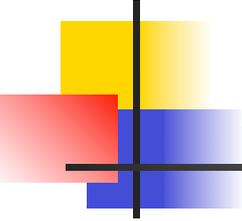
The logo for ECOR 1010 consists of three overlapping squares: a yellow one at the top, a red one on the left, and a blue one at the bottom. A black crosshair is centered over the intersection of the squares.

ECOR 1010

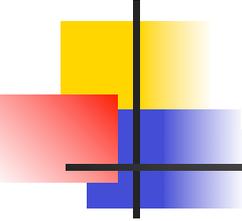
Lecture 17

MATLAB Programming

The logo consists of three overlapping squares: a yellow one at the top left, a red one at the bottom left, and a blue one at the bottom right. A black crosshair is centered over the intersection of the squares.

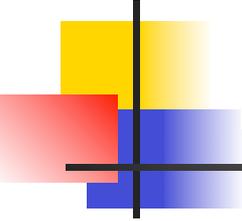
MATLAB Programming

- Use MATLAB to solve programming related problems
- Simple and practical programming language
- Generally use the Editor window
- Can develop script m-files and function m-files.



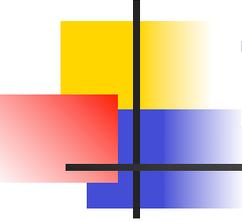
Relational and Logical Operators

<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
==	Equal to
~=	Not equal to
~	Not
&	And
	Or



Relational and Logical Operators

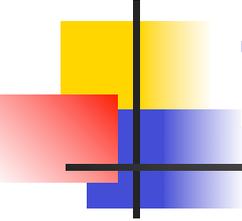
- Useful when comparing and selecting values
- Used to determine if an expression will evaluate to true or false.
- Used in if statements and in while loops.
- Used whenever a logical decision must be made



if statements

```
if (expression)
    statements
end
```

- If the expression evaluates to true, then the statements between the if command and the end command are executed.
- If the logical expression evaluates to false, then the program will skip the actions inside of the if statement and jump to the statement immediately after the end statement.

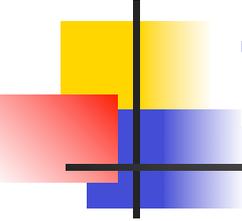


if statements

```
if expression
    statements
end
```

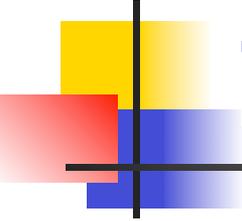
- Any number of commands can be included in the statements section, and the semicolon rules still apply to these commands.

```
if expression
    statement1;
    statement2;
    statement3
end
```



if statements

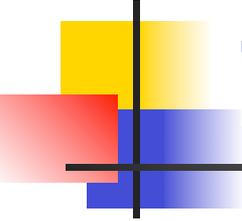
- Create an if statement that will write a message if a number is greater than 6.



if statements

- Create an if statement that will write a message if a number is greater than 6.

```
Number = 8; %this value can be changed
```

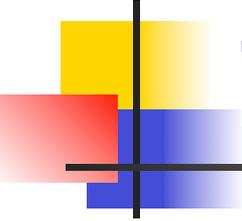


if statements

- Create an if statement that will write a message if a number is greater than 6.

```
Number = 8; %this value can be changed
```

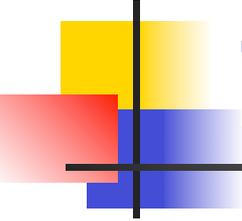
```
if Number > 6
```



if statements

- Create an if statement that will write a message if a number is greater than 6.

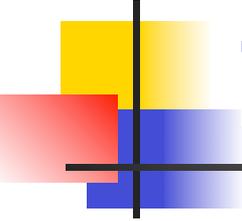
```
Number = 8; %this value can be changed  
if Number > 6  
    disp('They're learning for free!')
```



if statements

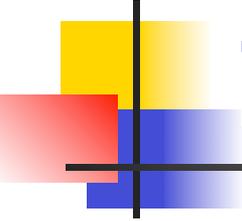
- Create an if statement that will write a message if a number is greater than 6.

```
Number = 8; %this value can be changed
if Number > 6
    disp('They're learning for free!')
end
```



if statements

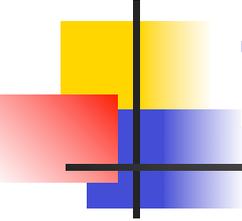
- Create an if statement that will test to see if a student is old enough to go to the bar (Must be at least 19). If they are, display an appropriate message.



if statements

- Create an if statement that will test to see if a student is old enough to go to the bar (Must be at least 19). If they are, display an appropriate message.

```
Age = 18; %this can be changed
```

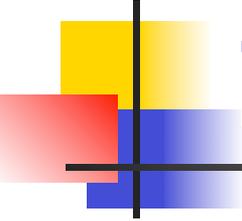


if statements

- Create an if statement that will test to see if a student is old enough to go to the bar (Must be at least 19). If they are, display an appropriate message.

```
Age = 18; %this can be changed
```

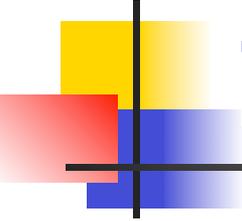
```
if Age >= 19
```



if statements

- Create an if statement that will test to see if a student is old enough to go to the bar (Must be at least 19). If they are, display an appropriate message.

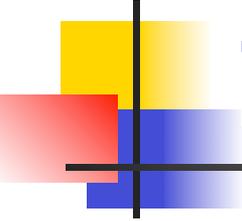
```
Age = 18; %this can be changed
if Age >= 19
    disp('Old enough to drink')
```



if statements

- Create an if statement that will test to see if a student is old enough to go to the bar (Must be at least 19). If they are, display an appropriate message.

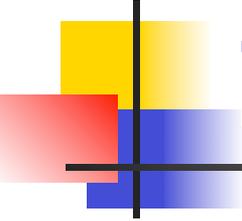
```
Age = 18; %this can be changed
if Age >= 19
    disp('Old enough to drink')
end
```



if-else Statements

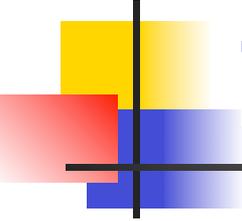
```
if expression
    statements
else
    statements
end
```

- Very similar to an if statement
- If the expression is true, the first set of statements are performed.
- If the expression evaluates to false, the second set (else) of statements are performed.
- An action is performed in either case



if-else Statements

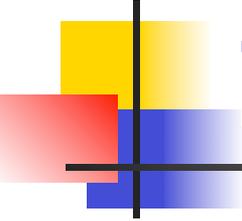
- Write an if statement that will test to see if a grade is an A (85.0-89.9). If the grade is an A, then increase a counter, assign the appropriate number of grade points to a variable `Grade_Points`, and display an appropriate message. If the grade is not an A, display an appropriate message.



if-else Statements

- Write an if statement that will test to see if a grade is an A (85.0-89.9). If the grade is an A, then increase a counter, assign the appropriate number of grade points to a variable `Grade_Points`, and display an appropriate message. If the grade is not an A, display an appropriate message.

```
Grade = 86.3 %can be changed
```

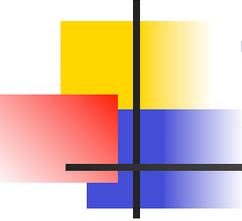


if-else Statements

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```
Grade = 86.3 %can be changed
```

```
if (Grade >= 85.0) & (Grade < 90.0)
```



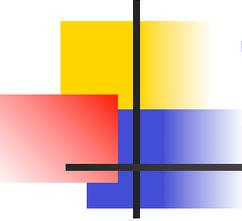
if-else Statements

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```
Grade = 86.3 %can be changed
```

```
if (Grade >= 85.0) & (Grade < 90.0)
```

```
    Grade_Points = 11;
```



if-else Statements

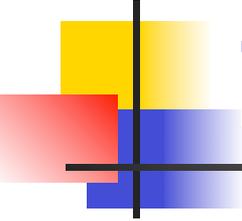
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```
Grade = 86.3 %can be changed
```

```
if (Grade >= 85.0) & (Grade < 90.0)
```

```
    Grade_Points = 11;
```

```
    Counter = Counter + 1;
```



if-else Statements

- Write an if statement that will test to see if a grade is an A (85.0-89.9). If the grade is an A, then increase a counter, assign the appropriate number of grade points to a variable `Grade_Points`, and display an appropriate message. If the grade is not an A, display an appropriate message.

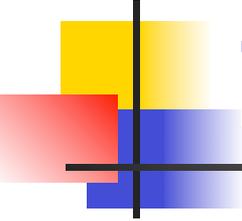
```
Grade = 86.3 %can be changed
```

```
if (Grade >= 85.0) & (Grade < 90.0)
```

```
    Grade_Points = 11;
```

```
    Counter = Counter + 1;
```

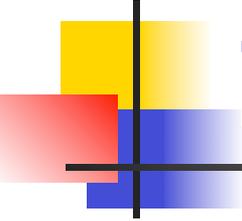
```
    disp('The grade is an A')
```



if-else Statements

- Write an if statement that will test to see if a grade is an A (85.0-89.9). If the grade is an A, then increase a counter, assign the appropriate number of grade points to a variable `Grade_Points`, and display an appropriate message. If the grade is not an A, display an appropriate message.

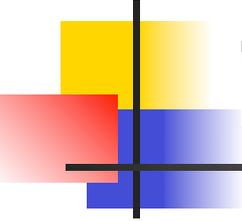
```
Grade = 86.3 %can be changed
if (Grade >= 85.0) & (Grade < 90.0)
    Grade_Points = 11;
    Counter = Counter + 1;
    disp('The grade is an A')
else
```



if-else Statements

- Write an if statement that will test to see if a grade is an A (85.0-89.9). If the grade is an A, then increase a counter, assign the appropriate number of grade points to a variable `Grade_Points`, and display an appropriate message. If the grade is not an A, display an appropriate message.

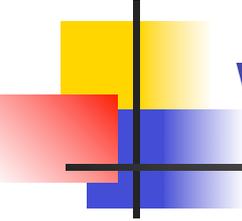
```
Grade = 86.3 %can be changed
if (Grade >= 85.0) & (Grade < 90.0)
    Grade_Points = 11;
    Counter = Counter + 1;
    disp('The grade is an A')
else
    disp('The grade is not an A')
```



if-else Statements

- Write an if statement that will test to see if a grade is an A (85.0-89.9). If the grade is an A, then increase a counter, assign the appropriate number of grade points to a variable `Grade_Points`, and display an appropriate message. If the grade is not an A, display an appropriate message.

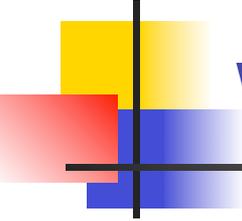
```
Grade = 86.3 %can be changed
if (Grade >= 85.0) & (Grade < 90.0)
    Grade_Points = 11;
    Counter = Counter + 1;
    disp('The grade is an A')
else
    disp('The grade is not an A')
end
```



while Loops

```
while expression
    statements
end
```

- Used to repeat a set of commands as long as the specified condition continues to evaluate to true
- Tests the expression before the actions are performed.
- If the expression evaluates to false, no actions within the loop will be performed.

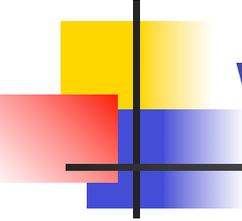


while Loops

```
while expression
    statements
end
```

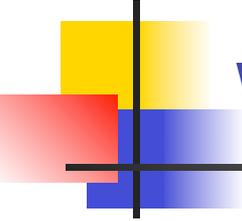
- The end command signifies the end of the loop. The program will then go back to the beginning of the loop to re-evaluate the expression to decide if the loop will be performed again.
- You can have any number of commands inside the loop:

```
while expression
    statement1
    statement2;
    statement3
end
```



while Loops

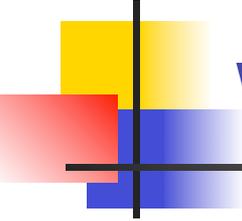
- Find the first positive even integer whose square is greater than, or equal to 2000



while Loops

- Find the first positive even integer whose square is greater than, or equal to 2000

```
Number = 2;
```

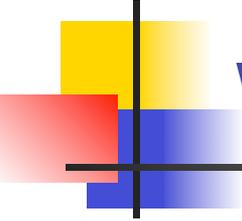


while Loops

- Find the first positive even integer whose square is greater than, or equal to 2000

```
Number = 2;
```

```
Square = Number * Number;
```



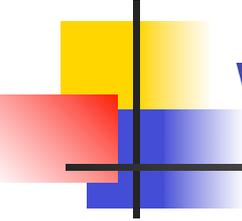
while Loops

- Find the first positive even integer whose square is greater than, or equal to 2000

```
Number = 2;
```

```
Square = Number * Number;
```

```
while Square < 2000
```



while Loops

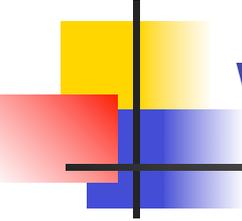
- Find the first positive even integer whose square is greater than, or equal to 2000

```
Number = 2;
```

```
Square = Number * Number;
```

```
while Square < 2000
```

```
    Number = Number + 2;
```



while Loops

- Find the first positive even integer whose square is greater than, or equal to 2000

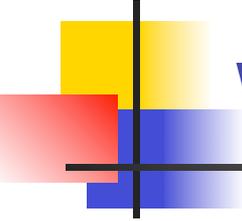
```
Number = 2;
```

