Introduction to Matlab

Dr. Daniel B. Rowe
Professor of Computational Statistics
Department of Mathematical and Statistical Sciences
Marquette University

Outline

Installing Matlab

Using Matlab

Saving/Loading from/into Matlab

Functions in Matlab

Discussion

Homework

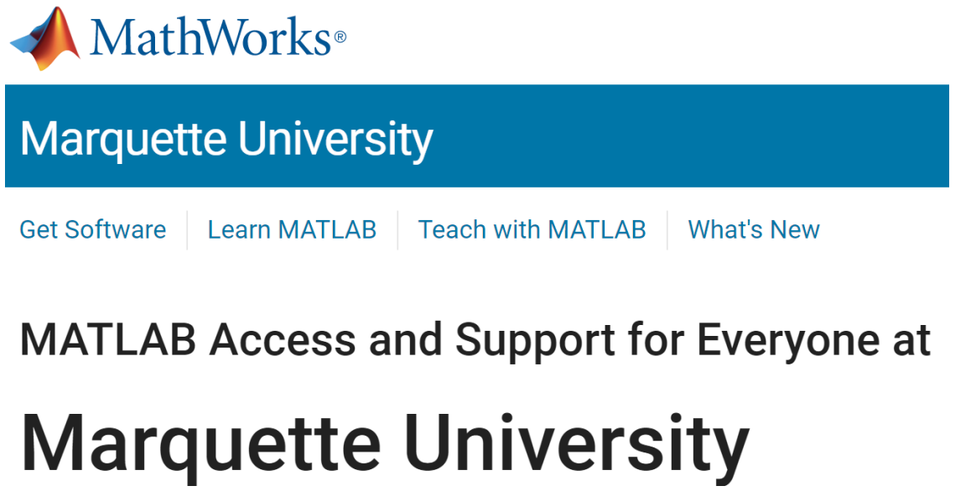
Installing Matlab

For Marquette University students, Matlab is available

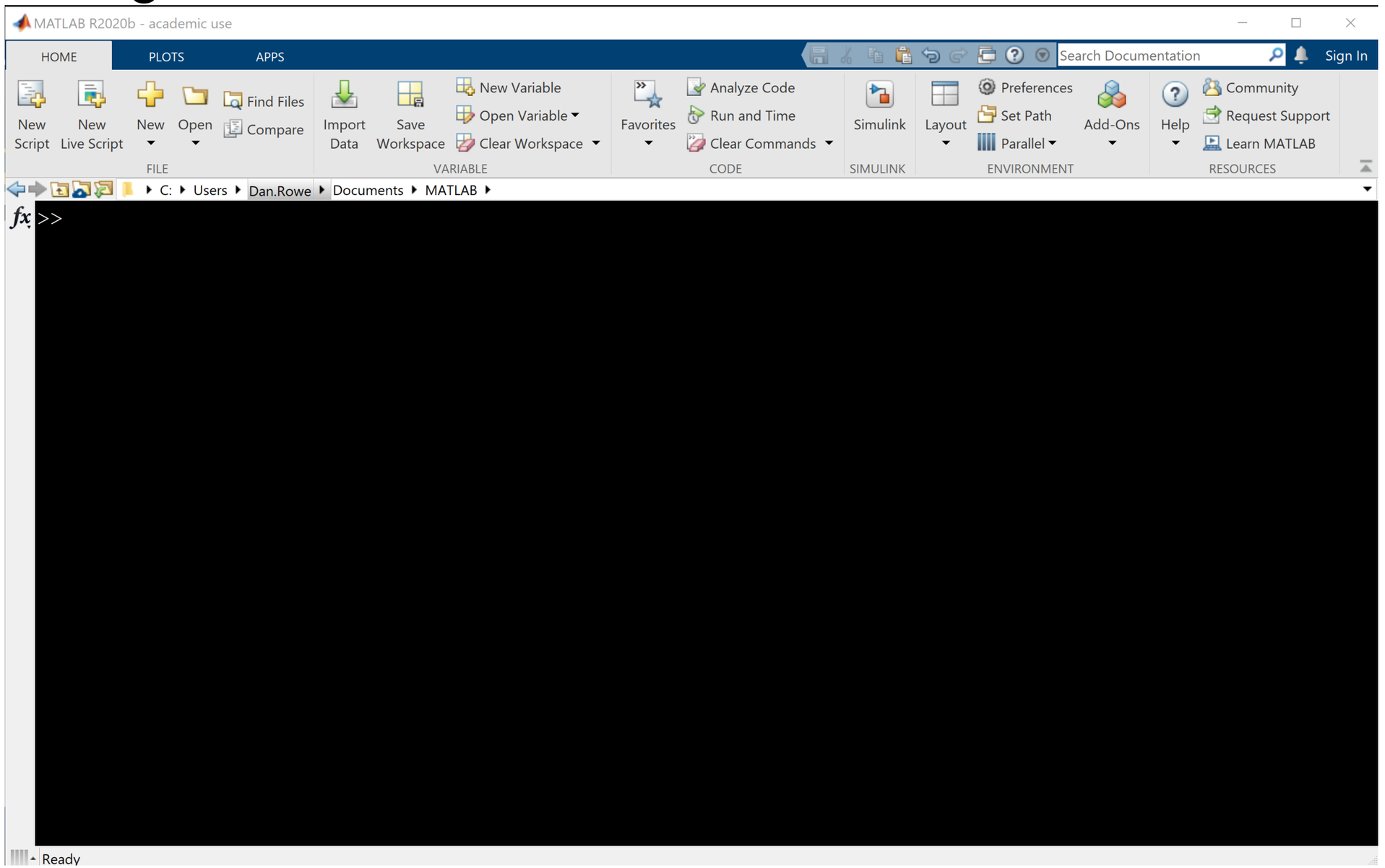
to download without cost using the institutions license.

