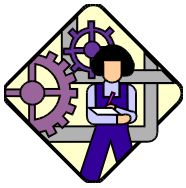
Building your own

Functions



CS112 Scientific Computation
Department of Computer Science
Wellesley College

Built-in MATLAB functions

math: sum, prod, mean, std, abs, sqrt, sin, cos, abs, exp, min, max

logical: any, all, and, or, not

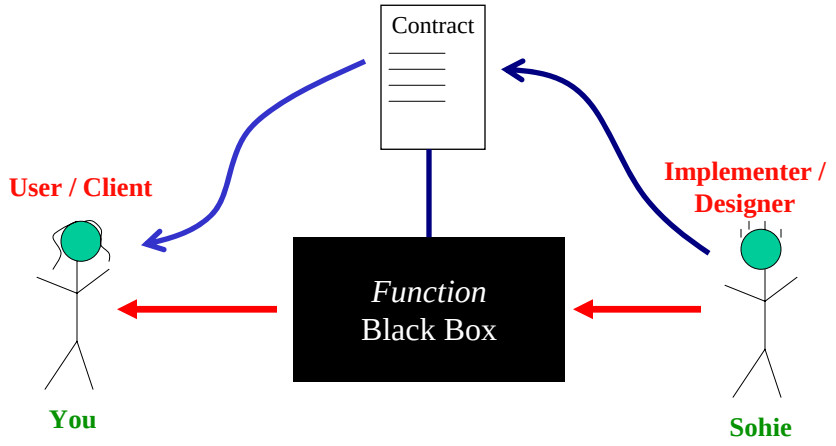
creation: linspace, colon, ones, zeros

dimensions: size, length

graph/display: plot, figure, subplot, xlabel, ylabel, title, axis, legend, imshow, imtool

input/output: input, disp

Big idea: Abstraction

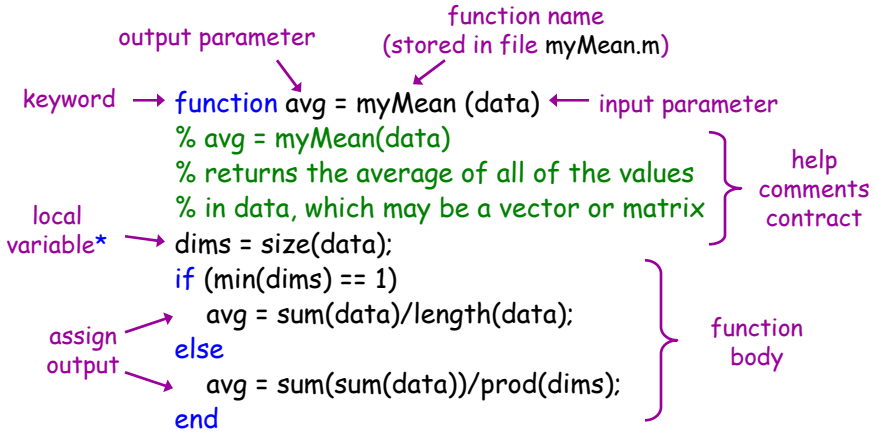


The other side of the contract

We've been using functions built by others - let's try writing a few of our own

Implement a **myMean** function that returns a single value representing the average value of a *vector or matrix*

Rules of the road



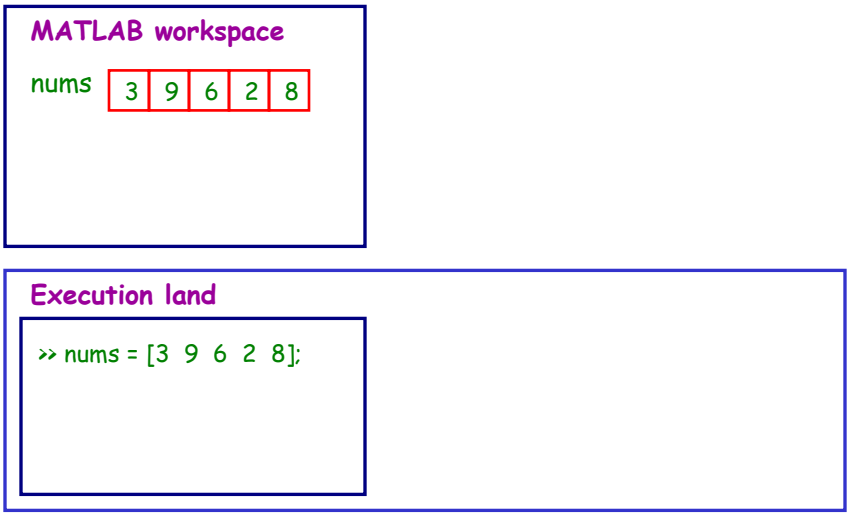
* Local variables only exist during the execution of the function

