Generating random numbers: The rand( ) function

The **rand( )** function generates random numbers between 0 and 1 that are distributed uniformly (all numbers are equally probable). If you attempt the extra credit, you likely will need to use the **rand( )** function.

rand(1) – generates a single random number
rand(N) – generates a NxN array of random numbers
rand(1,N) – generates an array of N random numbers

Example:

```
number1 = rand(1)
number2 = rand(1)
N = 3;
Nnumbers = rand(1,N)
Nnumbers(2)
```

After execution:

```
number1 =  0.42932
number2 =  0.29074
Nnumbers =
   0.27551   0.33193   0.71718
ans =  0.33193
```

If you want to generate random numbers from 0 to 10, you multiply the random number by 10.

Example:

```
multfactor = 10;
randomArray = rand(1,5)
multfactor*randomArray
```

After execution:

```
randomArray =
   0.74785   0.20773   0.23973   0.60396   0.47957
ans =
   7.4785   2.0773   2.3973   6.0396   4.7957
```

If you want to generate N random numbers from A to B, use the following formula:

A + (B-A)*rand(1,N);

"(B-A)" makes the difference between the lowest and highest random number the same as the difference between A and B.

"A +" adjusts the lower part of the random number range to A

Example:

```
A = 5;  B = 10;
randomArray = A + (B-A)*rand(1,5);
```

After execution:

```
intarray =
   9.7675  9.3214    6.5982    7.0010    9.8172
```

If you want to generate random integers from A to B in Matlab, you can use the **randi( )** function. However, this function does not exist in Octave, so let's create our own random integer generator. Let's first look try using the formula for creating random numbers from A to B.

randomArray = A + (B-A)*rand(1,5);

If we tried A=1, B=10,

1 + (10-1)*rand(1,5) creates random numbers from 1 to 10. We can use the **floor( )** command to round the random numbers down to integers. For example, floor(9.6234) is 9.

intArray = floor(randomArray)

This creates a list of integers 1 to 9, which is too small of a range. One way around this problem is to add 1 to (B-A).

```
randomArray = A + (B-A+1)*rand(1,5);
intArray = floor(randomArray)
```

1 + (10)*rand(1,5) creates random numbers from 1 to 11. The **floor( )** function creates an array of integers ranging from 1 to 10.

Example: Generate random integers from 5 to 10.

```
A = 5;  B = 10;
randomArray = (A-1) + (B-(A-1))*rand(1,5);
intarray = floor(randomArray) + 1
```

After execution:

```
intarray =
   10   10    6    7    9
```

PLOTTING:

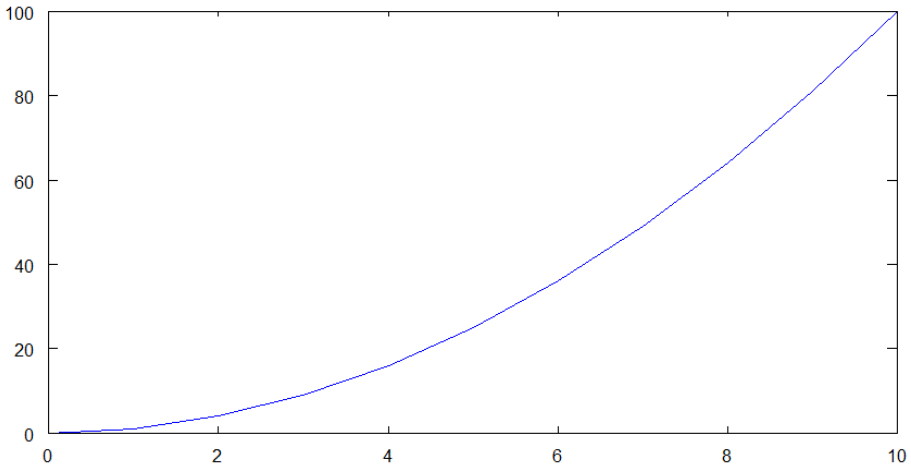
With many other computer languages, such as Fortran, you can write the output to a file but must plot the data with a separate program (such as Excel or Gnuplot). However, Matlab/Octave has a built-in plotting program. I won't be showing you all the features of this program, but it can do quite a lot.

