

Syllabus

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Department of Mathematical and Statistical Sciences

Marquette University

Syllabus

Fall 2020

Course: MSSC 6010 Computational Probability

Time: TuTh 5:00-6:15 Cudahy Hall 417

Instructor: Daniel B. Rowe, Ph.D.

Office Hours: TuTh 4:00-5:00 pm

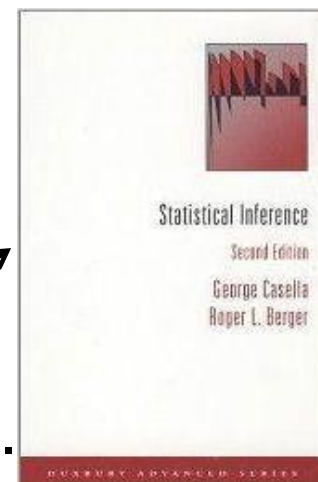
Office: Via Teams/Cudahy Hall 313

E-mail: daniel.rowe@marquette.edu

Text: (reference) Casella, G. & Berger, R.L. (2002).

Statistical Inference, Second edition, Duxbury.

ISBN: 0-534-24312-6



Grading: A take-home midterm on Oct 24, weekly homework & class participation, and a final project presented on Dec 2, 5:45 pm – 7:45 pm.

Homework & Participation (30%), Mid-Term (30%), Final (40%).

Matlab Introduction

- Arithmetic and Variables, Arrays and Indexing, Programming, Plotting, Functions and m-files, Importing and Exporting Images

Math Review

- Differentiation, Integration

Discrete Distributions

- properties, moments, expectation, MGF, transformation of variable
- Bernoulli, binomial, Poisson, hypergeometric

Continuous Distributions

- properties, expectation, moments, MGF, transformation of variable
- uniform, beta, normal, chi square, gamma, exponential, student t, F,
- random samples, likelihood, MLE, hypothesis testing, LRT

Multivariate Distributions

- normal, student t, Wishart, inverse Wishart

Numerical Flavor

All slides are a summary of the material and do not contain all detail. Book is ultimate authority.

Matlab Introduction

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Outline

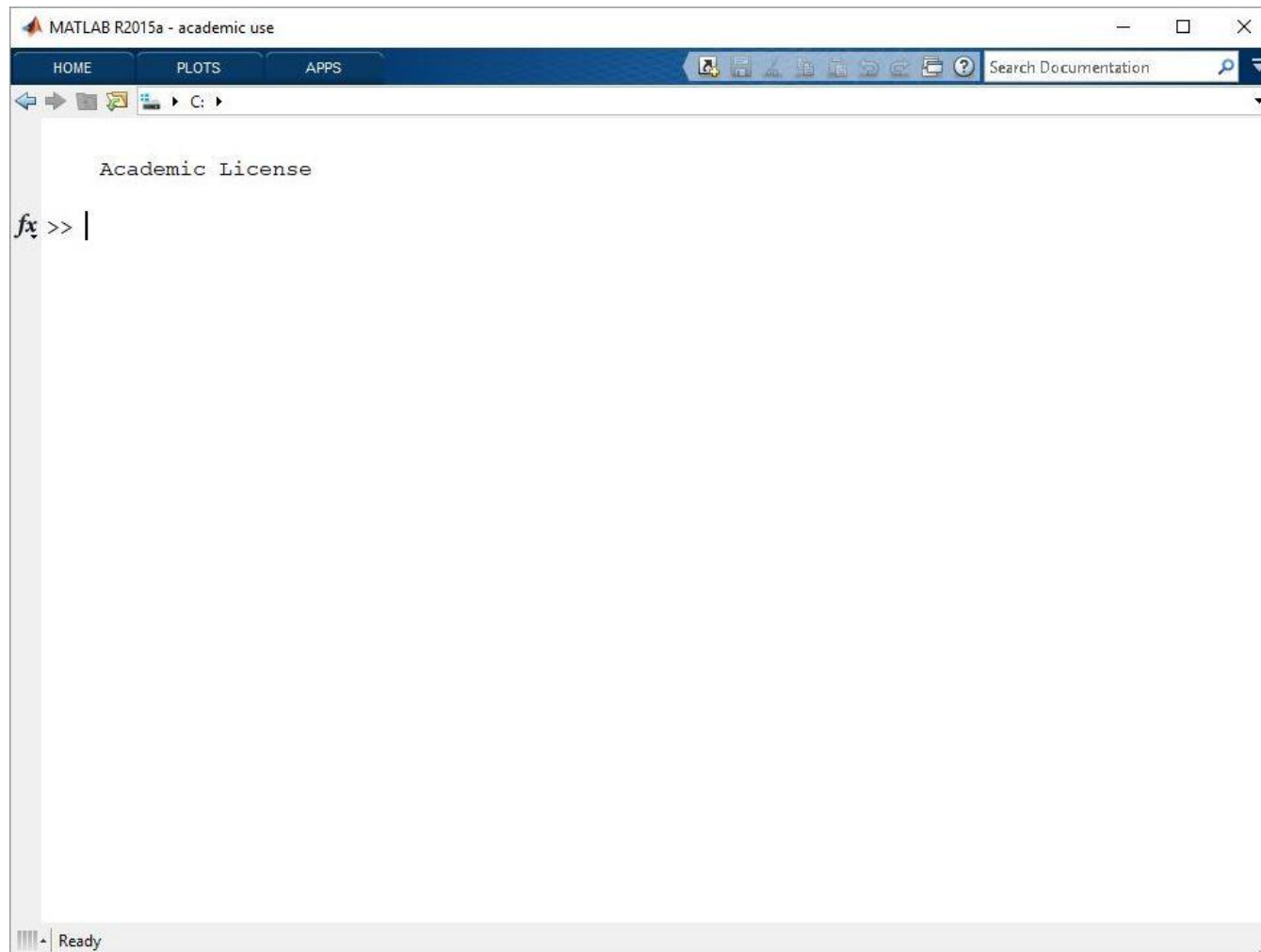
- About Matlab
- Arithmetic and Variables
- Arrays and Indexing
- Programming
- Plotting
- Functions and m-files
- Importing and Exporting
- Images
- Summary

About MATLAB

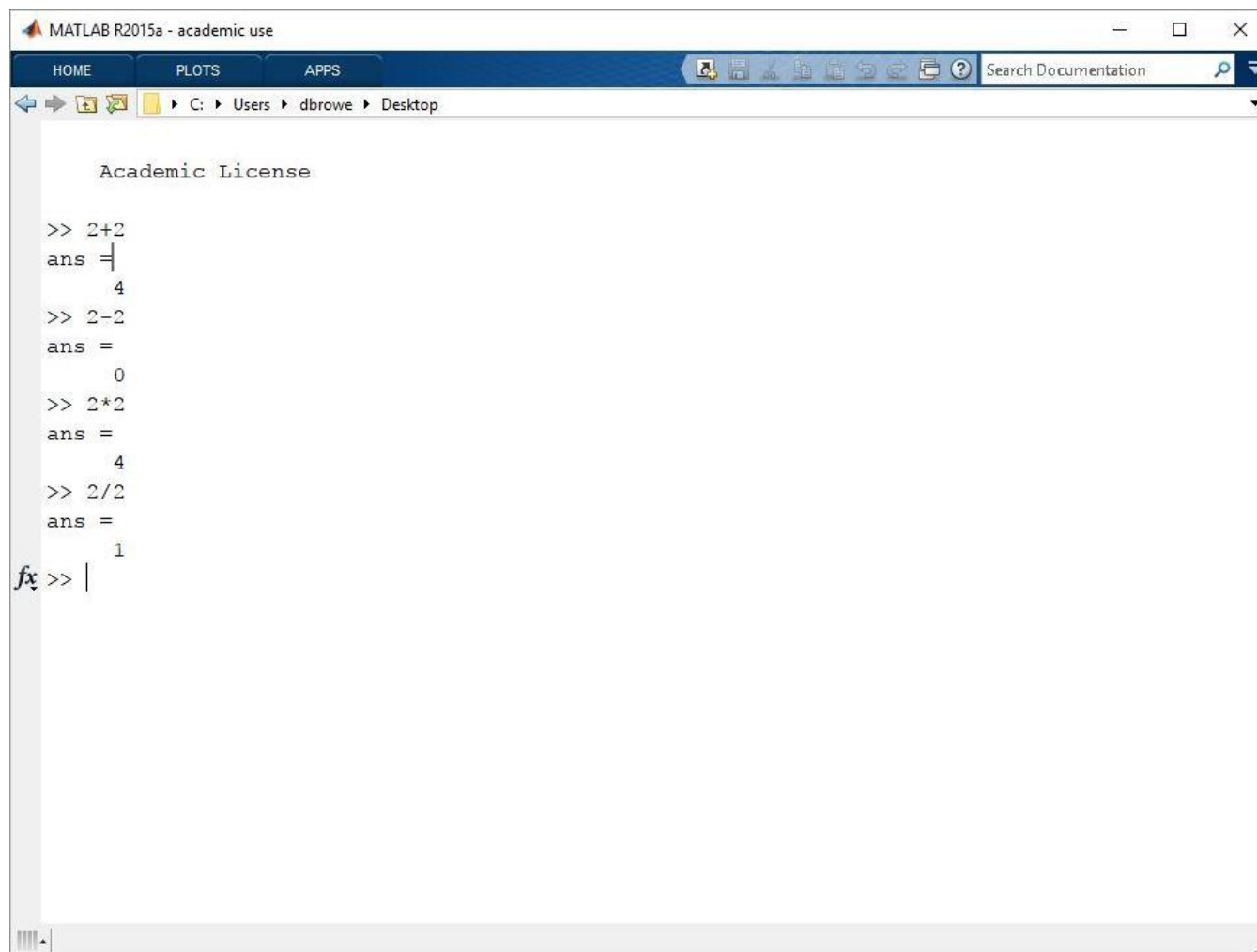
“MATLAB® is a high-level language and interactive environment that enables you to perform computationally intensive tasks faster than with traditional programming languages such as C, C++, and Fortran.”

