

The logo 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 superimposed on the squares.

ECOR 1010

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# Lecture 17

MATLAB Programming



# 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

---

- 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)
```



# 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;
```



# 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;
```



# 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

```
Number = 2;
```

```
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

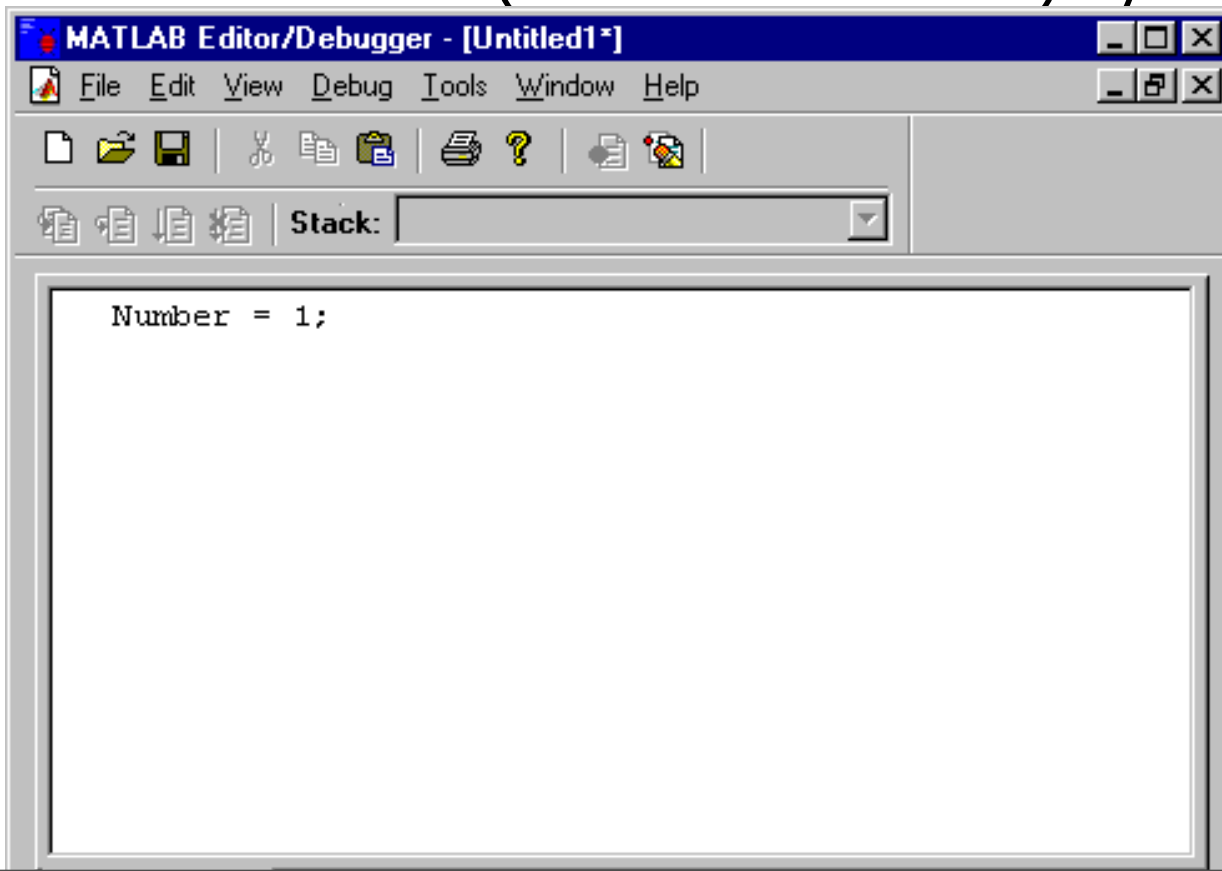
---

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



# while Loops

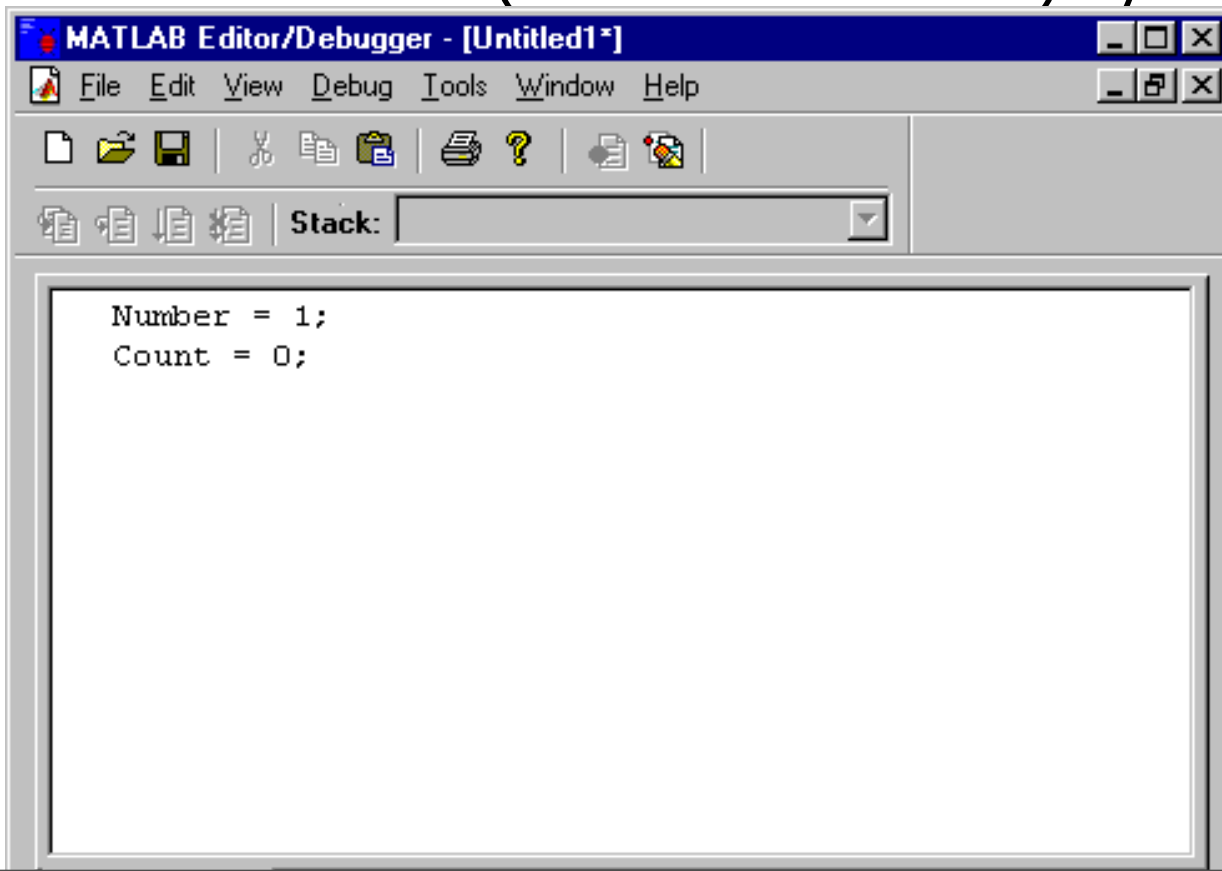
- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.