You plot data with the **plot(x,y)** function. This function requires at minimum two arguments, the x-coordinates and y-coordinates.

Example: Plot $y(x) = x^2$ for from x = 0 to 10.
In main.m:

```
x = (0:1:10);
for i=1:numel(x)
   y(i) = x(i)^2;
end
plot(x,y)
% The first set of values will be treated as the x-coordinates
% The second set of values will be treated as the y-coordinates
```

Type 'main' at the command line and the following plot should appear.



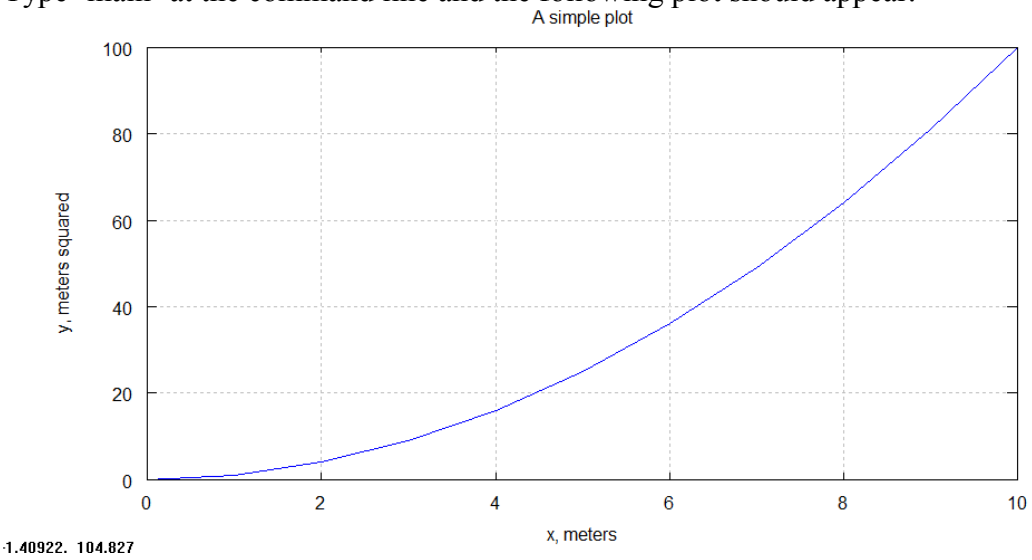
0.0741975, -17.3563

You can add axis labels, a title, and gridlines too. IMPORTANT: You must create a graph before you add the title and labels.

In main.m:

```
x = (0:1:10);
for i=1:numel(x)
   y(i) = x(i)^2;
end
plot(x,y)
xlabel('x, meters')
ylabel('y, meters squared')
title('A simple plot');
grid on;
```

Type ‘main’ at the command line and the following plot should appear.



You can add labels to the data and change the line style by adding some information in the **plot** command within single quotation marks. Change the **plot(x,y)** command in the previous example to

```
plot(x,y, '--xr')
```

-- changes the *line type* to dashed
x puts x-marks at the *data points*
r changes the *line color* to red

