תחרות "מיומנות בכלי MATLAB"

פתרונות

MATLAB Virtual Conference Contest

1. Introduction

Are you completely new to MATLAB?
Ok, no problem, we have resources that will get you started quickly with the basics of MATLAB.
By accessing this link, you will be given access to *MATLAB Onramp,* a free 2-hour course designed to introduce novice users to MATLAB.
It is interactive and it uses real-time feedback to help students learn at their own pace.

This and other Onramp courses are free for everyone. Please, feel free to explore the other courses created by MathWorks for its main development and application platforms!
And now it is time to try to solve the first set of problems: they will allow you to familiarize with the Grader environment.

1.1. Your first SCRIPT problem

Welcome to your first exercise in MATLAB Grader! It uses a simple case to demonstrate how to solve a coding problem with a MATLAB script.
You will recall that the equation for computing the volume of a cone is

$$V = \pi r^2 \frac{h}{3}$$

Write a script that:

- Computes the volume of a cone with radius $r = 5\ \mathrm{mm}$ and height $h = 12\ \mathrm{mm}$.
- Assigns the resulting value (in mm^3) to a variable named **vol**.

Reference Solution

```
% Cone parameters
r = 5;
h = 12;
vol = pi*r^2*h/3;
```

1.2. Vector Creation

Ok, well done! This test is a bit more articulated.
We ask you to write a script with commands that create the following vectors and assign them to the indicated variable names.

- Create an evenly-spaced row vector **A** with elements starting at 0 and ending at 50 with increments of 0.5.
- Create a row vector **B** with 80 evenly-spaced elements starting at 0 and ending at $\pi/2$.
- Create a row vector **C** with elements counting backward from 200 to 0 in increments of 5.

Your code should not include the following MATLAB functions or keywords: **for**, **while.**
Hints:
The operator : (semicolon) will help you to create the variable A
This link points to the description for the function linspace that will help you in the creation of vector B.
Please note that before you submit your solution you can run it, to ensure that there are no formal errors and, eventually, execute any defined pretest.

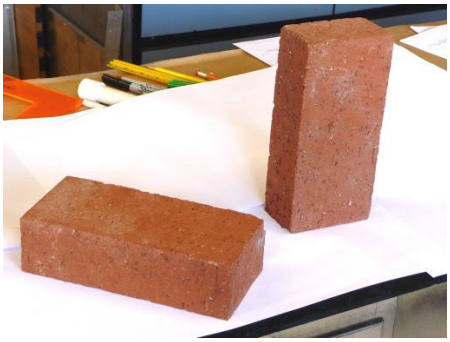
Reference Solution

```
A = 0:0.5:50;
B = linspace(0,pi/2,80);
C = (200:-5:0);
```

1.3. Just two other bricks in the wall

OK, this is a kid riddle:

A brick weighs a kilo plus half a brick. How much do two bricks weigh?



Can you solve it in MATLAB? And moreover, can you use the MATLAB symbolic capabilities to solve it?
We have already defined for you the symbolic variable brick; you will use the command solve to compute the variable weight of two bricks.
Please store the end result in a variable named T_Weight.
Hints:

- *please, note the difference between the sign '=' that assigns a value and '==' that is the element-wise equality operator*
- *you will need to use the function* solve*: here is a link to the documentation*

Reference Solution

```
% Define the symbolic variable 'Brick'
syms Brick
% solve the equation for 'brick' and compute the weight of two of them
Brick_Weight = solve(Brick==1+(Brick/2))
T_Weight = 2*Brick_Weight
```

1.4. Recreate Durer's magic square

In MATLAB the command

```
load durer
```

loads in the workspace the variable X and map.
X is the 648x509 matrix of an image and map is its associated colormap.
The command

```
imshow (X, map)
```

will display an image (for your convenience I have reproduced it here below).

Many of you will recognize ***Melencolia I,*** a 1514 engraving by the German reinessance artist Albrecht Durer. Although Durer never explained the symbolism of this masterpiece, it is believed to represent the mood of the thinker unable to take action. To solve this problem, however, you will need to take action and show your proficiency in manipulating matrices in MATLAB.

At the top right Durer represented a symmetrical magic square. Magic squares are sets of whole numbers, taken in order of succession, starting with 1 and arranged in a square pattern so that the total of each row, column and main diagonal is the same. The "order" of a magic square is the number of cells on one of its sides. In MATLAB, the magic (n) function generates a magic square of order n, but you cannot use magic to solve this exercise.

The magic square represented by Durer is called symmetrical, since each number added to the number symmetrically opposite to the center gives 17. Constructing a square of this type is very simple: write the numbers from 1 to 16 in a square arrangement and in order of succession, then invert the two diagonals. Durer swapped the two middle columns of this square so that the two middle cells of the last lower row indicated the year he made the engraving.