You will need your Marquette email address for this.

https://techsquad.mu.edu/support/solutions/articles/21001160044-Download-and-Install-MATLAB-and-Simulink-Software



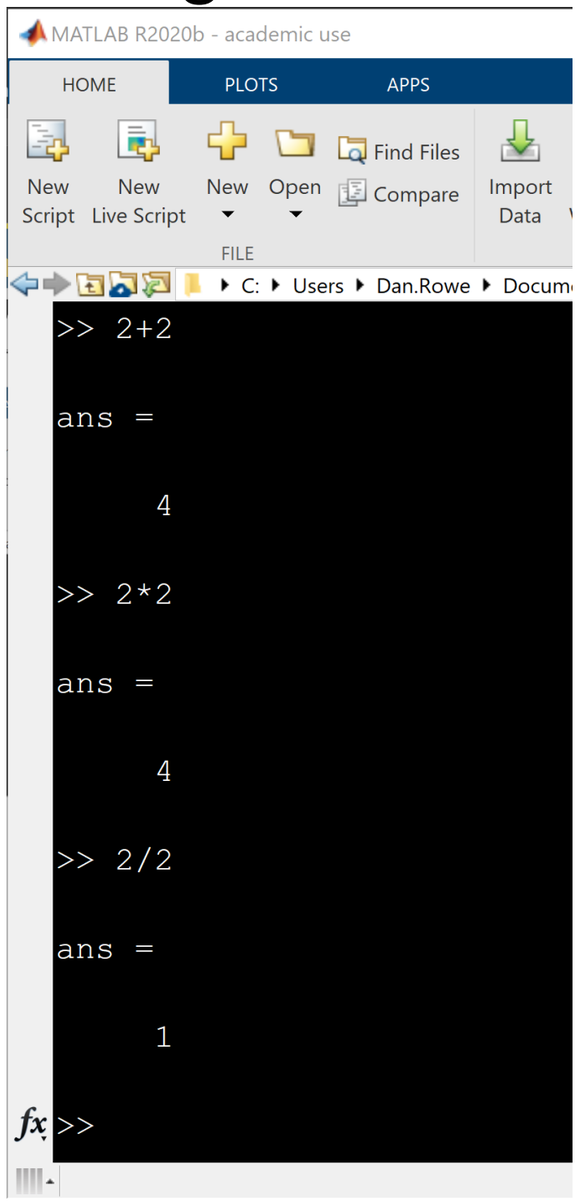
Using Matlab



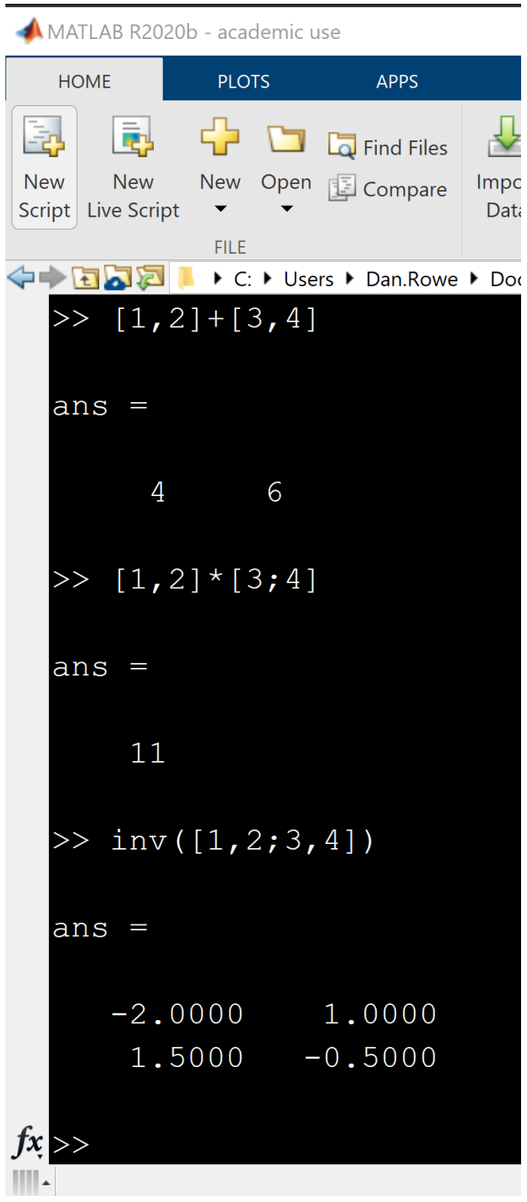
Command Window

You can type directly.

Using Matlab



Type directly into the command window for arithmetic



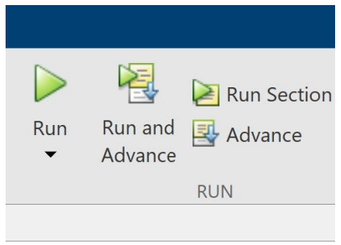
Type directly into the command window for vector and matrix operations.

Using Matlab

Don't type directly into the command window.

Type into a script.

Save and run!



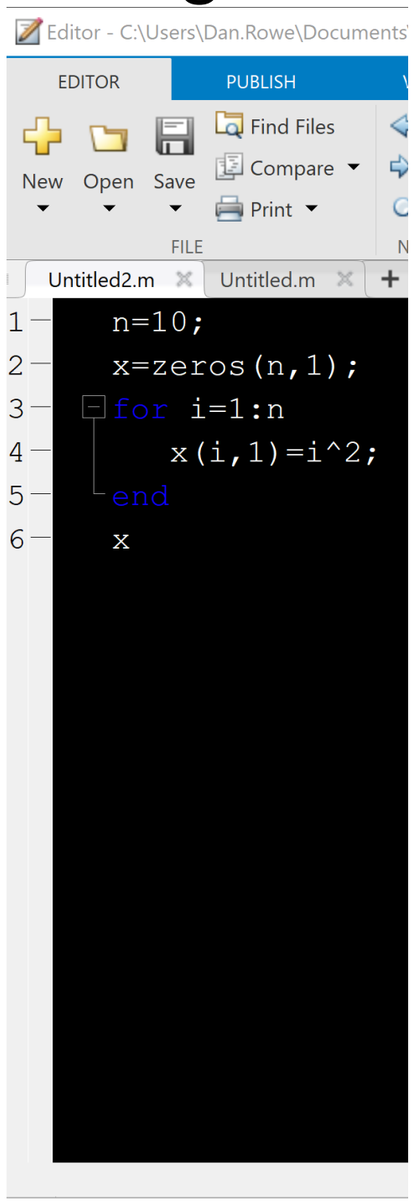

```
x=1;
y=2;
z=x+y
u=x/y

v=[1,2]
w=[3,4]
vwt=v*w'

A=[1,2;3,4]
B=[5,6;7,8]
AB=A*B
AinvB=A*inv(B)
AdivB=A./B
```