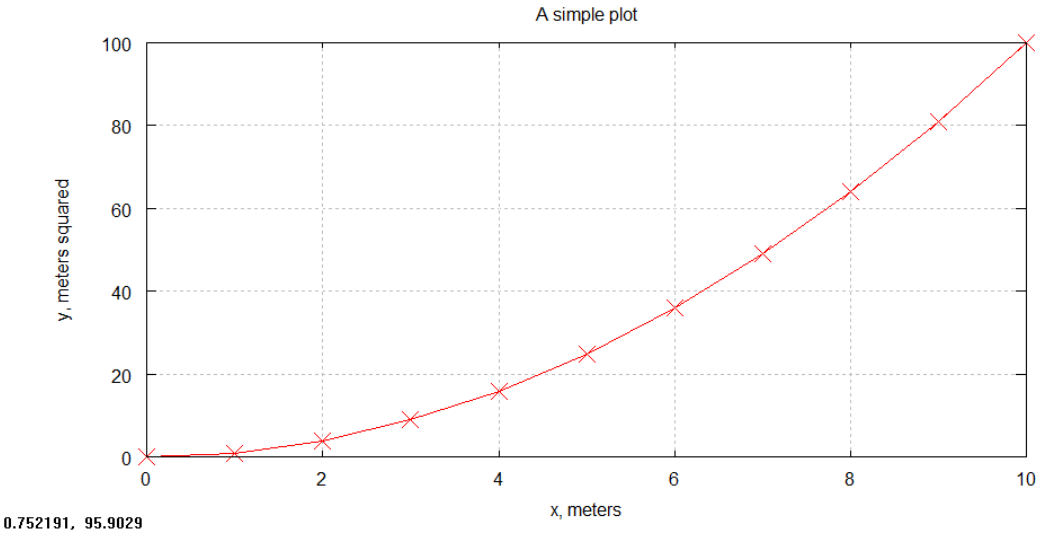


Table 5.2 (page 147) in your book shows you the various line type, point type, and color options. Here are a few more:

Line Type:	Point Type:	Color:
- solid	. point	b blue
: dotted	x x-mark	g green
-. dash-dot	+ plus	r red
-- dashed	* star	k black

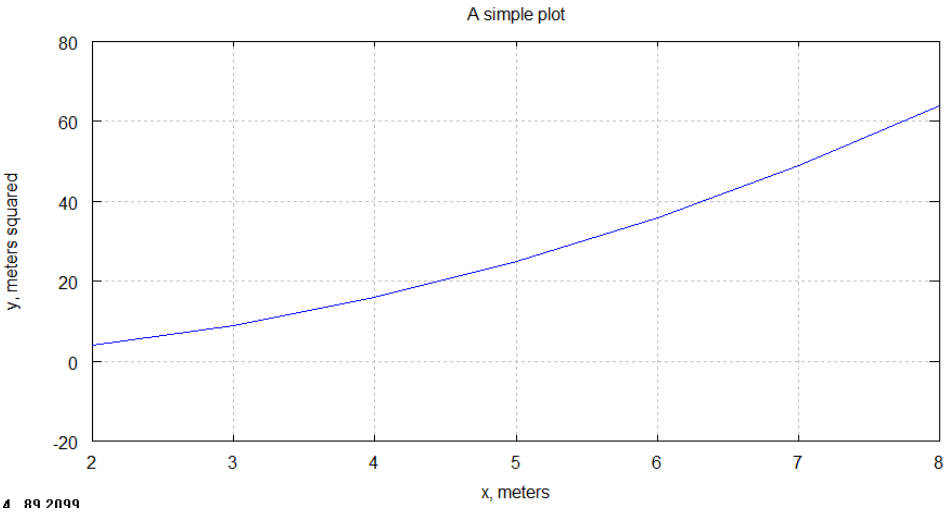
Changing Axes:

Matlab/Octave usually will choose appropriate ranges for the axes. However, you can change the axes' range using the **axis( )** function. Notice that an array of values is sent to the **axis( )** function.

axis([xmin, xmax, ymin, ymax])

In m-file:

```
x = (0:1:10);
y = x.^2;
plot(x,y)
xlabel('x, meters')
ylabel('y, meters squared')
title('A simple plot');
axis( [2,8,-20,80])
grid on;
```



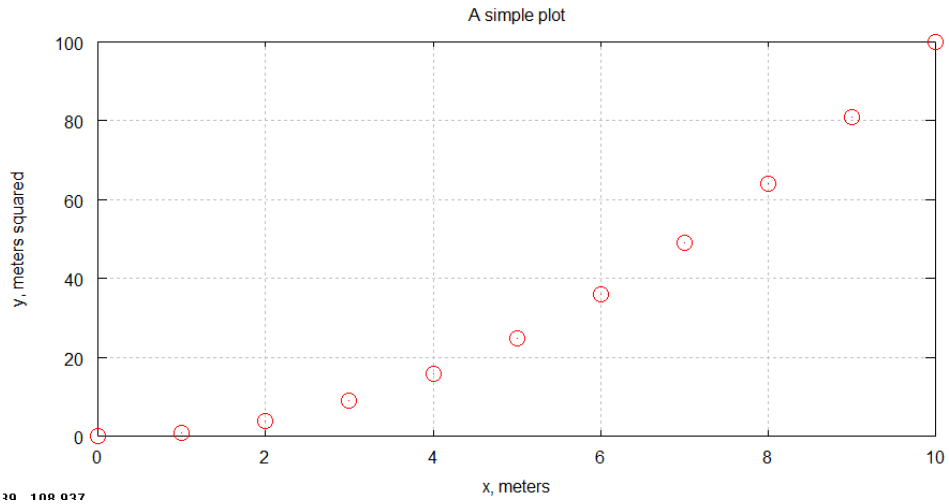
Although you have data from x = 0 to 10 and y = 0 to 100, you only display a subset of that data.