Calling the new myMean function

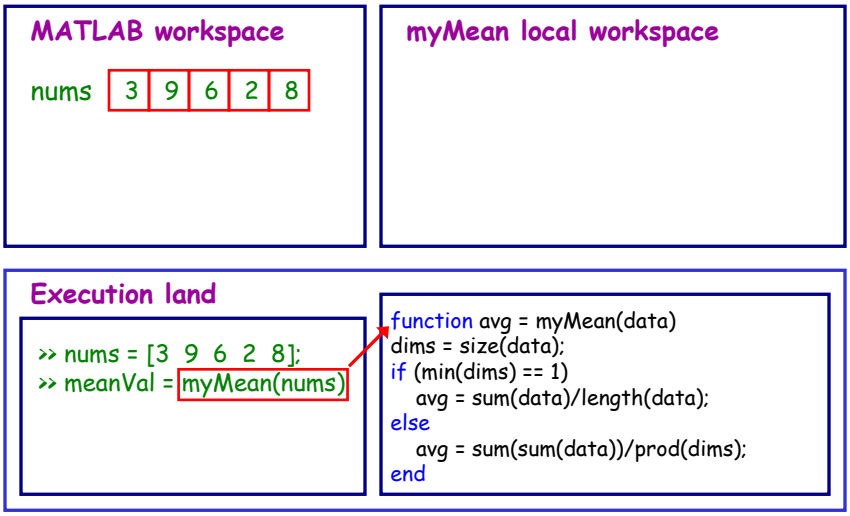
```
>> nums = [3 9 6 2 8];
>> meanVal = myMean(nums)
meanVal =
      5.6000
>> nums = [3 4 7; 2 8 6]
nums =
      3    4    7
      2    8    6
>> meanVal = myMean(nums)
meanVal =
      5.0000
```