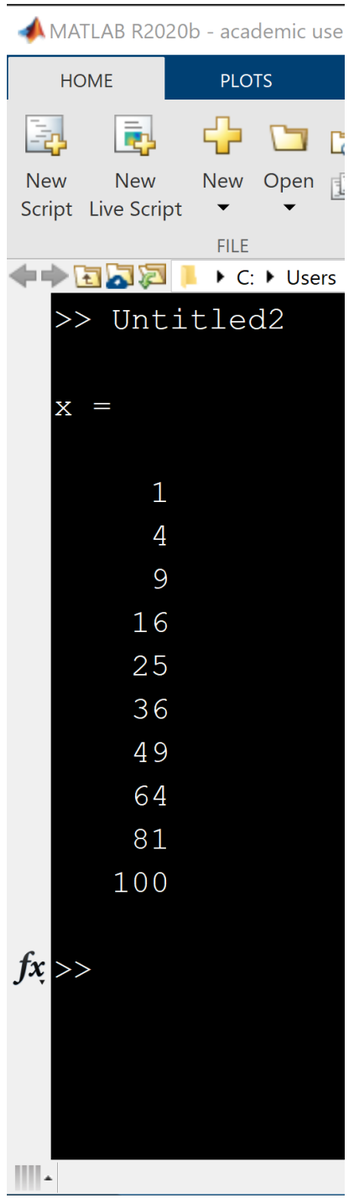
```
>> Untitled

z =

     3

u =

    0.5000

v =

     1     2

w =

     3     4
```

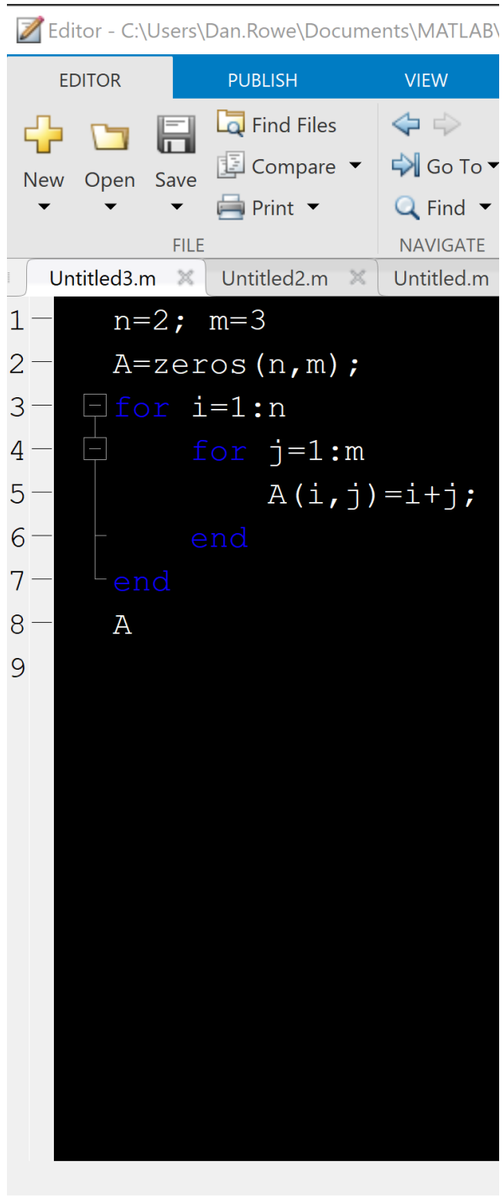
...

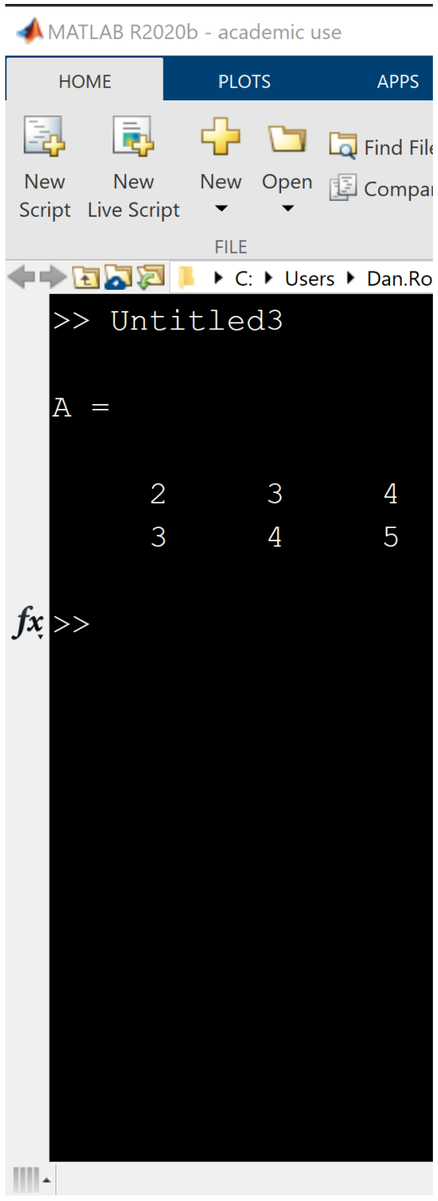
```
AB =

    19    22
    43    50

AinvB =

    3.0000   -2.0000
    2.0000   -1.0000

AdivB =

    0.2000    0.3333
    0.4286    0.5000

>>
```

