

MATH 22AL

Lab # 3 . This lab must be done in room 2118 MSB, and MATH Department Computers must be used.

Starting MATLAB and Recording your work

1 Objectives

In this lab, you will explore the following topics using MATLAB:

- Using the plotting commands of MATLAB to create graphs.
- Creating and using m-files
- Exploring linear transformations in \mathbb{R}^2
- Exploring Matrix Multiplication.

Starting MATLAB and Recording your work

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The following steps will help you start and record your work and save and submit it successfully.

- **Open a terminal window.**
 - In Computer LAB (2118 MSB) click on terminal Icon at the bottom (or left side) of the screen
- **Start a MATLAB Session** that is :
 - After opening a terminal window and login, Type `textmatlab` then Press Enter
 - It may take about 10 seconds or more for MATLAB to start.
 - You should see MATLAB command line prompt: `>>`

To have MATLAB to save what you are typing now in a file called LAB2.text

- Type `diary LAB3.text` then Press Enter

This will open a file in the background called LAB1.text and copy what ever you type here in that file.

```
type % First Name: Example: % Jennifer
type % Last Name: Example: % Brown
type % Date: Example: % 12/24/2022.
type % Username: m22als?-??. ( this your username replace "?" )
```

Plotting Graphs

3

Note: to see plots, you have to use one of the terminals in the Mathematics department computer lab. Connecting from home via ssh will not allow you to see plots.

3.1 Generating 2-D Graphs

type `vt1=datestr(now)`

To graph a line segment passing through the points $(-1, 4)$ and $(2, -3)$,

type `x = [-1 2]; y = [4 -3];`
type `plot(x, y)`

Use the `axis` command to rescale the axes so that the line segment does not take up the entire window.

type `axis([-3 6 -4 5])`

You may chose a color for your lines by specifying it with a string.

type `plot(x, y, 'r')`

The line is now red! You can also make it dashed or dotted by specifying it with a string.

type `plot(x, y, 'g- -')`

The line is now dashed and green!

Later on you can visit

<http://www.mathworks.com/help/matlab/ref/plot.html>
for information on line styles.

You can also add a title and label to the graph.

type `title('Plotting x and y')`
type `xlabel('x axis')`
type `ylabel('y axis')`

To add a new graph to the same plot without removing the original graph, use the `hold` command.

type `hold on`
type `y = -y`
type `plot(x, y, 'r')`
type `x = -x; plot(x, y, 'g')`
type `axis([-5 5 -5 5])`

To stop adding graphs,

type `hold off`

Plotting Graphs

3.2

Of course, graphing three line segments is not very interesting. Let us graph some more complicated functions.

```
type    t = linspace(0, 4, 100);
type    y = exp(t); plot(t, y, 'r'), hold on
type    y = -2*exp(t); plot(t, y, 'b')
type    y = 3* exp(t); plot(t, y, 'm'), hold off
```

The comma (in the second and fifth line above) allows you to put multiple commands on the same line, unlike the semicolon which prevents printing output. If MATLAB printed a very long vector, then you forgot a semicolon somewhere.

3-D Mesh Surface Plots

3.3

If you have a function $Z(x, y)$, you can plot its surface in 3-D using the commands `mesh`, `meshgrid`, and `surf`. For more information, use the help command or see the documentation online. Here are some examples.

```
type    A = eye(9); mesh(A)           It's the identity matrix in 3-D!
type    [t,s] = meshgrid(-1:.2:4, -3:.2:3);
type    z =sin(s.*t); mesh(z)
```

M-Files

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How to create M-Files

MATLAB can execute a sequence of statements stored in an ordinary text file with a .m extension. Because of this extension, such files are called “m-files”.

One type of m-file is the function m-file.

The first line of a function m-file must define the m-file as a function, specify its name, and specify its input and output variable names. A function m-file’s function name and filename must be identical. For example, a function named “changerows” must be stored in a file named “changerows.m”. When a function has more than one output variable, the output variables are enclosed by brackets: For example, `[m, n] = size(A)`. If your m-file is not in the working directory (this will default to your home directory), you must specify the path to it.

`%` Open a new terminal window,
login and then in this new terminal window use `pico` (or any text editor), create the following file and save it as `rowchange.m`

`type` `pico rowchange.m` This command must be typed in the new terminal window

Pico will open you a new editor window in that window type the following exactly as you see

Type the following in the window opened by pico

```
function rowchange(A, c, d)
display(A)
r = A(c,:);
A(c,:) = A(d,:);
A(d,:) = r;
display(A)
```

Use `Ctrl+O` to save the file, then go back to the first terminal window which is running your LAB3 Matlab session. And enter the following commands:

(Note The `display` function at the end of the program file prints a variable to the screen.)