# while Loops

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

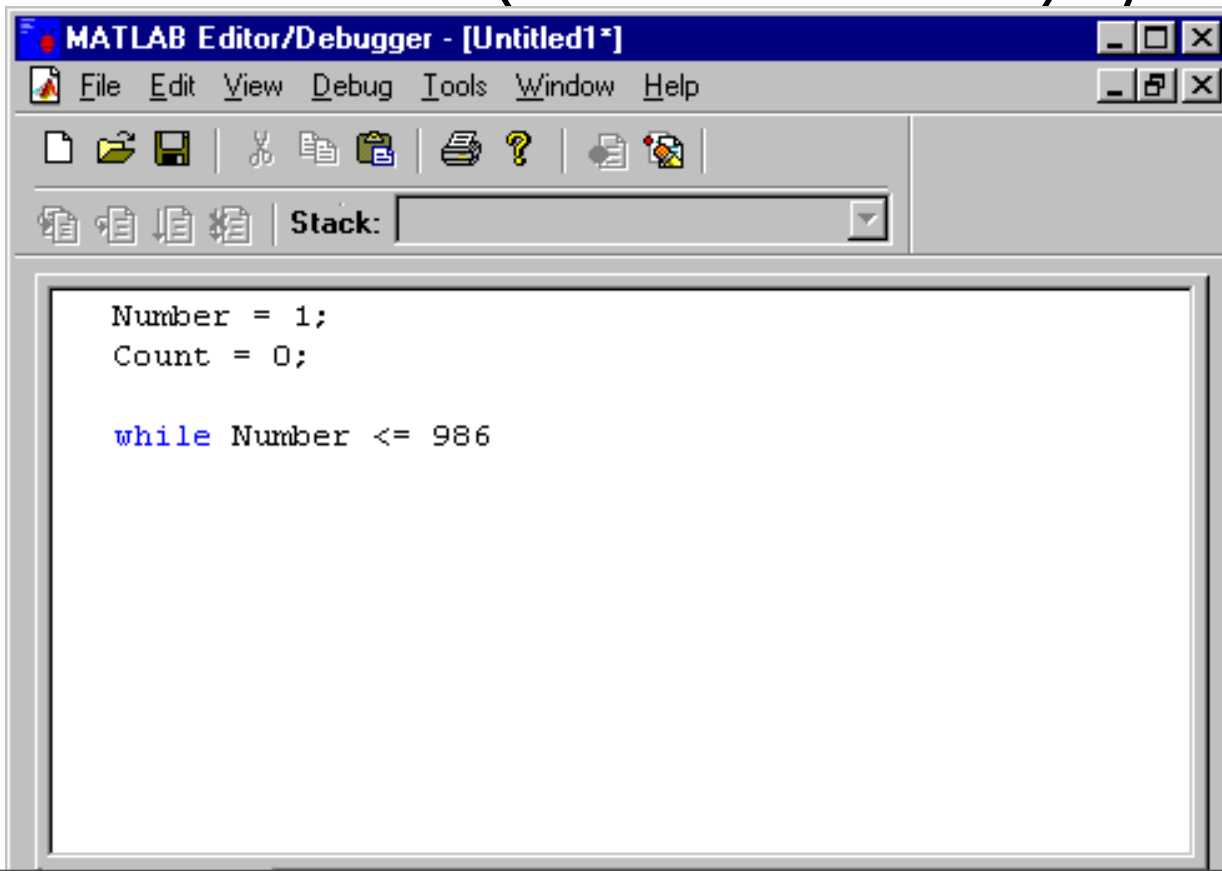






# while Loops

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



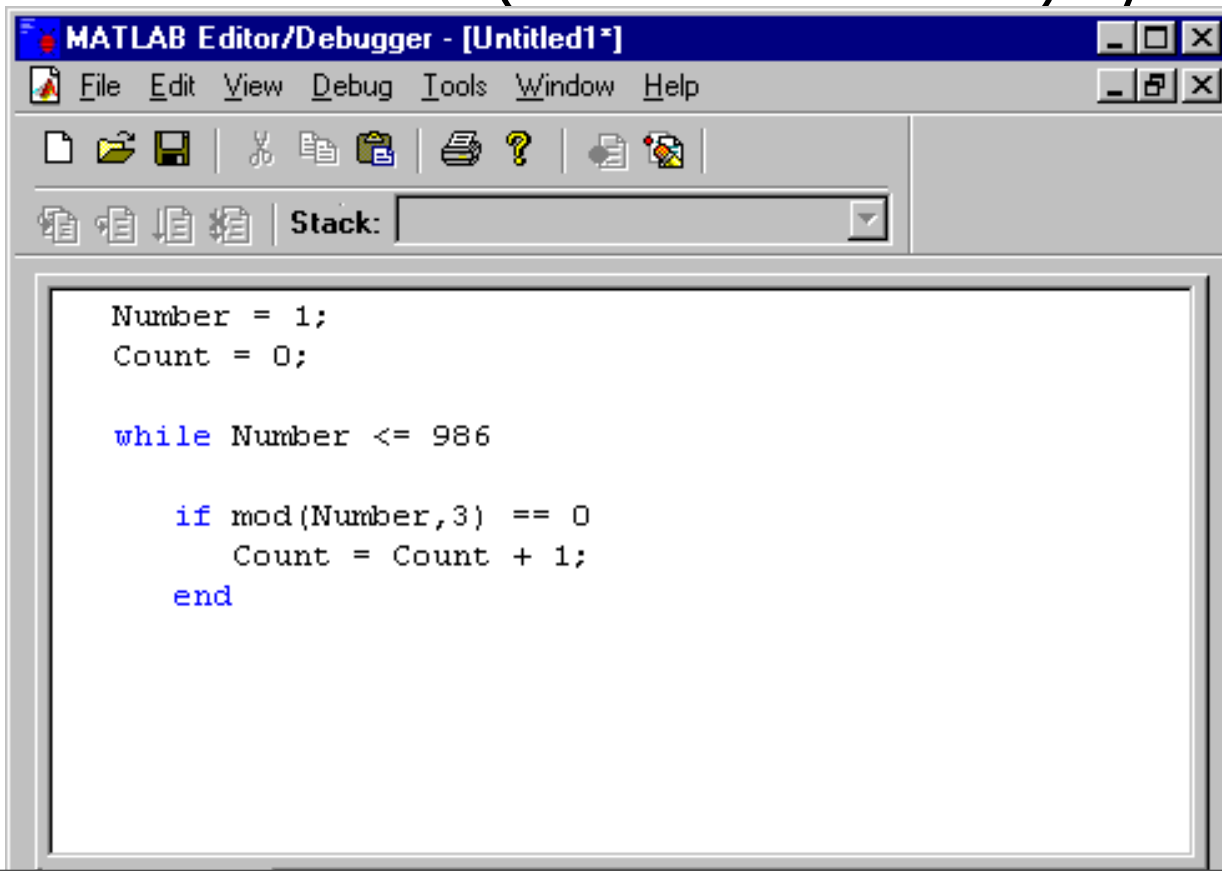
The image shows a screenshot of the MATLAB Editor/Debugger window. The title bar reads "MATLAB Editor/Debugger - [Untitled1\*]". The menu bar includes "File", "Edit", "View", "Debug", "Tools", "Window", and "Help". The toolbar contains icons for file operations (new, open, save, print, etc.) and a "Stack" panel. The main editor area contains the following code:

```
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.

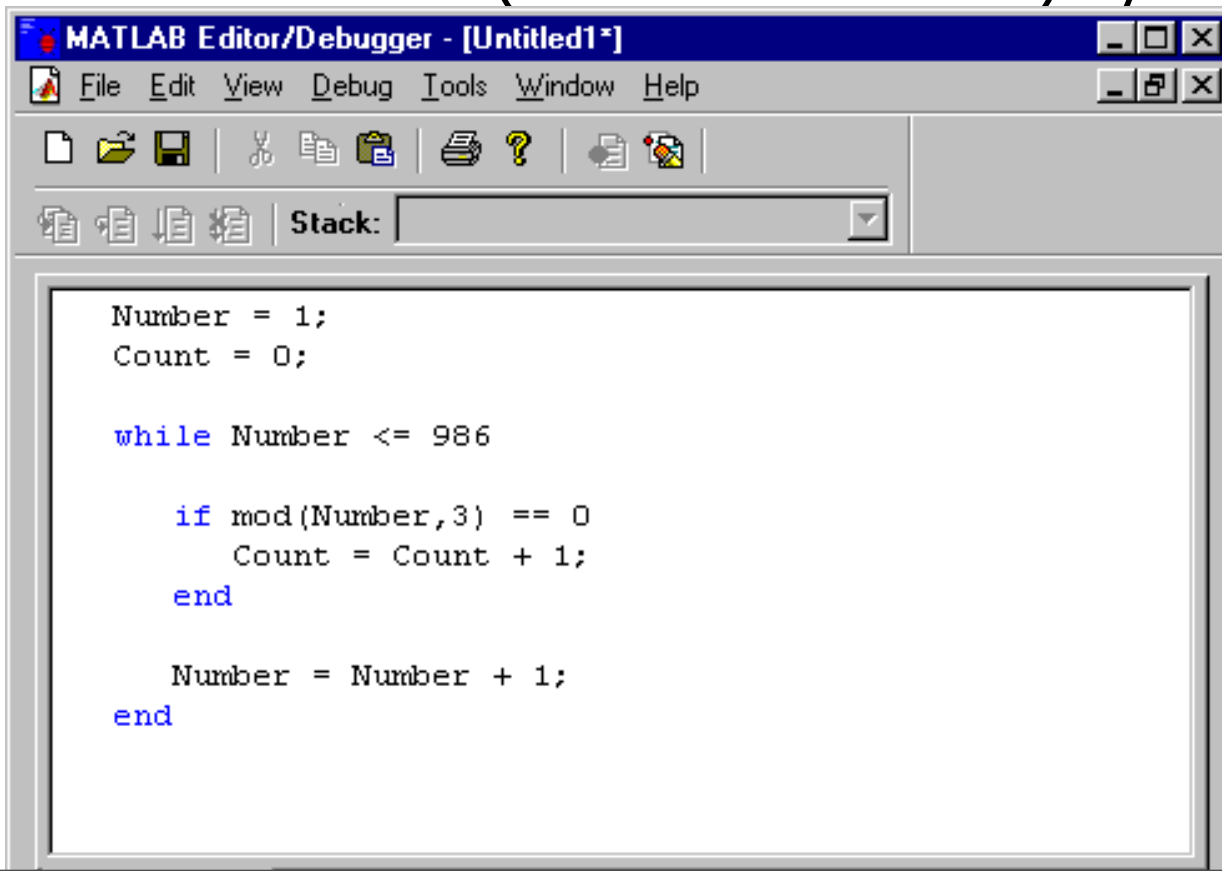


```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
[Icons: New, Open, Save, Cut, Copy, Paste, Undo, Redo, Print, Help, Run, Stop, Continue, Step In, Step Out, Step Over, Breakpoints]  
Stack: [Dropdown]  
  
Number = 1;  
Count = 0;  
  
while Number <= 986  
    if 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
[Icons: New, Open, Save, Cut, Copy, Paste, Undo, Redo, Print, Help, Run, Stop, Continue, Step In, Step Out, Step Over]
Stack: [Dropdown]

Number = 1;
Count = 0;