Using Matlab









Using Matlab

Editor - C:\Users\Dan.Rowe\Documents\MATLAB\Untitled4.m

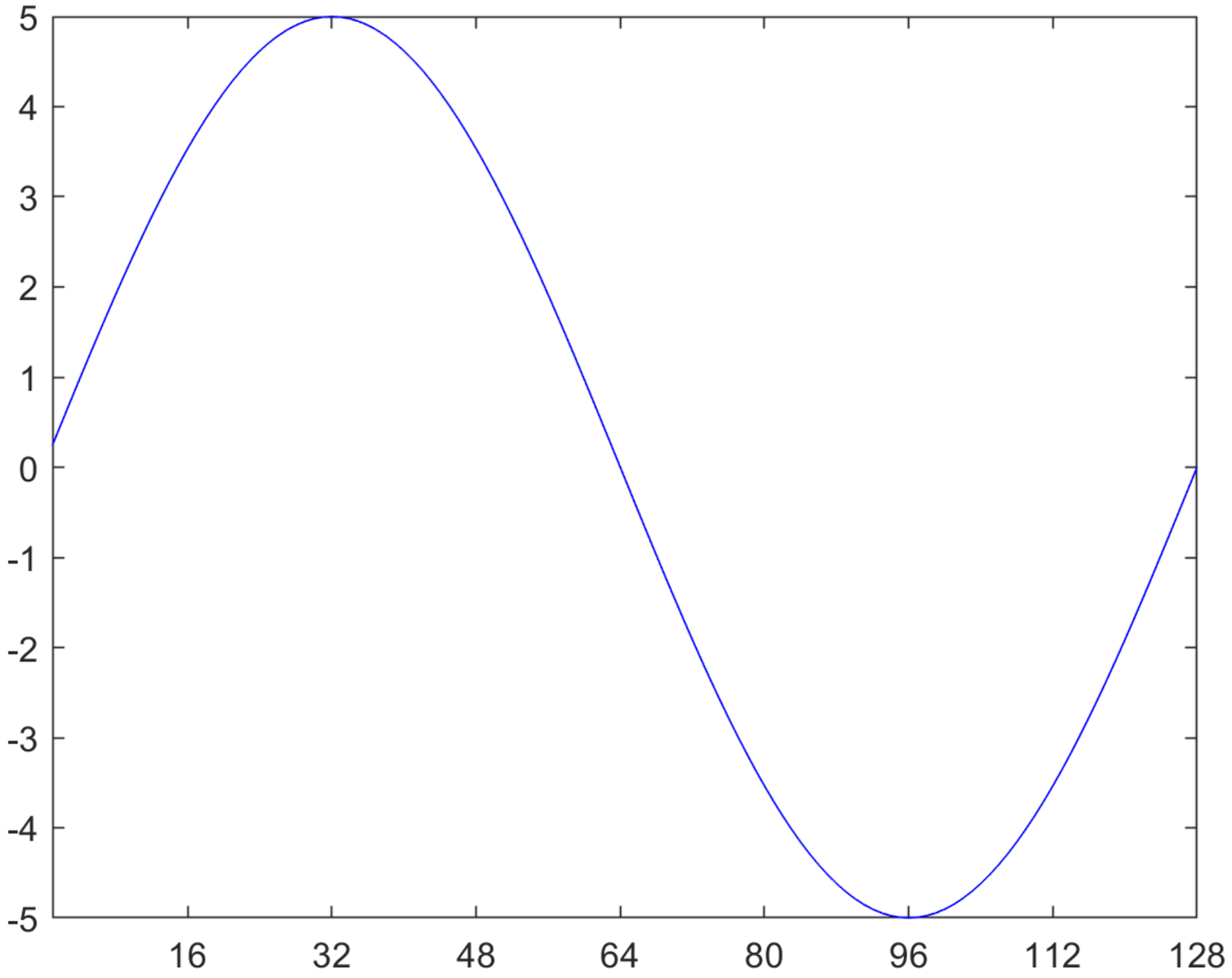
EDITOR | PUBLISH | VIEW

New | Open | Save | Find Files | Compare | Print | Go To | Find | Insert | Comment | Indent

FILE | NAVIGATE

Untitled4.m | Untitled3.m | Untitled2.m | Untitled

```
1   T=128;
2   t=(1:T);
3   A=5;
4   y=A*sin(2*pi/T*t);
5
6   figure;
7   plot(t,y,'b')
8   xlim([1,T]), ylim([-A,A])
9   set(gca,'xtick',[0:16:T])
10  set(gca,'ytick',[-A:1:A])
```



Using Matlab

Editor - C:\Users\Dan.Rowe\Documents\MATLAB\Untitled5.m

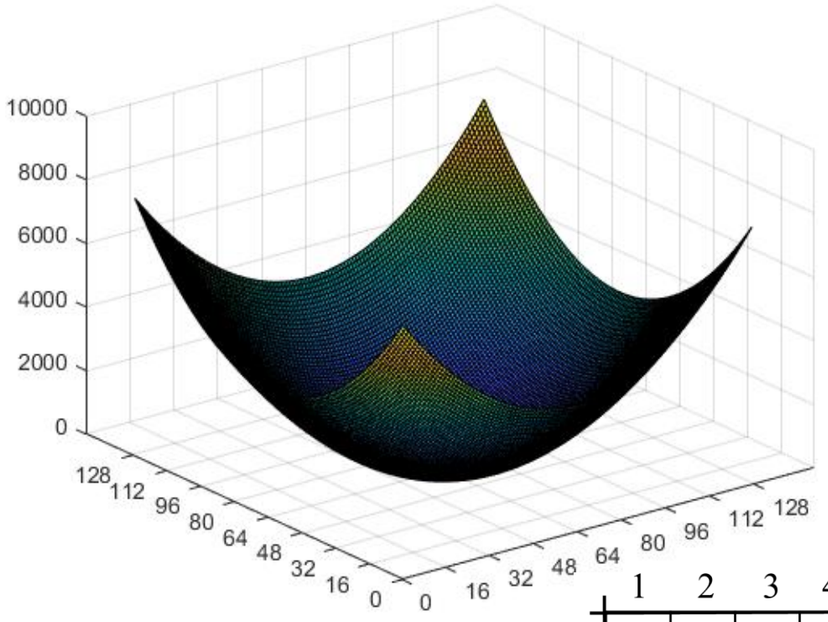
EDITOR | PUBLISH | VIEW

New | Open | Save | Find Files | Compare | Print | Go To | Find | Insert | Comment | Indent | Breakp