`type` `rng shuffle`

`type` `A = round(10*rand(5))`

`type` `rowchange(A, 1, 4)`

Try it for other rows. For example rows 2 and 3 by typing

`type` `rowchange(A, 2, 3)`

Linear Transformations

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Create the following m-file and save it as `lintr2.m`

This means in the second terminal window exit `pico` and open a new file by typing :
`pico lintr2.m` `pico` will show you a new blank file, type the following in that window:

Type the following in the window opened by `pico`

```
function lintr2(obj, A)
whitebg('w')
plot(obj(1,:), obj(2,:), 'k')
hold on
y = A * obj;
display(y)
plot(y(1,:), y(2,:), 'r')
hold off
```

This m-file plots the points in the matrix `obj`, and then plots the points in the matrix `A*obj`. Now in the first window that MATLAB session is running, Enter the following matrix; it describes the vertices in a drawing of a house.

```
type house = [0 0; 0 1; 1 2; 2 1; 2 0; 3 0; ...
type 1.75 0; 1.75 .5; 1.25 .5; 1.25 0; -1 0]'
```

```
type lintr2(house, eye(2))
```

Create a matrix that reflects across the x -axis

```
type reflectX = [1 0; 0 -1]
type lintr2(house, reflectX)
```

The house should be in black and its reflection about the x -axis in red.

Do the same thing for the y -axis:

```
type reflectY = [-1 0; 0 1]
type lintr2(house, reflectY)
```

To rotate the house 30 degrees counterclockwise, type the following.

```
type rot30 = [cos(pi/6) -sin(pi/6); sin(pi/6) cos(pi/6)]
type lintr2(house, rot30)
```

Write code and rotate the house 45 degrees .

Linear Transformations

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Now we will consider shear.

```
type shearX = [1 2; 0 1]
type lintr2(house, shearX)
```

```
type shearY = [1 0; 0 3]
type lintr2(house, shearY)
```

```
type lintr2(house, reflectY * shearX)
```

If the reflection is applied first,
type s5a1 = 'reflectY'

If the shear is applied first,
type s5a2 = 'shearX'

Now try the other order.

```
type lintr2(house, shearX * reflectY)
```

In which order are the transformations being applied here?

If the reflection is applied first,

If the shear is applied first,

```
type s5a2 = 'reflectY'
```

```
type s5a1 = 'shearX'
```

```
type vtm=datestr(now)
```

Matrix Multiplication

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Matrix multiplication can be expressed and observed in several ways; we will see a few of them.

```
type A = [-2 1 0; 2 0 1; 8 5 3; 1 2 -3]
```

```
type B = [1 5 -2; 0 -7 5; 1 3 -2 ]
```

Enter the following commands. Some will give errors; this is expected.

```
type A * B
```

```
type B * A
```

```
type inv(A)
```

```
type inv(B)
```

```
type inv(A*A')
```

```
type inv(A'*A)
```

```
type size(A'*A)
```

```
type size(A*A')
```

There should have been two errors. Explain each of them:

```
Comment: % [an explanation of why the first error occurred]
```

```
Comment: % [an explanation of why the second error occurred]
```

Let A and B be $\ell \times m$ and $m \times n$ matrices, respectively.

Then the matrix product $C = A \cdot B$ exists.

There are multiple ways to view matrix multiplication:

```
type C = A * B
```

1. The element in the i th row and j th column of C , c_{ij} , is equal to the dot product of the i th row of A with the j th row of B . That is, $c_{ij} = \sum_{k=1}^m a_{ik}b_{kj}$.
2. The k th column of C is A times the k th column of B .
3. The k th row of C is the k th row of A times B .

Matrix Multiplication

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Find the entry in position (2,3) of the matrix C in two ways.

```
type C(2,3)
```

```
type A(2,:) * B(:,3)
```

Find the second column of C in two ways.

```
type C(:,2)
```

```
type A * B(:,2)
```

Find the second row of C in two ways.

```
type C(2,:)
```

```
type A(2,:) * B
```

Find C in two different ways.

```
type C = A * B
```

```
type A(:,1) * B(1,:) + A(:,2) * B(2,:) + A(:,3) * B(3,:)
```

Do you think you can justify why

```
AB == A(:,1) * B(1,:) + A(:,2) * B(2,:) + A(:,3) * B(3,:)?
```

(You do not have to answer.)

```
type vt2=datestr(now)
```

```
type vt3=vt2-vt1
```

```
type vt4=vt2-vtm
```

This is the end of LAB 3

You reviewed and learned about:

1. Plotting in MATLAB
2. Linear transformation
3. Matrix multiplication

Please use pico to edit your LAB3.text file, remove all errors you typed and make sure to add needed comments then save and submit the file.