```
Square = Number * Number;
```

```
while Square < 2000
```

```
    Number = Number + 2;
```

```
    Square = Number * Number;
```



while Loops

- Find the first positive even integer whose square is greater than, or equal to 2000

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Number = 2;
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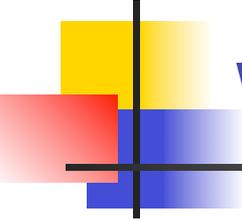
```
Square = Number * Number;
```

```
while Square < 2000
```

```
    Number = Number + 2;
```

```
    Square = Number * Number;
```

```
end
```



while Loops

- Find the first positive even integer whose square is greater than, or equal to 2000

```
Number = 2;
```

```
Square = Number * Number;
```

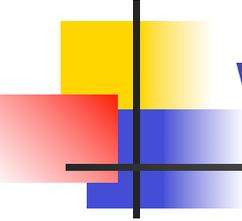
```
while Square < 2000
```

```
    Number = Number + 2;
```

```
    Square = Number * Number;
```

```
end
```

```
disp(Number)
```



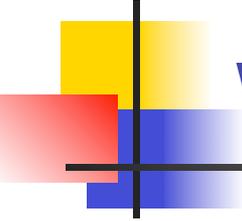
while Loops

- Find the first positive even integer whose square is greater than, or equal to 2000

```
Number = 2;  
Square = Number * Number;  
  
while Square < 2000  
    Number = Number + 2;  
    Square = Number * Number;  
  
end  
  
disp(Number)
```

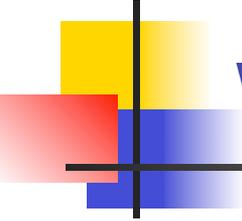
Solution:

» 46



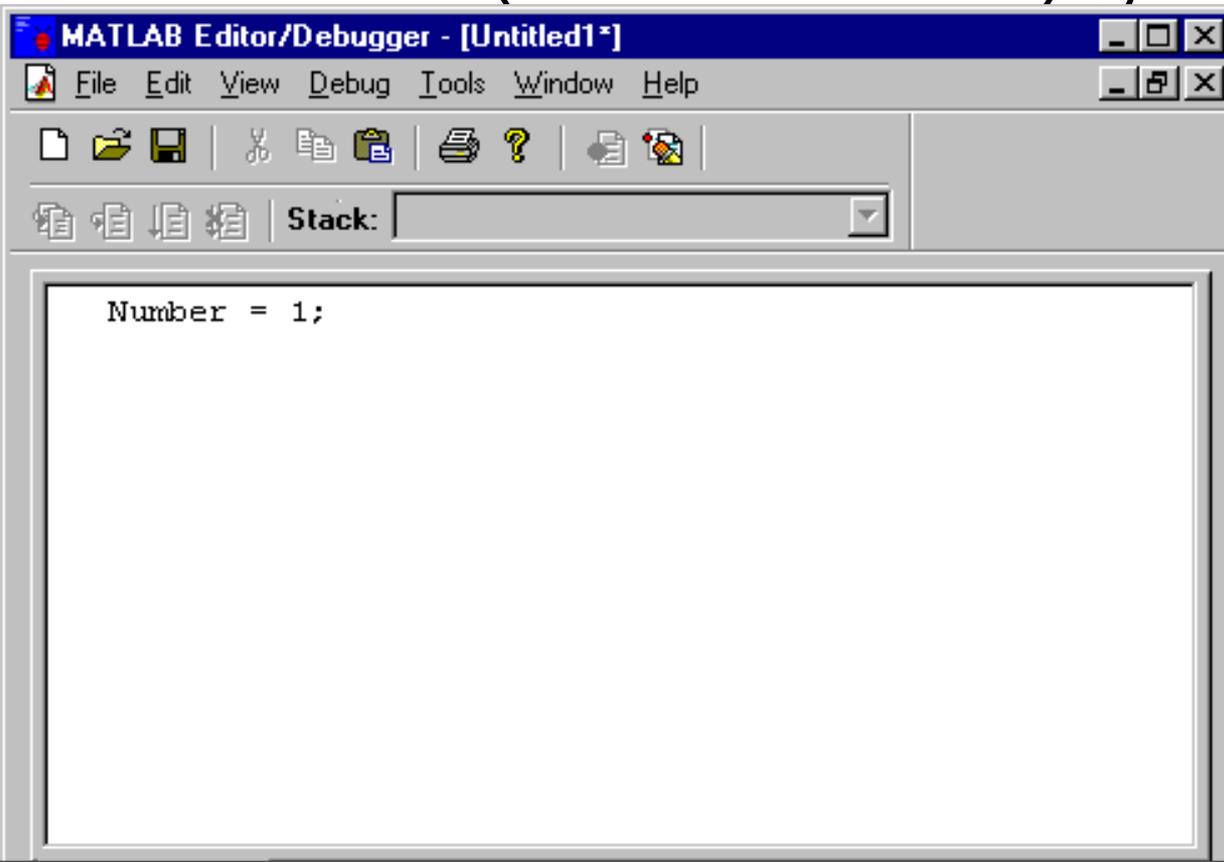
while Loops

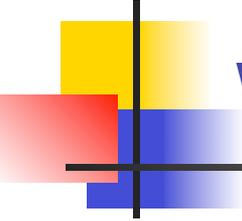
- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.



while Loops

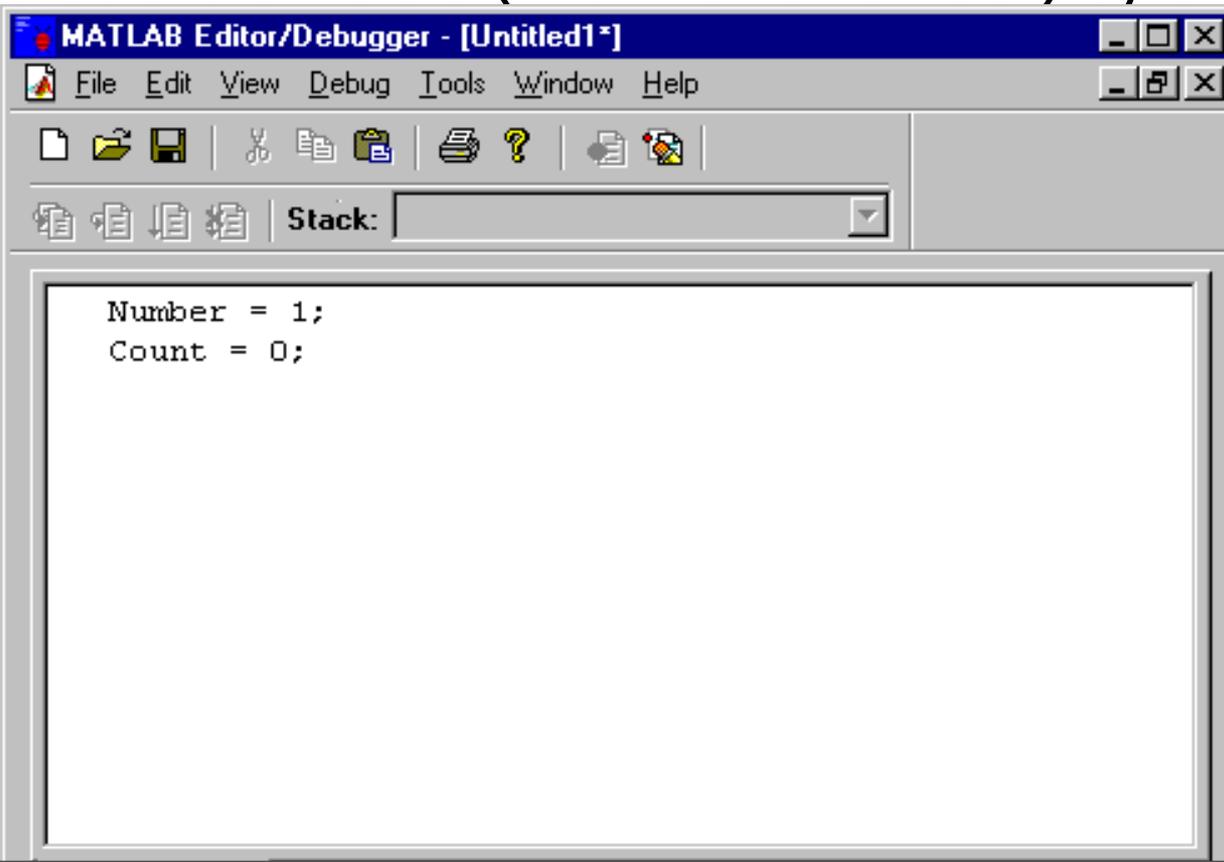
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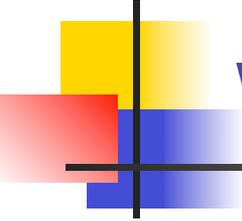


while Loops

- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.

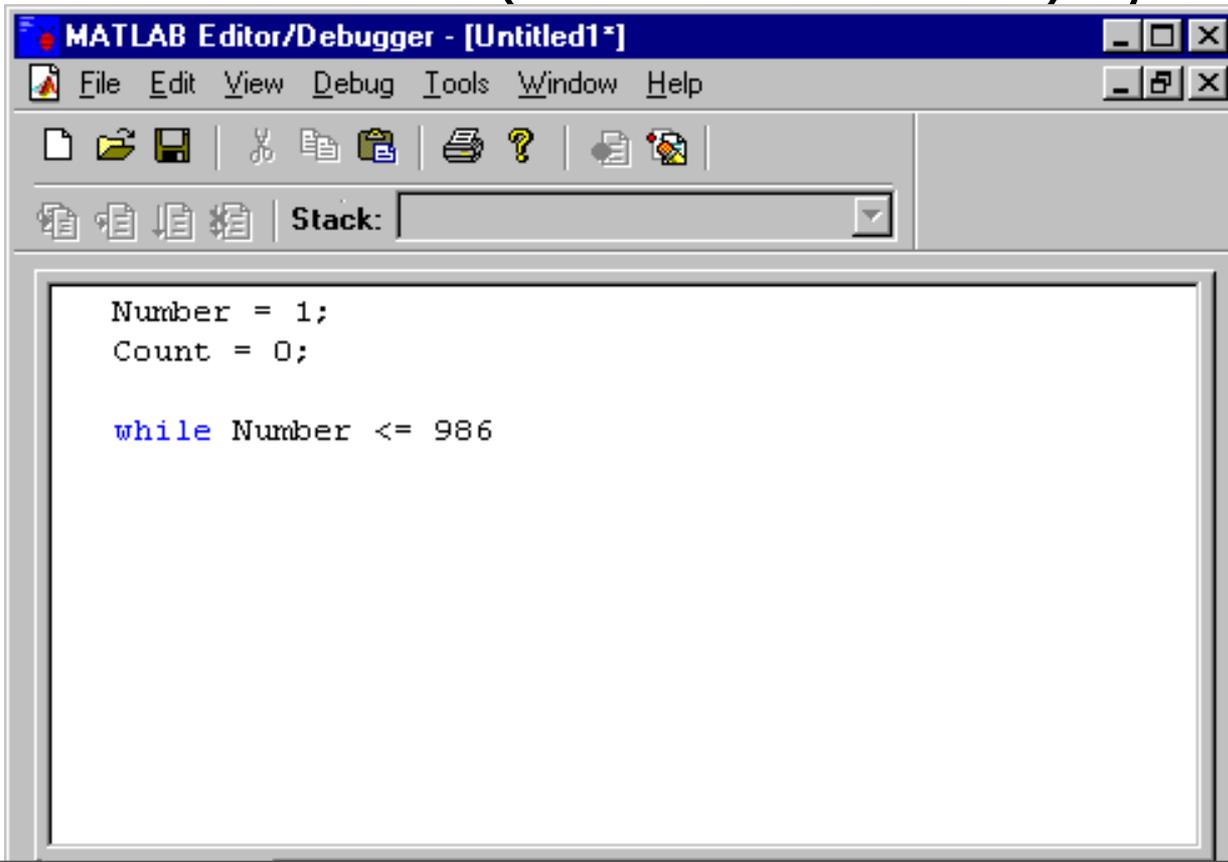


```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
[Icons]  
Stack: [Dropdown]  
  
