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Exercise - 01:

Problem statement: Fibonacci Sequence

The Fibonacci number sequence is following:

0,1,1,2,3,5,8,13,21,34,55, ...

Can you see the pattern?

Each number in the sequence is the summation of two numbers before that.

Find the nth entry in the sequence. [e.g. n=20]

- This problem can be solved using recursion. But that is not a good approach. Can you think why? Try to get an intuition what is happening behind the curtain; behind your code.
- For large values of n, see how pre-allocation helps.

Additional Exercise:

Compute the 15th entry in the Tribonacci sequence.

Key Takeaway:

- tic toc
- pre-allocation

Exercise - 02:

Problem statement:

Write a function named 'max_out' that takes a matrix and an integer (a) as an input and performs the following operation on the matrix –

```
Mat= [244 323 312 113 453 302 43 119
      18 190 294 86 490 356 132 230
      224 406 104 114 220 111 401 482
      154 267 151 218 56 59 15 274
      255 176 236 156 130 149 465 261
      256 470 116 462 205 160 366 116
      409 438 423 216 298 213 245 245
      398 276 98 93 132 254 290 313]
```

a=2;

Since a=2, take 2-by-2 block in your original matrix and pick the maximum element.

Create a new matrix with those maximum elements of each block, maintaining the sequence.

The output matrix should look like the following --

```
Out= [ 323 312 490 230
      406 218 220 482
      470 462 205 465
      438 423 298 313]
```

As you can see, the output matrix size is halved.

Exercise - 03:

Problem statement: 3D matrix

So far, we've worked with 2-Dimensional matrix. We can also create a 3D, 4D or higher dimensional matrix very easily.

Let's try to understand first what is a 3D matrix.

Say, you are taking notes in your diary. The page in which you're writing can have x-axis and y-axis i.e. can be divided as a 20-by-20 matrix. The next page also has the same size and can be divided as the same 20-by-20 matrix.

Now, try to look at your diary from outside. There are say 100 pages stacked on top of one another; each of which (page) is a 20-by-20 matrix.

So, your diary is actually a 3D matrix of size – (20,20,100).

Here, 100 is no. of pages which is the 3rd dimension. Each page is 2D matrix of size (20,20).

Now, Say I want to create a 3D matrix of size (5,5,3).

So, I have 3, 2D matrix of size (5,5). Let's create 3 such matrix first.

- M1= eye (5)
- M2= spiral (5)
- M3= magic (5)

Now we've to stack them on top of one another.

- Mat_3d (:, :, 1) = M1
- Mat_3d (:, :, 2) = M2
- Mat_3d (:, :, 3) = M3

➤ Try to create a 3D matrix of size (12,5,4).

Exercise - 04:

Problem statement: Insert, Replace, Erase, Extract

Last week you saw how to work with regular expression. It's quite a bit tricky. But compared to MATLAB, Python's regular expression library is quite easy and offers much more flexibility.

MATLAB has some other built-in functions that can make the handling much simpler.

Some of the four functions named above offers 3 operations – after, before and between.

For example, 'insertBefore', 'insertAfter'.

Say, I have a string like this -- "Dhaka, Bangladesh"

Here 1st I have the capital and 2nd I have the country name. What if I want to extract the country name?

Test Case – 01:

- **Input:** "Dhaka, Bangladesh"
- **Output:** "Bangladesh"

Test Case – 02:

- **Input:** "Beijing, China"
- **Output:** "China"
- Try to extract the capital name by yourself.

Key Takeaway:

- Alternative to regexp

Exercise - 05:

Problem statement:

Suppose, following table contains the information of the students of IUT.

ID	Section	CGPA	Year
732	1	3.6	3
813	2	3.4	3
709	1	3.85	2
842	3	3.2	3
987	2	3.9	2

Now, you want to sort the students based on their ID. You're already familiar with the sort function. But there is one catch.

If you sort the ID column of the data, other columns remain the same. But they should also be changed accordingly. Otherwise, there will be mismatch in the information.

So the question is, how to do that?

Part_02:

Next, say I want to find the information of the 3 students who has the highest CGPA. How can we do that?

Additional Exercise:

- Can you extract the information of the students from 3rd year?
- Can you extract the information of the students from 2nd year, section-1?

Key Takeaway:

- `sortrows`
- `topkrows`
- `Boolean masking`

Exercise - 06:

Problem statement:

Say, you're given three points $a=(3,5)$, $b=(4,9)$, $c=(-4,8)$.

You can think of the points as cartesian coordinates (x,y) .

As you know, three points can create a triangle. So, you want to know, if you connect those points, how the triangle might look like.

Similarly, you're given 4 points. You want to know how the quadrilateral might look like.

Or maybe 10 points or more. How the points are scattered in the xy plane.

How to visualize them?

- After visualization, you may also wonder, what is the area or perimeter of the triangle or any other polygonal object.
 - We've using the randi function for a while. But does it really create random integers. Is there any way to understand that?
- Visualizing the points can be a good approach.

`Data= randi(100,2,500)` – is going to create a 2-by-500 matrix with integers up to 100. Is the distribution really random?

Key Takeaway:

- Scatter plot
- Histogram plot
- Polyshape

Exercise - 07:

Problem statement:

Let's take a look at our university data again.

	BUET	RUET	KUET	CUET	IUT
CSE	120	120	100	80	40
EEE	180	120	150	80	80
ME	150	80	150	80	55
CIVIL	195	80	150	80	45
CE	40	nan	30	80	nan
Architecture	100	50	80	80	nan
Management	50	50	nan	80	30

Previously you saw, how to visualize data of a particular university or a department.

But now, say you want to compare all the varsity's data together. Instead of plotting the data one by one in separate window, one way would be much helpful, if we could just visualize all the data separately in a single window.

How can we do that?

Key Takeaway:

- Sub-plot
- Bar-plot
- Title, label, legend

Exercise - 08:

Problem statement:

So far, we've worked with scattered data. But what if we want work with continuous data?

Say for example, if we want plot a sine wave or cosine wave.

Additional Exercise:

- Try to create a square wave by yourself
- Try `area(x,y)`
- Create a polyshape object with 4 points, plot it and find out the area, perimeter etc.

Key Takeaway:

- Plot
- Hold on, hold off
- Figure
- Axis
- Grid on
- `Linspace, logspace`

- ✚ Introduction to `Live Script`
- ✚ Introduction to `geoscatter plot`

- ✚ `Importing data` in MATLAB