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

Can you recreate Durer's magic square in MATLAB? Please, save the result in a variable named A.
Let me give you the list of MATLAB commands that you will find useful in manipulating the matrics:

- reshape: reshape array
- diag: get diagonal elements of a matrix
- flip: flip order of elements
- fliplr: flip array left to right

The problem is easy, but not that easy :-)
Hints:

- remember the ':' (semicolon) operator
- remember the difference between '=' and '=='
- are you familiar with logical indexing? Please, find a nice explanation here
- and here is the WIKI page for Melencolia

Reference Solution

```
A=1:1:16;
A=reshape(A, 4, 4);
A=A';
A(diag(A))=flip(diag(A));
idadiag=(A==diag(fliplr(A)));
A(idadiag)=diag(fliplr(A));
A=A(:,[1 3 2 4]);
```

2. Selling Hamsters and Parrots

Alex owns a pet shop.
He buys a number of hamsters and half that number of pairs of parrots, paying €2 for each hamster and €1 for each parrot.
Alex sells each hamster and pair of parrots at a price 10% higher than the purchase price.
After selling all but seven beasts, Alex realizes that he has made a sum exactly equal to what he originally paid. His potential profit, therefore, is represented by the total sales value of the seven remaining animals.
How much is it?
Hint:

- in order to solve this problem, you will work with a **Diophantine equation**, **equation** involving only sums, products, and powers in which all the constants are integers and the only solutions of interest are integers. Have a look at the WIKI page here.

2.1. Step 1 - Selling Hamsters and Parrots

Alex owns a pet shop.
He buys a number of hamsters and half that number of pairs of parrots, paying €2 for each hamster and €1 for each parrot.
Alex sells each hamster and pair of parrots at a price 10% higher than the purchase price.
After selling all but seven beasts, Alex realizes that he has made a sum exactly equal to what he originally paid. His potential profit, therefore, is represented by the total sales value of the seven remaining animals. How much is it?
We have defined for you the symbolic variables that you will use in the solution. We have also pre-coded an assumption that will constrain the solution.
Analyze the description of the problem and define:

- C_Total: the total cost of the animals
- R_Total: the total revenue

Do not expect solve to return a single pair of solutions: you will have to choose the right couple of numbers and use them to compute the variable T_Sales_Revenue.
Keep note of the pair of values returned by solve, as you will need in the next step, to complete the solution of the problem.

Reference Solution

```
syms T_Hamsters L_Hamsters 'integer'
syms C_Total R_Total
assumeAlso (L_Hamsters > 0 & L_Hamsters < 8)
C_Total = (T_Hamsters * 2) + (T_Hamsters * 1)
R_Total = (T_Hamsters - L_Hamsters)*2.2 + (T_Hamsters - 7 + L_Hamsters) * 1.1
eqn = simplify (C_Total == R_Total)
[Total_Hamsters, Left_Hamsters] = solve(eqn, [T_Hamsters L_Hamsters])
```

2.2. Step 2 - Selling Hamsters and Parrots

Alex owns a pet shop.
He buys a number of hamsters and half that number of pairs of parrots, paying €2 for each hamster and €1 for each parrot.
Alex sells each hamster and pair of parrots at a price 10% higher than the purchase price.
After selling all but seven beasts, Alex realizes that he has made a sum exactly equal to what he originally paid. His potential profit, therefore, is represented by the total sales value of the seven remaining animals. How much is it?
In this second step, you must compute the revenue that will come from the sale of the left animals. In the previous step you have solved the Diophantine equation that has returned you two pairs of values.

- How many of the left animals are Hamsters? Please, store the value in the variable named L-Hamsters
- And how much will Alex get from selling all the left animals? Please, store the value in the variable T_Earnings

Reference Solution

```
L_Hamsters = 5
T_Earnings = L_Hamsters * 2.2 + (7 - L_Hamsters) * 1.1
```

3. Train Regression Network as an Image Rotator

Train a network than can predict the angles of rotation from video footage frames.

This script trains a regression network using the pretrained network ResNet-18, ResNet-18 is a convolutional neural network that is 18 layers deep.
Convolutional neural networks (CNNs, or ConvNets) are essential tools for deep learning, and are especially suited for analyzing image data. For example, you can use CNNs to classify images. To predict continuous data, such as angles and distances, you can include a regression layer at the end of the network.
In this Folder you will find Video frames **DataSet** and **Scripts** that will help you get started on your solution for the competition.
This is what you need to do:

1. Download the scripts from the folder above, start with 'SystematicsNext_TrainRegressionNetwork.mlx'.
2. Download the files from the folder above and add to your MATLAB path.
3. Use the scripts to train and evaluate the Network.
4. **Submit** a mat file, saved in this format: 'myFullName.mat', containing the network you trained to this link.

To solve this question, you will use:

- Image Processing Toolbox
- Deep Learning Toolbox
- Statistics and Machine Learning Toolbox

If you are using an older version of MATLAB (< R19b) please use this link to get a trial.

Reference Solution

To see a solution to this question, click on the link below, which includes the following code files:

- EvaluateRegressionNetwork.mlx
- TrainRegressionNetwork.mlx

https://systematics.sharefile.com/d-s1ea6c1d07f304ae08cd0b8e4347cfd58