Number = 1;  
Count = 0;
```

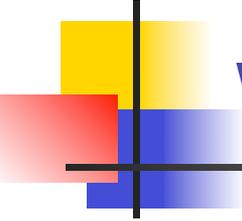


while Loops

- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.

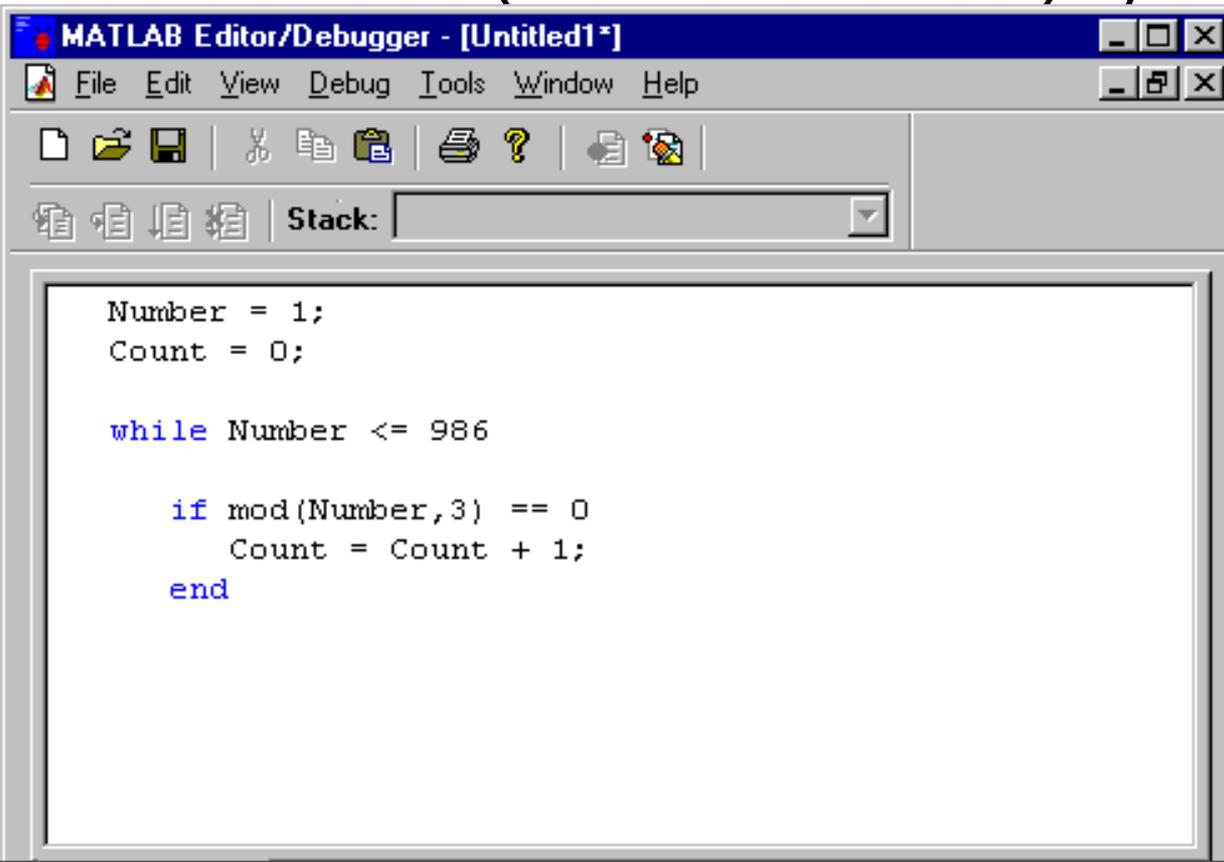


```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
[Icons for File, Edit, View, Debug, Tools, Window, Help]  
Stack: [Dropdown]  
  
Number = 1;  
Count = 0;  
  
while Number <= 986
```

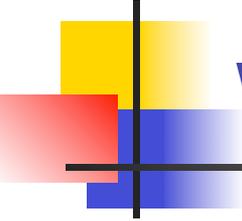


while Loops

- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.

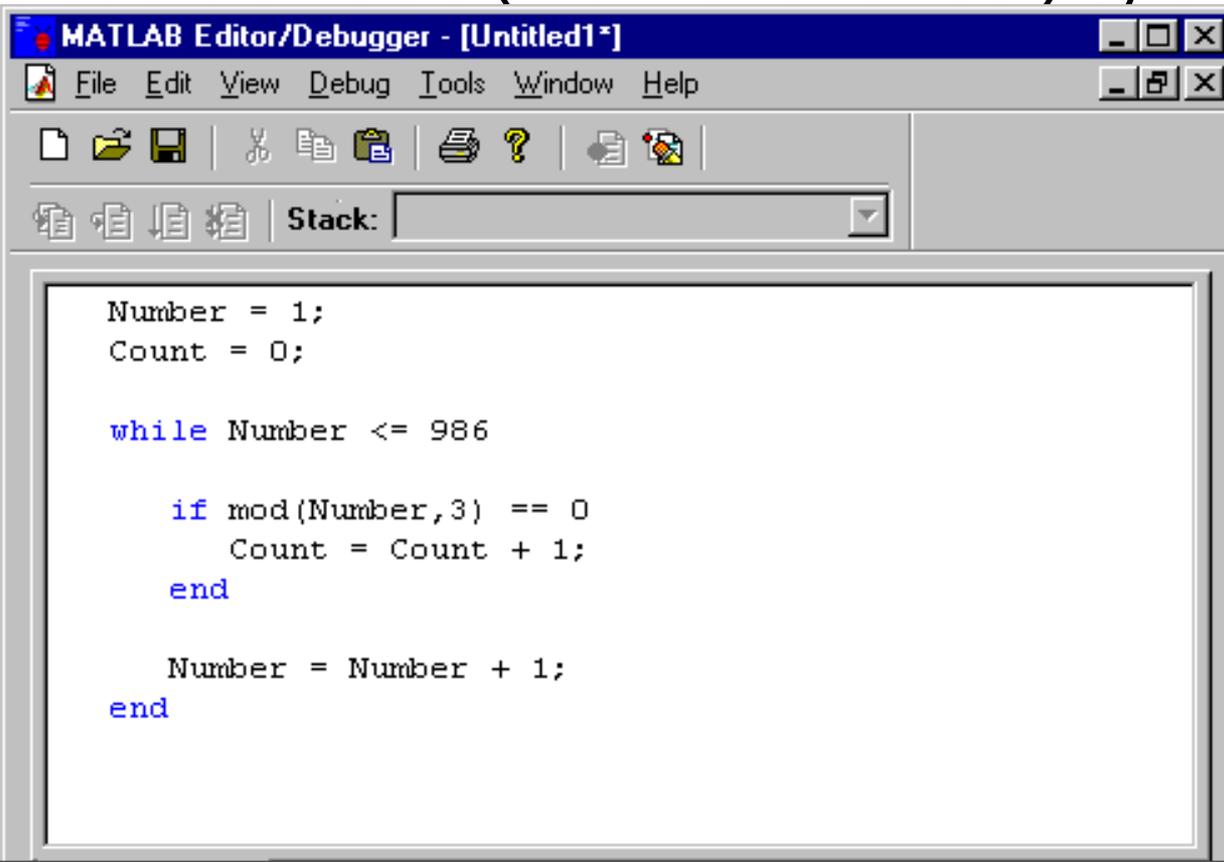


```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
[Icons for File, Edit, View, Debug, Tools, Window, Help]  
Stack: [Dropdown]  
  
Number = 1;  
Count = 0;  
  
while Number <= 986  
  
    if mod(Number,3) == 0  
        Count = Count + 1;  
    end
```

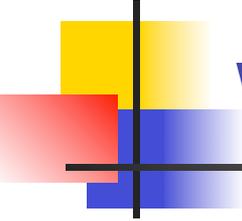


while Loops

- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.

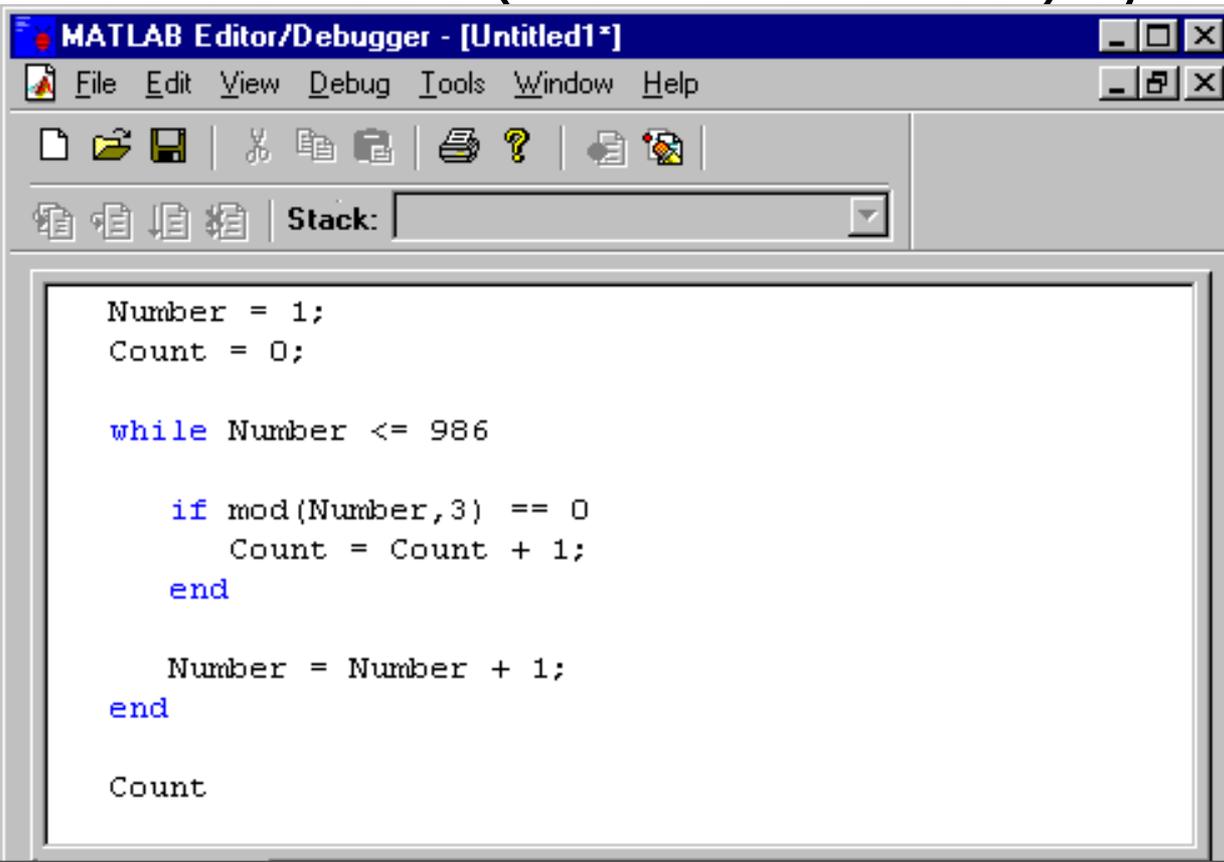


```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
Stack:  
Number = 1;  
Count = 0;  
  
while Number <= 986  
    if mod(Number,3) == 0  
        Count = Count + 1;  
    end  
    Number = Number + 1;  
end
```

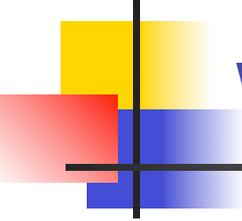


while Loops

- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.

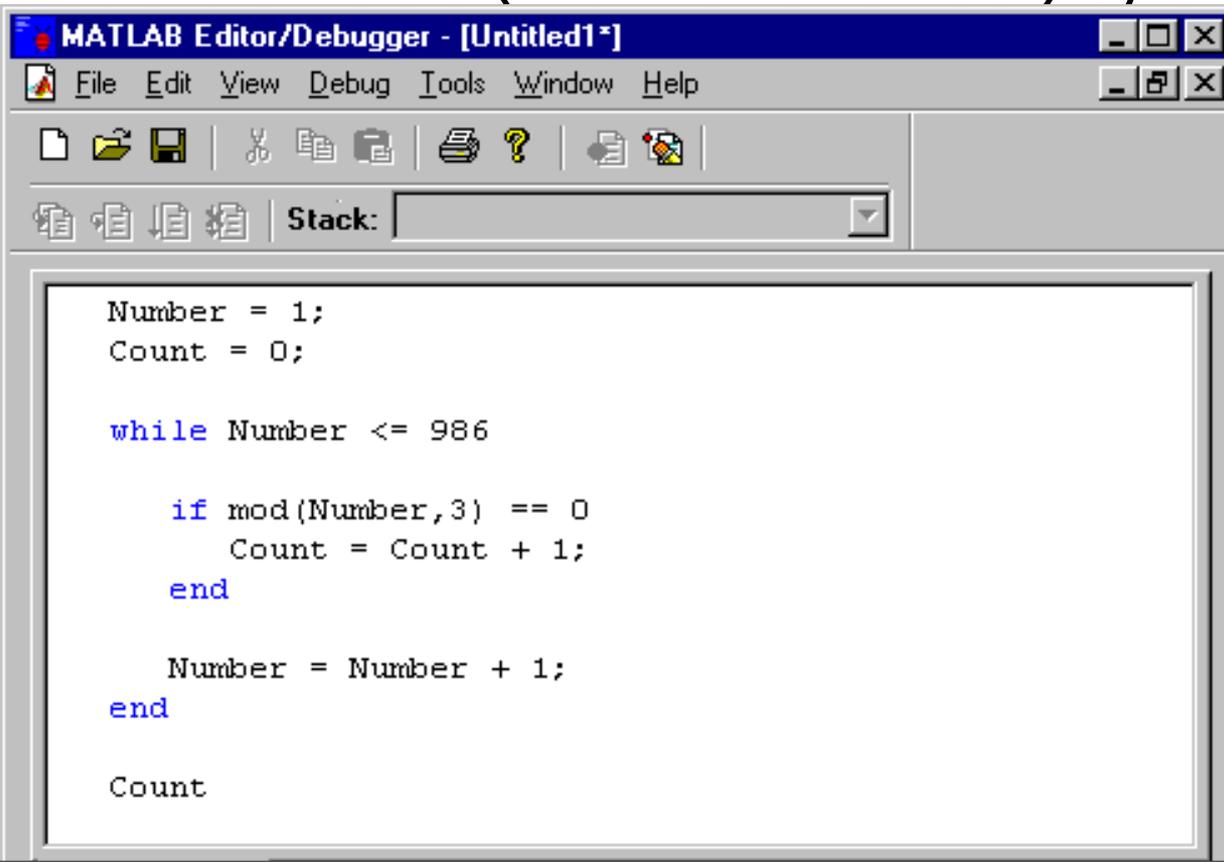


```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
[Icons: New, Open, Save, Cut, Copy, Paste, Undo, Redo, Print, Help, Run, Stop, Breakpoint]  
Stack: [Dropdown]  
  