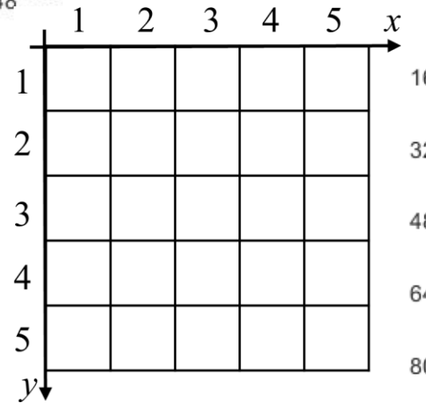
FILE | NAVIGATE | EDIT | BREAKPC

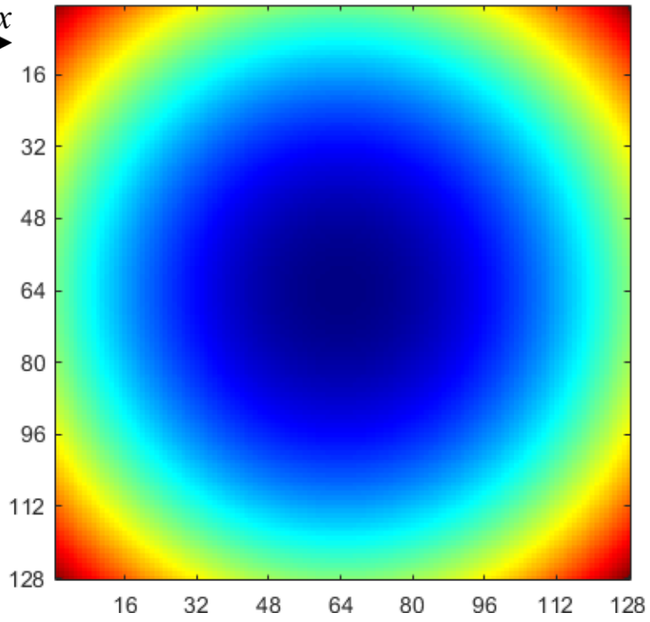
Untitled5.m | Untitled4.m | Untitled3.m | Untitled2.m | Untitled.m

```
1   n=128; m=128;
2   fxy=zeros(n,m);
3   for i=1:n
4       for j=1:m
5           fxy(i,j)=(i-n/2)^2+(j-m/2)^2;
6       end
7   end
8
9   x=(1:n); y=(1:m);
10  [X,Y] = meshgrid(x,y);
11  figure;
12  surf(X,Y,fxy)
13  set(gca,'xtick',[0:16:128])
14  set(gca,'ytick',[0:16:128])
15
16  figure;
17  imagesc(fxy)
18  colormap(jet)
19  set(gca,'xtick',[0:16:128])
20  set(gca,'ytick',[0:16:128])
21  axis image
```



pseudocolor





Saving/Loading from/into Matlab

You can save the worksheet from the quadratic surface as

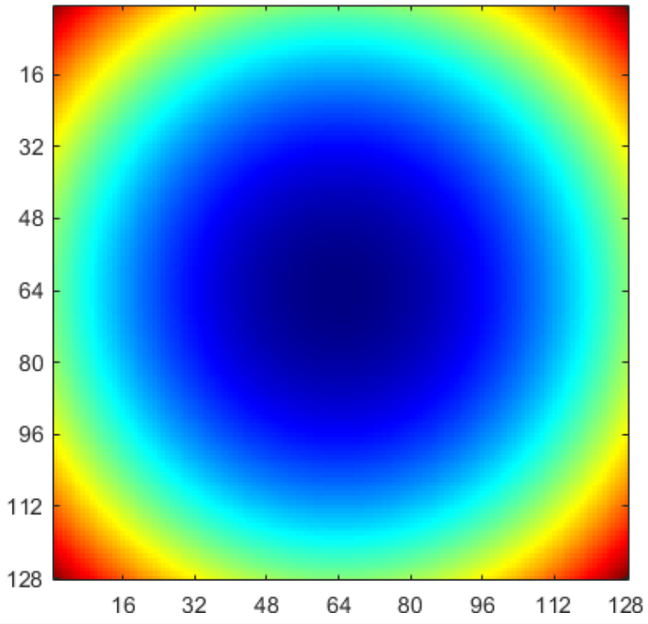
```
save('MySurfData') % saves entire worksheet in MySurfData.mat
```

or save only the variables we want

```
save('Myfxy','fxy','X','Y') % saves fxy, X, Y in file Myfxy.mat
```

