

MA 302 – Spring 2019
Homework 3: Due on Wednesday, February 27

Instructions:

The code submitted should be your own creation. You may consult MATLAB's documentation or the notes from class. The submission of codes obtained from online sources is a violation of Loyola's honor code.

Exercise 1: Relational expressions and Arrays

- Let $x=1:10$ and $y = [2\ 5\ 6\ 1\ 8\ 2\ 9\ 4\ 0\ 7]$. Execute and interpret the results of the following commands
 - $x > y$
 - $x \& (\sim y)$
 - $y==2$
 - $y(\text{logical}(\sim \text{rem}(y,2)))$
 - $x(y<0)$
 - $y((x<2) | (x>=8))$
- Let $x = [3\ 16\ 9\ 12\ -1\ 0\ -12\ 9\ 6\ 1]$. Provide command(s) that will
 - set the positive values of x to zero.
 - set the values that are multiples of 3 to 3.
 - set the values of x that are less than or equal to the mean to 0.
 - set the values of x that are above the mean to their difference from the mean.
- Let $A = \text{ceil}(5*\text{randn}(6,6))$. Use logical indexing and the `find` command without any loops to write commands that will:
 - find the indices and list all the elements of A which are smaller than -3 .
 - find the indices and list all elements of A that are smaller than 6 but larger than 1.
 - Remove those columns of A which contain at least one 0 element.

Exercise 2: Loops and Functions

- Write a script to find the largest value of n such that the sum:

$$\sqrt{1^3} + \sqrt{2^3} + \dots + \sqrt{n^3}$$

is less than 1000.

- Create an 20 by 10 array of random numbers using `rand`. Loop through the array, element by element, and set any value that is less than 0.5 to 0 and greater than or equal to 0.5 to 1. Check your script by comparing to calling MATLAB's built in functions.
- Write a function `approx_pi = series_approx_pi(N)` that computes the value of π using the following series:

$$\frac{\pi^2 - 8}{16} = \sum_{n=1}^{\infty} \frac{1}{(2n-1)^2(2n+1)^2}$$

You may begin by computing the sum using a for loop to get an idea of how the approximation works but your submission should be a vectorized computation of the sum. This is way more efficient. See `for_loop_demo.m` from class. To run your code, create a script `run_series_approx_pi` that will test the approximation of π for $N = 10, 100, 1000, 10000$, When you run your script, it should output the following table:

```

1      >> run_series_approx_pi
2      N      Error
3      10     4.574574e-05
4      100    5.226273e-08
5      1000   5.297141e-11
6      10000  4.352074e-14

```

4. Write a function `m = wmean(x,w)` that computes the weighted mean, given the the vector `x` and a vector of non-negative weights `w`, such that $\sum_{i=1}^n w_i > 0$. The mean should be computed as

$$\frac{\sum_{i=1}^n w_i x_i}{\sum_{i=1}^n w_i}$$

Use the MATLAB `error` function to display an error message and terminate execution in the case when:

- (a) `x` and `w` are not of the same length
- (b) at least one of the elements of `w` are negative
- (c) the sum of all weights is negative

Test your code as follows

- (a) Pick a random vector `x` of length 10 and a random vector of weights, `w` on $[0, 1]$
- (b) Test your error routines with a vector of weights with at least one negative value and another whose sum is negative.

5. Write a function `[approx_root, num_its] = bisection(f,a,b,tol)` that implements the bisection method. Your function should take as input 4 arguments with the last argument being optional, i.e, if the user does not provide the accuracy `tol` use a default of `1.0e-6` (use `varargin` to attain this). Your function should output the approximate root, `approx_root` and the number of iterations it took to attain the root, `num_its`. However, if the user calls the function with one argument, your function should return a vector consisting of the approximate root and the number of iterations (see how we used `nargout` in class). In addition, your function should display an error message and terminate if the user provides an interval without a root. Test your method to solve the following:

- (a) $x^x = 50$
- (b) $\ln(x) = \cos(x)$

In each case first find an interval of size 1 that contains the root, sketch the graphs to determine this. You should also provide tests showing

- (a) Your error code handling error messages is correct.
- (b) Run the code with the different options for input and output.
- (c) Run your code with `tol = 1.0e-12` and the default, `tol = 1.0e-06`.

Submission of exercises

Place all your files (`m-files`, `summary.txt`, `diary.txt`) in a folder named `lastname_hwN` and zip the folder to create a file `lastname_hwN.zip`. Email your zip file `lastname_hwN.zip` to `pchidyagwai@loyola.edu` with subject `MA302_hwN`.