Number = 1;  
Count = 0;  
  
while Number <= 986  
  
    if mod(Number,3) == 0  
        Count = Count + 1;  
    end  
  
    Number = Number + 1;  
end  
  
Count
```

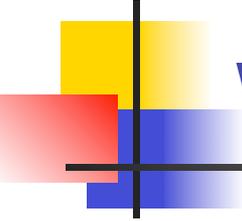


while Loops

- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.

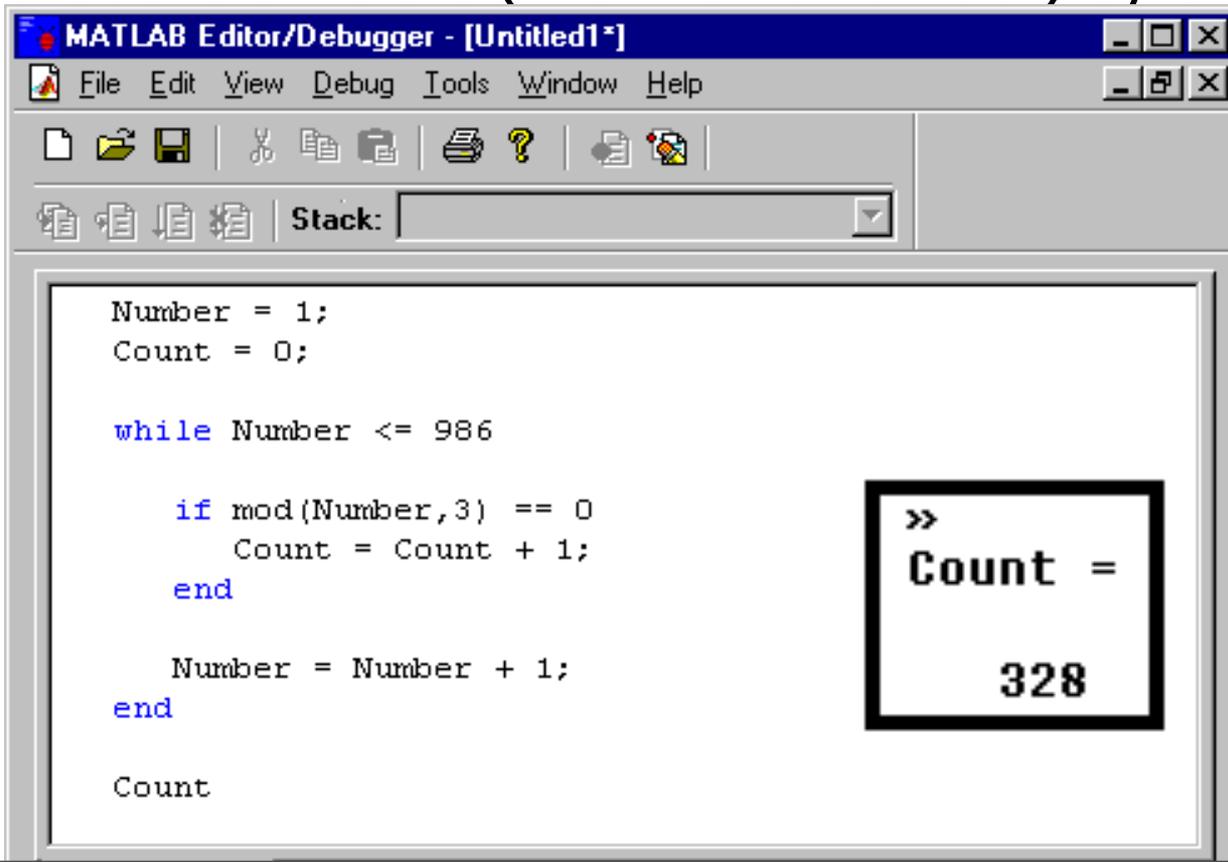


```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
Stack:  
Number = 1;  
Count = 0;  
  
while Number <= 986  
    if mod(Number,3) == 0  
        Count = Count + 1;  
    end  
    Number = Number + 1;  
end  
  
Count
```



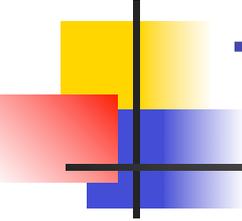
while Loops

- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.



```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
Stack: [dropdown]  
  
Number = 1;  
Count = 0;  
  
while Number <= 986  
    if mod(Number,3) == 0  
        Count = Count + 1;  
    end  
    Number = Number + 1;  
end  
  
Count
```

»
Count =
328

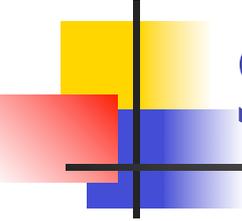


Types of M-Files

- There are two types of m-files:

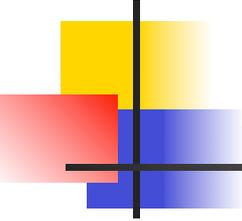
Scripts and Functions

- Both are created in the Editor window
- Up to this point, we have been creating script files



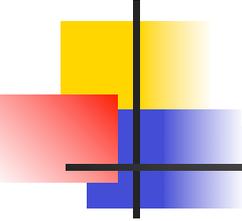
Script m-files

- Sequence of MATLAB commands
- Equivalent to typing a series of commands in the command window, except that scripts can be run at any time
- Cannot accept input
- All constants/values that need to be used should be defined at the beginning of the script file
- Values cannot be passed between script files.



Function M-Files

- Sub-program
- Can accept input and return outputs
- Creating a file that works just like a pre-defined MATLAB function (`sin(x)`, `mean(x)`), where the input `x` is required
- Can extend the MATLAB language
- Can access functions from within other scripts and functions



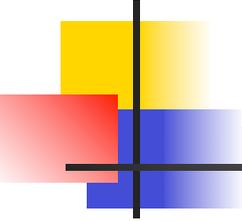
Function M-Files

```
function [x, y, ...]=FunctionName (arg1, arg2, ...)
```

- The name of the function (`FunctionName`) must be the same as the saved m-file name, and is used to call upon the function
- The input arguments for the function appear in parenthesis after the function name. You can have any number of arguments
- The m-file must begin with the function declaration
- If there are output arguments, they are specified in square brackets. If there is no output, leave the output blank.
- You can't run a function file from the Editor. You have to call the function in the command window:

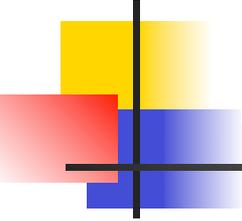
FunctionName(arg1, arg2)

Where `arg1` and `arg2` are the input values that will be used in the function



Function M-Files

- Write a function that will calculate the hypotenuse of a right angle triangle, given the other two sides.

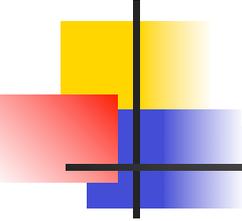


Function M-Files

- Write a function that will calculate the hypotenuse of a right angle triangle, given the other two sides.

```
function pythagoras(Side1, Side2)
```

```
Hypotenuse = sqrt((Side1^2) + (Side2^2))
```



Function M-Files

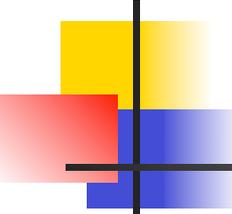
- Write a function that will calculate the hypotenuse of a right angle triangle, given the other two sides.

```
function pythagoras(Side1, Side2)
```

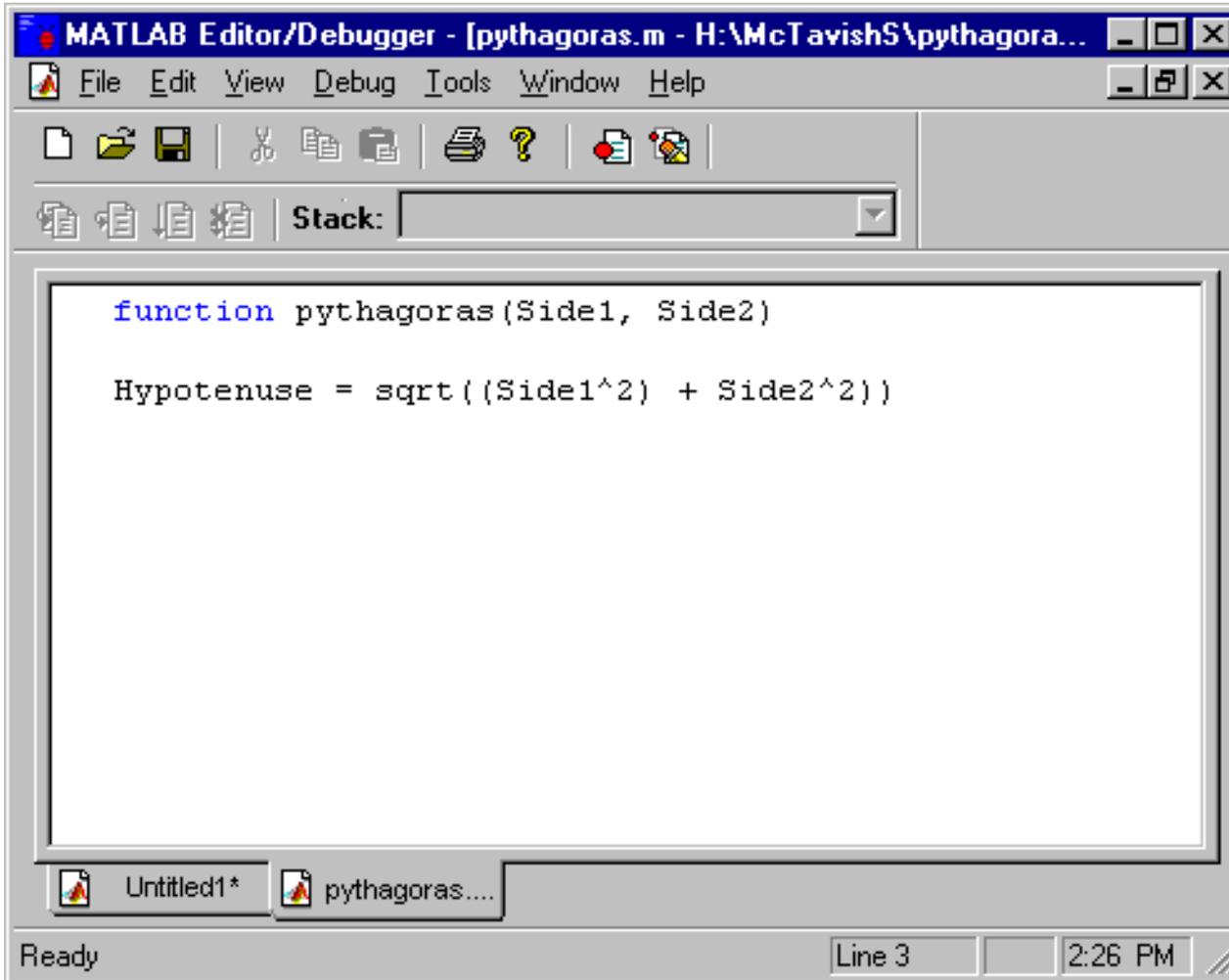
```
Hypotenuse = sqrt((Side1^2) + (Side2^2))
```

To use this function, simply type in the command window (or from within a script file):

```
pythagoras(Length of side1, Length of side2)
```



Functions



MATLAB Editor/Debugger - [pythagoras.m - H:\McTavishS\pythagora...]

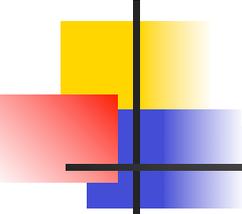
File Edit View Debug Tools Window Help

Stack:

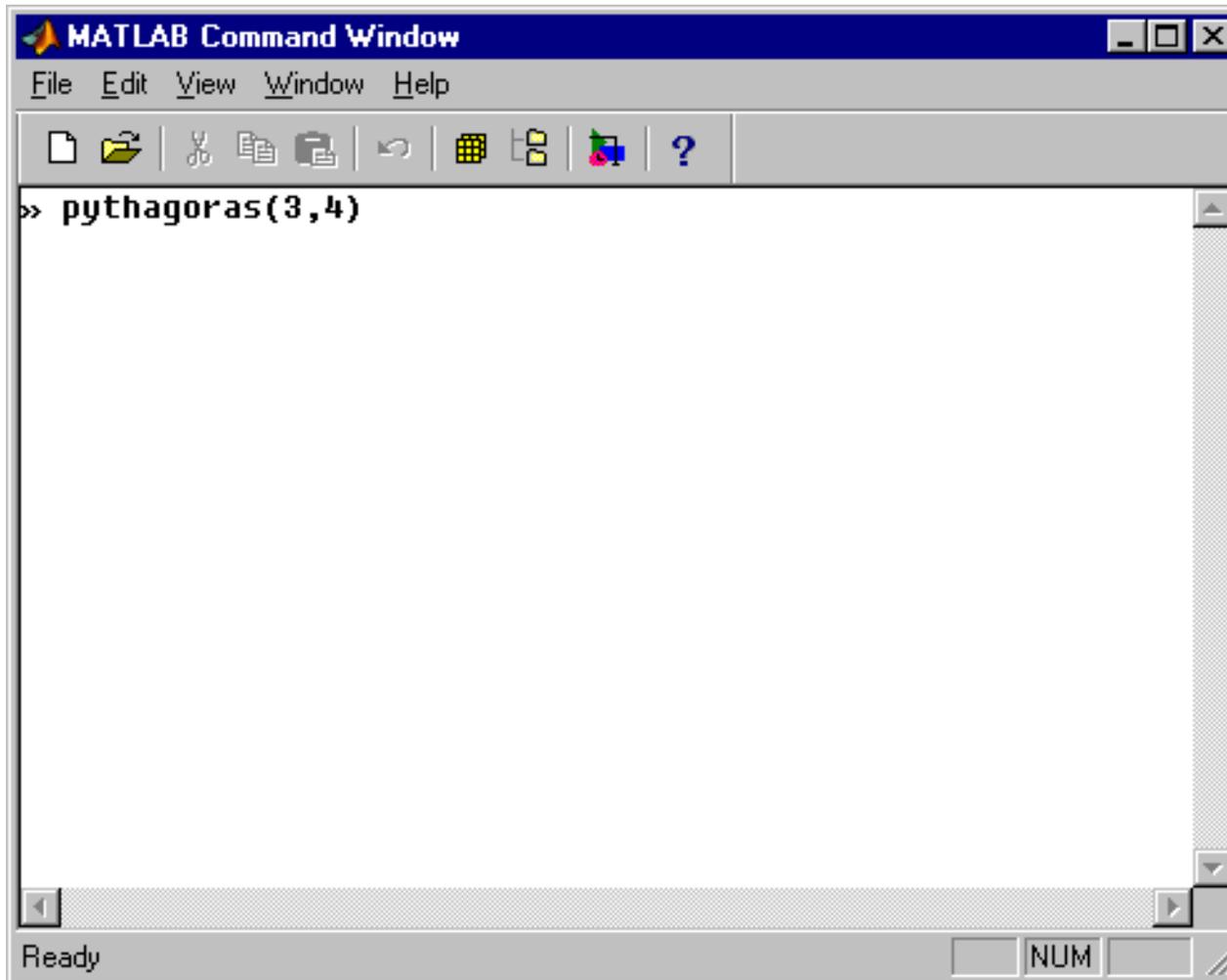
```
function pythagoras(Side1, Side2)