Executing a function

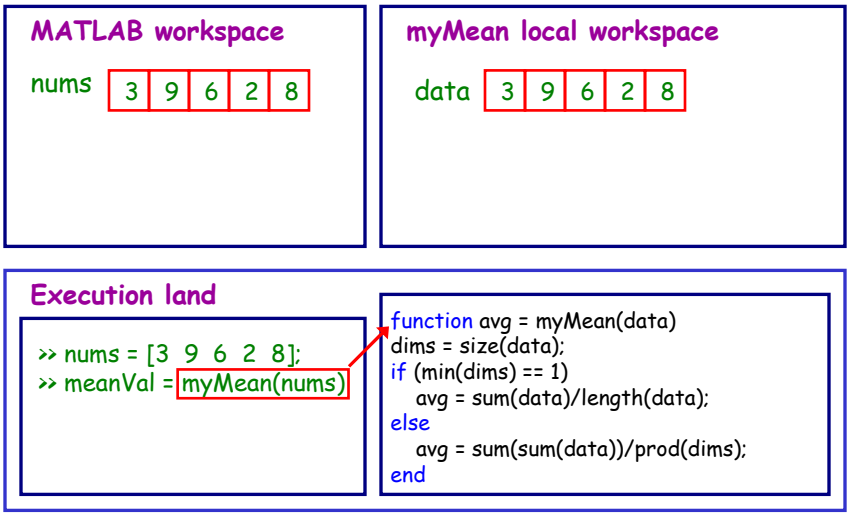
Create nums vector



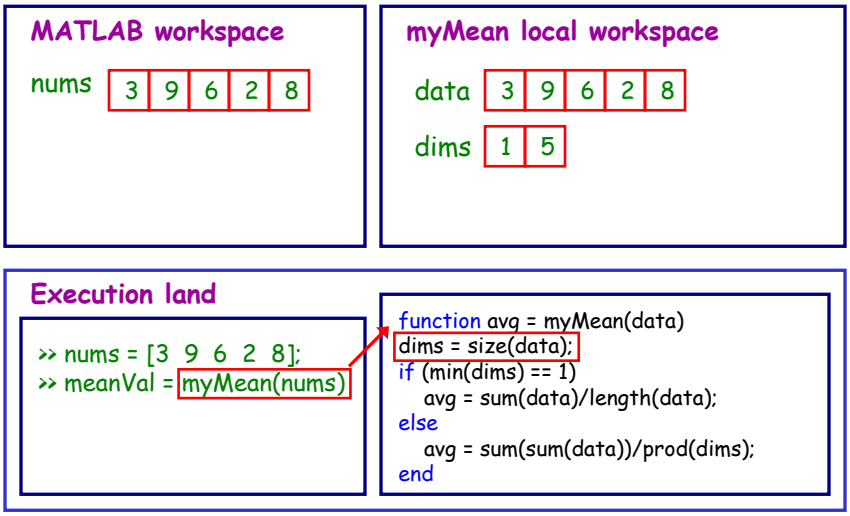
Invoke myMean function



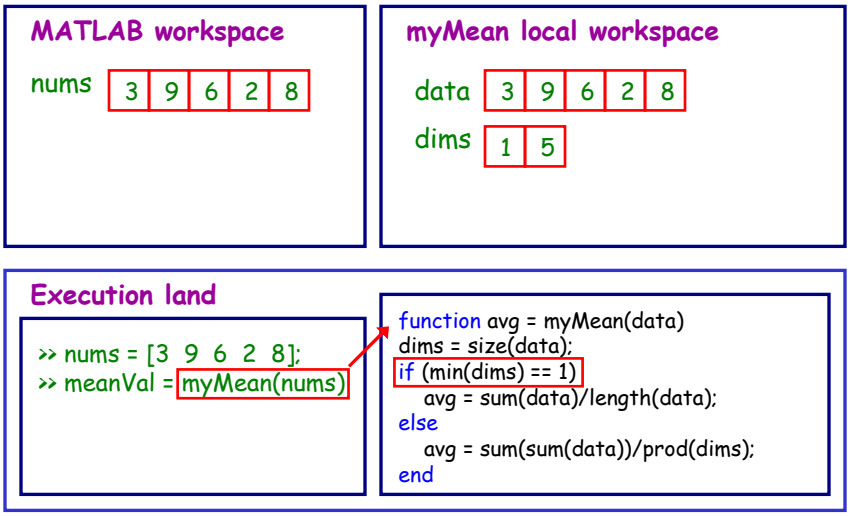
Create variable for input parameter data and copy value of nums to data