Incredible for piloting and development!

About MATLAB



Arithmetic and Variables

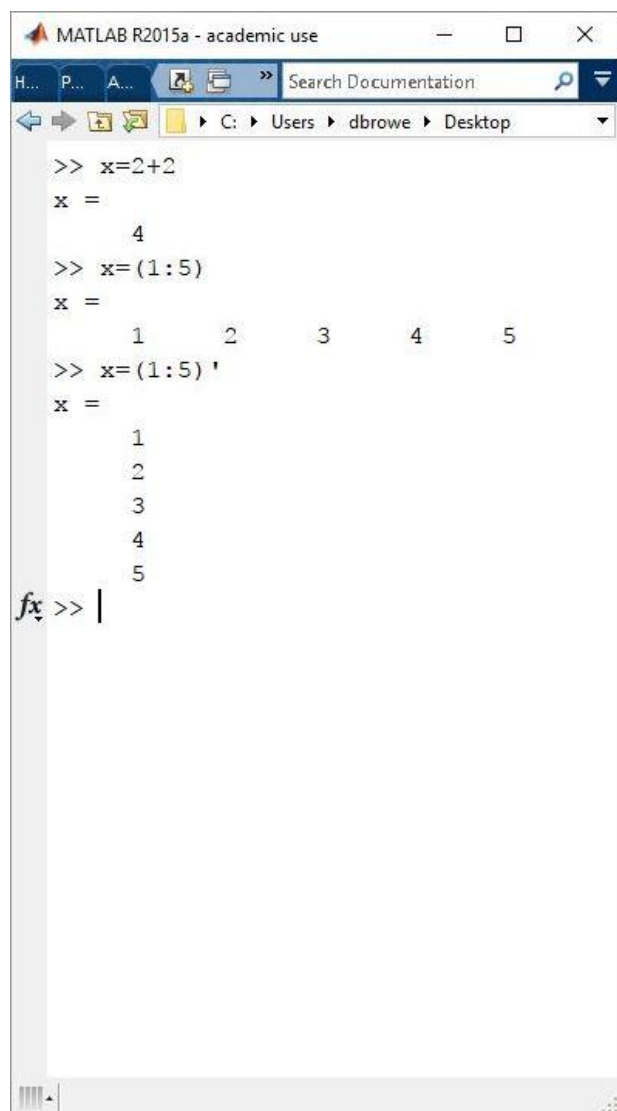


The image shows the MATLAB R2015a - academic use window. The title bar indicates the version and license. The interface includes a ribbon with tabs for HOME, PLOTS, and APPS. Below the ribbon is a toolbar with various icons and a search bar labeled "Search Documentation". The main workspace displays the file path "C:\Users\dbrowe\Desktop". The Command Window, located at the bottom, shows the following text:

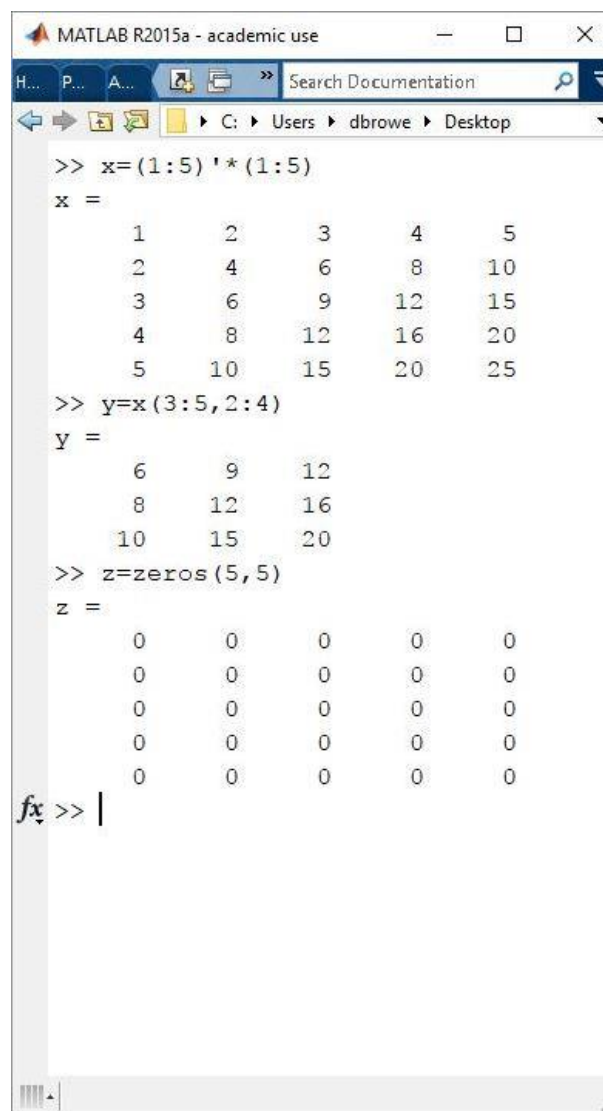
```
Academic License

>> 2+2
ans =
    4
>> 2-2
ans =
    0
>> 2*2
ans =
    4
>> 2/2
ans =
    1
fx >> |
```

Arrays and Indexing



```
MATLAB R2015a - academic use
>> x=2+2
x =
    4
>> x=(1:5)
x =
    1    2    3    4    5
>> x=(1:5) '
x =
    1
    2
    3
    4
    5
fx >> |
```



```
MATLAB R2015a - academic use
>> x=(1:5) '*(1:5)
x =
    1    2    3    4    5
    2    4    6    8   10
    3    6    9   12   15
    4    8   12   16   20
    5   10   15   20   25
>> y=x(3:5,2:4)
y =
    6    9   12
    8   12   16
   10   15   20
>> z=zeros(5,5)
z =
    0    0    0    0    0
    0    0    0    0    0
    0    0    0    0    0
    0    0    0    0    0
    0    0    0    0    0
fx >> |
```

Arrays and Indexing

```
MATLAB R2015a - academic use
H... P... A... » Search Documentation
C: > Users > dbrowe > Desktop

>> x=[1,2,3;4,5,6]
x =
     1     2     3
     4     5     6
>> x=ones(3,3)
x =
     1     1     1
     1     1     1
     1     1     1
>> x=eye(4)
x =
     1     0     0     0
     0     1     0     0
     0     0     1     0
     0     0     0     1
fx >> |
```

```
MATLAB R2015a - academic use
H... P... A... » Search Documentation
C: > Users > dbrowe > Desktop

>> x=randn(3)
x =
     0.5377     0.8622    -0.4336
     1.8339     0.3188     0.3426
    -2.2588    -1.3077     3.5784
>> x(3,:)=[]
x =
     0.5377     0.8622    -0.4336
     1.8339     0.3188     0.3426
>> x=[x;1,2,3]
x =
     0.5377     0.8622    -0.4336
     1.8339     0.3188     0.3426
     1.0000     2.0000     3.0000
fx >> |
```

