Additional programming exercises

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INFO

Solutions can be found on GitHub.

Exercises

1. Write a function that finds the maximum value and its position, in terms of row and column number, of the matrix M = magic(234) and compare the result obtained with the MATLAB builtin function max() and find().
2. Write a MATLAB script that proves that the magic matrix definition is correct. And compare the result with a randomly generated one.
3. Write a function that, taken as input an array A of n integers, returns its number of positive elements, without using predefined MATLAB library functions. For example:

   > **Input**: A = [1, 5, -3, -9];
   > **Output**: ans = 2

4. Given a randomly generated matrix 8×8 substitute, within the matrix, the central 4×4 submatrix with a matrix where all the elements are equal to one.

   > **Input**:
   >
   > $$A = \begin{bmatrix} 0.1981 & 0.4228 & 0.5391 & 0.5612 & 0.8555 & 0.2262 & 0.9827 & 0.2607 \\ 0.4897 & 0.5479 & 0.6981 & 0.8819 & 0.6448 & 0.3846 & 0.7302 & 0.5944 \\ 0.3395 & 0.9427 & 0.6665 & 0.6692 & 0.3763 & 0.5830 & 0.3439 & 0.0225 \\ 0.9516 & 0.4177 & 0.1781 & 0.1904 & 0.1909 & 0.2518 & 0.5841 & 0.4253 \\ 0.9203 & 0.9831 & 0.1280 & 0.3689 & 0.4283 & 0.2904 & 0.1078 & 0.3127 \\ 0.0527 & 0.3015 & 0.9991 & 0.4607 & 0.4820 & 0.6171 & 0.9063 & 0.1615 \\ 0.7379 & 0.7011 & 0.1711 & 0.9816 & 0.1206 & 0.2653 & 0.8797 & 0.1788 \\ 0.2691 & 0.6663 & 0.0326 & 0.1564 & 0.5895 & 0.8244 & 0.8178 & 0.4229 \end{bmatrix}$$
   >
   > **Output**:
   >
   > $$A^* = \begin{bmatrix} 0.1981 & 0.4228 & 0.5391 & 0.5612 & 0.8555 & 0.2262 & 0.9827 & 0.2607 \\ 0.4897 & 0.5479 & 0.6981 & 0.8819 & 0.6448 & 0.3846 & 0.7302 & 0.5944 \\ 0.3395 & 0.9427 & 1 & 1 & 1 & 1 & 0.3439 & 0.0225 \\ 0.9516 & 0.4177 & 1 & 1 & 1 & 1 & 0.5841 & 0.4253 \\ 0.9203 & 0.9831 & 1 & 1 & 1 & 1 & 0.1078 & 0.3127 \\ 0.0527 & 0.3015 & 1 & 1 & 1 & 1 & 0.9063 & 0.1615 \\ 0.7379 & 0.7011 & 0.1711 & 0.9816 & 0.1206 & 0.2653 & 0.8797 & 0.1788 \\ 0.2691 & 0.6663 & 0.0326 & 0.1564 & 0.5895 & 0.8244 & 0.8178 & 0.4229 \end{bmatrix}$$

5. Write a MATLAB script that draws the plot of the function $f(x) = \frac{sin(x)}{x^4+2}$, with x within the interval $[-1, 1]$, with a spacing equal to 0.1.

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6. Write a MATLAB program, that given two random points inside the Cartesian plane draws the corresponding line that pass through the two points:

   Remember that the slope and the intercept of a generic line $y = mx + q$ passing by two points, $P1(x_1, y_1)$, $P2(x_2, y_2)$ are given by the following formulas:

   $m = \frac{y_2 - y_1}{x_2 - x_1}$ and $q = y_1 - mx_1$

   Input: $P_1 = (4, -3)$; $P_2 = (5, 1)$;
   Output: $m = 4$, $q = -19$

7. Given a square matrix **A**. We want to create a matrix **B** equal to the matrix **A** while replacing only the elements on the main diagonal with the average value of the corresponding rows.

   Input:

   $$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

   Output:

   $$B = \begin{bmatrix} 2 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 8 \end{bmatrix}$$

8. Given a square matrix A. You want to create a matrix B containing below the main diagonal all null elements, above the main diagonal all elements equal to the sum of all elements of matrix A, and on the main diagonal the corresponding elements of matrix A.

   Input:

   $$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

   Output:

   $$B = \begin{bmatrix} 1 & 45 & 45 \\ 0 & 5 & 45 \\ 0 & 0 & 9 \end{bmatrix}$$

9. Write a function that given a random vector returns the same vector but with the elements sorted in ascending order, by implementing a simple version of the *bubble sort* algorithm (reference).

   Pseudo code:

```
0. procedure BubbleSort(A:lista of elements to be sorted)
1.   change is true
2.   while scambio do
3.     change is false
4.     for i = 0 to length(A)-1 do
5.       if A[i] > A[i+1] then
6.         swap( A[i], A[i+1] )
7.         change is true
```

   Input: v = [5, 4, 6, 8, 11];
   Output: ans = [4, 5, 6, 8, 11]