L13. More on Arrays

Square Bracket Notation
Subscripts
Plotting and color
Built-In Functions:
ginput, fill, sum, axis

The Square Bracket

These are equivalent:

```
x = linspace(0,1,5)
x = [ 0 .25 .50 .75 1.00]
```

x:

0.00	0.25	0.50	0.75	1.00

Handy for setting up "short" vectors.

Three "Short Vector" Examples

Line Segments
Little Polygons
Color

Plotting a Line Segment

This draws a line segment that connects (1,2) and (3,4):

```
a = 1;
b = 2;
c = 3;
d = 4;
plot([a c],[b d])
```

A natural mistake: `plot([a b],[c d])`

Drawing Little Polygons

This draws an L-by-W rectangle with lower left corner at (a,b):

```
x = [a a+L a+L a a];
y = [b b b+W b+W b];
plot(x,y)
```

Connect (a,b) to (a+L,b) to (a+L,b+W) to (a,b+W) to (a,b)

Coloring Little Polygons

This draws an L-by-W rectangle with lower left corner at (a,b) and colors with the color named by c:

```
x = [a a+L a+L a a];
y = [b b b+W b+W b];
fill(x,y,c)
```

Connect (a,b) to (a+L,b) to (a+L,b+W) to (a,b+W) to (a,b) and then fill it in.

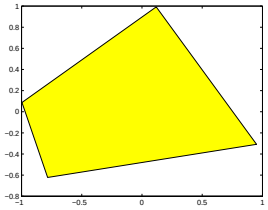
Built-In Function Fill

fill(, ,)

Vectors that specify the vertices of a polygon.

Specify the fill-in color.

```
x = [0.11 -0.99   -0.78   0.95]
y = [0.99  0.08   -0.62  -0.30]
fill(x,y,'y')
```



DrawRect

```
function DrawRect(a,b,L,W,c)
x = [a a+L a+L a a];
y = [b b b+W b+W b];
fill(x,y,c)
```

Color is a 3-vector

Any color is a mix of red, green, and blue.

Represent a color with a length-3 vector and an "rgb convention".

c = [0.25 0.63 0.00]

red value between 0 and 1

green value between 0 and 1

blue value between 0 and 1

Some Favorites

White	[0 0 0]	
Blue	[0 0 1]	
Green	[0 1 0]	
Cyan	[0 1 1]	
Red	[1 0 0]	
Magenta	[1 0 1]	
Yellow	[1 1 0]	
Black	[1 1 1]	

A Problem

Display all colors **[r g b]** where

r ranges over the values
0.00 0.25 0.50 0.75 1.00

g ranges over the values
0.00 0.25 0.50 0.75 1.00

b ranges over the values
0.00 0.25 0.50 0.75 1.00

Preliminary Notes

There will be 5 x 5 x 5 = 125 colors to display.

To display a color, we will draw a unit square with that color.

Script Derivation

```
for r = 0:.25:1
```
Display all colors with red value r.
```
end
```

Refine This!

Script Derivation

```
for r = 0:.25:1
  for g = 0:.25:1
```
Display all colors with red value r and green value g.
```
  end
end
```

Refine This!

Script Derivation

```
for r = 0:.25:1
  for g = 0:.25:1
    for b = 0:.25:1
```
Display the color with red value r, green value g, and blue value b.
```
    end
  end
end
```

Refine This!

Script Derivation

```
for r = 0:.25:1
  for g = 0:.25:1
    for b = 0:.25:1
       c = [r g b];
       fill(x,y,c)
    end
  end
end
```

Done!

Subscripts

It is possible to access and change specific entries in an array.

x:

0.00	0.25	0.50	0.75	1.00

The value of `x(1)` is 0.00 .
The value of `x(2)` is 0.25 .
The value of `x(3)` is 0.50 .
The value of `x(4)` is 0.75 .
The value of `x(5)` is 1.00 .

Subscripts

It is possible to access and change specific entries in an array.

x:	0.00	0.25	0.50	0.75	1.00

```
a = x(1)
a = x(2)
a = x(3)
a = x(4)
a = x(5)
```

```
0.00
0.25
0.50
0.75
1.00
```

Subscripts

It is possible to access and change specific entries in an array.

x:	0.00	0.25	0.50	0.75	1.00

```
for k = 1:5
  a = x(k)
end
```

```
0.00
0.25
0.50
0.75
1.00
```

Subscripts

It is possible to access and change specific entries in an array.

x:	0.00	0.25	0.50	0.75	1.00

```
a = x(1)+x(2)
a = x(2)+x(3)
a = x(3)+x(4)
a = x(4)+x(5)
```

```
0.25
0.75
1.25
1.75
```

Subscripts

It is possible to access and change specific entries in an array.

x:	0.00	0.25	0.50	0.75	1.00

```
for k=1:4
  a = x(k)+x(k+1)
end
```

```
0.25
0.75
1.25
1.75
```