Arithmetic and Variables

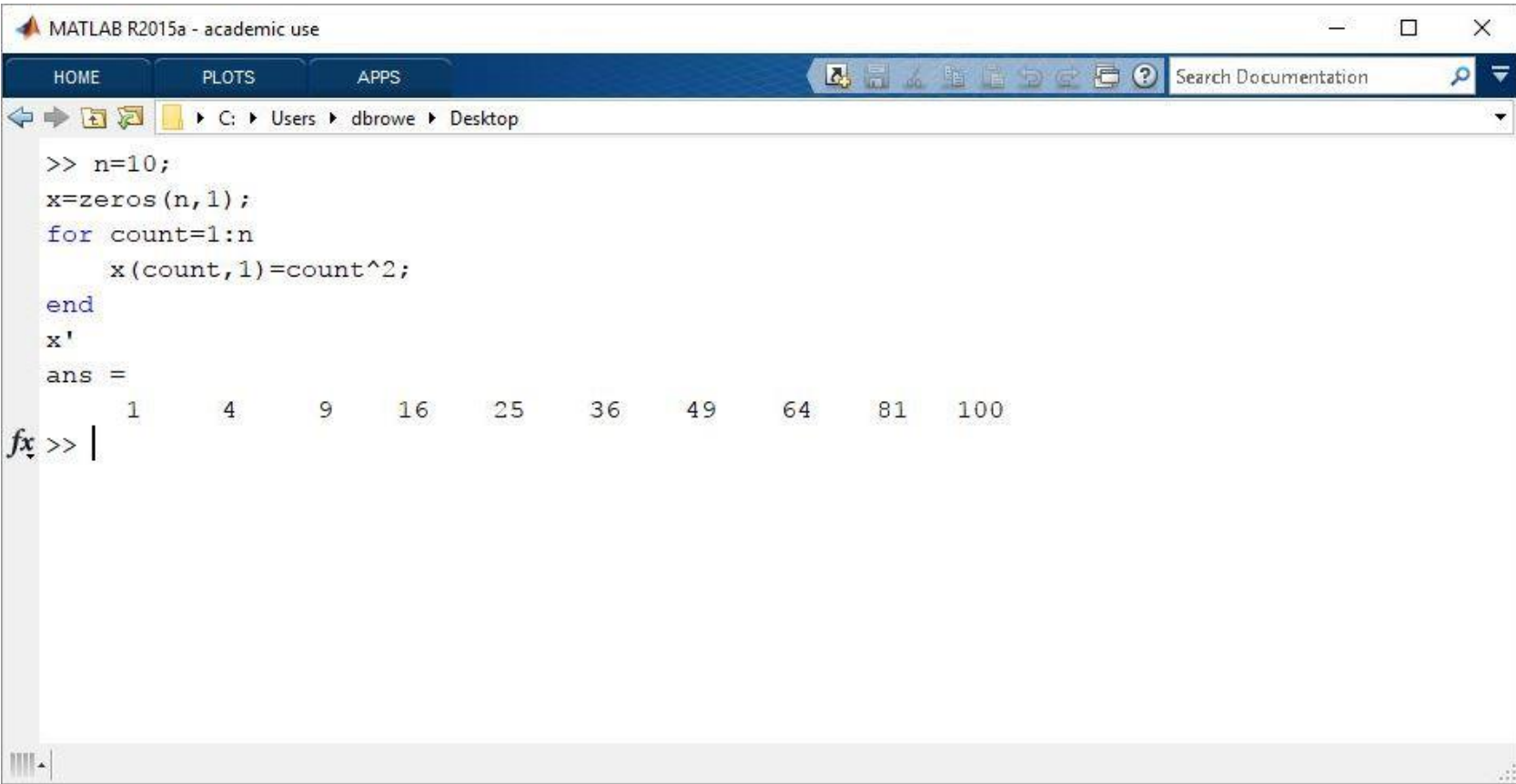
Matrix Operations:

$+$, $-$, $*$, $/$, $\text{sqrt}()$, $\text{sin}()$, $\text{det}()$, $\text{eig}()$, $\text{rank}()$, ...

Element Operations:

$.$, $*$, $/$, 2 , $A.*B$, $A./B$, ...

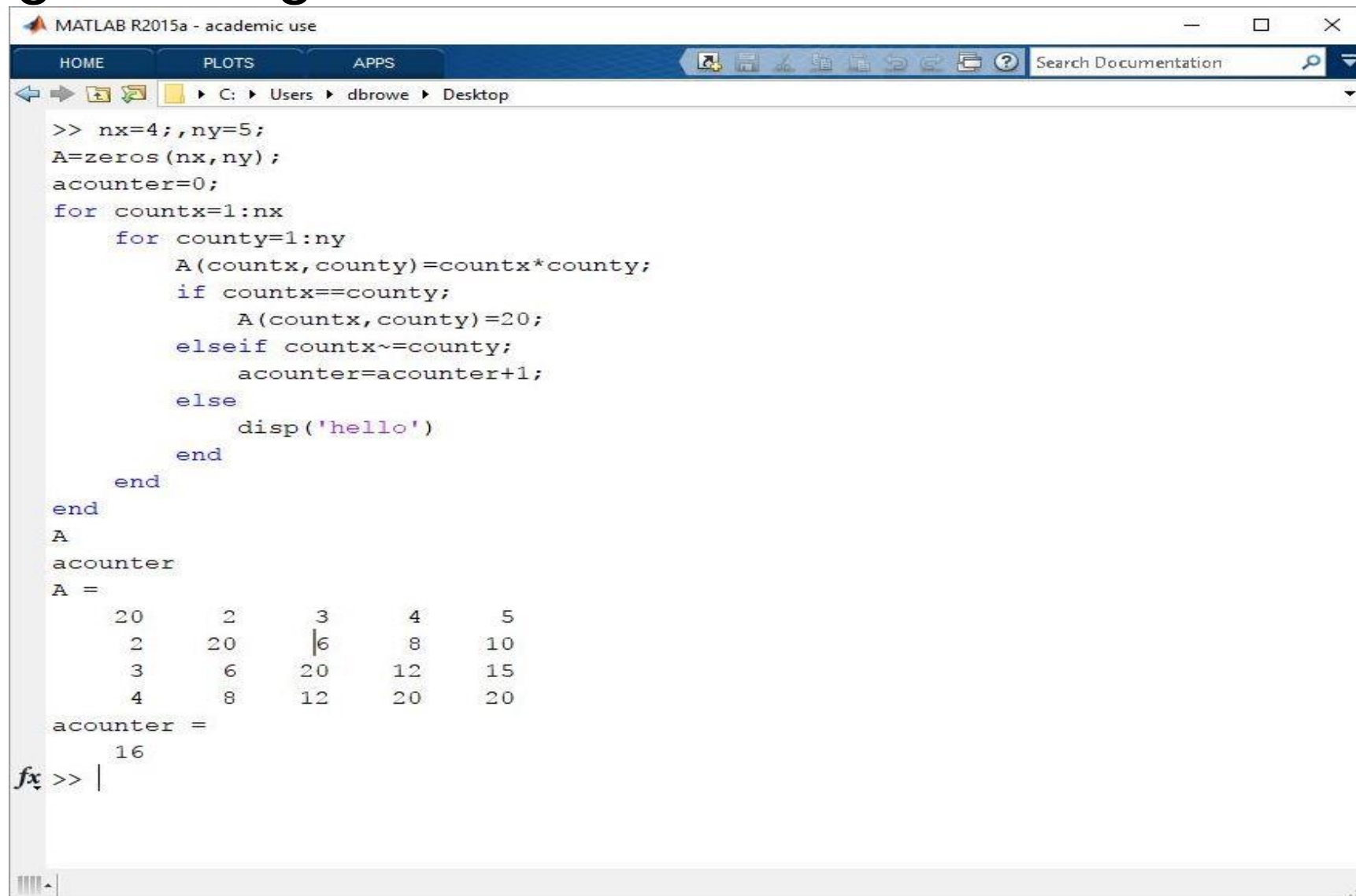
Programming



The image shows a MATLAB R2015a window titled "MATLAB R2015a - academic use". The window has a menu bar with "HOME", "PLOTS", and "APPS". Below the menu bar is a toolbar with various icons and a "Search Documentation" field. The main area displays a script being executed. The script defines `n=10`, creates a zero vector `x=zeros(n,1)`, and uses a `for` loop to calculate the squares of integers from 1 to 10, storing them in `x`. The output is displayed as `ans =` followed by the values 1, 4, 9, 16, 25, 36, 49, 64, 81, and 100. The command prompt shows `>> |`.

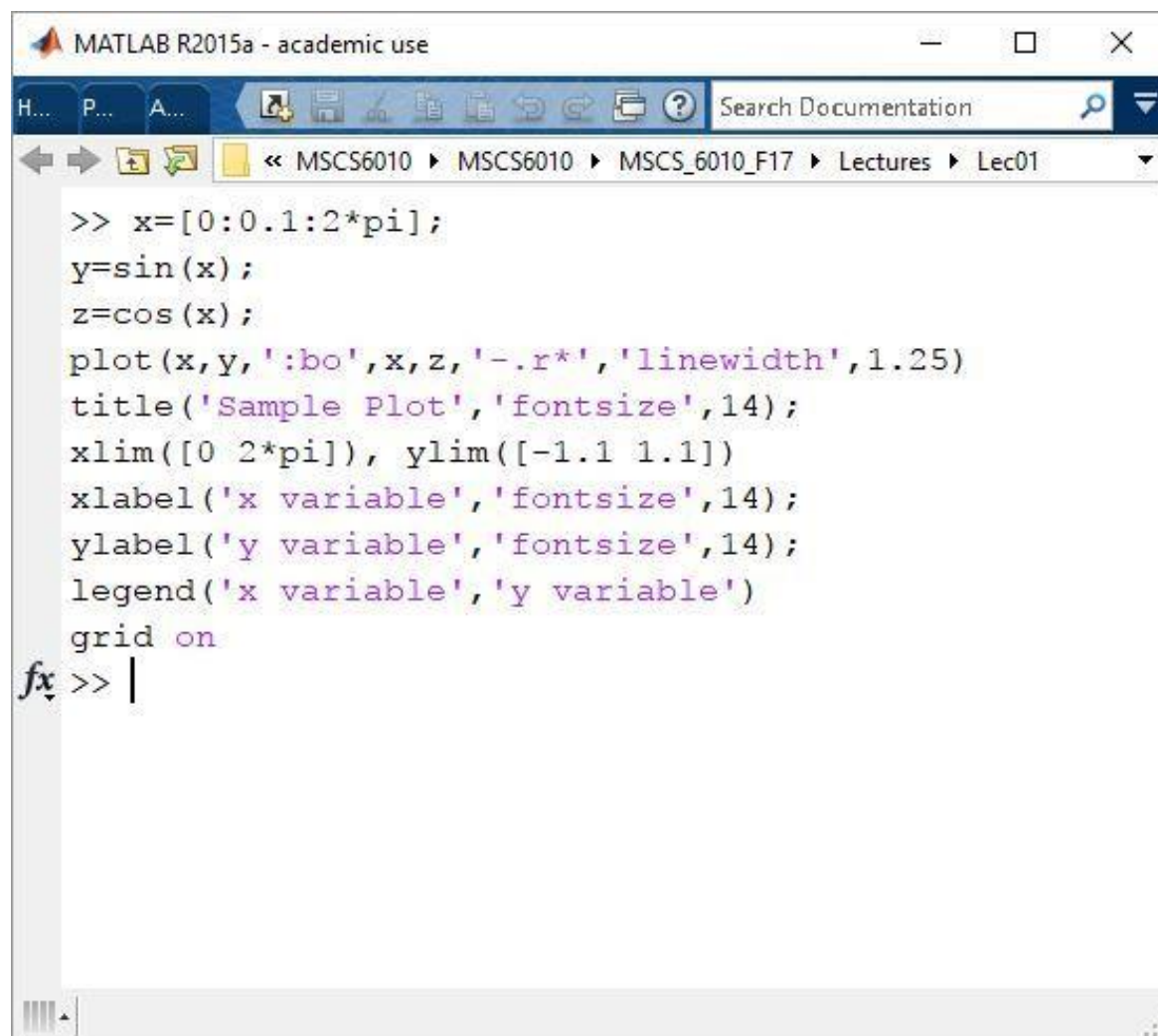
```
>> n=10;
x=zeros(n,1);
for count=1:n
    x(count,1)=count^2;
end
x'
ans =
    1     4     9    16    25    36    49    64    81   100
fx >> |
```