while Number <= 986

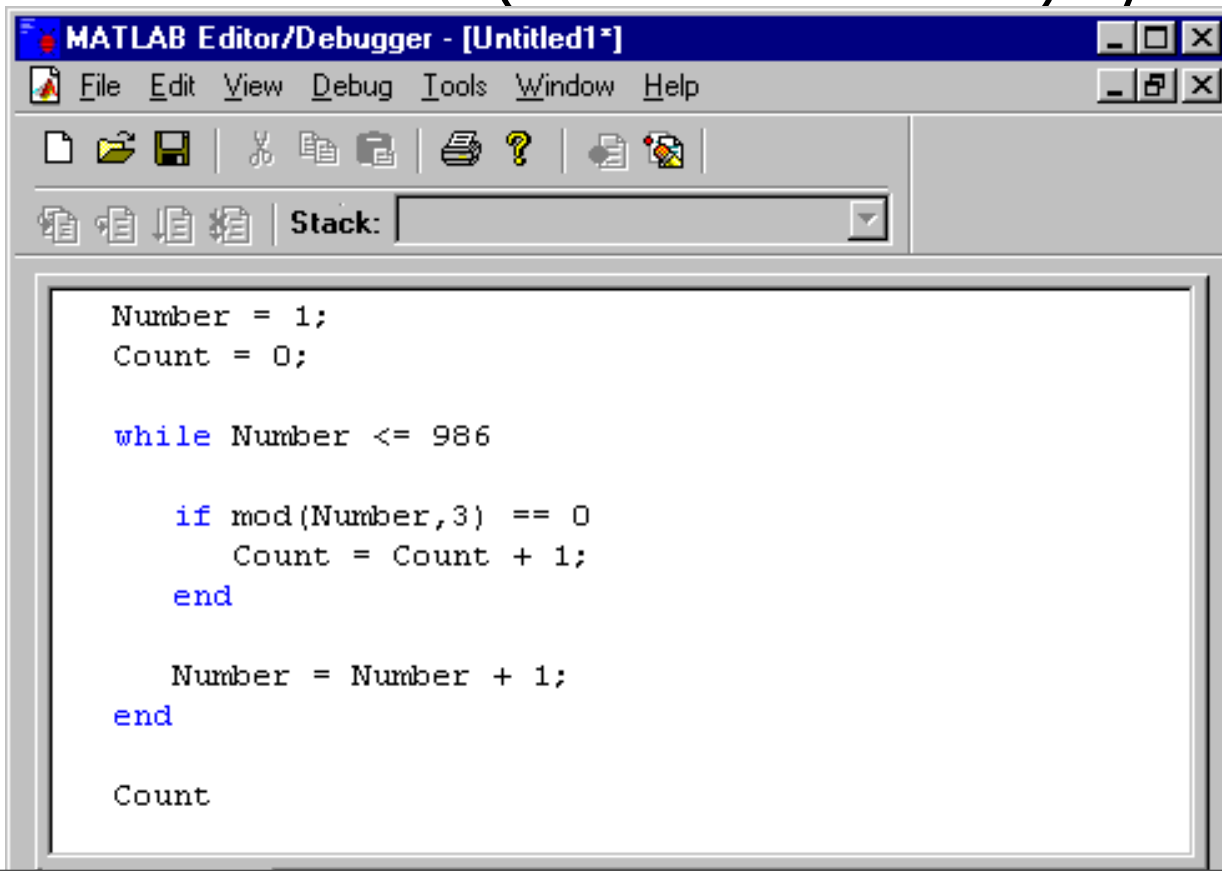
    if mod(Number,3) == 0
        Count = Count + 1;
    end

    Number = Number + 1;
end
```



# while Loops

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

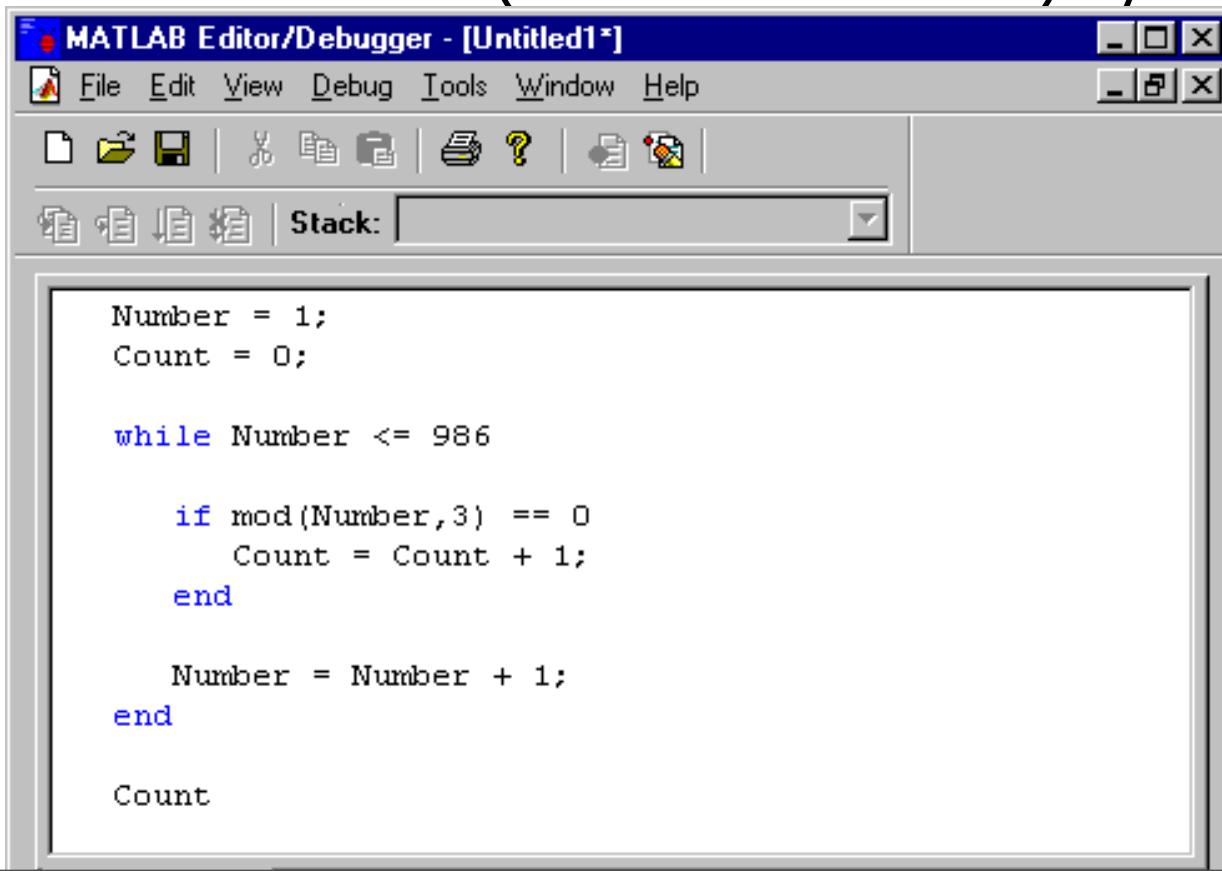


```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
[Icons]  
Stack: [Dropdown]  
  
Number = 1;  
Count = 0;  
  
while Number <= 986  
    if mod(Number,3) == 0  
        Count = Count + 1;  
    end  
    Number = Number + 1;  
end  
  