Plotting Points (no line):

Sometimes you just want to plot data points without a line connecting them. Simply omit the line type in the format string.

In m-file:

```
x = (0:1:10);
y = x.^2;
plot(x,y,'or')   % NOTICE: The dashes have been omitted.
xlabel('x, meters')
ylabel('y, meters squared')
title('A simple plot');
grid on;
```



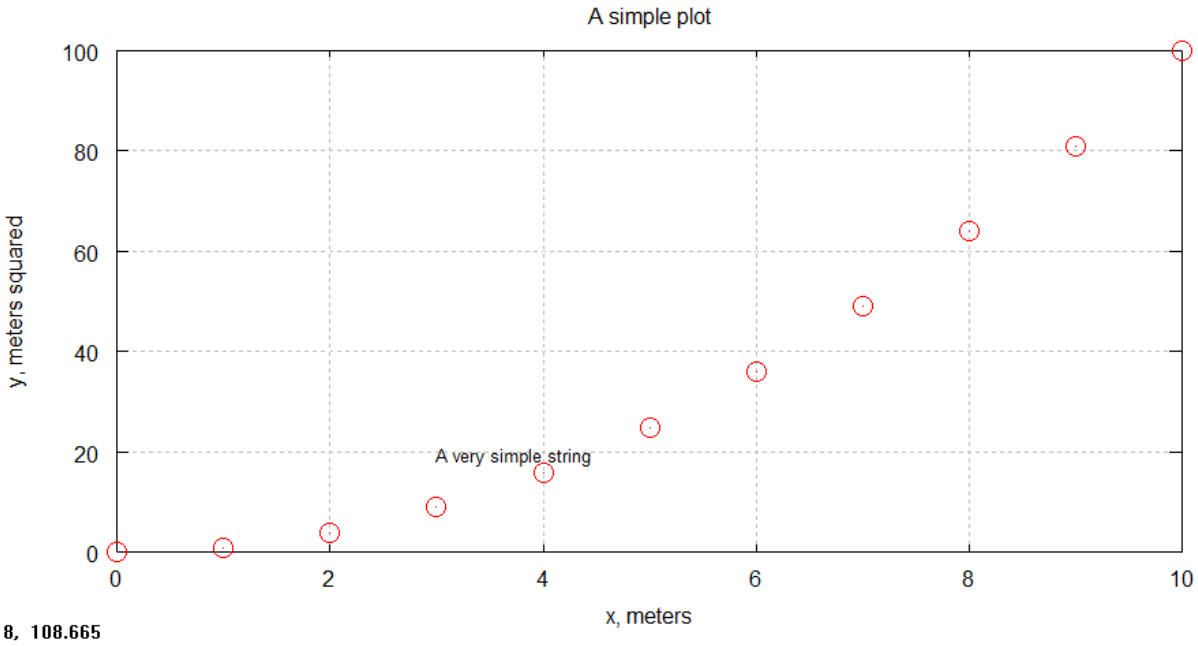
Adding text to a figure:

If you want to add text to a figure, use the **text( )** function.

text(x-coordinate, y-coordinate, ‘string’)

In m-file:

```
x = (0:1:10);
y = x.^2;
plot(x,y,'or')
xlabel('x, meters')
ylabel('y, meters squared')
title('A simple plot');
text(3,20,'A very simple string')
grid on;
```



8, 108.665