Programming



```
MATLAB R2015a - academic use
HOME PLOTS APPS
C:\Users\dbrowe\Desktop
>> nx=4;ny=5;
A=zeros(nx,ny);
acounter=0;
for countx=1:nx
    for county=1:ny
        A(countx,county)=countx*county;
        if countx==county;
            A(countx,county)=20;
        elseif countx~=county;
            acounter=acounter+1;
        else
            disp('hello')
        end
    end
end
A
acounter
A =
    20     2     3     4     5
     2    20     6     8    10
     3     6    20    12    15
     4     8    12    20    20
acounter =
    16
fx >> |
```

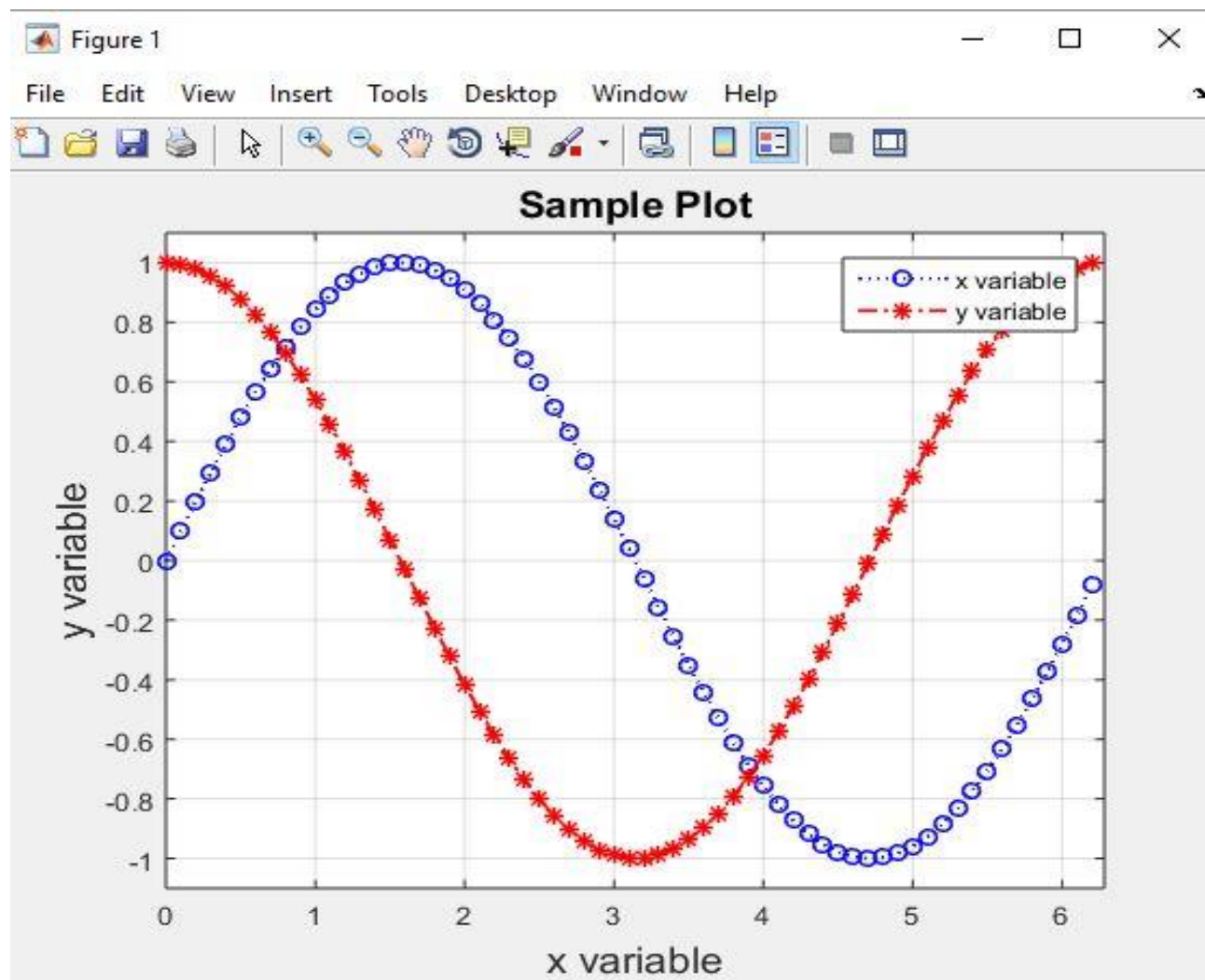
Plotting



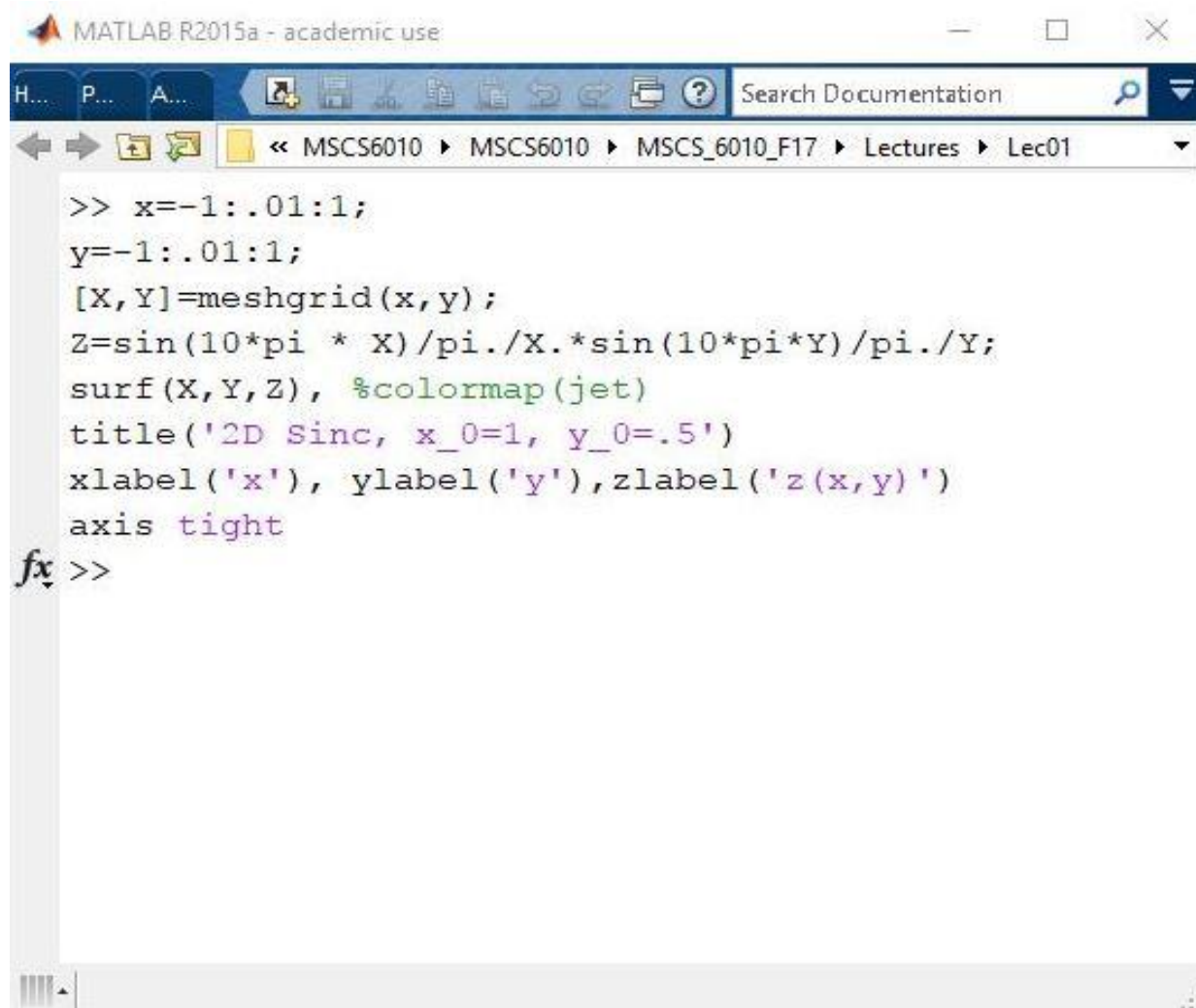
The image shows a MATLAB R2015a window titled "MATLAB R2015a - academic use". The window has a standard toolbar with icons for file operations, editing, and help. Below the toolbar is a search bar labeled "Search Documentation". The current directory is displayed as "MSCS6010 > MSCS6010 > MSCS_6010_F17 > Lectures > Lec01". The main area contains a MATLAB script with the following code:

```
>> x=[0:0.1:2*pi];  
y=sin(x);  
z=cos(x);  
plot(x,y,':bo',x,z,'-.r*', 'linewidth',1.25)  
title('Sample Plot','fontsize',14);  
xlim([0 2*pi]), ylim([-1.1 1.1])  
xlabel('x variable','fontsize',14);  
ylabel('y variable','fontsize',14);  
legend('x variable','y variable')  
grid on  
fx >> |
```