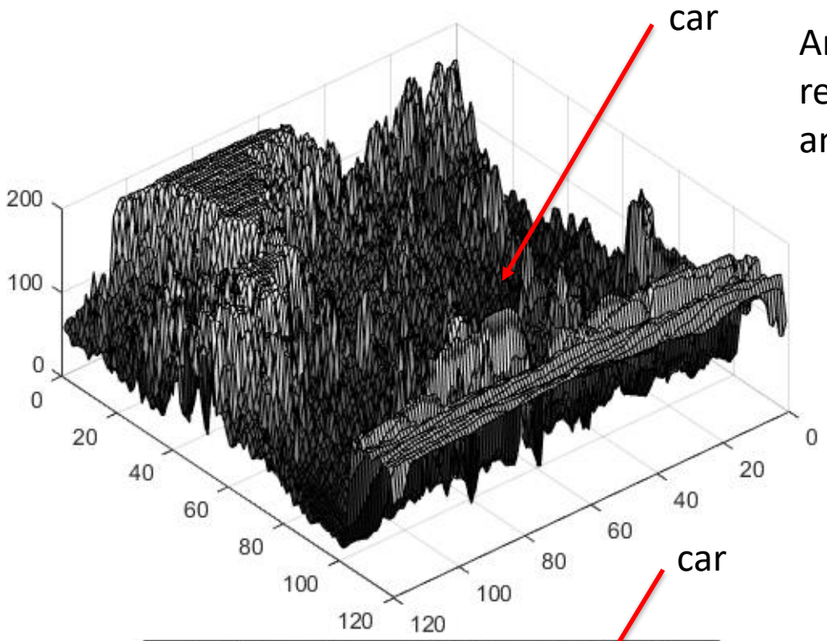
or save into a text file

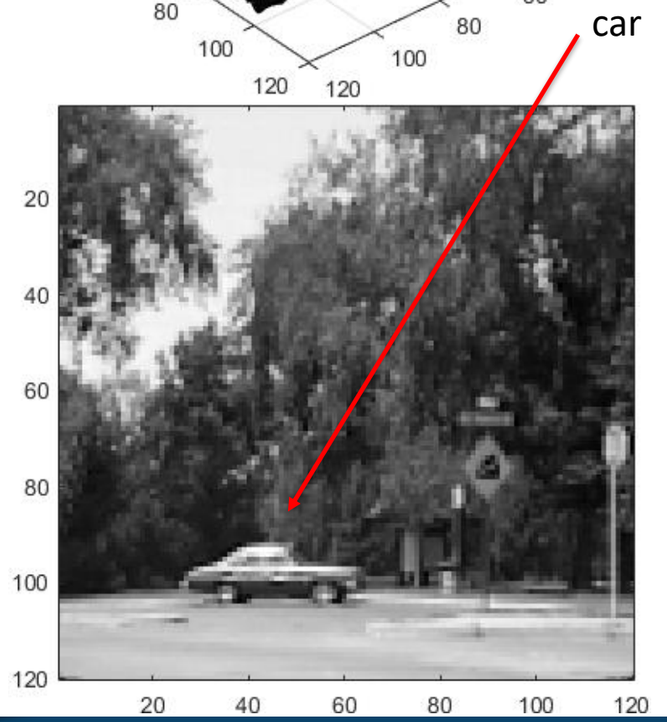
```
vecfxy=reshape(fxy,[n*m,1]);          % array to vector
dlmwrite('MyVecfxy.txt',vecfxy,'\t') % save
load MyVecfxy.txt                     % load txt file
Newfxy=reshape(MyVecfxy,[n,m]);       % vector to array
figure;                               % make image
imagesc(Newfxy), colormap(jet), axis off, axis image
```



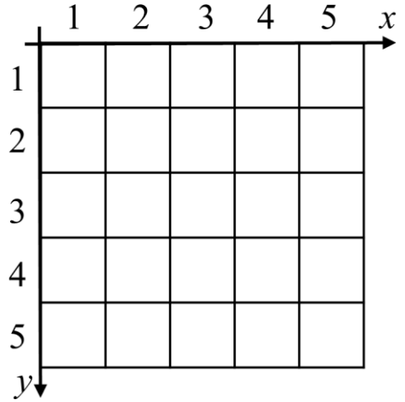
Saving/Loading from/into Matlab

```
load cardata.txt
[n,p]=size(cardata);
nx=sqrt(n);, ny=nx;
fxy=reshape(cardata,[ny,nx])';

x=(1:nx); y=(1:ny);
[X,Y]=meshgrid(x,y);
figure;
surf(X,Y,fliplr(fxy)), colormap(gray)
set(gca,'xtick',[0:20:nx])
set(gca,'ytick',[0:20:ny])
az=140;, el=60;, view(az,el)
print(gcf,'-dtiffn','-r100',['CarScene3D'])

figure;
imagesc(fxy)
axis image, colormap(gray)
set(gca,'xtick',[0:20:nx])
set(gca,'ytick',[0:20:ny])
print(gcf,'-dtiffn','-r100',['CarScene'])
```

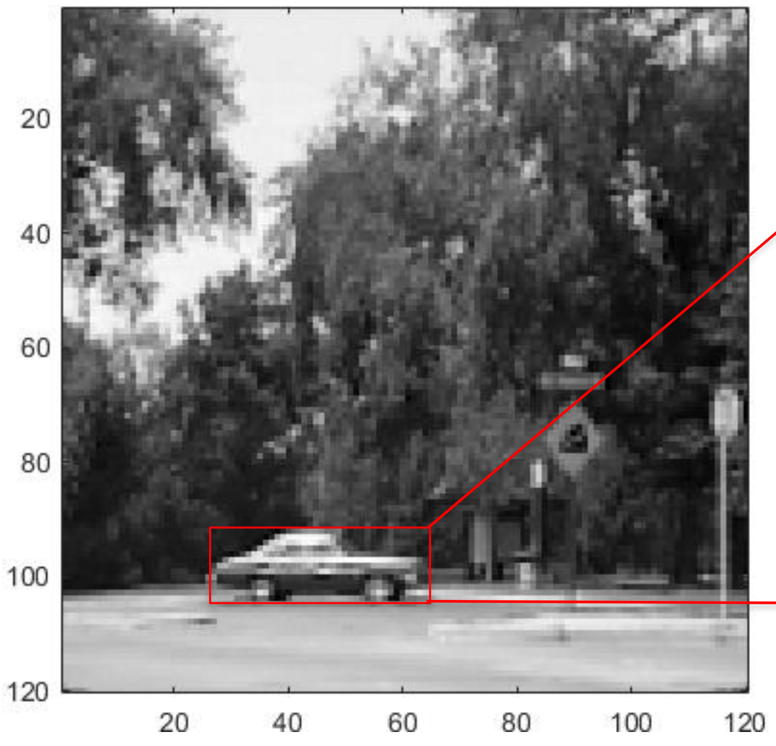


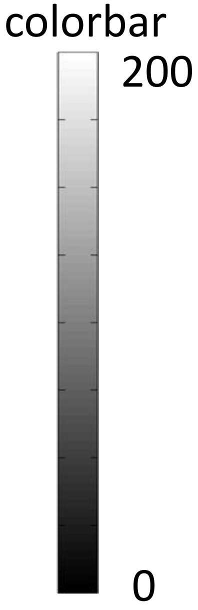


An image is a discrete digital representation of a continuous analog function $f(x,y)$.



