 2x2 matrix is not too difficult but 3x3 matrix inversion is difficult and 4x4 is really computationally intense. To expand this to a 3 unknown system would look like this:



The matrix equation would look like:



With the solution equation as:



Solving this equation using high school Algebra would be quite challenging. So we are going to use a Python library to do the hard work for use. We will be using a module called PyLab. PyLab is actually three libraries in one:

* Mathplotlib – a library that contains tools for plotting data
* Numpy – a library for numerical computation
* SciPy – a library with many scientific tools

You can download and install all of these libraries but the easiest method is to download and install the Enthought Python distribution. To test that you havePyLab installed, type import pylab and you should get the shell prompt (>>>) back without any error messages.

To solve this problem, we will be using a numpy two dimensional array which is actually a list of lists.

Here is the code to solve the first problem:

**## Demo problem 1**

**##**

**## 2x + 3y = 10**

**## 3x - y = -1.5**

from pylab import \*

M = array([[2, 3], [3, -1]])

V = array([10, -1.5])

print (solve(M, V))

Here is the code to solve the second problem

**## Demo problem 2**

**##**

**## 2x + 3y + 4z = 119**

**## 5x - 6y + 7z = 80**

**## 8x + 9y + 10z = 353**

from pylab import \*

M = array([[2, 3, 4], [5, -6, 7], [8, 9, 10]])

V = array([119, 80, 353])

print (solve(M, V))

**Problem 1**

John inherited $25,000 and invested part of it in a money market account, part in municipal bonds, and part in a mutual fund. After one year, he received a total of $1,620 in simple interest from the three investments. The money market paid 6% annually, the bonds paid 7% annually, and the mutually fund paid 8% annually. There was $6,000 more invested in the bonds than the mutual funds. Find the amount John invested in each category.

\begin{displaymath}\begin{array}{rrrrrrrrr}
x &+& y &+& z & = & \$ \; 25,000 \\ ...
...\;
\begin{array}{r}
(1) \\
\\
(2) \\
\\
(3)\\
\end{array}\end{displaymath}

**Problem 2**

Your company has three acid solutions on hand: 30%, 40%, and 80% acid. It can mix all three to come up with a 100-gallons of a 39% acid solution. If it interchanges the amount of 30% solution with the amount of the 80% solution in the first mix, it can create a 100-gallon solution that is 59% acid. How much of the 30%, 40%, and 80% solutions did the company mix to create a 100-gallons of a 39% acid solution?

\begin{eqnarray*}&& \\
x+y+z &=&100 \\
&& \\
&&
\end{eqnarray*}

\begin{eqnarray*}&& \\
0.30x+0.40y+0.80z &=&39 \\
&& \\
&&
\end{eqnarray*}

\begin{eqnarray*}&& \\
0.80x+0.40y+0.30z &=&59 \\
&& \\
&&
\end{eqnarray*}

**Problem 3**

Five hundred tickets were sold for a certain music concert. The tickets for the adults sold for $7.50, the tickets for the children sold for $4.00, and tickets for senior citizen sold for $3.50. The revenue for the Monday performance was $3,025. Twice as many adult tickets were sold as children tickets. How many of each ticket was sold?



**Problem 4**

Solve the following system:

 2W   + 3X   +  4Y     - 5Z   =   - 6  
 6W   + 7X     - 8Y   +  9Z   =   96  
10W + 11X + 12Y +  13Z   = 312  
14W + 15X + 16Y +  17Z   = 416

**Answers**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Problem | W | X | Y | Z |
| 1 | Not Applicable |  |  |  |
| 2 | Not Applicable |  |  |  |
| 3 | Not Applicable |  |  |  |
| 4 |  |  |  |  |