LEARNING OBJECTIVES:

1. Matrix Multiplication. What's it used for?
2. While and for loops
3. Working with scripts and functions

REMINDER: You may ask the course TA and Tutors for assistance. You must complete this assignment without looking at other student's code or copying solutions from any source.

Description:
This assignment consists of following a series of instructions and reporting on outcomes.

Lab Instructions:
Login and set up same environment as Lab#1 (cs7sXX MyDocuments, Notepad++, MATLAB).
Refer to Lab#1.

PART ONE: WORKING WITH SIMPLE MATRIX MULTIPLICATION
Let's look at a simple example. Type the following code into the command window.

```matlab
>> A = [14 7 1; 89 3 14; 56 78 50];
B = [1; 1; 1];

QUESTION #1. What happens when you type C=A*B? What are the dimensions of the resulting matrix and what are the values?
1. So what’s actually going on? Let’s think of matrix A in terms of its sub-components

\[
\begin{bmatrix}
  a_{11} & a_{12} & a_{13} \\
  a_{21} & a_{22} & a_{23} \\
  a_{31} & a_{32} & a_{33}
\end{bmatrix} \times \begin{bmatrix}
  b_1 \\
  b_2 \\
  b_3
\end{bmatrix} = \begin{bmatrix}
  a_{11} b_1 + a_{12} b_2 + a_{13} b_3 \\
  a_{21} b_1 + a_{22} b_2 + a_{23} b_3 \\
  a_{31} b_1 + a_{32} b_2 + a_{33} b_3
\end{bmatrix}
\]

Notice that the **inner dimensions must be equal**. In the example above, the number of columns in the first matrix is 3 and that must be equal to the number of rows in the second matrix (also 3). Also, notice that the output matrix, C, has the same number of rows as the first matrix and the same number of columns as the second matrix.

2. In the above diagram, every element in each row of matrix A is multiplied by every element in each column of matrix B.

3. Reset B so that it now is equal to

\[
\begin{bmatrix}
  1 \\
  0 \\
  0
\end{bmatrix}
\]

**QUESTION #2** Now what happens when you multiply A and B? Can you explain why?

**QUESTION #3** In regular scalar multiplication \(x \times y = y \times x\); this is called the **commutative property**. For example, \(9 \times 5 = 5 \times 9 = 45\). Is it the same with matrices? Try executing \(B \times A\) in MATLAB, and report your outcome.

4. Now reset B one more time so that it is equal to:

\[
B = \begin{bmatrix}
  1 & 0 & 0 \\
  0 & 1 & 0 \\
  0 & 0 & 1
\end{bmatrix};
\]

**QUESTION #4** What is the resulting output of \(A \times B\)? How about \(B \times A\)? What is special about this particular B matrix?

5. Before proceeding, type the following at the command prompt and read:

\[
>> \text{help eye}
\]
PART TWO: SHOPPING WITH MATRICES

1. Let’s consider a simple situation where you might want to use matrix multiplication. Suppose you are at the farmer’s market where they sell a jar of jelly for $5.99, a head of lettuce for $0.99, a box of pasta for $1.99 and a bag of rice for $12.50.

2. Now, imagine that you purchase 1 of each item. What is the total amount of money that you spent? The calculation is simply $1 \times 5.99 + 1 \times 0.99 + 1 \times 1.99 + 1 \times 12.50 = $21.47

3. In order to figure out the total amount of money you spent using matrix multiplication, create a row vector that represents the quantity of each item in the Command Window.

   \[
   \mathbf{A} = [1 \ 1 \ 1 \ 1]; \quad \text{this represents the quantity of each item purchased}
   \]

   Then create a column vector that represents the cost of each item in the Command Window.

   \[
   \mathbf{B} = [(\text{fill in price values})]; \quad \text{this represents the cost of each item}
   \]

   Now multiply \( \mathbf{A} \times \mathbf{B} \) and verify that the result is the same as the calculation in step 2.

QUESTION #5 How would you modify one of the matrices above for a separate scenario, where another customer purchased 2 jars of jelly, 5 heads of lettuce, 3 boxes of pasta and 2 bags of rice? Use this modification to calculate the new total.

4. Imagine if instead you are an employee at the same farmer’s market and you want to calculate the totals of multiple customers all at once. Simply add rows to the matrix \( \mathbf{A} \) such that each row represents the quantities of each item purchased for a single customer.

   For example, this matrix indicates that the first customer (the first row) bought one of each item and that the second customer (the second row) bought 6 of each item:

   \[
   \mathbf{A} = [1 \ 1 \ 1 \ 1; \ 6 \ 6 \ 6 \ 6];
   \]

   Perform matrix multiplication (\( \mathbf{A} \times \mathbf{B} \)) as before. What do you think each row represents?

QUESTION #6. Calculate the totals for these 5 customers. Report each customer’s total.

<table>
<thead>
<tr>
<th>Customer</th>
<th>Jelly</th>
<th>Lettuce</th>
<th>Pasta</th>
<th>Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>8</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>
PART THREE: MORE PRACTICE WITH IF/ELSE

1. As practice, let’s write a function that uses decisions to print your top three vacation locations.
2. Start by creating a new function called top_vacation_location. This function should have one input called preference and no outputs.
3. preference will be a number 1, 2 or 3 or a string ‘first’, ‘second’ or ‘third’ indicating which place the function should display. For example, the function call top_vacation_location(1) or top_vacation_location(‘first’) should display your favorite vacation location of choice.

Question #7  Given that the variable x = 355546, how can I turn the value of x into a string? In other words, how would you change the right hand side of the assignment to store a string value instead of a number value?

The PSEUDO CODE (NOT REAL CODE) for this function is given below. Note that the function to display a value is disp. Use help disp if you would like more information.

