CNBC/IGERT
MATLAB Minicourse:
Lecture 2

David S. Touretzky

January 2007

Set Your Working Directory

Make sure you have a directory called W:\mystuff and make that your current directory:

```
mkdir W:\mystuff

cd W:\mystuff
```

Scientific Functions

Trig:	sin, cos, tan, asin, acos, atan, sinh, cosh, tanh, asinh, acosh, atanh
Rounding:	floor, ceil, round, fix
Modular:	rem, mod
Exponential:	exp, log, log2, log10, sqrt
Primes:	factor, primes
Matrix:	det, inv, pinv, eig, svd, fft *and many more*
Polynomials:	roots, polyfit, polyval

Inf and NaN

3/0 returns Inf

0/0 returns NaN

3+Inf

Inf/Inf

-Inf

-NaN

Predicates

isreal(3)

isprime(17)

isnumeric([2 3 5])

isempty([ ])

isinf(Inf)

isnan(NaN)

islogical(1==1)

ischar('a')

isequal('foo','aardvark')

Return Values

Functions can return multiple values.

```
A = rand(5,3);

[rows,cols] = size(A)
```

Functions can return values or not, depending on whether the user is asking for values.

```
plot([1 2 3],[3 1 2])

h = plot([1 2 3],[3 1 2])

set(h,'LineStyle','--')

set(h,'LineWidth',8)
```

Variable No. of Arguments

Some functions take a variable number of arguments.

```
peaks

peaks(10)
```

```
hist(randn(2000,1))

hist(randn(2000,1), 50)

b = hist(randn(2000,1), 50)

[b,c] = hist(randn(2000,1), 50)
```

nargin and nargout

Inside a function, **nargin** is the number of input arguments supplied with the call.

nargout is the number of output arguments requested with the call.

```
function [x,y,z] = test(p,q,r,s,t)
   % inputs are ignored

   if nargout >= 1
     x = 50;
     if nargout >= 2
       y = 'foo';
       if nargout >= 3
          z = 3:7;
       end
     end
   end
   whos
```

Name Spaces

Base workspace: variables created outside of any function exist in the base workspace.

Local workspaces: each function executes in a separate local workspace holding the arguments, return variables, and any local variables created by the function.

Functions cannot access variables of the base workspace.

Global workspace: variables declared global by a function are accessed in the global workspace. It's a good idea to also declare the variable global in the base workspace.

Global Variables

In the base workspace:

```
global pts
pts = 0 : pi/20 : 2*pi;
```

Inside a function:

```
function h = circ(x,y)

 % h = CIRC(x,y) draw circle at (x,y)

 global pts
 hh = plot(x+cos(pts),y+sin(pts));

 if nargout > 0, h = hh; end
```

Scripts Called by Functions

Scripts do not have their own workspaces.

A script called from the keyboard executes in the base workspace.

A script called from within a function executes in the function’s local workspace.

Resetting Variables

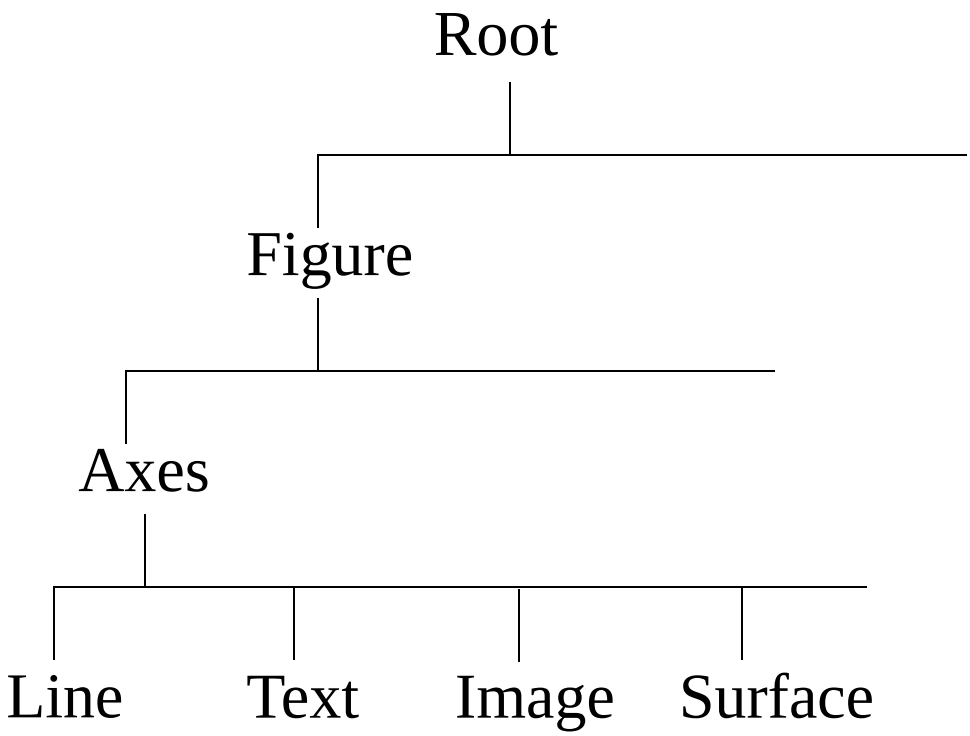
clear x	removes variable x (and undoes global decl.)