Plotting - 2D



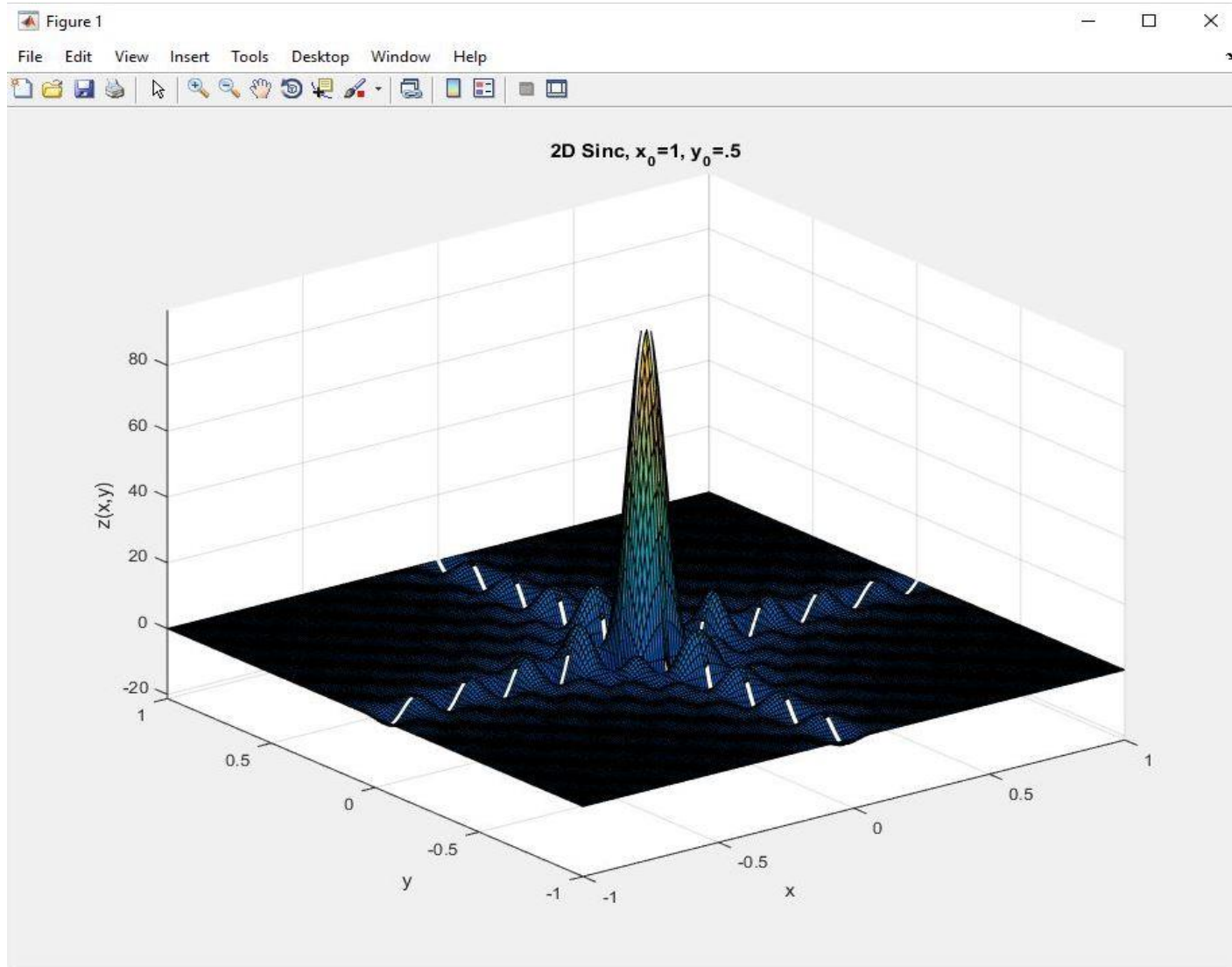
Plotting - 3D



The image shows a MATLAB R2015a window titled "MATLAB R2015a - academic use". The window has a menu bar with "H...", "P...", and "A...". Below the menu bar is a toolbar with icons for file operations and a search bar labeled "Search Documentation". The current directory is displayed as "<< MSCS6010 >> MSCS6010 >> MSCS_6010_F17 >> Lectures >> Lec01". The command window contains the following code:

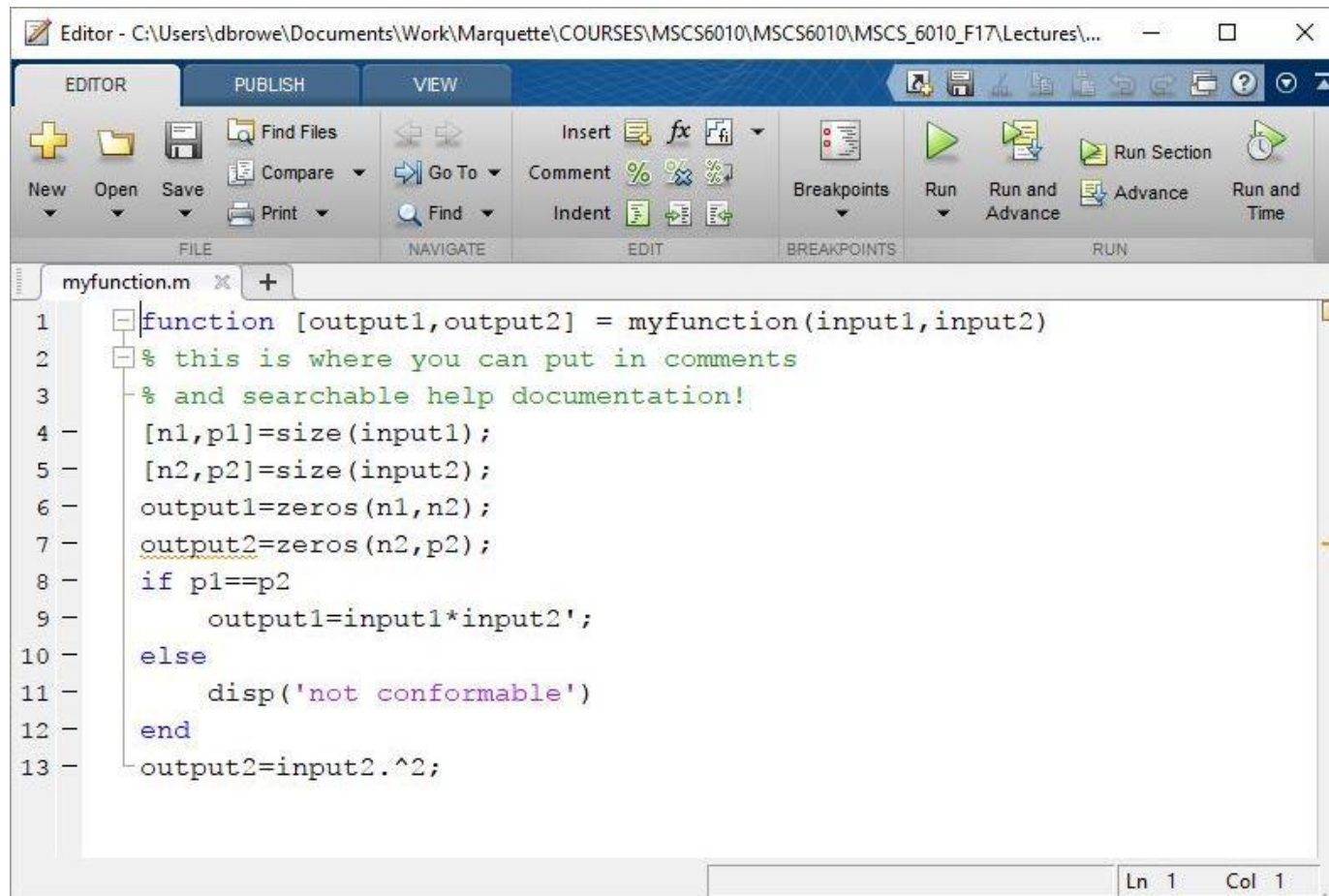
```
>> x=-1:.01:1;  
y=-1:.01:1;  
[X,Y]=meshgrid(x,y);  
Z=sin(10*pi * X)/pi./X.*sin(10*pi*Y)/pi./Y;  
surf(X,Y,Z), %colormap(jet)  
title('2D Sinc, x_0=1, y_0=.5')  
xlabel('x'), ylabel('y'), zlabel('z(x,y)')  
axis tight  
fx >>
```

