

MATLAB Programming for Numerical Computation
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Module No. #01
Lecture No. #1.2b

Introduction to MATLAB programming – Arrays operations revisited

Hello and welcome to MATLAB programming for numerical computations course. We are in module 1 which is introduction to MATLAB programming. Today we are going to revisit lecture 1.2 where we had discussed some of the array operation in MATLAB we are going to take one simple example to look at how the array operations can be fairly powerful tool in MATLAB.

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Tapping some Array Operations in MATLAB

- Also view “Working with Arrays in MATLAB” on MATLAB website:

<http://in.mathworks.com/videos/working-with-arrays-in-matlab-69022.html>

- Consider the following example (Marks earned by students)

Name	Math	Programming	Thermodynamics	Mechanics
Amit	24	44	36	36
Bhavna	52	57	68	76
Chetan	66	53	69	73
Deepak	85	40	86	72
Elizabeth	15	47	25	28
Farah	79	72	82	91

So, the example that we are going to take basically on marks that are earned by 6 students in 4 different courses. The courses are mathematics, programming, thermodynamics and mechanics. And the marks that are obtained by the 6 students are listed over here. We are going to undergo certain computations that we did in the previous lectures. We are going to revisit them with this specific example.

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Some things to try

- Create a 6×3 matrix `allMarks` to contain marks for first three courses
- Append marks for the Mechanics course to `allMarks` when received
- Do the following computations
 - Mechanics course was out of 50. Scale the marks to half
 - Extract row 3 and give the marks to Chetan. Also calculate his total marks
 - Extract marks of our best students, Deepak and Farah for first three courses
 - Calculate average marks obtained in each of the four courses
 - Scale all the marks out of 10*

So, the computation that we are going to do is, first we will create a matrix called all marks which will contain the marks for the first 3 courses. The 3 courses are math programming and thermodynamics for all of the 6 students and then when the mechanics marks come in from the teachers for mechanics we are going to add those marks or append those marks to the matrix that we are formed.

If you recall what we said in the in the previous lecture, basically this is going to be a matrix which has 6 rows and 4 columns and therefore is going to be 6/4 matrix after we have appended the mechanics marks. Once we have done at appending the marks for the mechanic's course, we are going to do several computations.

First is going to be the scaling the marks for the various for the mechanic's course, we are going to extract the marks of Chetan and give it to him as well as calculate his total marks. Two of our students Deepak and Farah are the best students. So, we are going to extract the marks for the first 3 courses. For these 2 students, we are going to calculate average marks and we are going to scale all the marks out of 10.

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Some things to try

- Create a 6×3 matrix `allMarks` to contain marks for first three courses
- Append marks for the Mechanics course to `allMarks` when received
- Do the following computations
 - Mechanics course was out of 50. Scale the marks to half
 - Extract row 3 and give the marks
 - Extract marks of our best student
 - Calculate average marks obtained
 - Scale all the marks out of 10

We will use matrix fundaes for this:

$$\begin{bmatrix} a & b \\ c & d \\ e & f \end{bmatrix} \begin{bmatrix} 2 & 0 \\ 0 & 0.1 \end{bmatrix} = \begin{bmatrix} 2a & 0.1b \\ 2c & 0.1d \\ 2e & 0.1f \end{bmatrix}$$

And we are going to use one of the matrix fundaes for this in matrix multiplication. So, if you have matrix of this sort a, b, c, d, e, f , so, we have 3 rows and 2 columns. And we multiply this with a diagonal matrix of this form. We are post multiplying with the diagonal matrix what is going to happen over here is that the number 2 is going to multiply with the first row and the number 0.1, sorry first column and the number 0.1 is going to multiply with the second column and this is the result that we are going to get.

You can just simply do this matrix multiplication and see this for yourself. So, $a * 2 + b * 0$ is going to be $2a$. a multiply by 0 + b multiply by 0.1 is going to be $0.1b$, so on and so forth okay. So, if we want to scale all the marks out of 10, this is the kind of computation that we need to do remember that at this stage the marks for the 3 lectures are going to be out of 100, whereas eventually the marks for mechanics is going to be out of 50 so that is what we are going to do in MATLAB so let go to MATLAB to do this array operations okay.

(Video Starts: 03:33) So rather than typing out all the stuff I have already created a file which calculates the marks for 3 courses for all the 6 students. And we also given mechanics marks in another vector called `mechMarks` okay. So, let us type `allMarks` sorry let us type `markList` and when we execute this we are going to get `allMarks` and `mechMarks` as the 2 vectors.

So, let us type `allMarks` okay. So these are the marks for the 6 students in the 3 courses and `mechMarks` are the less, are the marks for all the 6 students in mechanic's course. Okay now

what we want to do is, we want to append mechanics marks to allMarks array. So, I will do this
all marks = allMarks, mechMarks okay. I am going to get an error over here. But let us try this
out and let us see what happens.

The error that we get is the error using horizontal catenation that means what we are trying to do
is, we are trying to put 1/6 array besides a 6/3 array which is something that we cannot do so we
have this particular box over here. And we want to put this box next to it that is something that is
not possible in MATLAB. What we need to do is, we need to transpose this particular array and
once we transpose that array we are going to put it next to the allMarks array.