Saving/Loading from/into Matlab





38	37	31	32	28	26	25	27	24	13	35	126	174	194	200	200	200	199	197	194	180	132	94	45	35	41	43	62	39	33	50	70	42	45	44	43	45	38	51	47	59
33	29	30	33	32	26	28	21	16	86	157	171	186	168	170	181	193	196	188	162	161	141	77	66	53	38	43	51	39	40	61	74	60	59	54	47	32	26	43	45	38
35	27	36	36	31	25	14	43	127	172	165	143	139	92	91	99	131	119	92	83	96	123	122	66	72	55	36	49	38	48	61	68	53	47	40	40	24	32	47	32	26
30	26	23	15	26	56	116	174	183	147	122	129	106	121	126	136	157	149	138	135	137	145	162	126	82	95	88	84	73	66	68	63	46	32	31	40	27	27	40	24	32
21	38	98	152	178	179	173	180	184	182	179	185	190	189	180	182	180	185	186	182	192	197	197	198	198	198	197	197	197	193	189	183	169	154	141	127	84	50	40	27	27
60	135	144	124	114	109	101	90	58	59	116	123	105	112	114	116	133	147	128	92	116	122	101	84	83	98	101	105	133	139	136	130	133	132	125	91	68	60	127	84	50
89	95	94	98	97	97	93	94	124	142	139	124	123	111	121	123	122	109	131	172	177	150	133	125	128	131	111	79	75	69	72	77	82	72	73	87	58	63	91	68	60
124	41	47	49	49	50	28	16	31	36	31	45	51	51	49	49	52	47	31	22	27	40	46	46	40	58	40	19	55	64	44	29	57	83	135	123	45	43	87	58	63
93	34	38	40	40	38	28	60	104	95	45	31	45	44	43	44	44	44	46	45	45	46	45	44	44	45	34	66	99	113	74	37	29	35	84	100	51	43	123	45	43
105	84	69	61	45	42	37	71	90	102	68	31	40	40	39	38	40	40	42	40	39	39	40	40	39	38	32	83	99	113	90	74	22	24	56	69	78	92	100	51	43
119	122	120	123	126	127	108	107	175	159	61	18	24	17	39	46	50	45	47	51	56	51	32	30	29	27	43	88	134	170	140	84	15	46	135	154	178	169	69	78	92
146	137	137	139	99	99	89	57	94	86	27	9	21	75	121	122	124	122	122	121	128	135	135	133	124	117	99	68	96	119	74	17	15	70	94	91	100	107	154	178	169
146	137	137	139	99	99	89	57	94	86	27	9	21	75	121	122	124	122	122	121	128	135	135	133	124	117	99	68	96	119	74	17	15	70	94	91	100	107	91	100	107

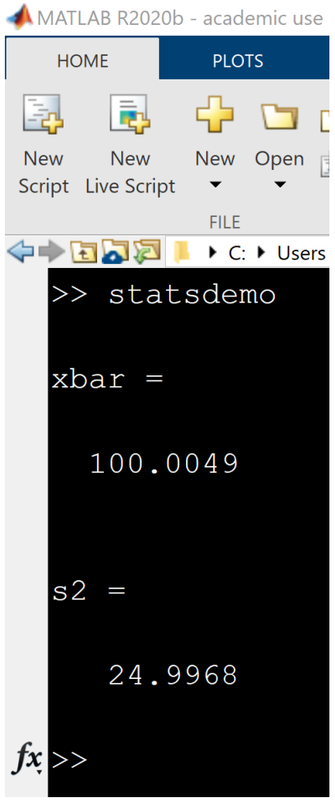
```
car=fxy(93:104,27:64);
figure;
imagesc(car)
axis image, colormap(gray), axis off
print(gcf,'-dtiffn','-r100',['car'])

filename = 'cardata.xlsx';
writematrix(car,filename,'Sheet',1,'Range','A1')
```

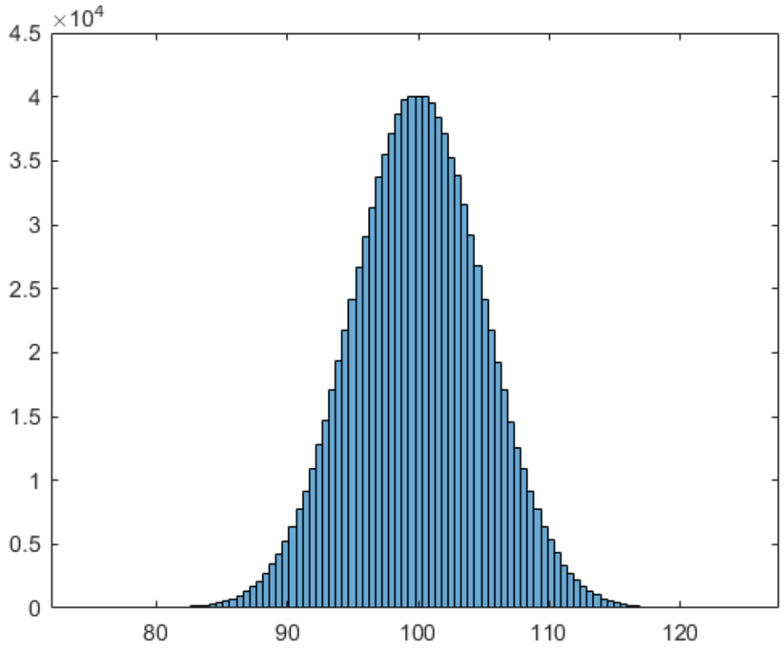
← Save into an excel spreadsheet!