Plotting - 3D



Functions and m-files

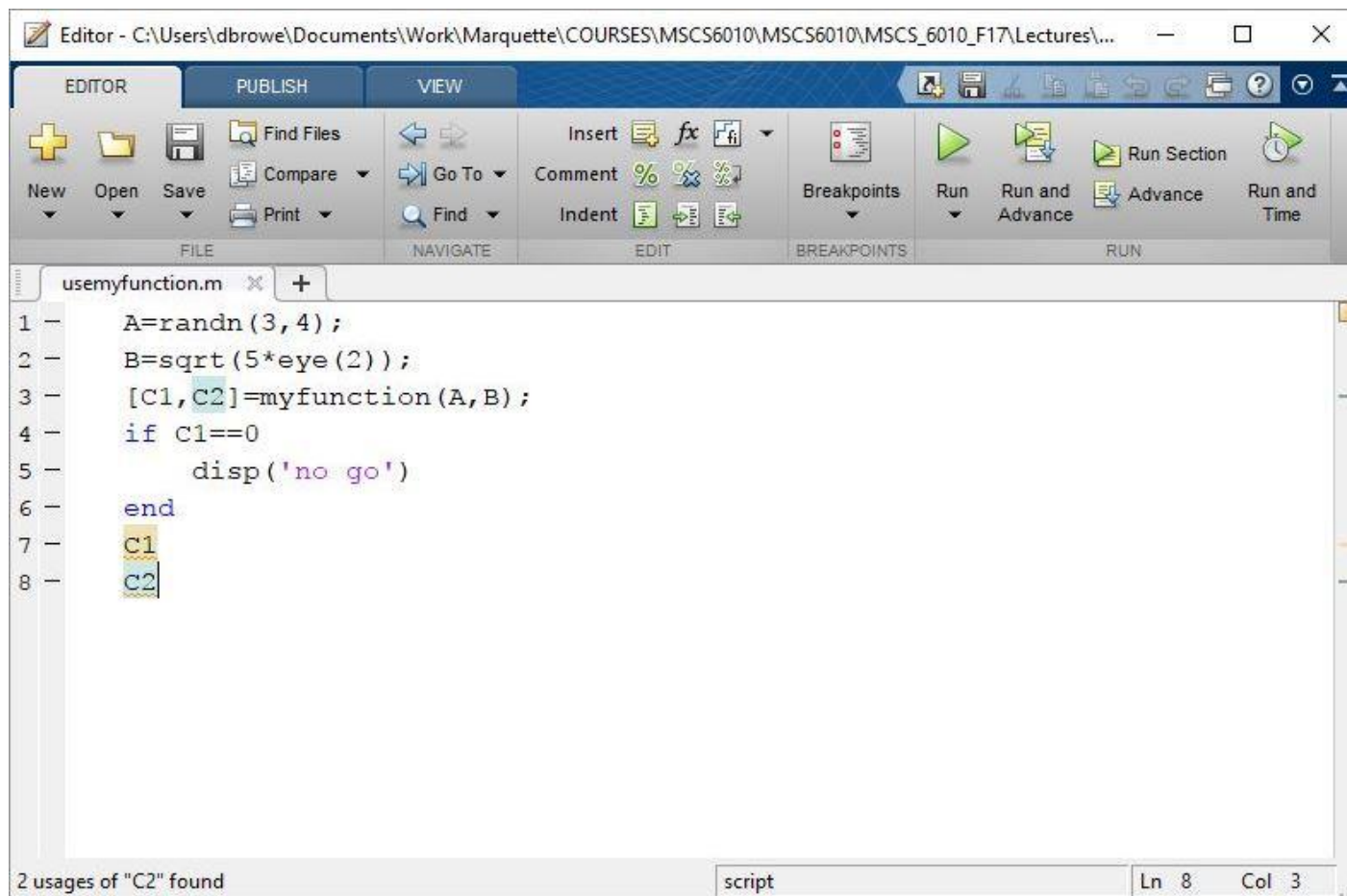
Create your own functions!



```
Editor - C:\Users\dbrowe\Documents\Work\Marquette\COURSES\MSCS6010\MSCS6010\MSCS_6010_F17\Lectures\...  
EDITOR PUBLISH VIEW  
New Open Save Find Files Compare Print Go To Find Insert Comment Indent Breakpoints Run Run and Advance Run Section Run and Time  
FILE NAVIGATE EDIT BREAKPOINTS RUN  
myfunction.m  
1 function [output1,output2] = myfunction(input1,input2)  
2 % this is where you can put in comments  
3 % and searchable help documentation!  
4 [n1,p1]=size(input1);  
5 [n2,p2]=size(input2);  
6 output1=zeros(n1,n2);  
7 output2=zeros(n2,p2);  
8 if p1==p2  
9     output1=input1*input2';  
10 else  
11     disp('not conformable')  
12 end  
13 output2=input2.^2;  
Ln 1 Col 1
```

Functions and m-files

Create your own functions!



Editor - C:\Users\dbrowe\Documents\Work\Marquette\COURSES\MSSC6010\MSSC6010\MSSC_6010_F17\Lectures\...

EDITOR PUBLISH VIEW

FILE NAVIGATE EDIT BREAKPOINTS RUN

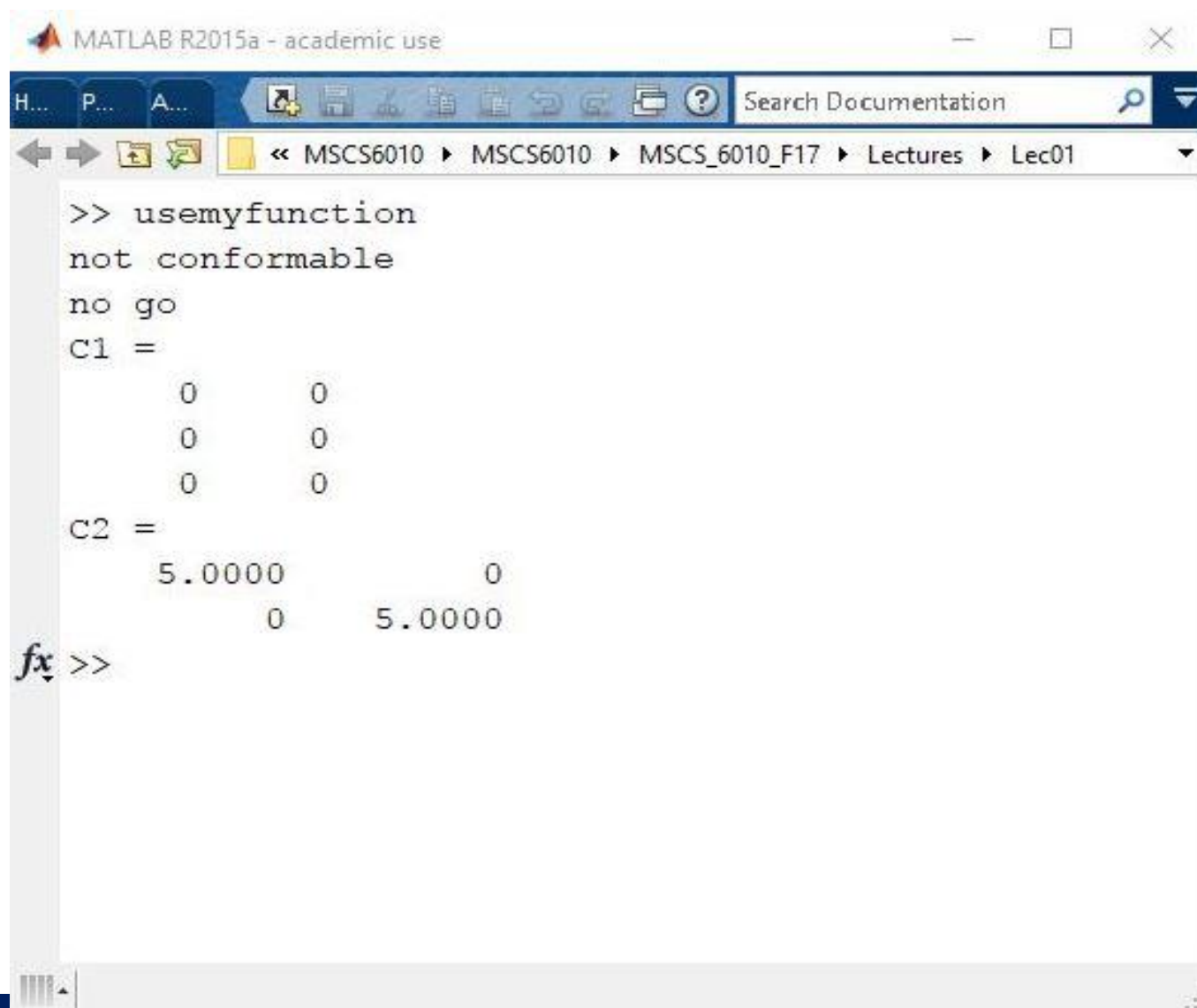
usemyfunction.m

```
1 - A=randn(3,4);
2 - B=sqrt(5*eye(2));
3 - [C1,C2]=myfunction(A,B);
4 - if C1==0
5 -     disp('no go')
6 - end
7 - C1
8 - C2
```