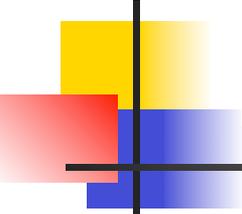
Hypotenuse = sqrt((Side1^2) + Side2^2)
```

Ready Line 3 2:26 PM

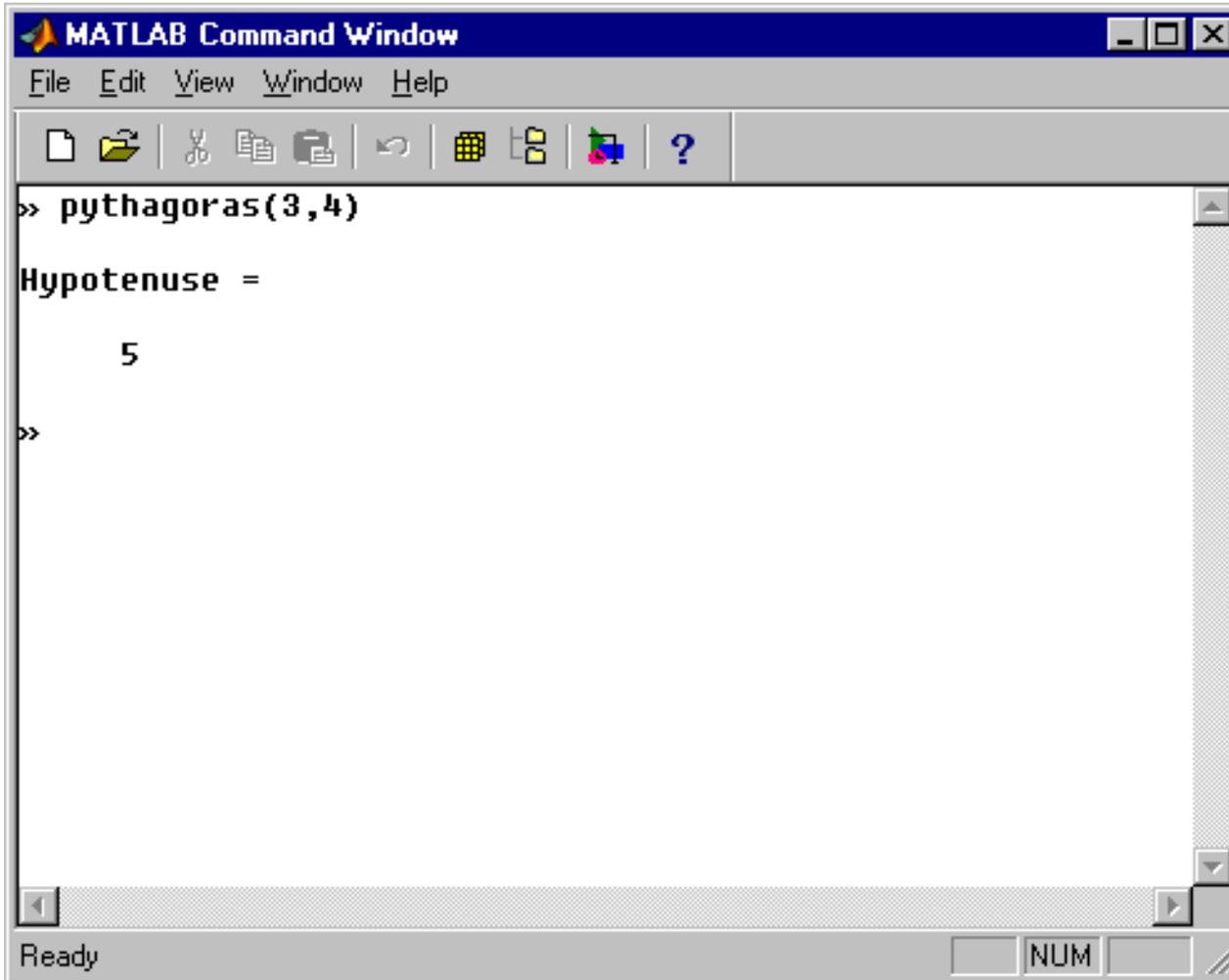


Functions





Functions



MATLAB Command Window

File Edit View Window Help

File Edit View Window Help ?

```
>> pythagoras(3,4)

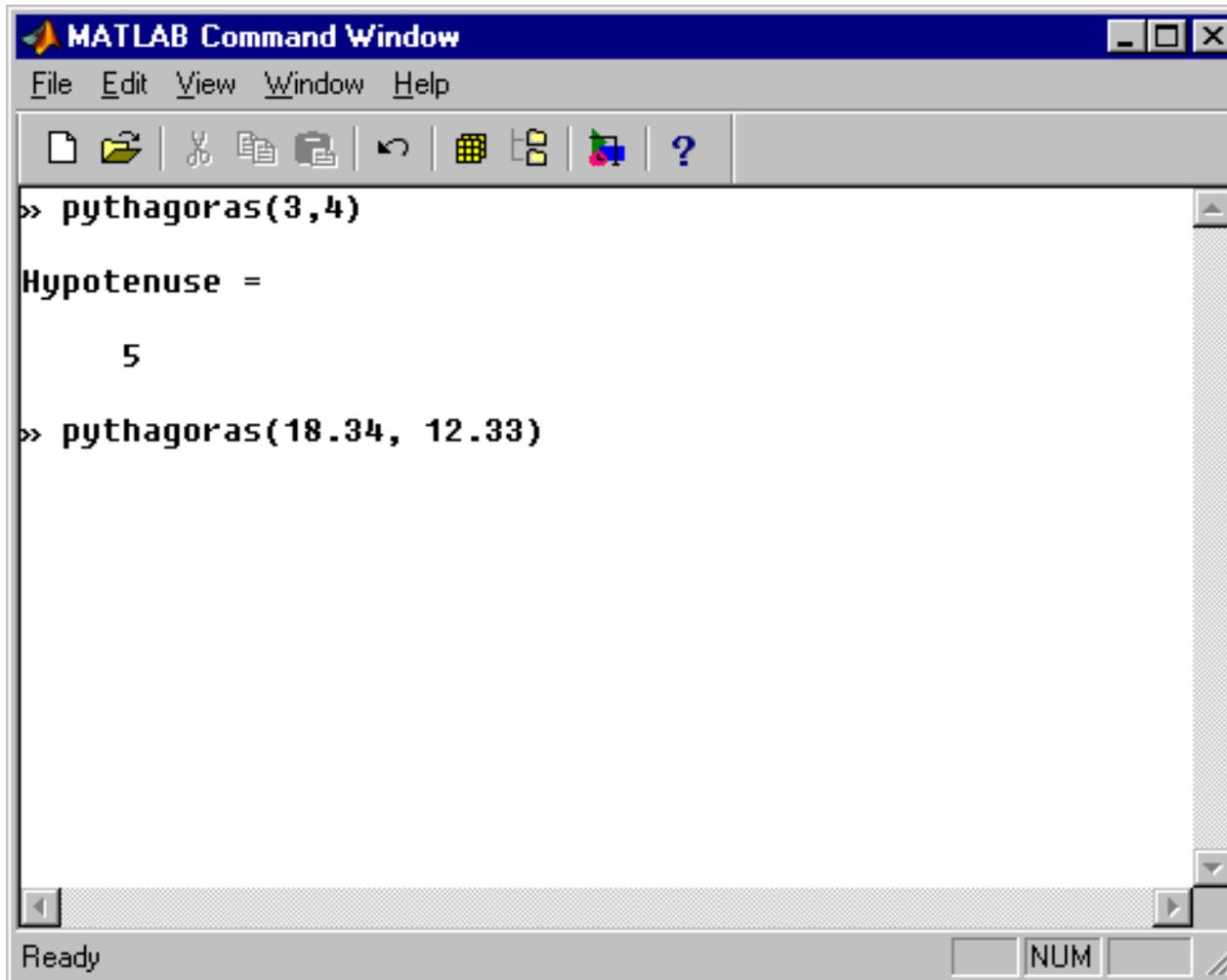
Hypotenuse =

     5

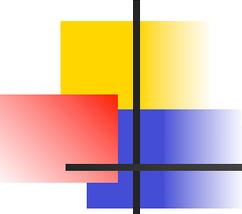
>>
```

Ready NUM

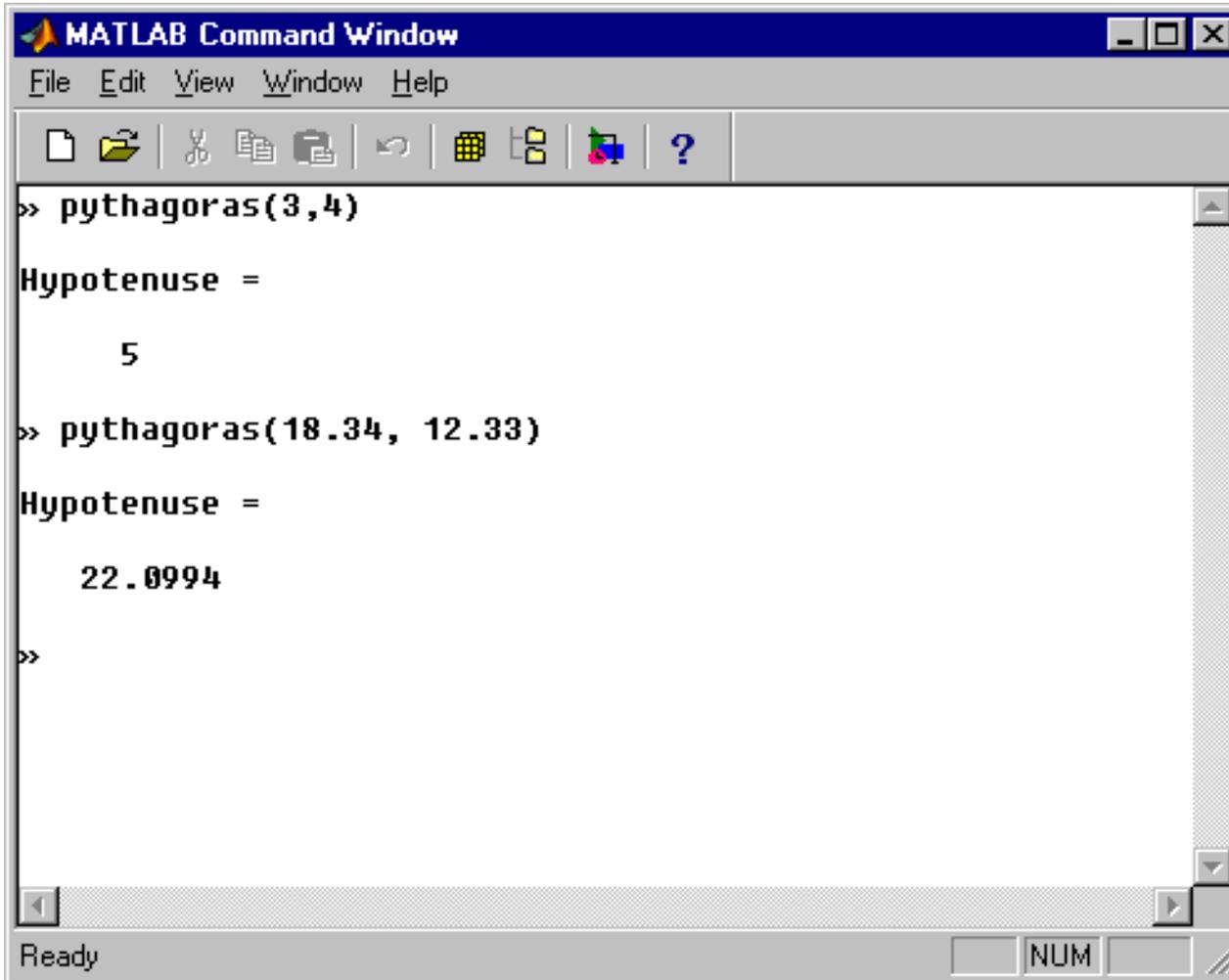
Functions

A screenshot of the MATLAB Command Window. The window title is "MATLAB Command Window". The menu bar includes "File", "Edit", "View", "Window", and "Help". The toolbar contains icons for file operations (new, open, save, print), editing (undo, redo), and help. The command prompt shows two function calls: "pythagoras(3,4)" which returns "Hypotenuse = 5", and "pythagoras(18.34, 12.33)". The status bar at the bottom shows "Ready" and a "NUM" button.

