MATLAB Basics Exercises

WDRP - Simple Discrete Models in Biology and MATLAB

Contents

1 Defining Variables and Operations

1.1 Exercise 1

Write a script that accomplishes the following

- Prompts the user to input a number.
- Takes the user's number and doubles it
- This should only be done using a single variable for the entire script.

1.2 Exercise 2

Recall that the distance between two coordinates $x = (x_1, x_2)$ and $y = (y_1, y_2)$ is given by the following formula.

$$d(x, y) = \sqrt{(y_1 - x_1)^2 + (y_2 - x_2)^2}$$

We will write a script that computes the distance between two given points. The script should do the following

- Prompt the user for the first coordinate, x_1, of the point x and stored in a variable called $x1$
- Prompt the user for the second coordinate, x_2, of the point x and stored in a variable called $x2$
- Do the same for both the first, y_1, and second, y_2, coordinates of the point y and stored in appropriately named variables.
- Calculate the distance between x and y using the formula above.
- Print the result with an appropriate message along the lines of "The distance between the points (x1,x2) and (y1,y2) is d" where all the variables should be the actual numbers.

1.3 Exercise 3

Do the previous problem again, except instead of just calculating the distance formula explicitly, write a function handle named "dist" which takes in four variables.

2 Arrays

2.1 Exercise 1

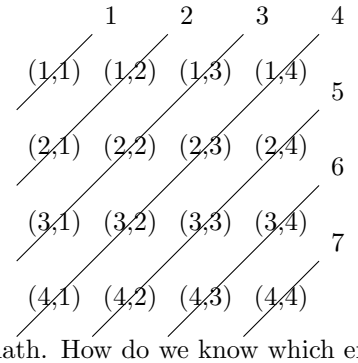
We will extract particular rows and columns of an array as follows

- Generate an array with 10 rows and columns containing random integers.
- Extract all even columns of the array into a variable called "ColEven".
- Extract all odd rows of the array into a variable called "RowOdd"
- How can we make arrays with all even/odd numbers appearing as rows/columns in the first array?

2.2 Exercise 2

We will create an array of ones and zeros where the antidiagonals alternate between 0 and 1.

$$\begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix}$$



Before we discuss how to do this, we need a bit of math. How do we know which enetries are on which antidiagonal. As it turns out the n^{th} antidiagonal contains entries (i, j) satisfying $n = i + j - 1$. For example, based on the diagram above and to the right:

The first antidiagonal (line labeled 1) only has the entry $(1, 1)$ which satisfies

$$1 + 1 - 1 = 1$$

The second antidiagonal (line labeled 2) has the entries $(1, 2)$ and $(2, 1)$ which satisfy

$$2 + 1 - 1 = 2 = 1 + 2 - 1$$

Then for a given row i, the column which makes (i, j) lie on the n^{th} antidiagonal is given by

$$j = n - i + 1.$$

So because we want the 0's to be on the even antidiagonals, in row 2, the second antidiagonal should have columns

$$n = 2 : j = 2 - 2 + 1 = 1$$
$$n = 4 : j = 4 - 2 + 1 = 3$$

So in the second row, the entries lying on even diagonals are $(2, 1)$ and $(2, 3)$.

Here's how to write the script

- Create an array of all ones with 4 rows and 4 columns called w.
- Identify for each row $i = 1, 2, 3, 4$ and each even antidiagonal the column number which makes that entry lie on an even antidiagonal. To do this use

  $w(i, [2 - i + 1, 4 - i + 1]) = \text{zeros}(1, 2)$

  and write it for each $i = 1, 2, 3, 4$.
- (Check) show the resulting array and make sure it looks like the first array above.

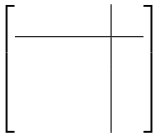
2.3 Exercise 3

(True insertion) As we saw in the notes, we can't really insert new entries, so much as we are replacing an existing entry with a new value. In this problem we will insert columns and rows into an array.

Remark. We can't truly insert single entries since all rows/columns must have the same number of entries.

Here is the procedure

- Prompt the user for the dimensions of the desired array ie. ask for the number of rows and the number of columns.
- Create an array, called w, of all zeros with the dimensions given by the user
- Create two arrays of all ones
  - The first with 1 row and the same number of columns as w and call it r.
  - The other, called c, which has 1 column and the same number of rows as w.
- Insert the array r into the second to last row of w.
  - Do this by first extracting the rows above where r is to be inserted
  - The extract the row below where r is to be inserted.
  - Then concatenate in the correct order and reassign to w.
  - (Challenge) Can you do this step in one line? With no new variables?
- Do the same for the array c, but into the second column.
- (Check) your matrix should look something like the diagram below, where the lines represent where the ones are, and the blank spots are zeros.



3 Plotting

3.1 Exercise 1

3.2 Exercise 2

In this problem we will plot multiple functions on the same figure. Here is the set up

- Make an array with the x coordinates, and entries from $-\pi$ to π with spacing 0.001.
- Create multiple arrays, one for each of the following functions, $\sin(x), \cos(x), e^x, \log(x)$, evaluated on the x coordinates.
- Plot these graphs using the plot command, and each graph should be on separate figures.
- The graphs should all be different colors, have different line styles and different marker styles.

4 Logical Operators