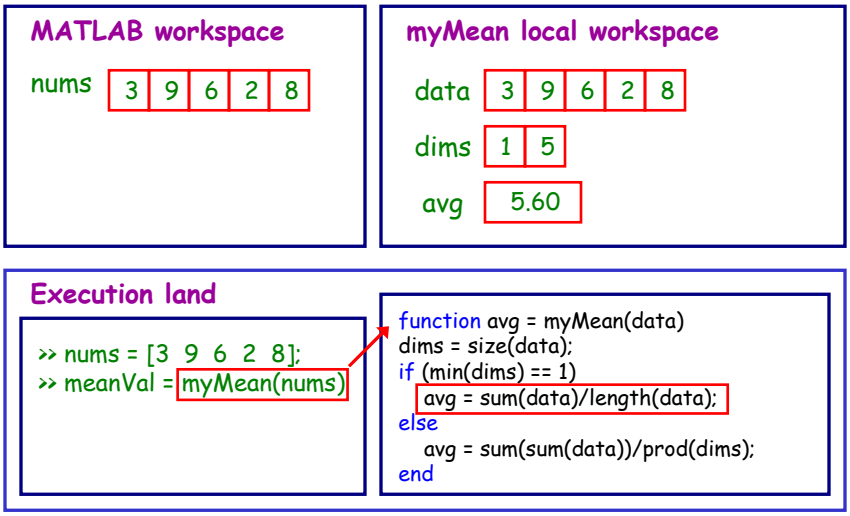
Execute function body



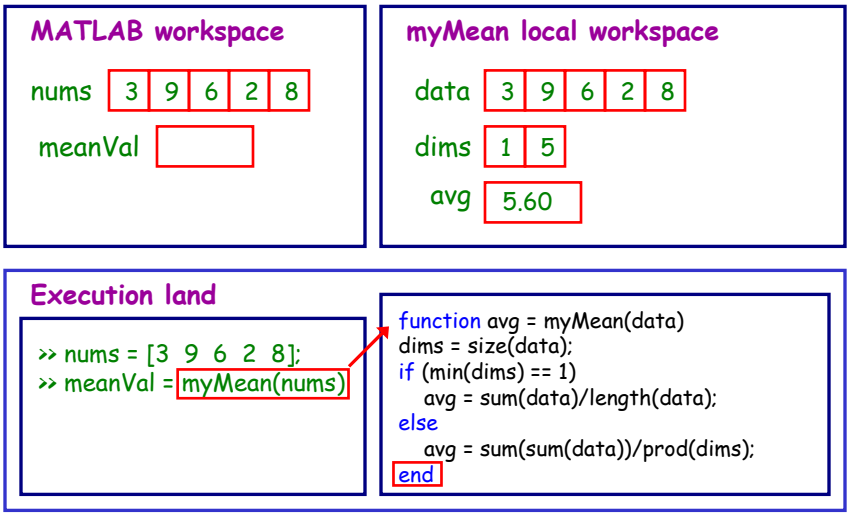
Is min(dims) == 1?



Yes, so we do 'then' clause



Return value stored in output variable



And the local workspace goes away

MATLAB workspace

nums	3	9	6	2	8
meanVal	5.60				

Execution land

```
>> nums = [3  9  6  2  8];
>> meanVal = myMean(nums)
meanVal =
      5.6000
```


Try another one?

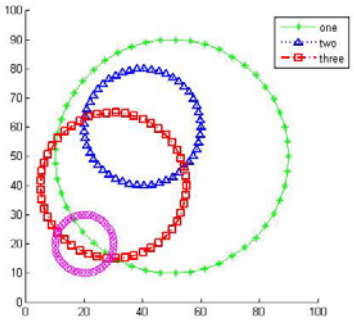
Write a function to draw a circle

Think first about the contract:

use inputs to control appearance: radius, location, color, markers, line style, line width

Call the new function drawCircle

and store it in an M-File named drawCircle.m



Getting started

```
function drawCircle (radius, xcenter, ycenter, properties, width)
% drawCircle(radius, xcenter, ycenter, properties, width)
% draws circle with the specified radius, centered on location
% (xcenter, ycenter) with the specified properties and width
```

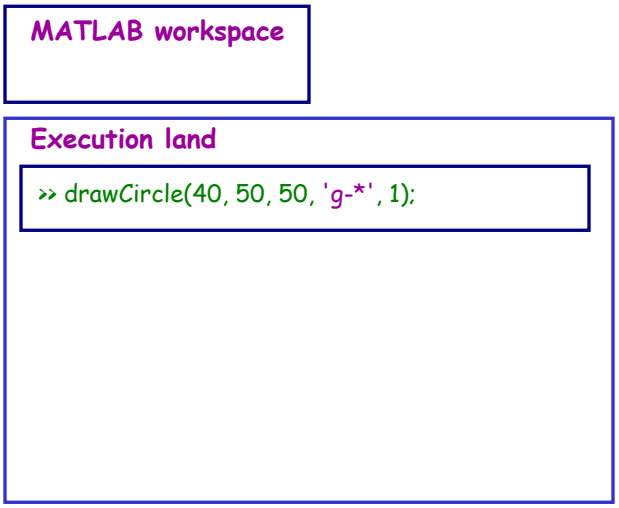
don't forget contract comments!