You can also click on a variable in the work-space pane, and hit the Delete key.

Or right-click on the variable and choose from the menu.

clear all	clears everything
clear global	clears global declarations
whos global	show all global vars.

Handle Graphics




```
clf, plot(rand(5,3))

ax = get(gcf,'Children')
get(ax)

lines = get(ax,'Children')
get(lines(1))
```

Multiple Axes

```
clf

subplot(2,2,1)       % uses row-major order
plot(rand(5,5))

subplot(2,2,2)
bar3(rand(5,3))

subplot(2,2,3)
a = rand(15,1);
pie(a, a>0.7)

subplot(2,2,4)
pts = 0:pi/20:2*pi;
polar(pts,cos(2*pts))

set(gca,'Position',[0.32  0.1  0.4  0.4])
```

Exploring Graphic Objects

propedit(gca)

Matlab Help: (F1 or select Help pulldown)
Matlab Handle Graphics PropertyBrowser

set(gca,'Units')

3D Graphics

peaks

rotate3d on
or click on the rotation arrow in toolbar

set(gca,'CameraViewAngleMode','manual')
or right-click in the figure,
select Rotate Options, then
select Fixed Aspect Ratio Axes

[x,y,z] = peaks;

surf(x,y,z,z)

surf(x,y,z,x)

surf(x,y,z,rand(length(x)))

Plotting in 3D

Don't type all this in! Instead, download the file helix.m from:

www.cs.cmu.edu/~dst/Tutorials/Matlab/helix.m

and store it in your W:\mystuff directory

```
function helix
  pts = 0 : pi/20 : 4*pi;
  x1 = cos(pts); y1 = sin(pts);
  x2 = cos(pts+pi); y2 = sin(pts+pi);
  z = pts/(2*pi);

  clf, whitebg(gcf,[0 0 0])
  hold on
  plot3(x1,y1,z,'y')
  plot3(x2,y2,z,'w')

  axis([-3 3 -3 3 0 2])
  view(95,9)
```

helix (cont.)

```
colors = 'rgbm';

for i = 4 : 4 : length(pts)-4
  plot3([x1(i) x2(i)], [y1(i) y2(i)], z([i i]),  ...
      colors(ceil(rand(1)*length(colors))), ...
      'LineWidth',3)
end

axis off
set(gcf,'Color','k')

set(gca,'CameraViewAngleMode','manual')

for az =  -180:5:180
  view(az,9)
  drawnow
  pause(0.05)
end
```

Color Maps

```
clf
peaks

colorbar

m = colormap;
whos m

colormap(autumn)
brighten(0.5)

colormap(jet)

colormap(bone)

colormap(hot)
```

2D Data

```
[x,y] = meshgrid(-2 : 0.05 : 2);

z = sin(x) .* cos(y);

contour(z,20)

colormap(jet)

imagesc(z)

imagesc(x(:),y(:),z)

surf(z)

surfc(z)
```

Surface Objects

sphere

[x,y,z]=sphere(20);

x(1 : 5 : 21*21)=NaN;

surf(x,y,z)

Use the rotate tool to rotate the sphere; set Fixed Aspect Ratio Axes first.

alpha(0.7)

surf(x,y,z,rand(21,21))

shading interp

Data From Files

Create a file temps.txt in Desktop*myuserid*:

38	50
42	53
33	57
45	56
44	46
41	40

load temps.txt

whos te*

plot(temps)

Importing Data from Files

You can import data from a variety of external file formats, including Excel, by using the Import Wizard:

go to the File pulldown menu
select Import
select the file you want to import
the wizard will guide you through the rest

There are also built-in functions specifically for dealing with Excel files:

doc xlsread

doc xlswrite

Polynomial Curve Fitting

load m:expt1.txt
whos expt1

x = expt1(: , 1); y = expt1(:,2);

clf, hold on, plot(x,y,'o')

c = polyfit(x,y,3)

example polynomial representation:

c = [5 -1 4 3]

$$5x^3 - x^2 + 4x + 3$$

c(1:2)

pts = min(x) : max(x);
plot(pts, polyval(c,pts), 'r')

doc polyfit

Saving Variables

```
clear all

a = ’aardvark’

[x,y,z] = sphere(5);

save stuff.mat

whos -file stuff.mat


save junk.dat x y -ascii

type junk.dat
```

General OS Stuff

pwd

cd

dir

ls *.m

delete stuff.mat

!dir

Debugging

Poor man's debugger:

Remove semicolons from assignments.

Add 'quoted strings' in appropriate places.

Add a call to **keyboard**. Use **return** to return from keyboard input mode.

```
function y = buggy(vec)

  p = vec > 5
'got this far'
keyboard

z = p*vec
v = sin(z);
```

dbtype helix

dbstop helix 3

helix

dbstep

dbstep 5

whos

dbstep 30

dbquit

dbclear helix

help debug

Formatted Output

```
for i = 1:10
  fprintf('The square-root of %2d is %f\n', ...
            i, sqrt(i))
end


doc fprintf


title(sprintf('f(x) over range %g to %g', ...
                    -3.5,  5.125))
```