2 usages of "C2" found

script Ln 8 Col 3

Functions and m-files

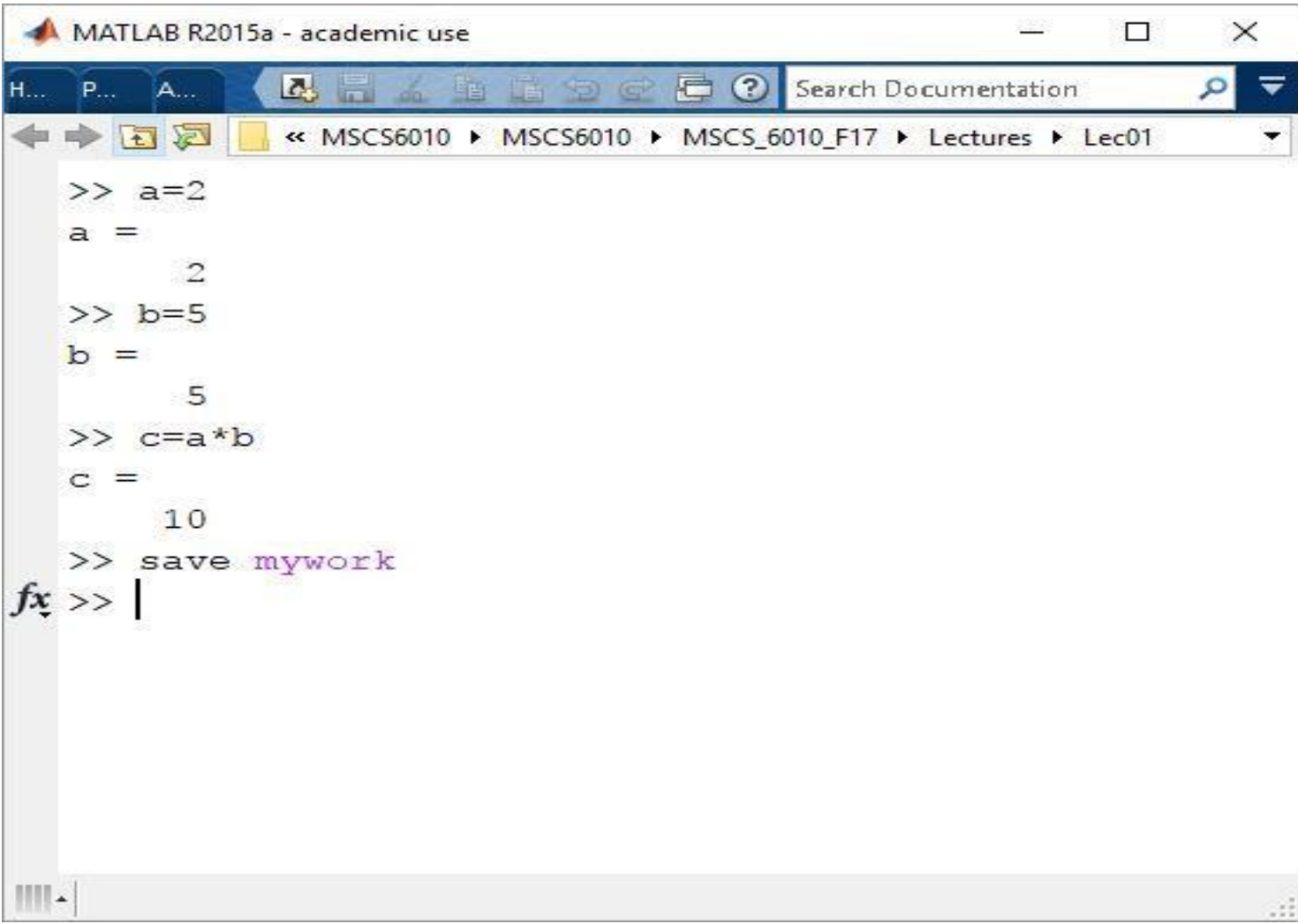


The image shows a MATLAB R2015a window titled "MATLAB R2015a - academic use". The window has a menu bar with "H...", "P...", and "A..." options. Below the menu bar is a toolbar with various icons, including a search icon. A search bar labeled "Search Documentation" is located to the right of the toolbar. Below the search bar is a breadcrumb navigation path: "<< MSCS6010 > MSCS6010 > MSCS_6010_F17 > Lectures > Lec01". The main area of the window displays the following text:

```
>> usemyfunction
not conformable
no go
C1 =
    0    0
    0    0
    0    0
C2 =
    5.0000    0
    0    5.0000
fx >>
```

The text "fx" is written in a stylized font and is followed by ">>".

Importing and Exporting

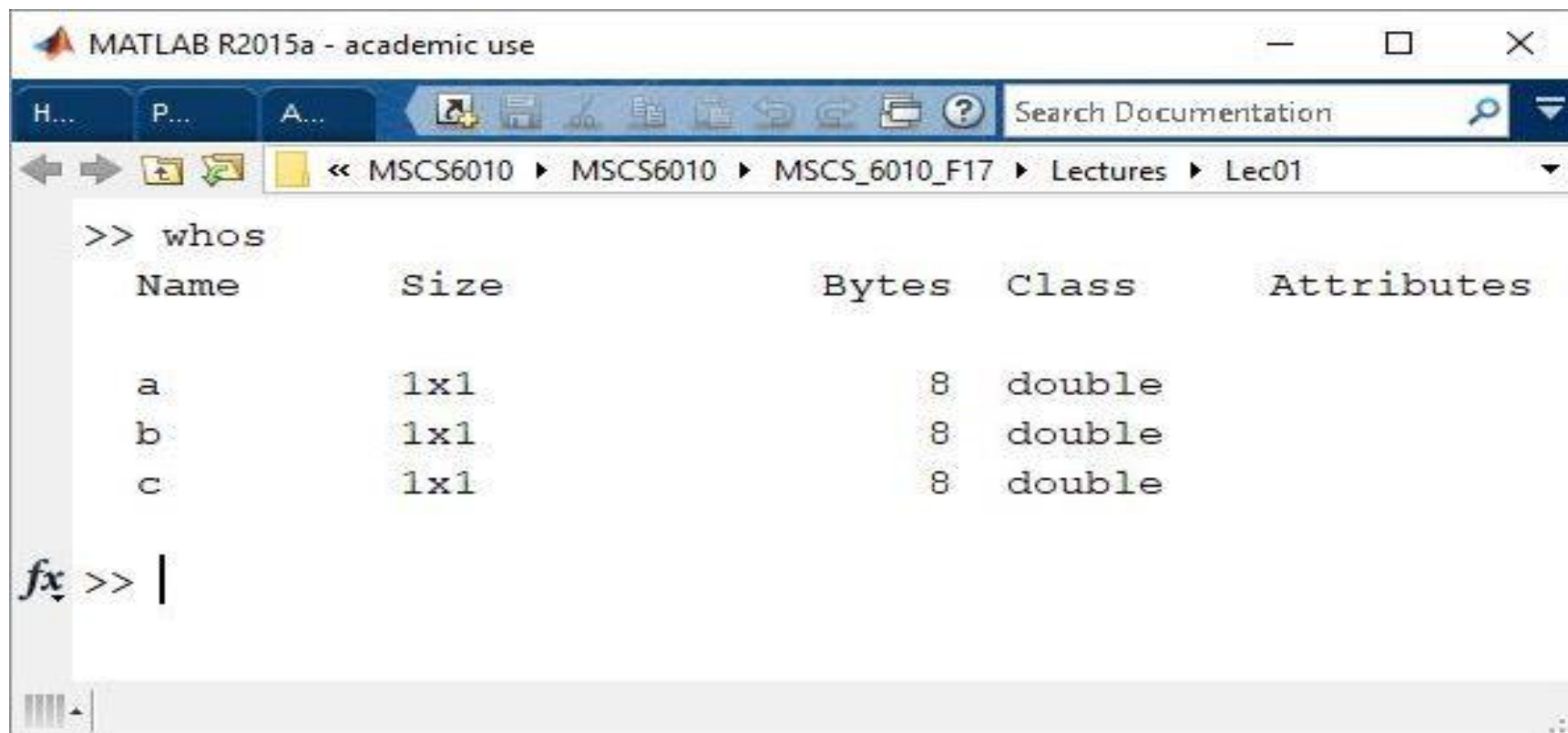


The image shows a screenshot of the MATLAB R2015a - academic use window. The window has a title bar with the MATLAB logo and text. Below the title bar is a toolbar with various icons for file operations and a search bar labeled "Search Documentation". The main area of the window displays a script with the following code:

```
>> a=2
a =
     2
>> b=5
b =
     5
>> c=a*b
c =
    10
>> save mywork
fx>> |
```

The script defines variables `a` and `b`, calculates `c = a*b`, and saves the workspace to a file named `mywork`. The cursor is positioned at the end of the last line of code.