So, let us try and do that. And in order to do that I will just clear the screen first okay.
Transposing mechMarks is the command for that is mechMarks dash, that is going to transpose
the mechMarks which is going to result in a 6/1 array 6/1 array we can catenated with a 6/3 array
and that is going to result in a 6/4 array okay. So, we can try do that we are now going to get our
allMarks as the marks for 6 students in the 4 courses and this is what we wanted. (Videos Ends:
06:05).

As the result of this first computation step, at the end of the first computation step we wanted to
append the marks for the mechanics course whenever to the allMarks array whenever we receive
okay. (Video Starts: 06:16) The next thing that we want to do is, we want to scale the marks for
mechanics by two marks out of 50 instead of marks out of 100. So, in that case what we need to
do is mechMarks = mechMarks multiplied by 0.5.

That is going to basically scale the marks out of 50 instead of out of 100 okay. Because this is the
scalar multiplication with the vector. We can actually do this and this is not going to be a
problem. And we are going to get mechanic. The marks in mechanics out of 50. So this is going
to be the marks in mechanics out of 50 okay. And now what we want to do is, we want to now
replace the last column with the actual scaled marks okay. So how do we access the last column
allMarks last column is going to be the fourth column okay.

So, it is going to be the 1 to 6. All the rows comma all comma fourth column okay. So this is going to access basically the last column and all the rows in that column, so the rows is going to be the first element in the reference and the column is going to be the second element in that reference okay.

If we type this let us see what we are going to get. We are just going to extract that particular column okay. So, when we type this is what is we are going to extract okay. What we want to do is not extract but assign the mechMarks that were shown over here. That is what we want to assign to that particular array.

So, what we are going to do is, allMarks colon comma 4. Remember if we just use this colon without any numbers on either side in an array notation that means the entire column. All the rows in a particular column, so that is going to be equal to mechMarks prime. Because we want to transpose that multiplied by 0.5 okay. And when we do that, we are going to get allMarks as seen over here okay. Now the reason why we are getting this in not an integer form but a real number form is because we have two marks over here 36.5 and 45.5 which are real numbers.

If this was a programming language such as mat as such as c++, we would have to define allMarks as a real number vector or real number array which is something we do not need to do in MATLAB. So, MATLAB is a higher level programming language that itself takes care of all this conversion from integers into double precession, double precession into integer and so on and so forth of all these numbers are by default defined as doubled precession numbers in MATLAB.

So, we do not really worry about defining or predefining any of the arrays in MATLAB okay. The next thing was to extract the marks of Chetan. So, we have, I have name the 6 students as a , b, c, d, e, f so that it is just easier for us to know to extract or to find what particular row that particular student belongs to. So, Chetan is row number 3, so we wanted to extract the marks for Chetan. So, I will say Chetan marks = allMarks okay.

We want to extract row number 3 now. So row number 3 and all the columns from that row number 3. So we can say 1: 4 so because we have colon, we have 4 marks or I can just put colon over here because we want that entire row okay. When I do that I am able to extract the marks for Chetan okay. So, these are the marks for Chetan. Now I wanted also to calculate the total marks for Chetan, all I need to do is to use the command `sum Chetan Marks` okay.

And I am going to get the marks sum of the total marks for Chetan which is 224.5 okay. So that is what I am going to get over here. Now what I wanted to do is, for Deepak and Farah I wanted to get their marks okay. For the first 3 courses only the Deepak is in row number 4, Farah is in row number 6 and I wanted column number 1, 2 and 3 okay. How do I do that is I will clear the screen over here allMarks okay. I wanted row numbers 4 and 6 so in [], I will put rows number 4 and 6 okay.

Then separated by comma and I will put all the columns that I need. And the columns that I needed are 1, 2 and 3 when I put that I and type enter. I am going to get the marks of the Deepak and Farah in the 3 courses. So, I will just type all marks again so that we can confirm what we have gotten. So the marks for Deepak are over here which we have gotten in the first row marks, for Farah are over here which we have gotten in the second okay.

So, this is how we are able to extract a sub array from any array or matrix in MATLAB okay. So, now let us next step that we wanted to do let us go over and find out okay. (Videos Ends: 12:07) Next what we wanted to do is to calculate average marks obtained in each of the 4 courses okay. (Video Starts: 12:17) And the way to compute average is in MATLAB is using the command `mean`, so let us do help mean okay. And it is let us read `s = mean x` is the mean value of element x. If x is a vector okay, for matrices s is a row vector containing mean values of each column

So what that means is that if we have the vector for example Chetan Marks, Chetan Marks was a vector. If we do `mean chetanMarks`, we are going to get the average of marks of Chetan ok. In all the 4 courses, instead what we wanted to do is, we wanted to get the mean in each column of all the 6 rows in each columns of all the 6 students in column number 1 likewise all the 6 students in column no 2, 3 and 4.