Count
```



# while Loops

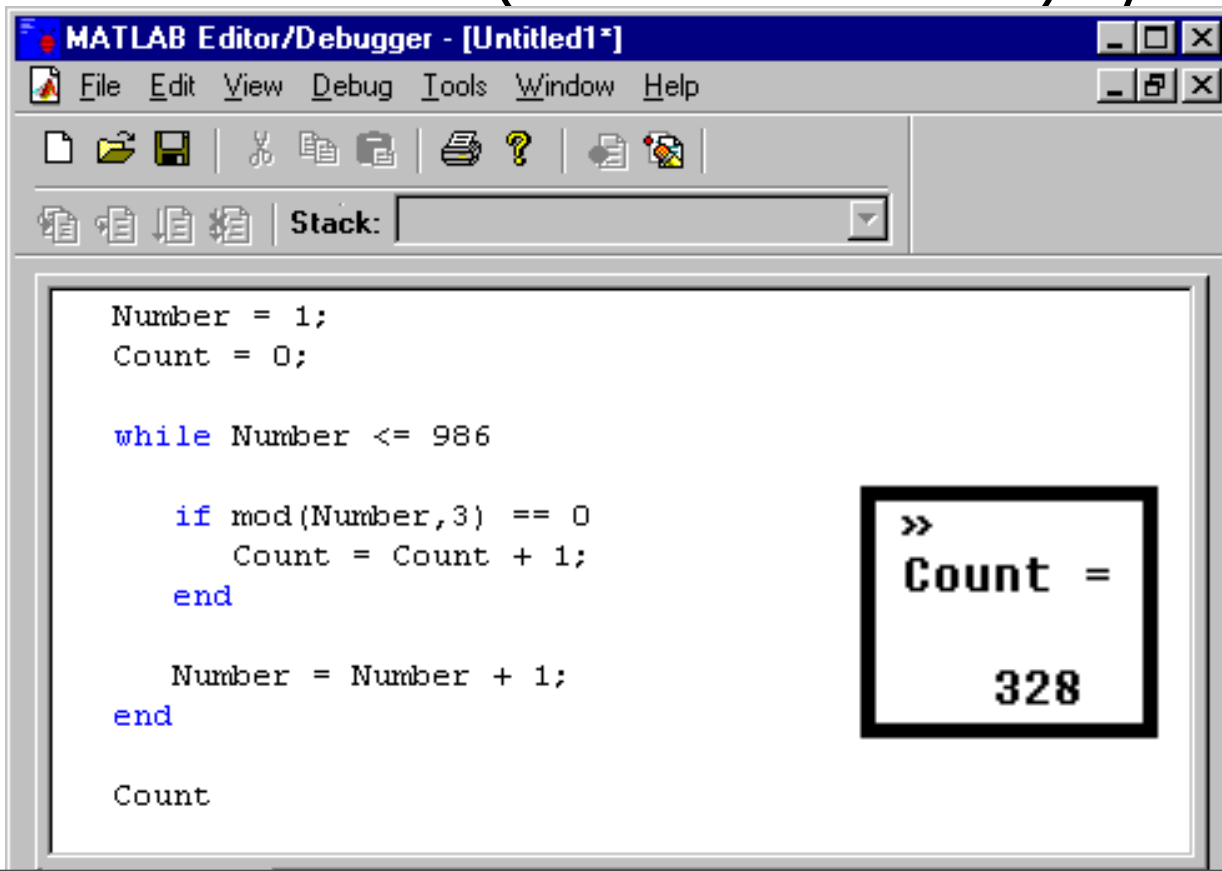
- Count the number of integers between 1 and 986 that are divisible (with no remainder) by 3.



```
MATLAB Editor/Debugger - [Untitled1*]  
File Edit View Debug Tools Window Help  
[Icons]  
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.



The image shows a screenshot of the MATLAB Editor/Debugger window. The title bar reads "MATLAB Editor/Debugger - [Untitled1\*]". The menu bar includes File, Edit, View, Debug, Tools, Window, and Help. The toolbar contains icons for file operations (New, Open, Save, Print, etc.) and a "Stack" panel. The main editor area contains the following MATLAB code:

```
Number = 1;
Count = 0;

while Number <= 986

    if mod(Number,3) == 0
        Count = Count + 1;
    end

    Number = Number + 1;
end

Count
```

To the right of the code, a command window (indicated by the ">>" prompt) displays the result of the script:

```
>>
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)
```

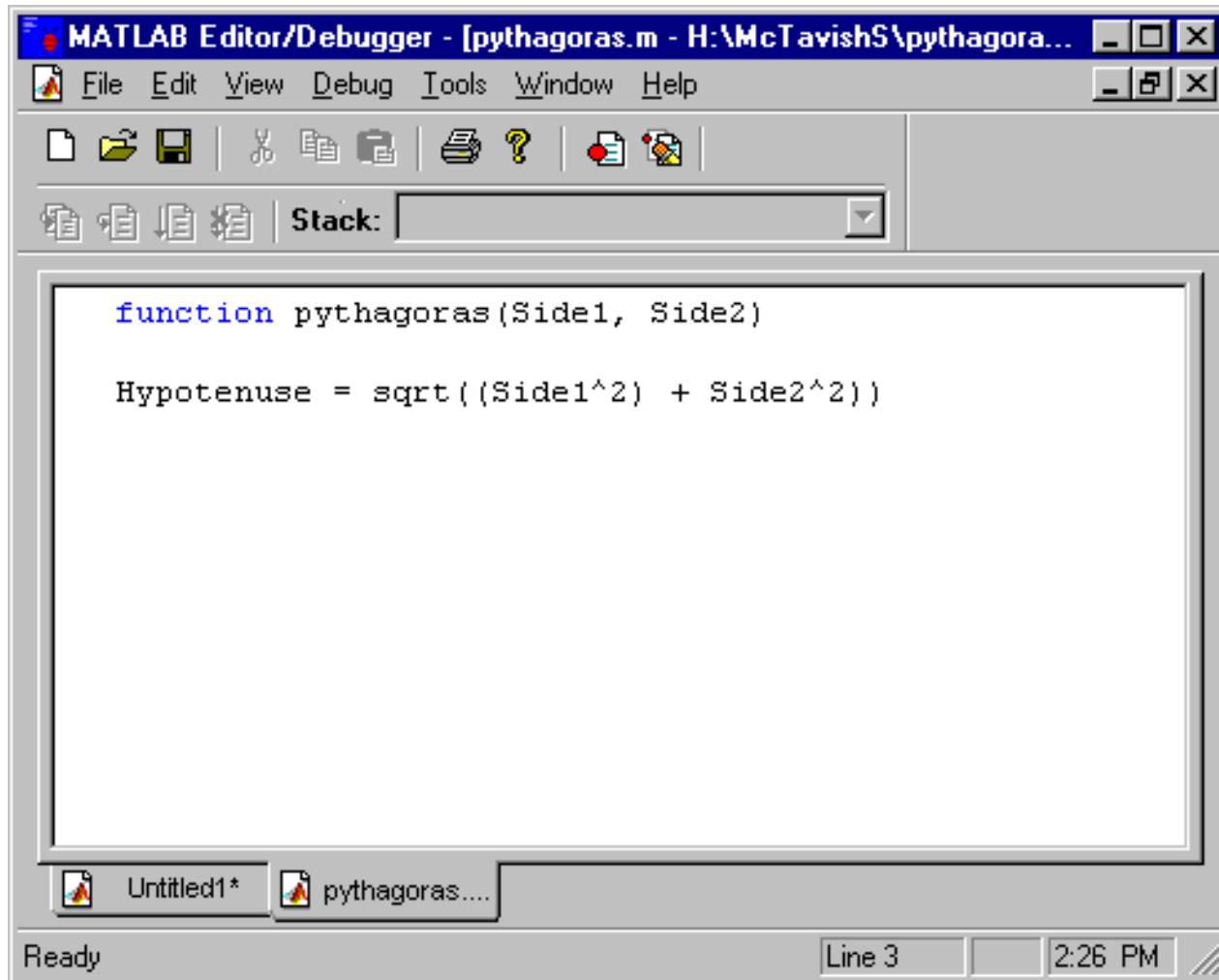
```
Hypotenuse = sqrt((Side1^2) + (Side2^2))
```

