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Department of Electrical and Electronic Engineering (EEE)

Exercise - 01:

Problem statement: Find the 1st 10 pentatope number.

n-th pentatope no $= \frac{\boldsymbol{n(n+1)(n+2)(n+3)}}{\boldsymbol{24}}$

output: [1,5,14,35,70,126,210,330,495,715]

Additional exercise:

I. Find the 1st 8 triangular numbers. [search web to find out what is a triangular number]
II. Find the 1st 20 prime numbers [There is a built-in function for that. Search the web to find it]

Key Takeaway:

- Broadcasting.
- Element-wise Multiplication.

*These two things will become more clear as you practice more and more problems.

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Exercise - 02:

Problem statement: Factorization

- Every positive integer has a unique prime factorization. For example, 8 = 2 * 2 * 2;
  12= 2*2*3.

  Here, (2,2,2) or (2,2,3) is called the prime factors of the integer 8 and 12 consecutively.

  There is a built-in function already provided in matlab to do this task for us.

  - factor(n)

- Now, say I want to find all the divisors of a number (excluding 1 and the number itself).
  For example, 8 = 2,4;   12 = 2,3,4,6
  Here 12 is divisible by 2,3,4,6. How to do that?

  Unfortunately, MATLAB doesn't provide a built-in function for that. So, we'll try to write our own function.
  Later in other codes, you'll be able to re-use your defined function just as the built-in functions that you've already used. That will prove a great advantage in many programming exercises later.

Key Takeaway:

- User-defined function
- Vectorization
- Logical indexing
- Variables – local, global, persistent

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Exercise – 03:

Problem statement: Given an array of integers, find the least common multiple(lcm) of the numbers.

Write a function named ‘lcm_array’ that takes an array as the input and returns the lcm.

Test Case - 01:

- Input: a= [6,7]
- Output: 42

Test Case - 02:

- Input: a= [4,12]
- Output: 12

Test Case - 03:

- Input: a= [4,12,25]
- Output: 300

Test Case - 04:

- Input: a= [4,12,25,2,3,14,52,23,45]
- Output: 1883700

Key Takeaway:

- lcm(a,b)
- gcd(a,b)

Additional Exercise:

- do the same for greatest common divisor(gcd)
- build a function named ‘gcd_array’

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Exercise – 04:

Problem statement: Write a function ‘prime_out’ that takes as input - a number or a vector or a matrix of integer values and returns –

I. if input is a number – return either of the following string based on whether the number is prime or not – “Input is a prime number” or “Input is not a prime number”
II. if input is a matrix – return a list containing only the prime numbers.
III. if input is a string – return the following string – “Input must be a numerical array”

Test Case – 01:

- Input: a = 7
- output: “Input is a prime number”

Test Case – 02:

- Input: a = [2,1,77,4,79]
- output: [2,79]

Key Takeaway:

- isprime() , isrow() , iscolumn() , isnumeric(), islogical(), ischar(), isscalar(), isequal() etc. There are many this type of inquiry functions. When you try to solve different problems, They’ll come in handy in many scenarios.
- MATLAB Toolbox
- Conditional statements

Additional Information:

- nthprime() , nextprime(), prevprime()
- If you search MATLAB documentation, you’ll find these functions belong to ‘symbolic math toolbox’.

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Exercise – 05:

Problem statement: “Zero Padding”

Given a matrix of size (m, n), pad zeros on its outer layer.

Test Case – 01:

- Input: x= [2,4;
  5,8]
- Output: y = [0,0,0,0;

  0,2,4,0;

  0,5,8,0;

  0,0,0,0]

Here the size of the output matrix = (m+2, n+2)

We’ve added 1 extra layer of zeros around the input matrix. So p=1.

Additional Exercise:

- Try to add 2 extra layers around x. so, p=2.
- Write a function called ‘zero_padding’ that will take p as an input and will provide the matrix y as output.
- Try it for different values of p as well as different size of input matrix (e.g. m=3, n=7).

Key Takeaway:

- Introduction to toolbox

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Exercise – 06:

Problem statement: "One-hot encoding"

Given an array x, say x = [3,1,0,2] – perform one hot encoding. The output looks like this:

Y= [0 0 1 0;

0 1 0 0;

0 0 0 1;

1 0 0 0]

Here, no of rows in y = (maximum element in x) + 1

No of columns in y = no. of elements in x

The mapping is done in the following way:

Since the 1st element of x is 3 – the (3+1)th element in the 1st column is 1. Others are 0.

Again the 2nd element of x is 1 – the (1+1)th element in the 2nd column is 1. Others are 0.

And so on.

You should write a function named "one_hot_encoding" that takes x as an input and outputs y.