```
MATLAB Command Window
File Edit View Window Help
[Icons]
>> pythagoras(3,4)
Hypotenuse =
    5
>> pythagoras(18.34, 12.33)
Ready NUM
```

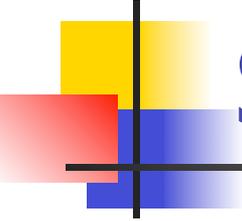


Functions



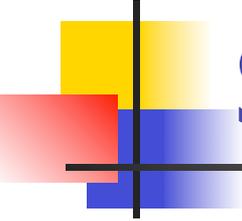
```
MATLAB Command Window
File Edit View Window Help
[Icons: New, Open, Copy, Paste, Undo, Redo, Grid, Home, Help]
>> pythagoras(3,4)
Hypotenuse =
    5
>> pythagoras(18.34, 12.33)
Hypotenuse =
    22.0994
>>
```

Ready NUM



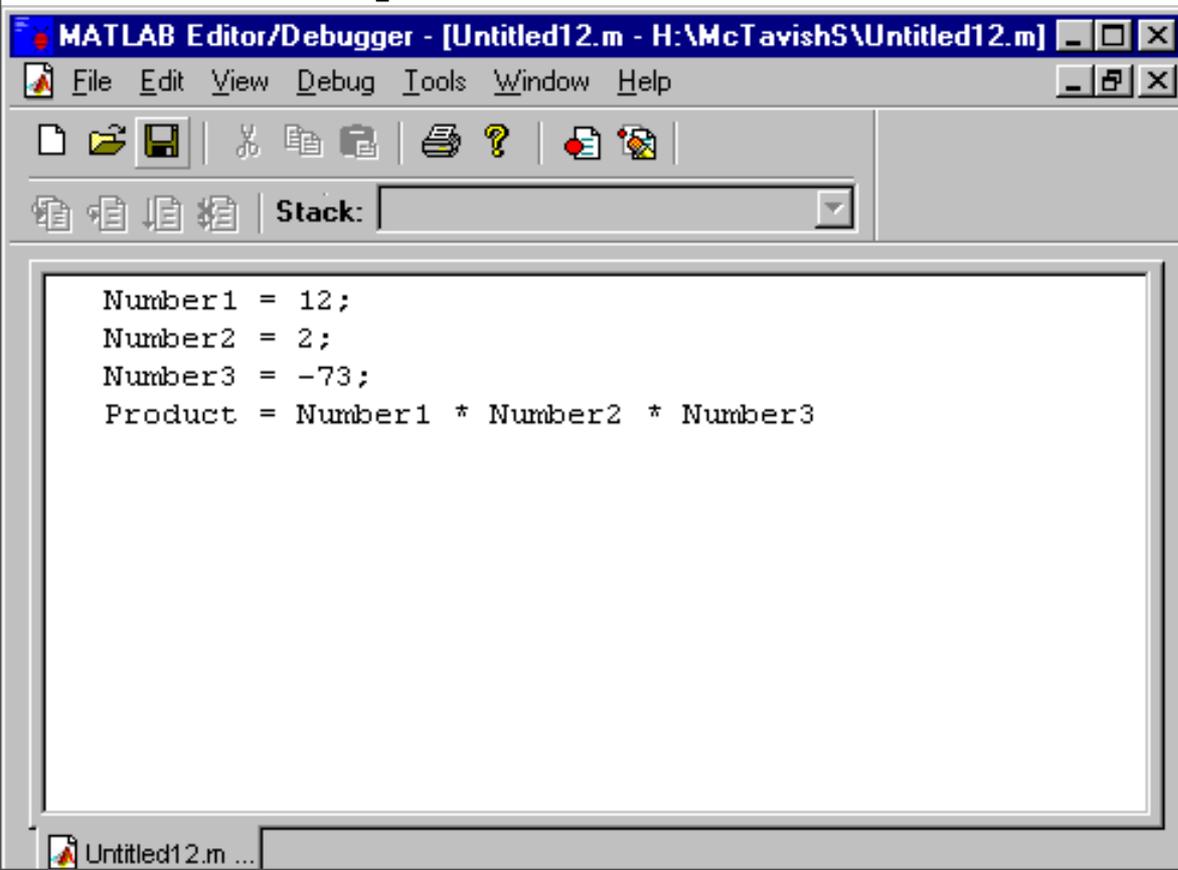
Script Vs. Function

- Write a script file and a function that will find the product of three numbers



Script Vs. Function

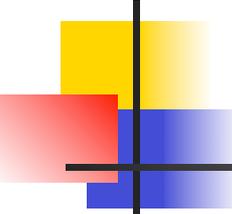
Script m-file



The screenshot shows the MATLAB Editor/Debugger interface. The title bar reads "MATLAB Editor/Debugger - [Untitled12.m - H:\McTavishS\Untitled12.m]". The menu bar includes "File", "Edit", "View", "Debug", "Tools", "Window", and "Help". The toolbar contains icons for file operations (New, Open, Save, Print, Help) and editing (Cut, Copy, Paste). Below the toolbar is a "Stack" panel. The main editor area contains the following MATLAB script:

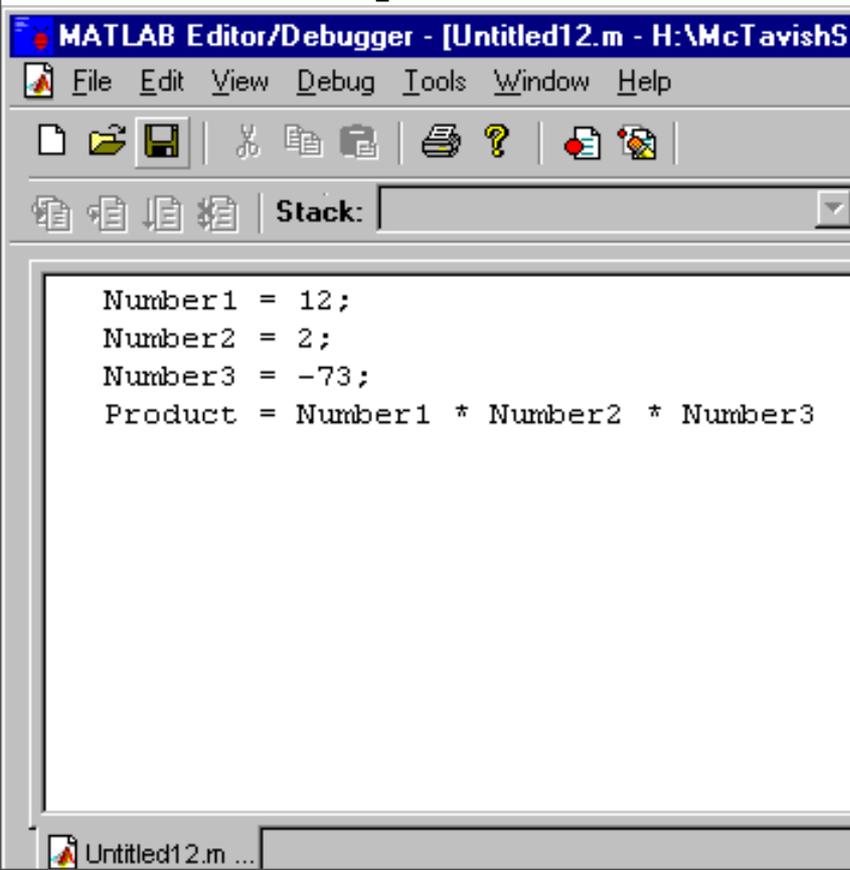
```
Number1 = 12;  
Number2 = 2;  
Number3 = -73;  
Product = Number1 * Number2 * Number3
```

The taskbar at the bottom shows the file name "Untitled12.m ...".



Script Vs. Function

Script m-file



MATLAB Editor/Debugger - [Untitled12.m - H:\McTavishS\...]

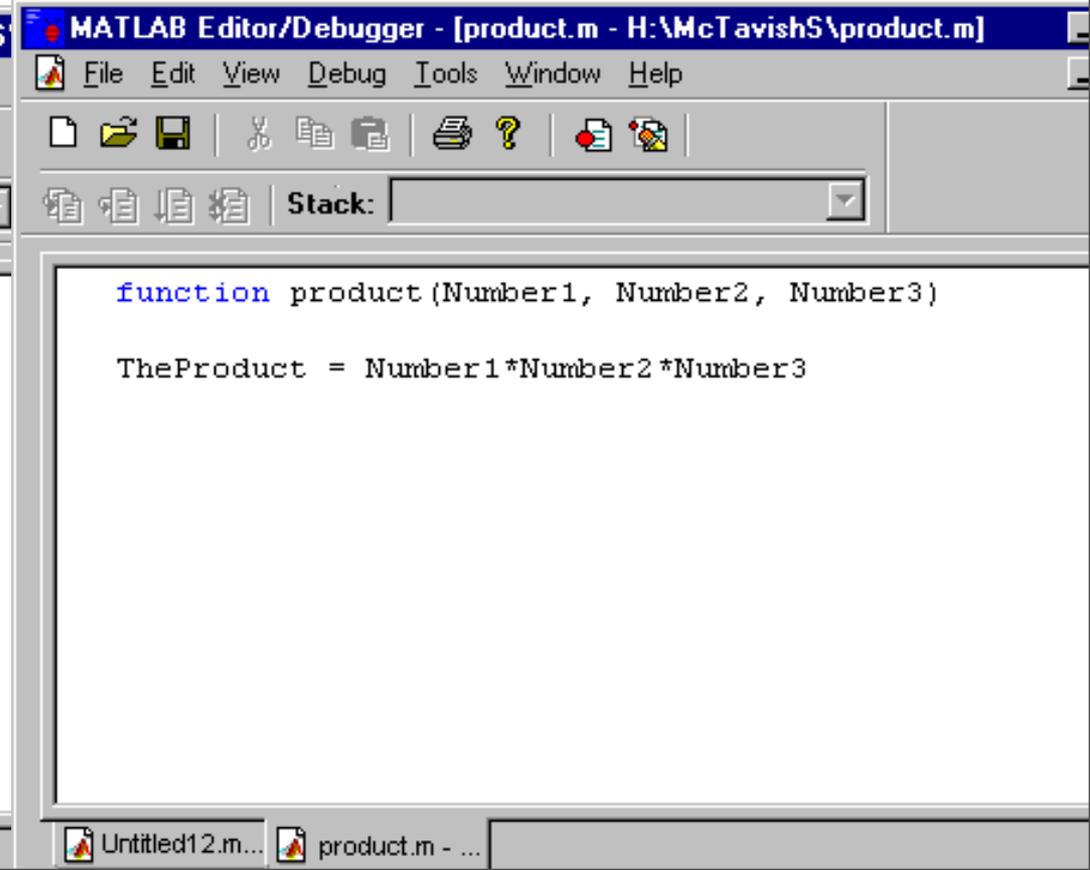
File Edit View Debug Tools Window Help

Stack: []

```
Number1 = 12;  
Number2 = 2;  
Number3 = -73;  
Product = Number1 * Number2 * Number3
```

Taskbar: Untitled12.m ...

Function m-file



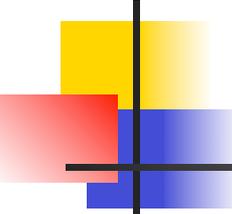
MATLAB Editor/Debugger - [product.m - H:\McTavishS\product.m]

File Edit View Debug Tools Window Help

Stack: []

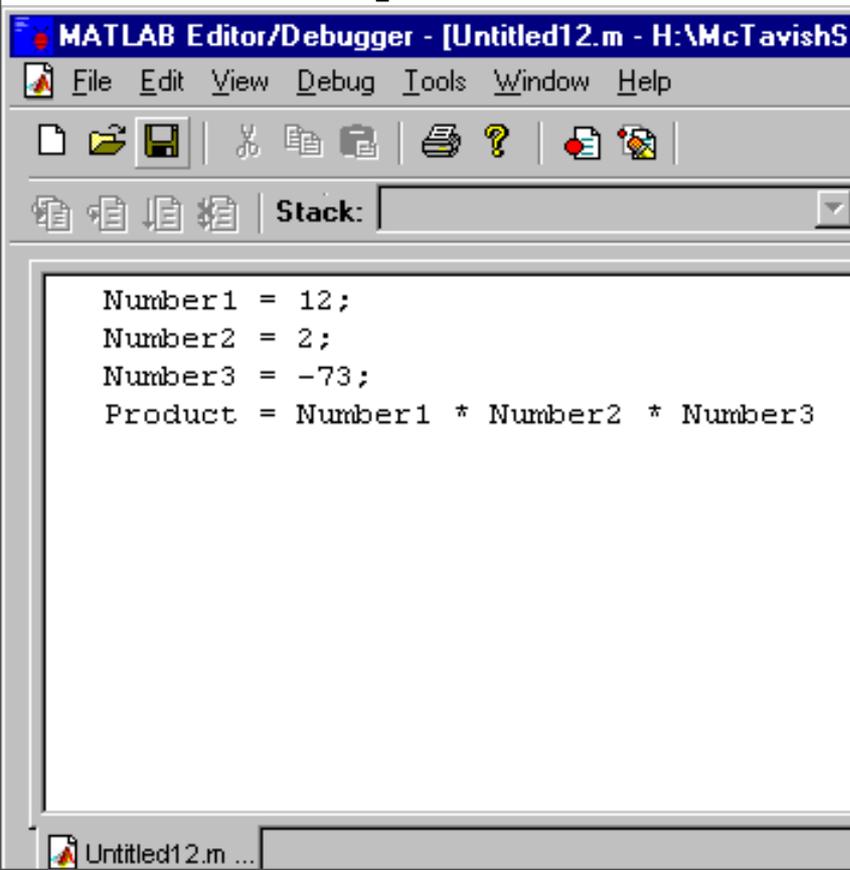
```
function product(Number1, Number2, Number3)  
  