Importing and Exporting



The screenshot shows the MATLAB R2015a - academic use window. The Command Window displays the output of the `whos` command, which lists the variables `a`, `b`, and `c` in the workspace. The output is as follows:

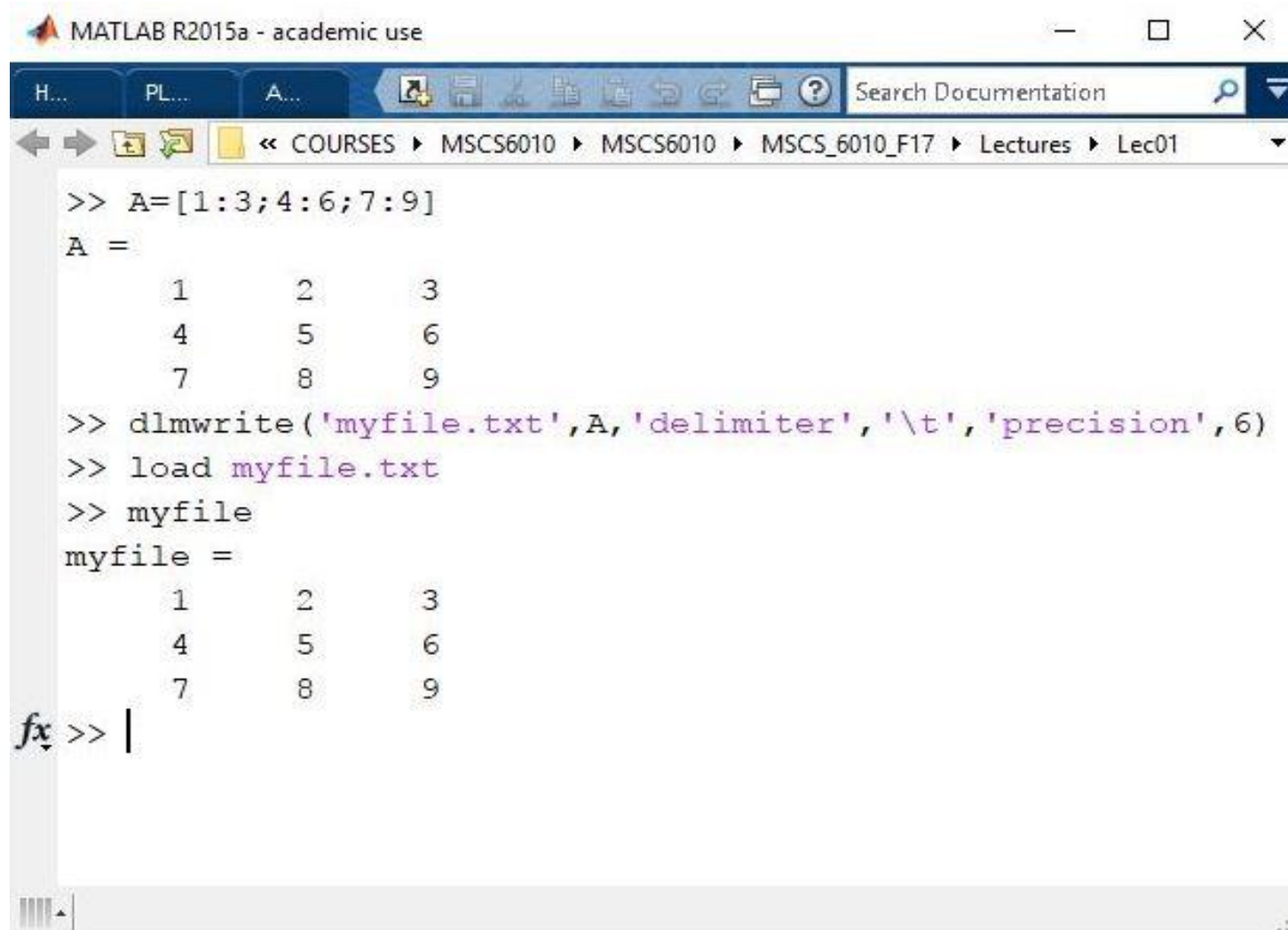
Name	Size	Bytes	Class	Attributes
a	1x1	8	double	
b	1x1	8	double	
c	1x1	8	double	

The Command Window prompt is `>> |`.

The file type is .mat

To read back in use “load mywork”

Importing and Exporting



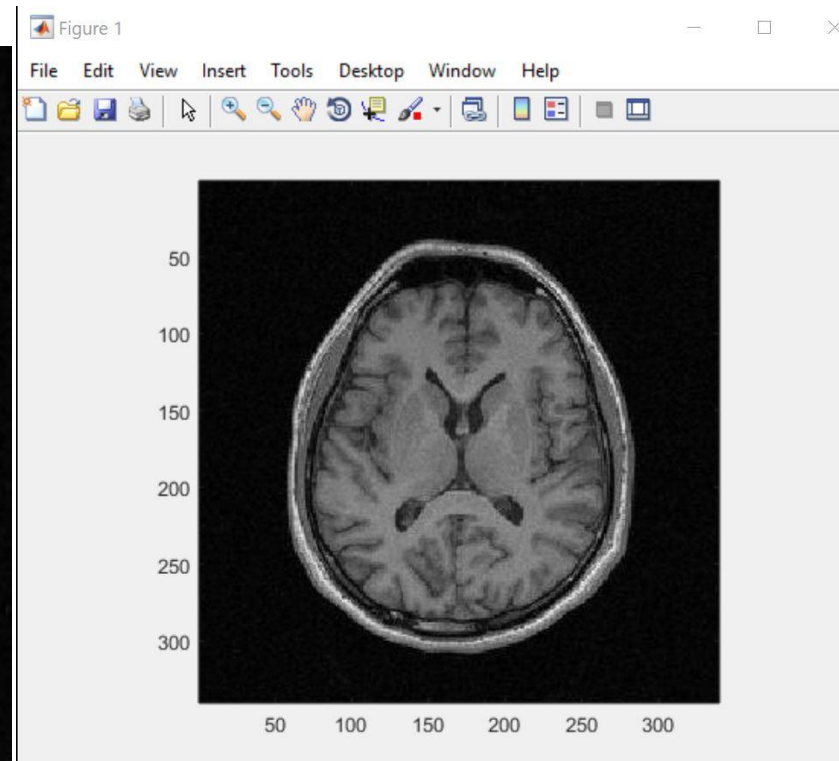
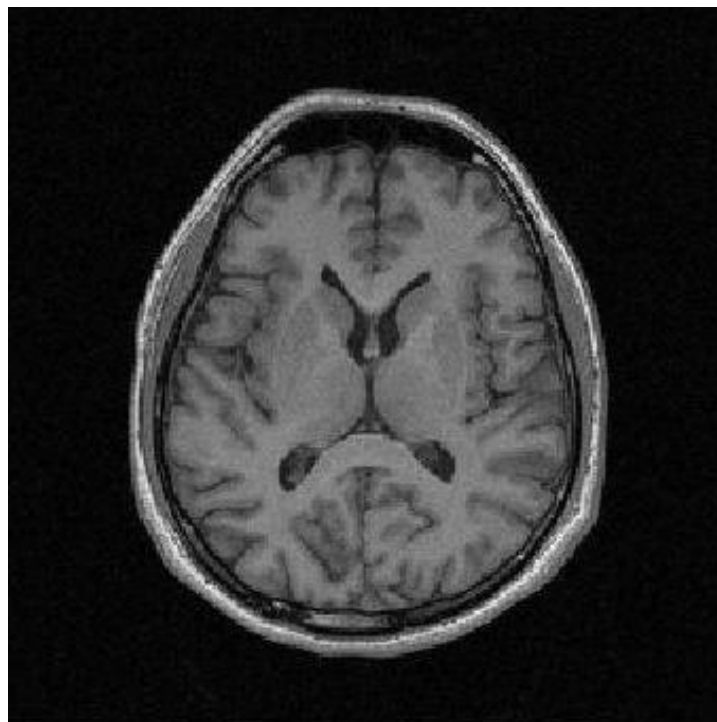
The image shows a MATLAB R2015a window titled "MATLAB R2015a - academic use". The window has a standard toolbar and a search bar. The current directory is set to "COURSES > MSCS6010 > MSCS6010 > MSCS_6010_F17 > Lectures > Lec01". The command window displays the following code and output:

```
>> A=[1:3;4:6;7:9]
A =
     1     2     3
     4     5     6
     7     8     9

>> dlmwrite('myfile.txt',A,'delimiter','\t','precision',6)
>> load myfile.txt
>> myfile
myfile =
     1     2     3
     4     5     6
     7     8     9

fx >> |
```

Images



Editor - C:\Users\dbrowe\Documents\Work\Marquette\COURSES\MSC56010\MSC56010\MSC5_6010_F17\Lectures\...

EDITOR PUBLISH VIEW

New Open Save Find Files Compare Print Go To Find Insert Comment Indent Breakpoints Run Run and Advance Run Section Advance Run and Time

imageSWI.m

```
1 brainimage=imread('imageSWI.jpg');
2 figure;
3 image(brainimage)
4 axis image
5
```

script Ln 1 Col 1

Movies

Some Additional Toolboxes

- Bioinformatics Toolbox
- Curve Fitting Toolbox
- Financial Toolbox
- Image Processing Toolbox
- Optimization Toolbox
- Signal Processing Toolbox
- Statistics Toolbox
- Wavelet Toolbox

Summary

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- Arithmetic and Variables
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- Programming
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- Images