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

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

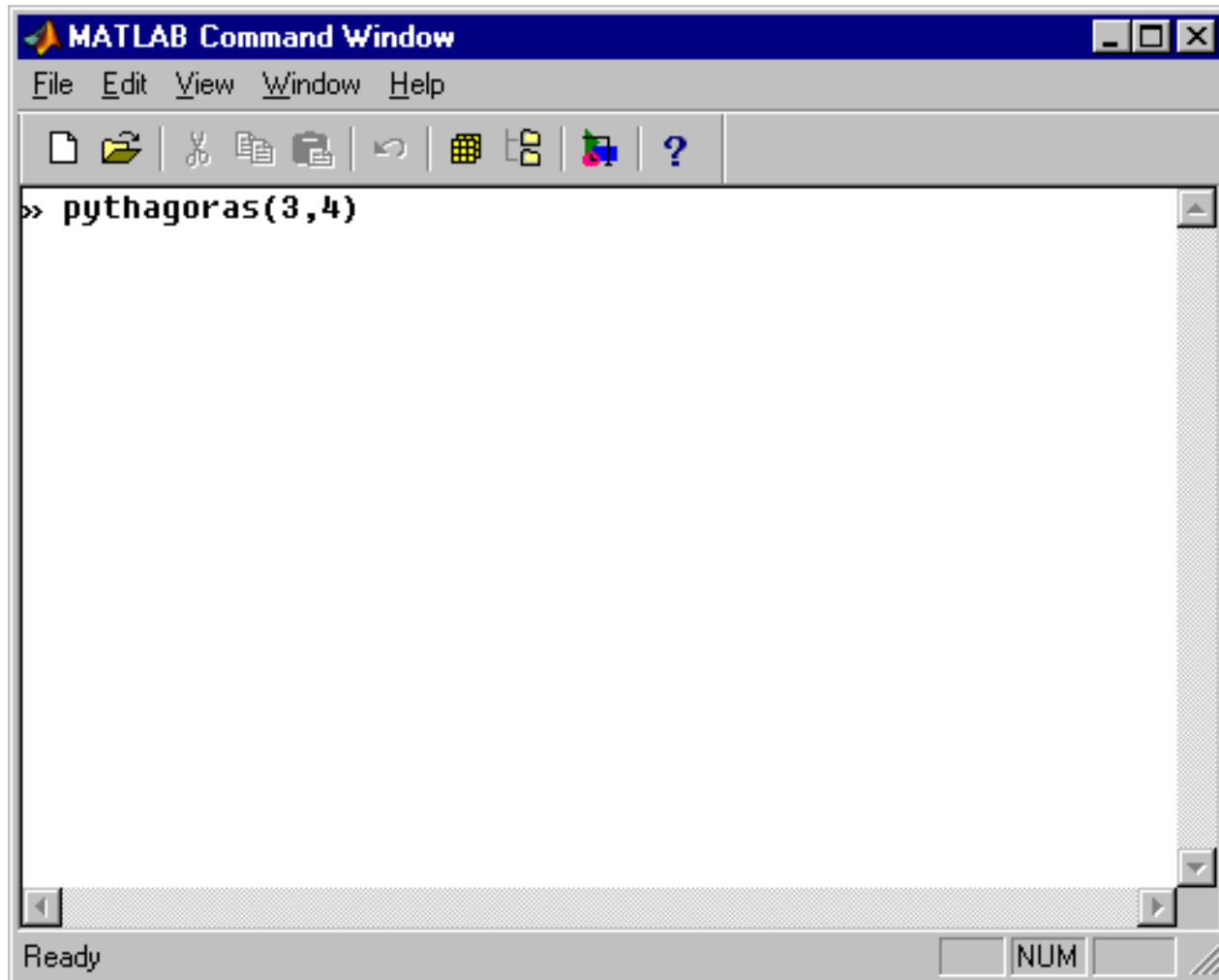


# Functions



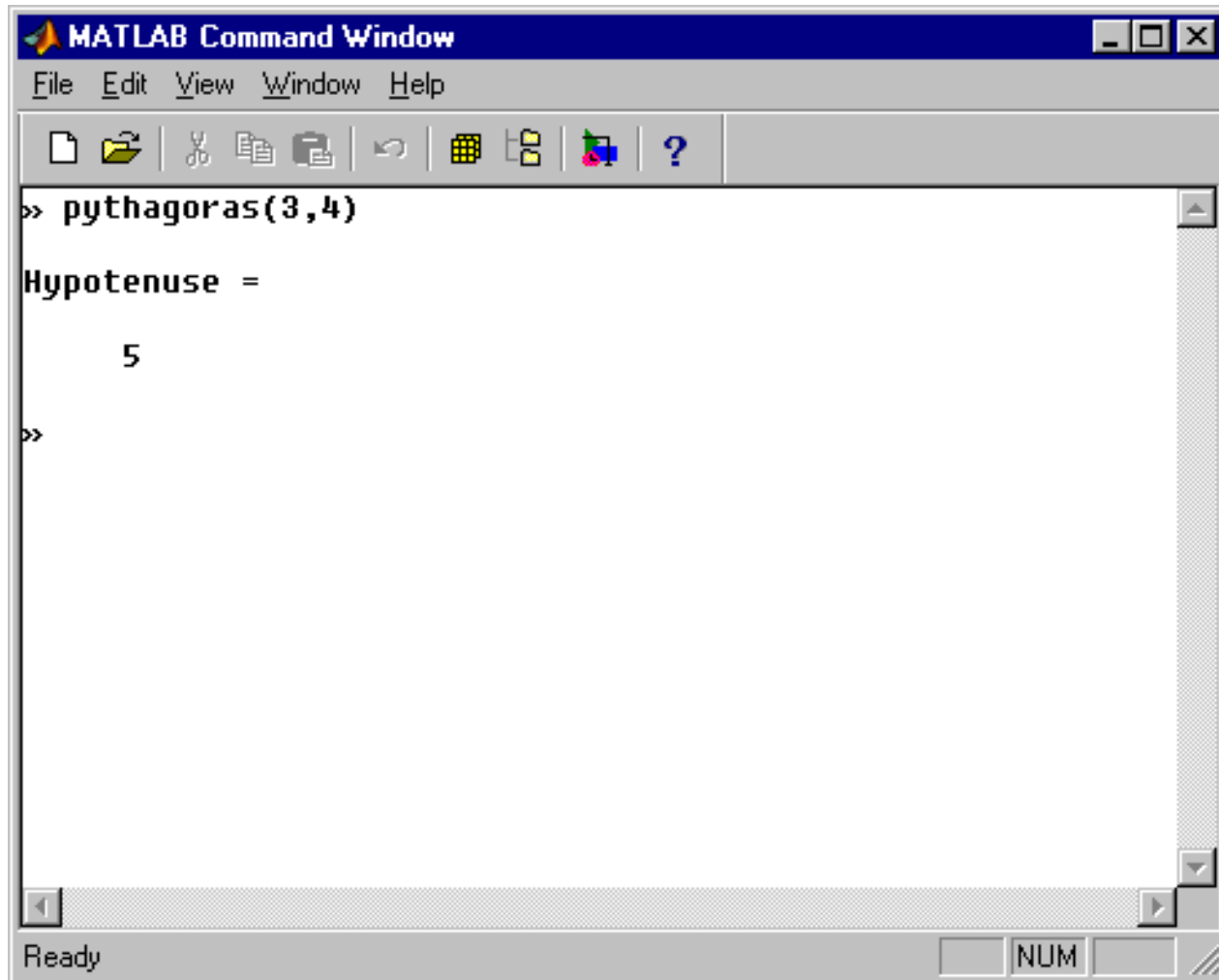


# Functions



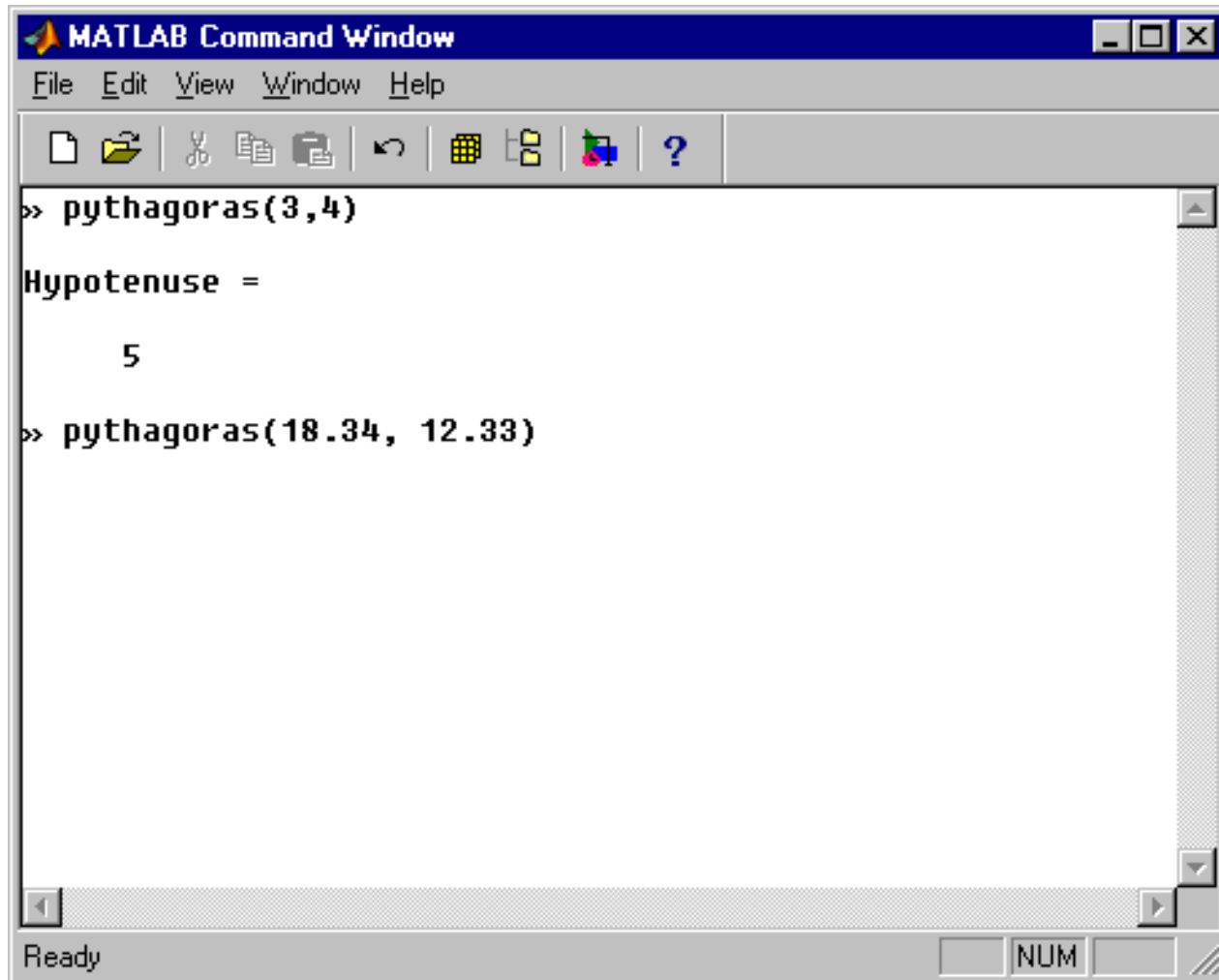


# Functions





# Functions

A screenshot of the MATLAB Command Window. The window has a blue title bar with the MATLAB logo and the text "MATLAB Command Window". Below