TheProduct = Number1*Number2*Number3
```

Taskbar: Untitled12.m... product.m - ...



Script Vs. Function

Script m-file



MATLAB Editor/Debugger - [Untitled12.m - H:\McTavishS\...

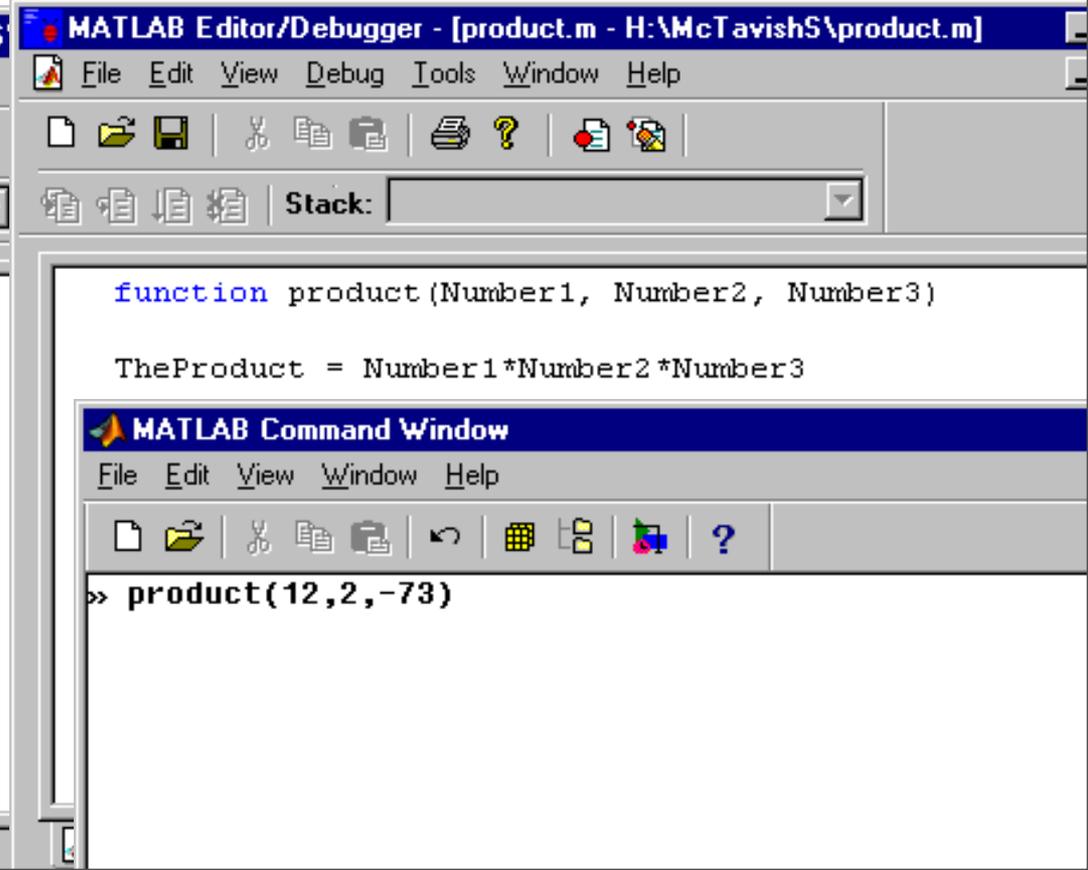
File Edit View Debug Tools Window Help

Stack: []

```
Number1 = 12;  
Number2 = 2;  
Number3 = -73;  
Product = Number1 * Number2 * Number3
```

Untitled12.m ...

Function m-file



MATLAB Editor/Debugger - [product.m - H:\McTavishS\product.m]

File Edit View Debug Tools Window Help

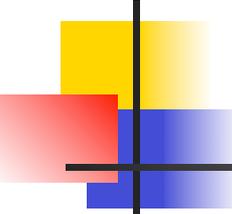
Stack: []

```
function product(Number1, Number2, Number3)  
  
TheProduct = Number1*Number2*Number3
```

MATLAB Command Window

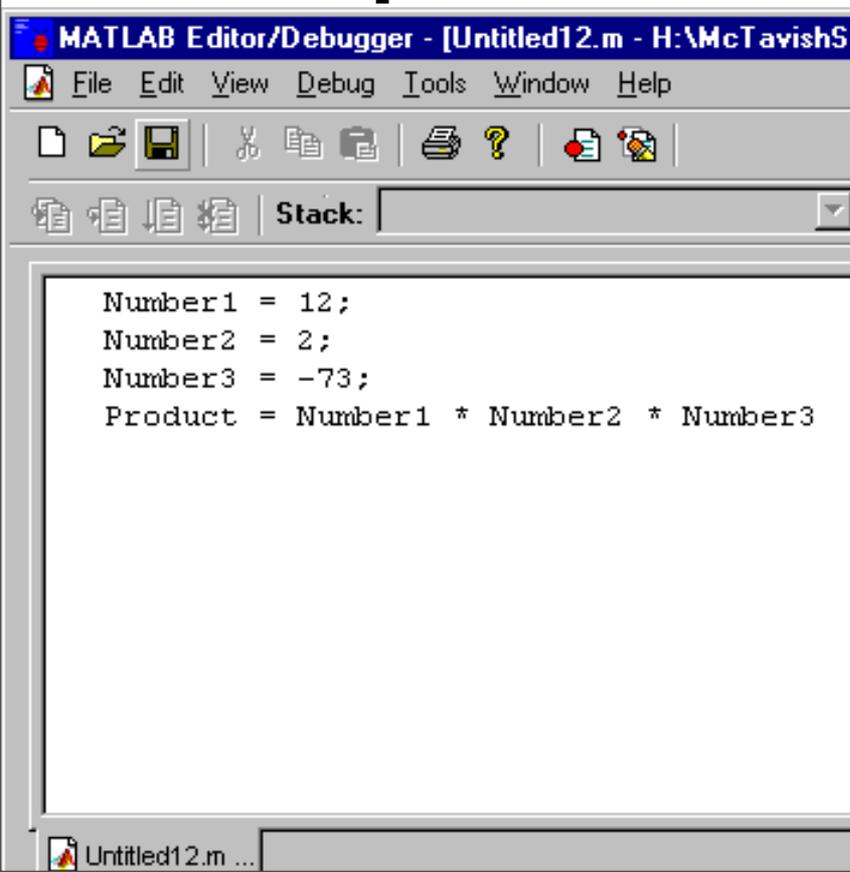
File Edit View Window Help

```
>> product(12,2,-73)
```



Script Vs. Function

Script m-file



MATLAB Editor/Debugger - [Untitled12.m - H:\McTavishS\...

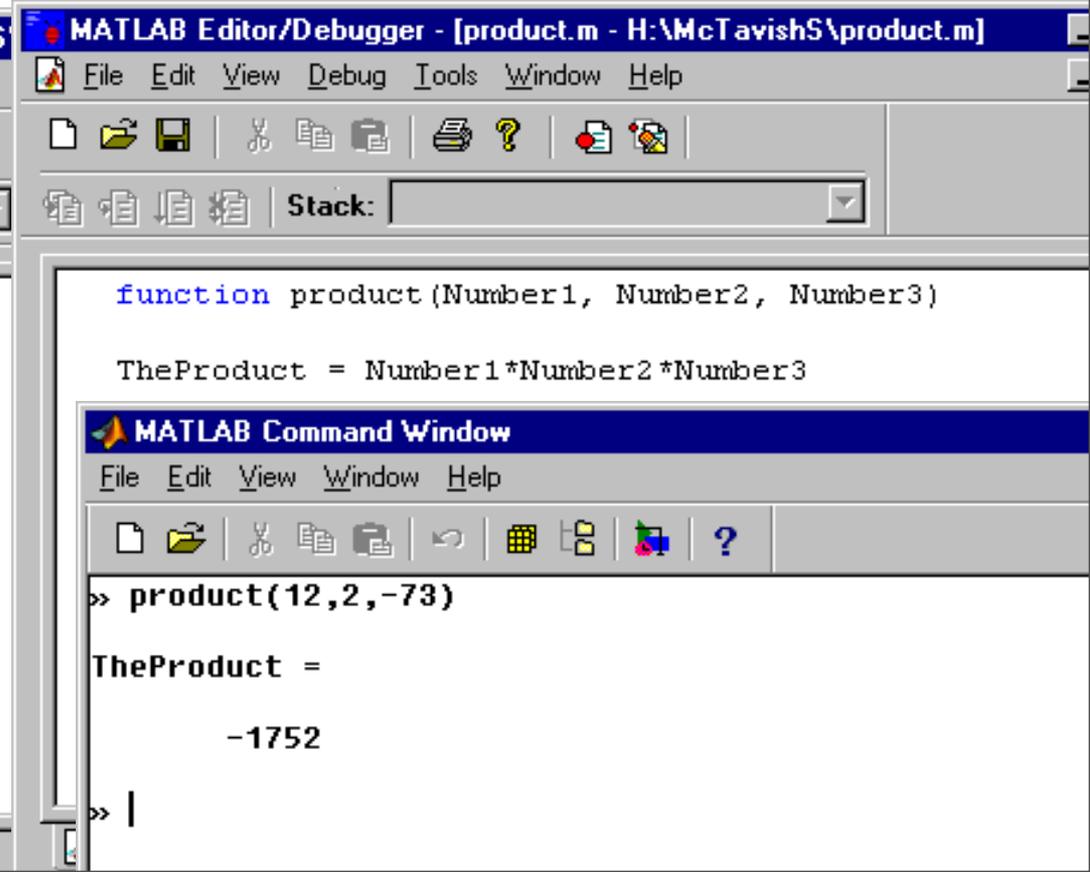
```
File Edit View Debug Tools Window Help
```

Stack:

```
Number1 = 12;  
Number2 = 2;  
Number3 = -73;  
Product = Number1 * Number2 * Number3
```

Untitled12.m ...

Function m-file



MATLAB Editor/Debugger - [product.m - H:\McTavishS\product.m]

```
File Edit View Debug Tools Window Help
```

Stack:

```
function product(Number1, Number2, Number3)  
  
TheProduct = Number1*Number2*Number3
```

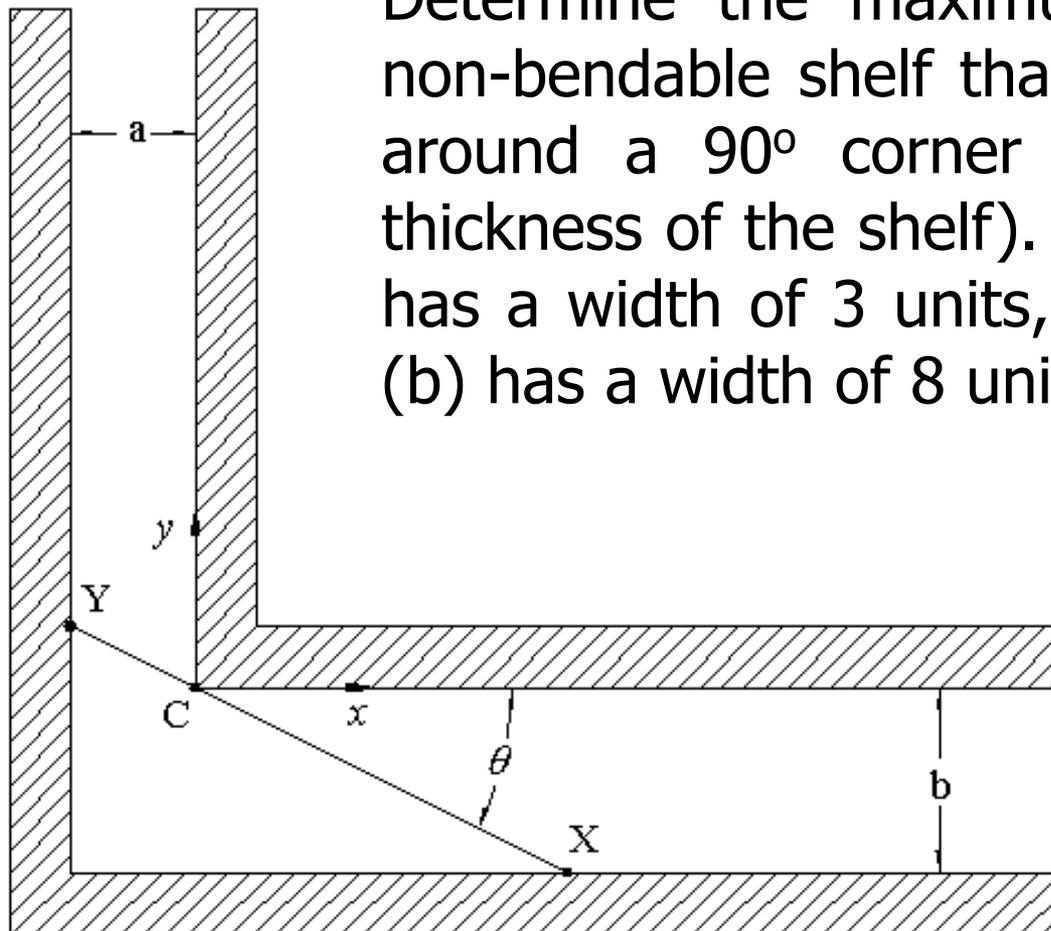
MATLAB Command Window