Filling in the function body

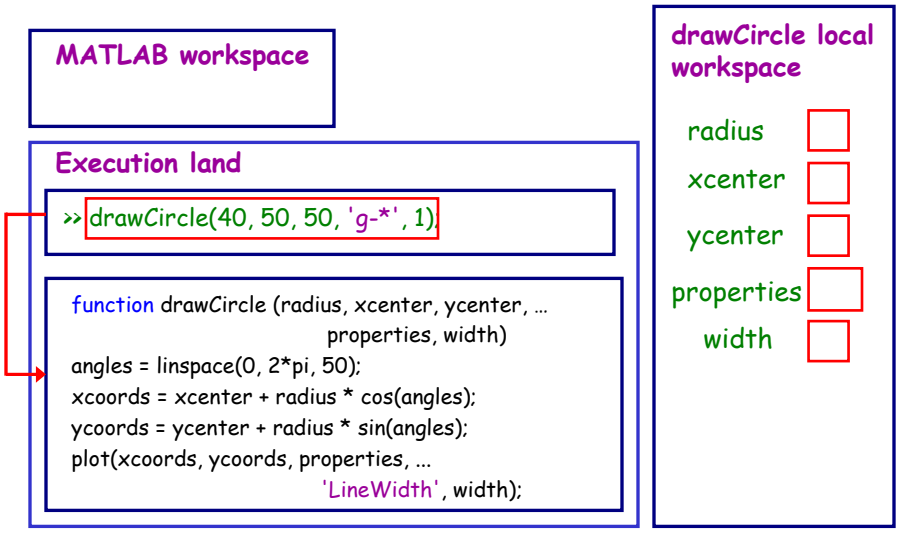
```
function drawCircle (radius, xcenter, ycenter, properties, width)
% drawCircle(radius, xcenter, ycenter, properties, width)
% draws circle with the specified radius, centered on location
% (xcenter, ycenter) with the specified properties and width

angles = linspace(0, 2*pi, 50);
xcoords = xcenter + radius * cos(angles);
ycoords = ycenter + radius * sin(angles);
plot(xcoords, ycoords, properties, 'LineWidth', width);
```

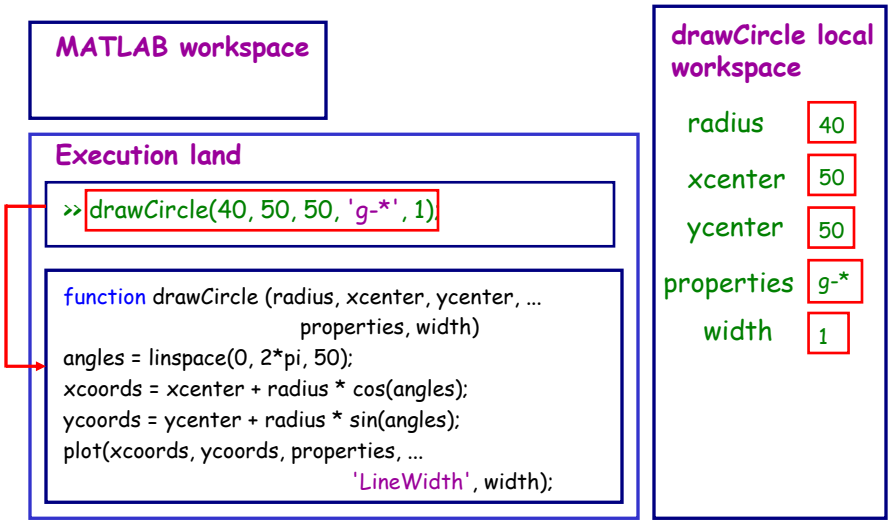
Executing drawCircle function



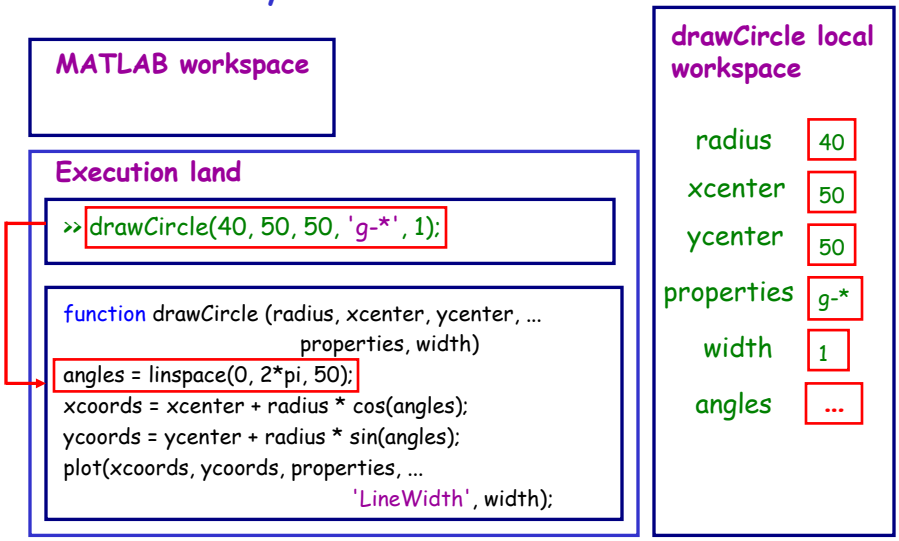
Create input parameter variables ...