Subscripts

This

```
x = linspace(a,b,n)
```

is equivalent to this

```
h = (b-a)/(n-1);
for k=1:n
   x(k) = a + (k-1)*h;
end
```

Subscripts

x:	0.00	0.25	0.50	0.75	1.00

```
h = (1-0)/(5-1);
x(1) = 0 + 0*h;
x(2) = 0 + 1*h;
x(3) = 0 + 2*h;
x(4) = 0 + 3*h;
x(5) = 0 + 4*h;
```

Subscripts

```
h = (b-a)/(n-1);
for k=1:n
   x(k) = a + (k-1)*h;
end
```

Where to put it.*

Recipe for a value

* Only now we compute where to put it.

A Problem

Click in the three vertices of a triangle.

Display the triangle.

Compute the centroid (xc,yc).

Highlight the centroid and the vertices.

Connect each vertex to the centroid.

Clicking in the Vertices

The command

```
[x,y] = ginput(3)
```

will assign the xy coordinates of the clicks to the arrays x and y.

Clicks: (1,2), (3,4), (5,6)

x:	1	3	5

y:	2	4	6

Display the Triangle

```
fill(x,y,'y')
```

Compute the Centroid

The x coordinate of the centroid is the average of the x-coordinates of the vertices. Ditto for y-coordinate.

```
xc = (x(1) + x(2) + x(3))/3;

yc = (x(1) + y(2) + y(3))/3;
```

Highlight the Vertices and Centroid

```
plot(x,y,'ok',xc,yc,'*k')
```

Connect Each Vertex to the Centroid

```
plot([xc x(1)],[yc y(1)])
plot([xc x(2)],[yc y(2)])
plot([xc x(3)],[yc y(3)])
```

Overall

```
[x,y] = ginput(3)
fill(x,y,'y')
hold on

xc = (x(1)+x(2)+x(3))/3;
yc = (y(1)+y(2)+y(3))/3;

plot(x,y,'ok',xc,yc,'*k')

plot([xc x(1)],[yc y(1)])
plot([xc x(2)],[yc y(2)])
plot([xc x(3)],[yc y(3)])
```

More General

```
n = 3;
[x,y] = ginput(n)
fill(x,y,'y')

xc = sum(x)/n;
yc = sum(y)/n;

plot(x,y,'ok',xc,yc,'*k')

for k=1:n
   plot([xc x(k)],[yc y(k)])
end
```

Question Time

What is the output?

```
x = [10 20 30];
y = [3 1 2]
k = y(3)-1;
z = x(k+1)
```

A. 11 B. 20 C. 21 D. 30 E. 31

A Problem

Plot the function y = sin(x) across [0,2pi] but add random noise if

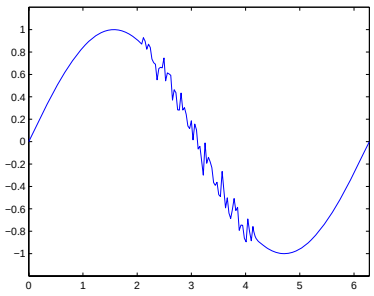
$$\frac{2\Pi}{3} \le x \le \frac{4\Pi}{3}$$

In particular, use sin(x)+.1*randn(1) if x is in this range.

Solution

```
x = linspace(0,2*pi,n);
y = sin(x);
for k=1:n
    if 2*pi/3 <= x(k) && x(k) <= 4*pi/3
       y(k) = y(k) + .1*randn(1);
    end
end
plot(x,y)
axis([0 2*pi -1.2 1.2 ])
```

x range:[0 2pi] y range: [-1.2 1.2]



Problem

On a black background, randomly generate 10 stars. (A "constellation".)

Repeat many times:

```
for k=1:10
    Redraw the k-th star using black
    or yellow with equal probability
end
```

This box redraws the constellation.

To Simulate Twinkling…

```
X = rand(1,10); y = rand(1,10);
for k = 1:100
   for j=1:10
      if rand < .5
         DrawStar(x(j),y(j),r,'k')
      else
         DrawStar(x(j),y(j),r,'y')
      end
      pause(.01)
   end
end
```

Subscripting Review

```
for j=1:3
   DrawStar(a(j),b(j),.1,'y')
end
```

j=1 `DrawStar(3,2,.1,'y')`

a:	3	1	7
b:	2	8	4

Subscripting Review

```
for j=1:3
   DrawStar(a(j),b(j),.1,'y')
end
```

j=2 `DrawStar(1,8,.1,'y')`

a:	3	1	7
b:	2	8	4

Subscripting Review

```
for j=1:3
   DrawStar(a(j),b(j),.1,'y')
end
```

j=3 `DrawStar(7,4,.1,'y')`

a:	3	1	7
b:	2	8	4