```
File Edit View Window Help
```

```
>> product(12,2,-73)  
  
TheProduct =  
  
    -1752  
  
>> |
```

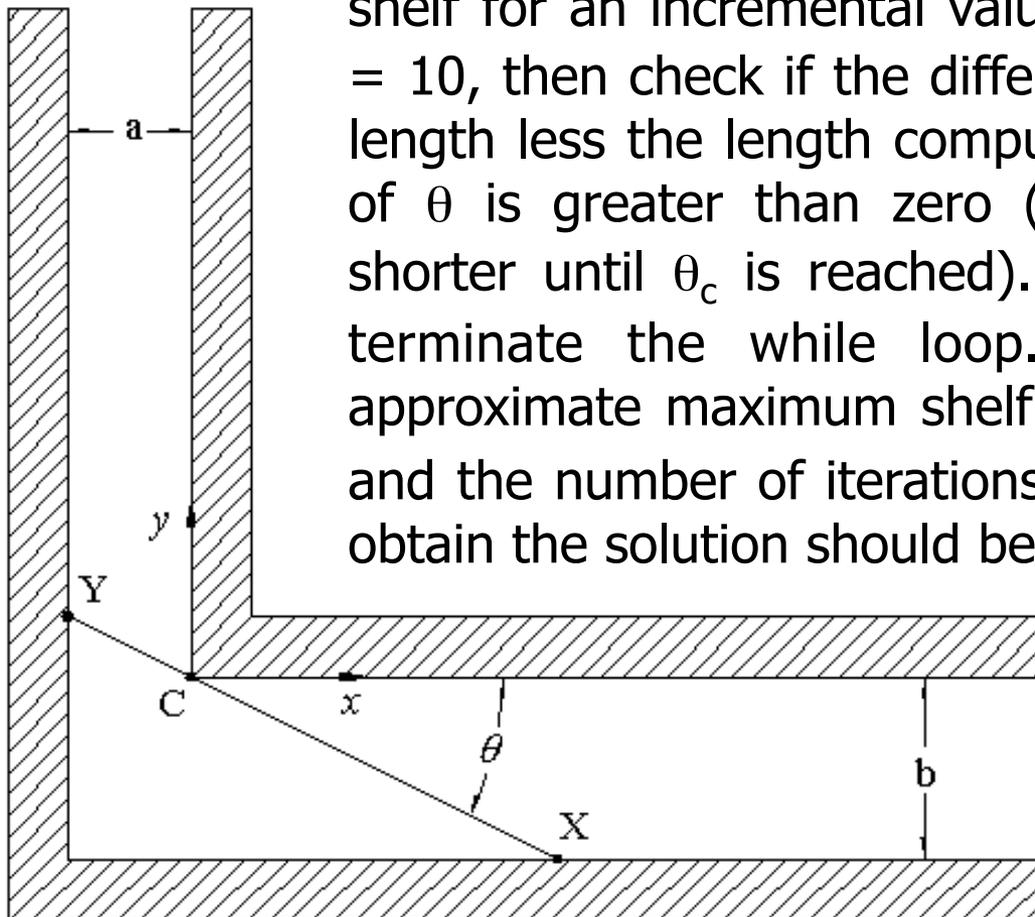
An Example

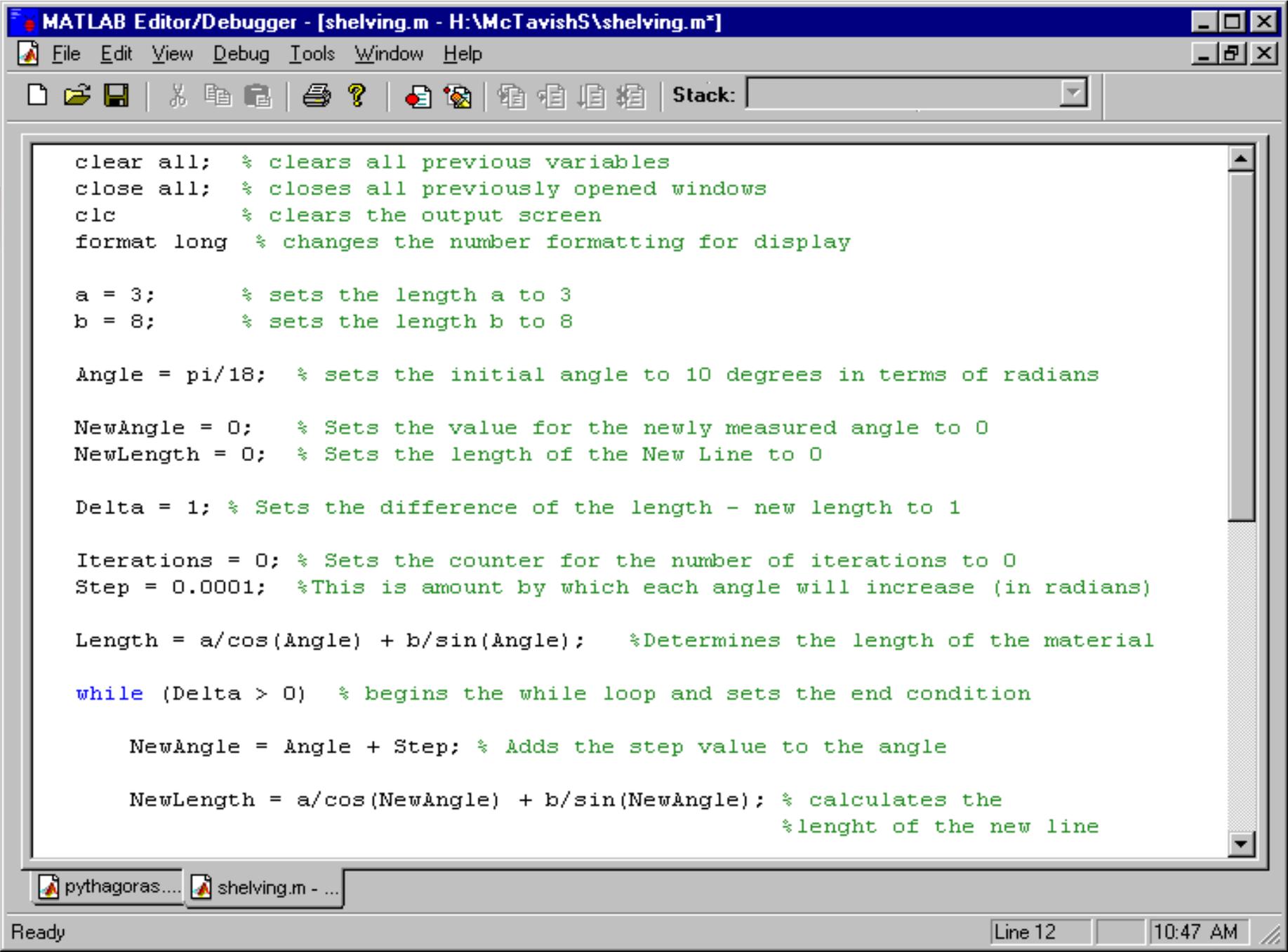
Determine the maximum length of a non-bendable shelf that can be carried around a 90° corner (neglecting the thickness of the shelf). One hallway (a) has a width of 3 units, while the other (b) has a width of 8 units.



An Example

Use a while loop. Calculate the length, YX , of the shelf for an incremental value of θ , starting with $\theta = 10$, then check if the difference of the computed length less the length computed for the next value of θ is greater than zero (since the length gets shorter until θ_c is reached). This condition should terminate the while loop. The value for the approximate maximum shelf length, θ_c in degrees, and the number of iterations that were required to obtain the solution should be displayed.





```

clear all; % clears all previous variables
close all; % closes all previously opened windows
clc % clears the output screen
format long % changes the number formatting for display

a = 3; % sets the length a to 3
b = 8; % sets the length b to 8

Angle = pi/18; % sets the initial angle to 10 degrees in terms of radians

NewAngle = 0; % Sets the value for the newly measured angle to 0
NewLength = 0; % Sets the length of the New Line to 0

Delta = 1; % Sets the difference of the length - new length to 1

Iterations = 0; % Sets the counter for the number of iterations to 0
Step = 0.0001; %This is amount by which each angle will increase (in radians)

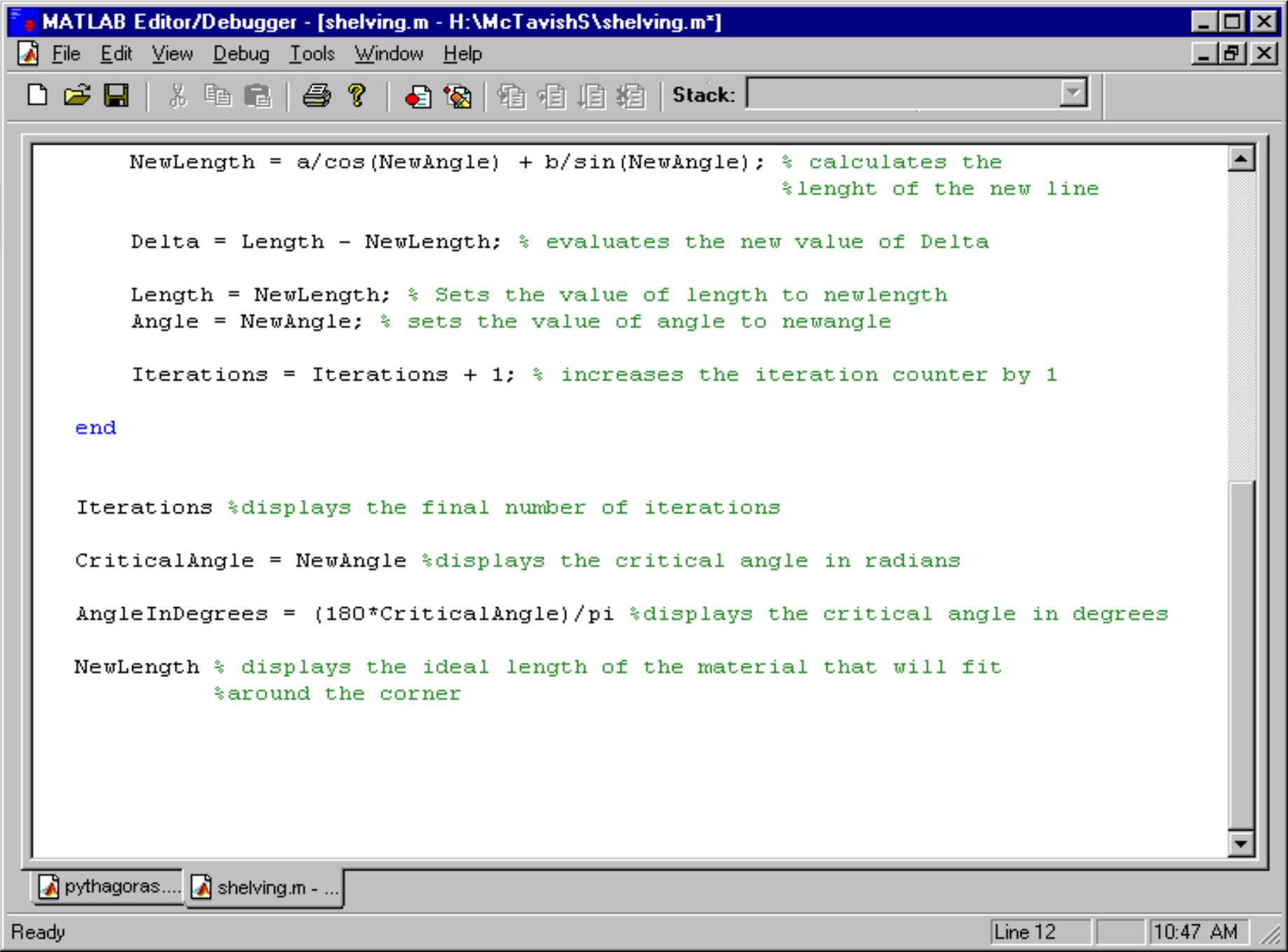
Length = a/cos(Angle) + b/sin(Angle); %Determines the length of the material

while (Delta > 0) % begins the while loop and sets the end condition

    NewAngle = Angle + Step; % Adds the step value to the angle

    NewLength = a/cos(NewAngle) + b/sin(NewAngle); % calculates the
                                                    %length of the new line

```



```
NewLength = a/cos(NewAngle) + b/sin(NewAngle); % calculates the
                                                %length of the new line

Delta = Length - NewLength; % evaluates the new value of Delta

Length = NewLength; % Sets the value of length to newlength
Angle = NewAngle; % sets the value of angle to newangle

Iterations = Iterations + 1; % increases the iteration counter by 1

end

Iterations %displays the final number of iterations

CriticalAngle = NewAngle %displays the critical angle in radians

AngleInDegrees = (180*CriticalAngle)/pi %displays the critical angle in degrees

NewLength % displays the ideal length of the material that will fit
          %around the corner
```



Iterations =

7716

CriticalAngle =

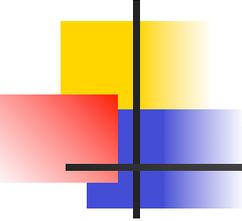
0.94613292519935

AngleInDegrees =

54.20942347228946

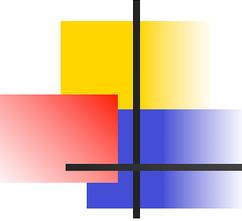
NewLength =

14.99216511329710



Help?

- For extra help, see the MATLAB support files on WebCT



Reading Assignment

Chapters 18 and 19