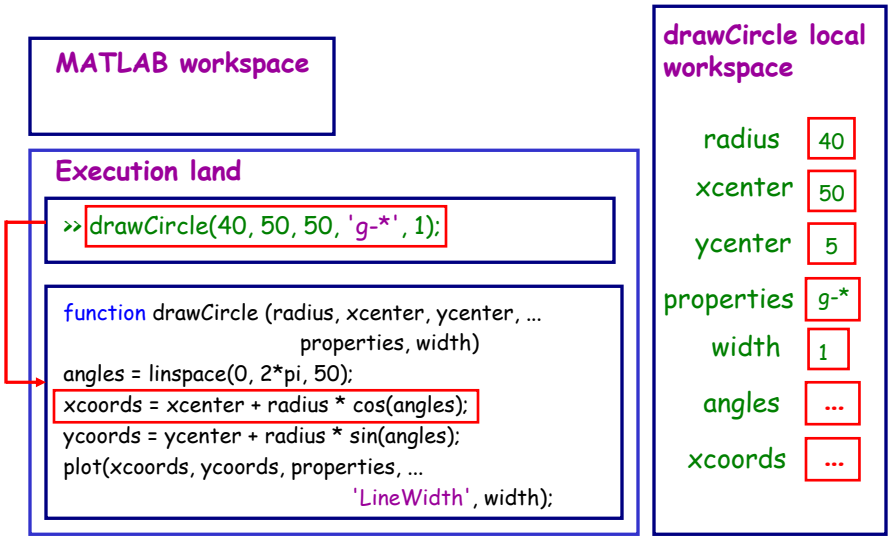
... and fill them in from call statement