Test case – 02:

- x= [0,0,1,0,3]
- y= [1 1 0 1 0;

  0 0 1 0 0;

  0 0 0 0 0;

  0 0 0 0 1]

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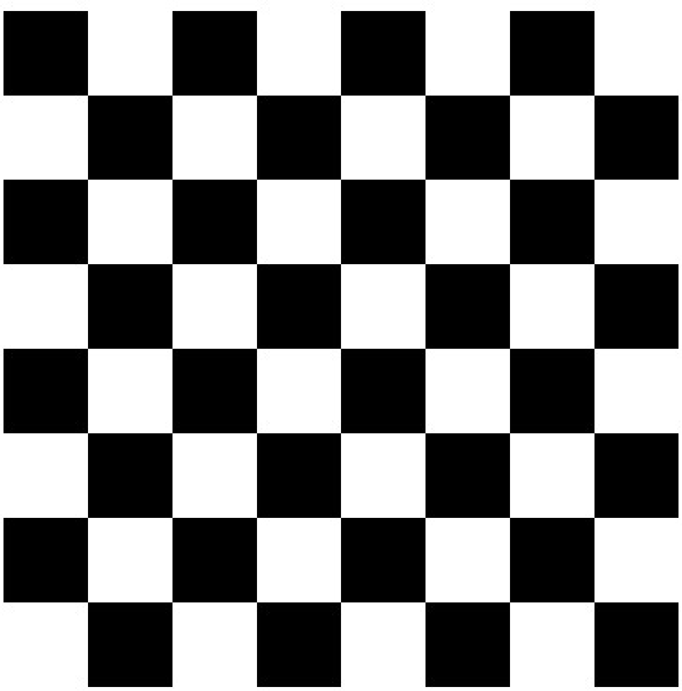
Exercise – 07:

Problem statement: I believe all of you have seen a chess board. It kind of looks like this – one white square, then one black square and so on.



Suppose that the white square represents 1 and black square represents 0.

Create a checkerboard matrix like this –

```
              [0 1 0 1 0
               1 0 1 0 1
               0 1 0 1 0
               1 0 1 0 1]
The matrix should be of size n [n is an integer – function input]
```

Key Takeaway:

- repmat, repelem, ceil, floor, imshow
- Introduction to binary Image

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Exercise - 08:

Problem statement: Refer back to exercise – 03 where we created the 'lcm_array' function of our own.

Now if you remember from earlier lectures, a function say max(x),

- provides the maximum of the array x.
- But if x is a matrix, the same function by default performs column-wise max operation.
- Moreover, it also takes addition input like max(x,2) to perform row-wise max operation. It performs column-wise if max(x,1) is provided – which is set to default.
- It takes an additional 3rd argument and performs max operation on the whole matrix if max(x, [ ], 'all') is given as input.

- As you can see, MATLAB functions can handle different types of inputs like vectors, matrices, char arrays [without having to be defined by the user what kind of input is fed to the function].
  This particular feature that MATLAB offers (unlike many other programming languages) is called 'Polymorphism'.

In this programming exercise, we want our 'lcm_array' function to perform similar task. You'll have to take necessary steps so that it can take an array as well as a matrix as the input and perform in the same fashion presented above.

Key Takeaway:

- varargin
- varargout
- nargin

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Exercise – 09:

Problem statement: Last week, you saw the following dataset. It contains the number of students in different departments in different universities in Bangladesh.

The data contains some nan values. If you remember from last week, these nan values sometimes create problem while plotting the data. Also create problems while use sum function.

In order to avoid that, let’s do something that will help us to process the data easily.

Let’s replace the nan values with 0.

Now we can work with this matrix without any hinderance. Try visualizing the matrix using the plots bar.

```
Data= [ 120   120   100    80    40

         180   120   150    80    80

         150    80   150    80    55

         195    80   150    80    45

          40   NaN    30    80   NaN

         100    50    80    80   NaN

          50    50   NaN    80    30]
```

- NaN is necessary to represent our original data. But while processing the data, we can ignore it and replace it with 0 for our convenience.

Key takeaway:

- isnan ( ) , ismissing ( )

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Exercise – 10:

Problem statement: Write a script that takes a string as an input and returns –

I. the count of #vowels.
II. Find the index of 'o'
III. The string removing all the vowels.
IV. The string removing all the letters from a to j.
V. The string removing all the consonants.
VI. The string replacing all the vowels with asterisk (*)
VII. The string removing all the digits.

Test Case – 01:

- Input: A= 'david attenborogh'
- Output:
  I. 6
  II. [13,15]
  III. 'dvd ttnbrgh'
  IV. 'v ttnoro'
  V. 'ai aeoo'
  VI. 'd*v*d *tt*nb*r*gh'
  VII. 'david attenborogh'

Key Takeaway:

- Regular Expression (regexp, regexprep)
- ismember(a,b)
- strfind, contains

- 'regular expression' is a very powerful technique for string manipulation. It is widely used for text data processing and cleaning. It can be quite a bit tricky and is like a complex web. So, this portion is only for introductory purpose. Don't sweat it.

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