Functions in Matlab

There are many built in functions in Matlab to make your life easier. You can do statistics, math, image analysis, ….

```
n=10^6;
mu=100; sigma2=25;
x=sqrt(sigma2)*randn(n,1)+mu;

xbar=mean(x)
s2=var(x)
figure;
histogram(x,100)
print(gcf,'-dtiffn','-r100',['demoHist'])
```



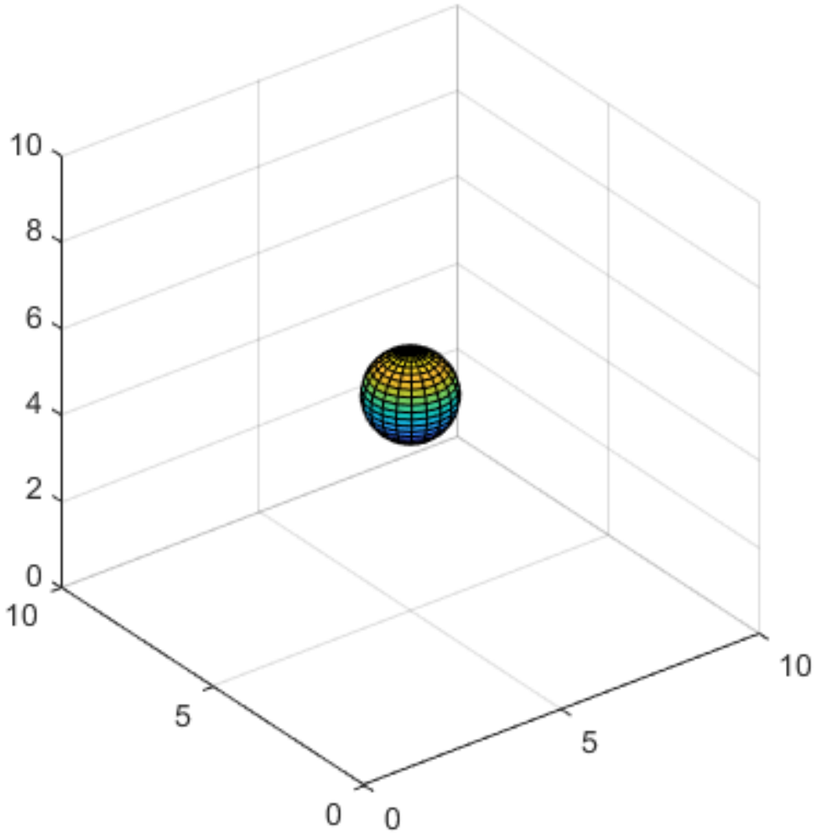


https://www.mathworks.com/content/dam/mathworks/fact-sheet/matlab-basic-functions-reference.pdf

Functions in Matlab

There are many built in functions in Matlab to make your life easier.
You can do statistics, math, image analysis. ….

```
[x,y,z] = sphere;
figure;
for t=1:.1:10
   surf(x+t,y+t,z+t)
   axis square
   xlim([0,10]),ylim([0,10]), zlim([0,10])
   pause(.1)
end
```

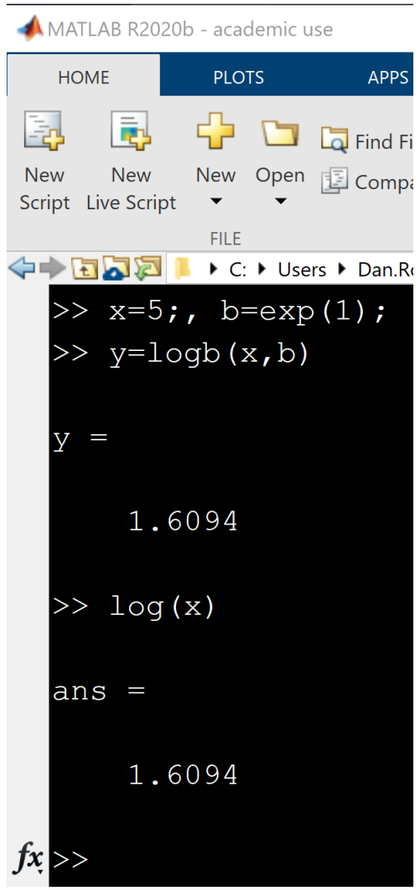


https://www.mathworks.com/content/dam/mathworks/fact-sheet/matlab-basic-functions-reference.pdf

Functions in Matlab

You can create your own functions.

```
% logarithm of x base b
% usage is y=log(x,b)

function y=logb(x,b);

y=log(x)./log(b);
```



Functions in Matlab

The built in functions may come as part of an add-on library

- Statistics and Machine Learning Toolbox™ (Statistics and Machine Learning Toolbox)
- Curve Fitting Toolbox™ (Curve Fitting Toolbox)
- Control System Toolbox™ (Control System Toolbox)
- Signal Processing Toolbox™ (Signal Processing Toolbox)
- Mapping Toolbox™ (Mapping Toolbox)
- System Identification Toolbox™ (System Identification Toolbox)
- Deep Learning Toolbox™ (Deep Learning Toolbox)
- DSP System Toolbox™ (DSP System Toolbox)
- Datafeed Toolbox™ (Datafeed Toolbox)
- Financial Toolbox™ (Financial Toolbox)
- Image Processing Toolbox™ (Image Processing Toolbox)
- Text Analytics Toolbox™ (Text Analytics Toolbox)
- Predictive Maintenance Toolbox™

for the most part we will only use low level functions so we learn how things work.

Discussion

Questions?

The best way to get better at this material is to do.

You don’t get better at it by reading about it, you have to do it for yourself.

Homework 1a

1. Write a for loop to add the numbers 1,2,3,4,5,6,7,8,9,10.

2. Make a surface plot of the function

$$f(x,y) = \frac{1}{2\pi} e^{-\frac{1}{2}(x^2+y^2)}$$

3. Run code, change colormap to copper, hot…

```
A = imread('FrMarquette.jpg');

figure;
imagesc(A)
axis image, axis off

I = rgb2gray(A);

figure;
imagesc(I)
axis image, axis off
colormap(gray)

imwrite(I,'GrayMarquette.jpg');
```

Homework 1a

4. Read your own image into Matlab.
   a) Convert to grayscale.
   b) Look at the pixel values of a distinctive feature in your image.
   c) load another image of the same size (same device).
   d) average the two images together.
   e) display an image of the average.
   f) Bonus: Repeat for multiple sequential images.

5) Generate $n=10^6$ random undergraduate heights with mean $\mu=69$ in and standard deviation $\sigma=2$ in. Make a histogram.
   Change μ to 65 and σ to 4. Calculate new mean and standard deviation.
   Make a new histogram and compare to the original.