That is exactly what the command `mean` does. If it operates on an array which means that it is going to mean over the first dimension. The first dimension is the row dimension is going to mean the first guy with the second guy with the third guy with the fourth guy with the fifth guy and the sixth guy in the column number 1 it is going to repeat the same operation for column number 2 and repeat the same operation for column number 3 and repeating the same operation for column number 4 also.

Let us try that `mean` of `allMarks`. When I type that and I press enter, this is what I am going to get so this is the mean of all the students in the first course that is math course. So the mean the average marks in mathematics is 53.5, average marks in computer is 52.2, average marks in the third course is 61, thermodynamics and the average marks in mechanics is 31.3 for all the 6 students.

Now let us say we wanted to get the sum of marks for each student. We can do `sum`, let us do `help sum` over here okay. And what we see over here in one of the things in the help section is `s=sum x, dimension sums along the dimension dim` okay. So, let us go back to the `allMarks` array over here. So what we wanted to do is we wanted to sum over all the columns sum over column 1 + column 2 + column 3 + column 4 okay. So column is this second dimension row is the first dimension column is the second dimension.

Recall when we said `allMarks i, j`; `i` was the row `j` was the column. So `i` is the first dimension. Row is the first dimension; `j` is the second dimension, column is the second dimension. So we wanted to sum over each and every column. So we want to use the command `sum allMarks, 2` okay. That is going to sum over the columns for all marks, so we will get the sum of marks.

The total marks each and every students okay and when we do that, we are going to get. So, first guy is in total marks for amith and the second guy is the total marks for Bhavna the third one is total marks for Chetan so on and so forth. So, we can see these are the total marks for each student okay. So, this is what we obtained the final thing that we wanted to do was to scale the marks out of 10 okay. (Video Ends : 16:08)

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Some things to try

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- Do the following computations
 - Mechanics course was out of 50. Scale the marks to half
 - Extract row 3 and give the marks to Chetan. Also calculate his total marks
 - Extract marks of our best students, Deepak and Farah for first three courses
 - Calculate average marks obtained in each of the four courses
 - Scale all the marks out of 10*

Okay recall the first 3 guys are marks out of 100 and the last guy is marks out of 50.

So, remember the matrix operation that we wanted to do the same matrix operations, now we need to do with a $6/4$ matrix. That is matrix of 6 students and 4 lectures. We wanted to scale it to $1/10$, $1/10$, $1/10$ and $1/5$ okay. Because the mechanics marks is out of 50 and not out of 100. So, we what we want to do is, to create a diagonal matrix of 4 rows and 4 columns. First guy is 0.1, second guy is 0.1, third guy is 0.1 and the last guy is 0.2. Because we want to scale out of 50 to out of 10 okay so how do we create that lets go back to our MATLAB.

(Video Starts 17:03) And we will create this using a command called `diag` which creates a diagonal matrix. So 0.1, 0.1, 0.1, 0.2 when I give this, okay and press enter, this is the matrix that I am going to get and what I need to do is to post multiply by all marks with this particular matrix okay. So, this all marks multiplied by this is going to give me scale.

If I pre multiply, I am trying to multiply a $4/4$ array with a $6/4$ array, $4/4$ and $6/4$ are not commutative under pre multiplication. So let me try this, `ans` multiplied by `allMarks` and let us see what I get. I should get an error okay. Error using `*` inner matrix dimensions must agree that means the number of columns of the first guy should be equal to number of rows of the second guy number of columns are 4 for our `ans`.

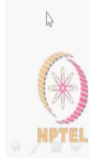
But number of rows for all marks was 6. So, this is not commutative under multiplication but anyway this is not what we wanted. What we wanted to do was a post multiplication. I just showed you what type of errors you can expect and what that error really means okay. So if I do all marks multiplied by `ans`, this is what I am going to get.

Now the marks are scaled out of 10 instead of out of 100, 100, 100, 50 they are now each of them are out of 10 okay. Again if you we combine the 2 commands, we can combine them saying allMarks multiplied by diag okay. 0.1, 0.1, 0.1, 0.2 square bracket closed round bracket closed okay diag has 1 vector.

That is an argument, so there is only 1 single argument to the command diag and that argument is a vector which has 4 elements okay. So note this that within the circular brackets I have created a square bracket okay. So, this is going to create a vector containing .1, .1, .1, .2 and that vector is a single argument to my diag command when I do that, I am going to get the same result okay.

And if I wanted to store this in a vector called let us say scaled marks, all I have to do is, I go up key. When I press up key the previous command is visible to me and now I say scaled marks = all marks multiplied by diag okay. When I do that and press enter, I am to going to get scaled Marks okay. So with this we come to the end of the recap for lecture 1.2. (Video Ends 20:14)
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End of Lecture 1-2b



So, what I have tried to do in this particular lecture is, take a simple example and go over some of the array operations that we did in the previous lecture okay. So as you can see the column notations, how to refer to a particular row to a particular column is something that we have seen and the final thing that we have seen is how to use some of the array operations such as sum

mean so on and so forth okay. So, thank you for listening to this lecture 1. 1-2b and I will see you in the next lecture where we are going to cover how to use for and while loops. Thank you.