```plaintext
<Function header goes here>
create local variable to hold your first choice vacation location
create local variable for your second choice
create local variable for your third choice

<if statement goes here> check if preference is 1 or "first"
    display 'My first choice is: '
    display variable first

<else-if statement goes here> check if preference is 2 or "second"
    display 'My second choice is: '
    display variable second

<else-if statement goes here> check if preference is 3 or "third"
    display 'My third choice is: '
    display variable third

<else statement goes here>
    display 'I do not recognize that choice!'
```

A couple notes:
- The function to display a value is called disp.
- Use the function strcmp when comparing preference to a string (i.e. ‘first’).
- All string values entered as preference and used in strcmp should be encased in single quotation marks ' ' and not in double quotation marks " " . This will break your code if you use them incorrectly.
- Feel free to Google or use the help function in MATLAB to figure out how to use any unknown functions.

**QUESTION #8** Copy and paste your top_vacation_location function into your text file. Now let’s test it. Call the function with 1, 2, and 3 as inputs in the command prompt and explain what happens for each input.

**PART FOUR: A FUNCTION WITH A SWITCH**

1. Switch statements are similar to if-statements in that they allow us to check a condition and only evaluate certain parts of code depending on the result of the condition (whether it is 0 or 1, aka true or false).

2. Create a new function called top_vacation_location2 that has one input called prefLoc and no outputs. Similar to the previous function’s input, the value of prefLoc determines which location will be displayed.

3. Instead of being a number (i.e. 1,2,3), prefLoc will be a string ‘one’, ‘two’, or ‘three’ that will determine whether the first, second, or third favorite location will be displayed.

4. Use a switch statement (instead of if-statement) to check the value of prefLoc and display the local variable that holds the location corresponding to that value. See lecture slides for switch statement structure. If you need any more help with how to write a switch statement, you can google the keywords “switch” and “MATLAB” and you should come upon some MATLAB documentation with very straightforward examples. Make sure you are indenting properly. Indentation matters a lot with switch statements and incorrect indentation will break your code.

**QUESTION #9** The otherwise part of a switch statement is optional and only executes when no other case is true. Which aspect of the if-statement in previous function top_vacation_location is this similar to?
5. Enter each of the following cases in the Command Window prompt and verify that your function is working as expected.

```matlab
>> top_vacation_location2('one')
top_vacation_location2('two')
top_vacation_location2('three')
top_vacation_location2('four')
```

**QUESTION #10** Copy and paste your `top_vacation_location2` function into the text file.

**QUESTION #11** Now that you know `top_vacation_location2` is performing as expected, suppose you have a friend that is trying it out by making function calls from the Command Window prompt such as

```matlab
>> top_vacation_location2('One')
>> top_vacation_location2('One')
>> top_vacation_location2('First')
```

Your friend claims that your function does not work, but you already verified that it does. How would you explain to your friend why `top_vacation_location2` is not working for them?

**QUESTION #12** You do not have to implement (a) and (b) just give some suggestions as to how you might improve the function `top_vacation_location2`.

(a) How could you improve the function to deal with cases such as your friend in Question #11?

(b) How could you improve the function to deal with cases when the input string is unrelated to the purpose of the function (e.g. `top_vacation_location2('chocolate')`)?

**PART FIVE: SAVING and SUBMITTING**

SUBMIT *THREE* THINGS: Save your Lab7_Lastname, and then also save a copy of your function file for `top_vacation_location.m` file and `top_vacation_location2.m` file. **MAKE SURE ALL YOUR FILES ARE IN YOUR cs7sXX HOME DIRECTORY.**
PART SIX: LAB #7 CHECKOFF CHECKLIST

To receive credit for this lab you need to:

- Show your TA/Tutor your Notepad++ document in your cs7sXX MyDocuments folder.
- Be prepared to show the TA/Tutor all questions answered in this document.
- Be able to answer questions about the MATLAB environment, case statements, matrix multiplication and more

Do not leave until you have seen a TA/Tutor mark your name down in autograder.

It is your responsibility to make sure you get credit for each lab!