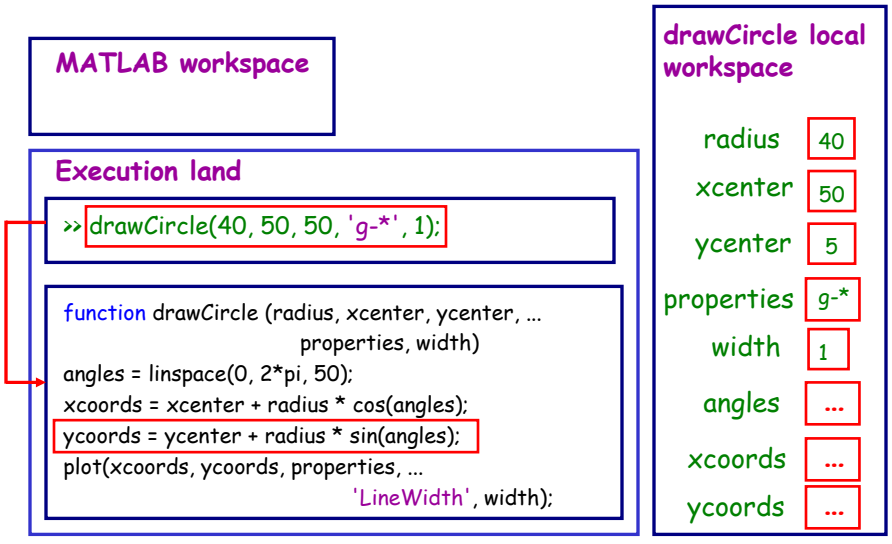
Execute body of function



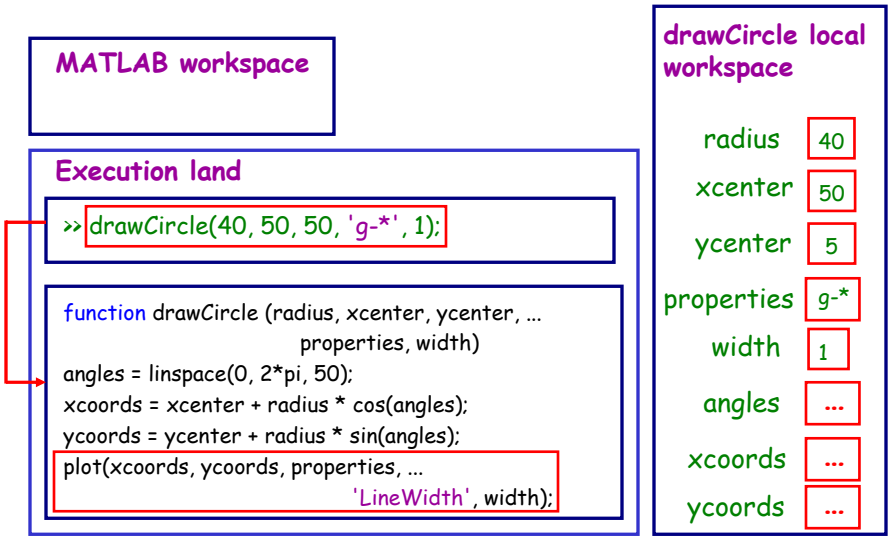
Next statement



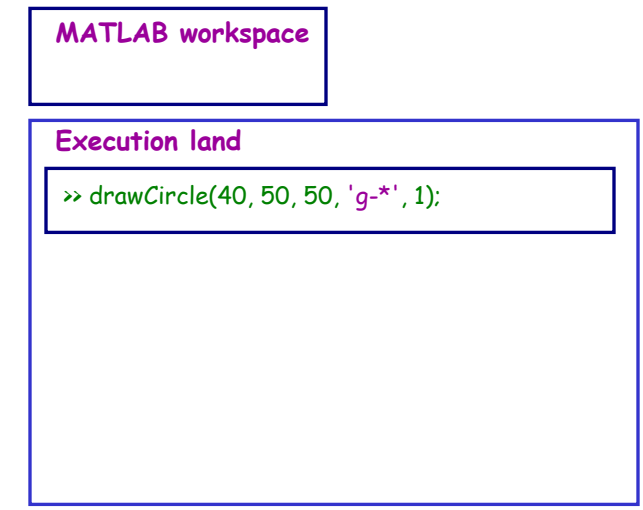
Next statement



And we draw the circle



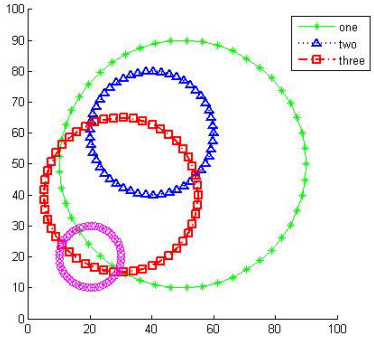
Where'd everybody go?



A thorough test

```
% testCircle.m
% tests the drawCircle function

hold on
drawCircle(40, 50, 50, 'g-*', 1);
drawCircle(20, 40, 60, 'b:^', 2);
drawCircle(25, 30, 40, 'r-.s', 2);
legend('one', 'two', 'three');
drawCircle(10, 20, 20, 'm--o', 1);
axis equal
axis([0 100 0 100])
hold off
```



Functions with multiple outputs

Suppose we'd like to write a variation of myMean that returns both the *arithmetic mean* and *geometric mean*

Given n numbers:

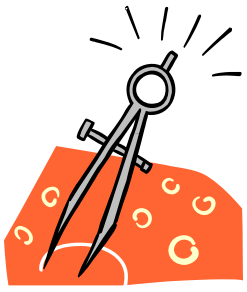
$a_1, a_2 \ldots a_n$

arithmetic mean:

$(a_1 + a_2 + \ldots + a_n)/n$

geometric mean:

$\sqrt[n]{a_1 * a_2 * \ldots * a_n}$



Consider first ...

Some built-in functions can return one or more values, depending on how the function is called

For example, consider the min function:

```
>> nums = [3  9  6  2  8];
>> minVal = min(nums)
minVal =
     2
>> [minVal minIndex] = min(nums)
minVal =
     2
minIndex =
     4
```


New lean mean machine

```
function [arith geom] = myMean2(data)
% [arith geom] = myMean2(data)
% returns both the arithmetic and geometric mean of
% the values in data, which may be a vector or matrix

dims = size(data);
if (min(dims) == 1)
   arith = sum(data)/length(data);
   geom = nthroot(prod(data), length(data));
else
   arith = sum(sum(data))/prod(dims);
   geom = nthroot(prod(prod(data)), prod(dims));
end
```