the title bar is a menu bar with "File", "Edit", "View", "Window", and "Help". Underneath the menu bar is a toolbar with icons for file operations (new, open, save, print), editing (undo, redo), and other functions (workspace, command window, help). The main area of the window contains the following text:

```
>> pythagoras(3,4)

Hypotenuse =

    5

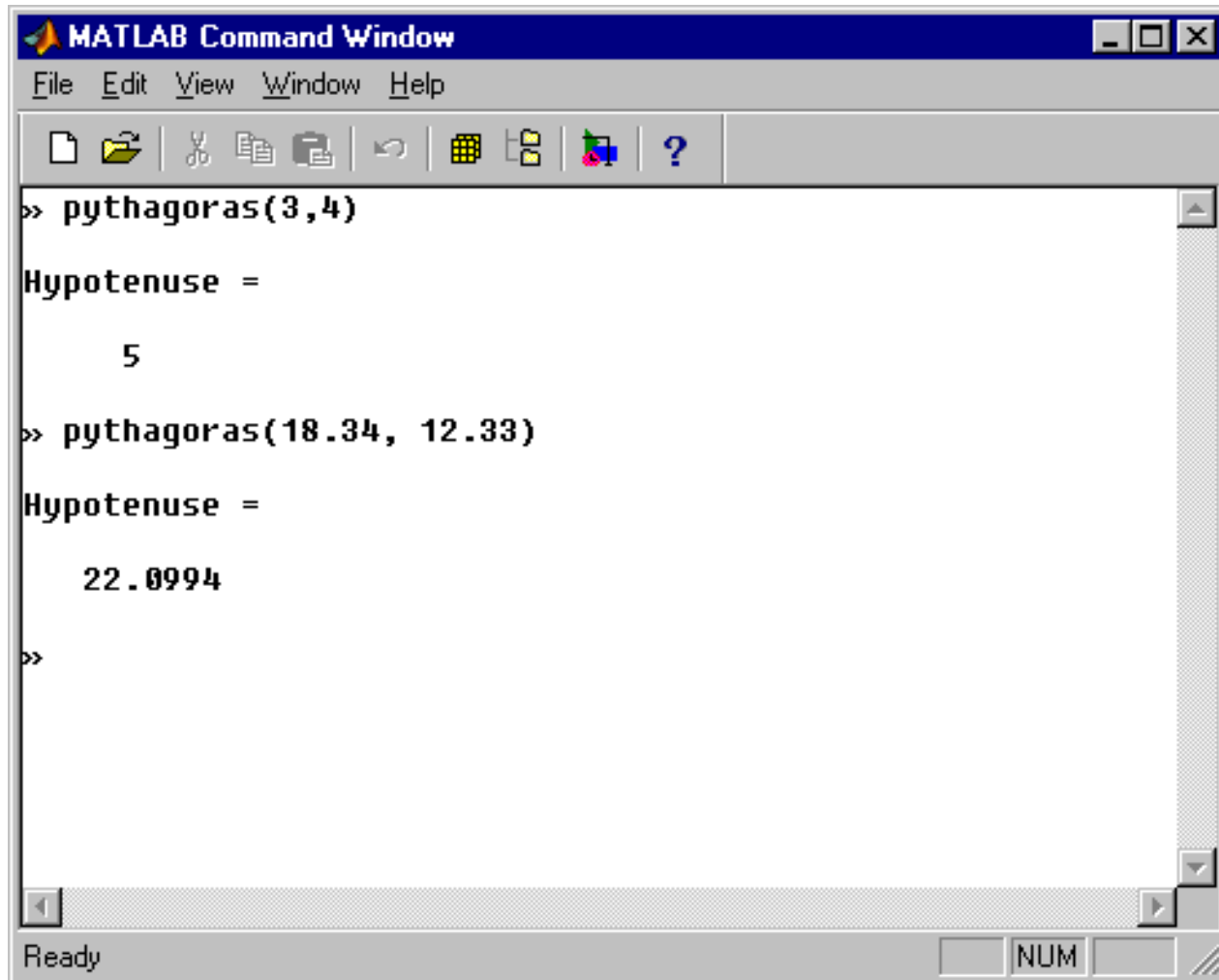
>> pythagoras(18.34, 12.33)
```

The status bar at the bottom of the window shows "Ready" on the left and a numeric keypad icon on the right.

```
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

» `pythagoras(3,4)`

Hypotenuse =

5

» `pythagoras(18.34, 12.33)`

Hypotenuse =

22.0994

»

Ready NUM



# Script Vs. Function

---

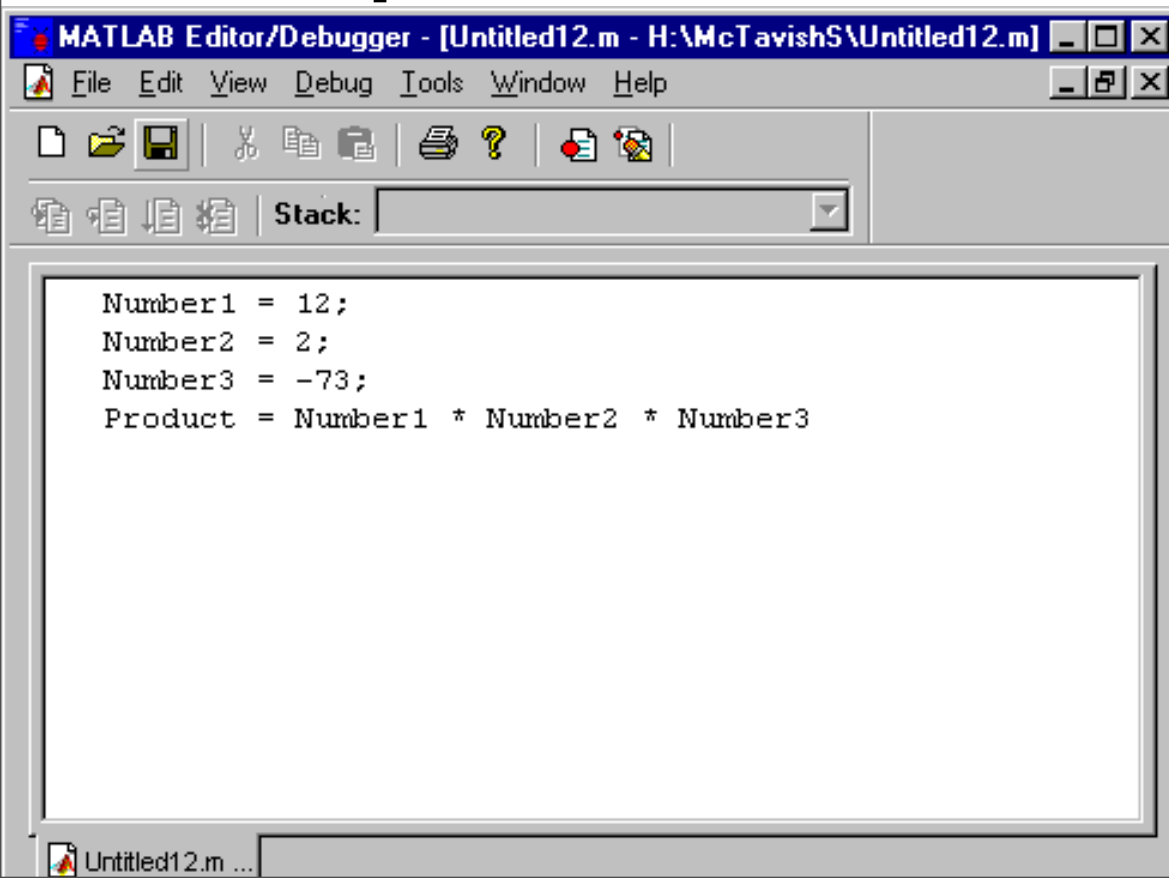
- Write a script file and a function that will find the product of three numbers



# Script Vs. Function

---

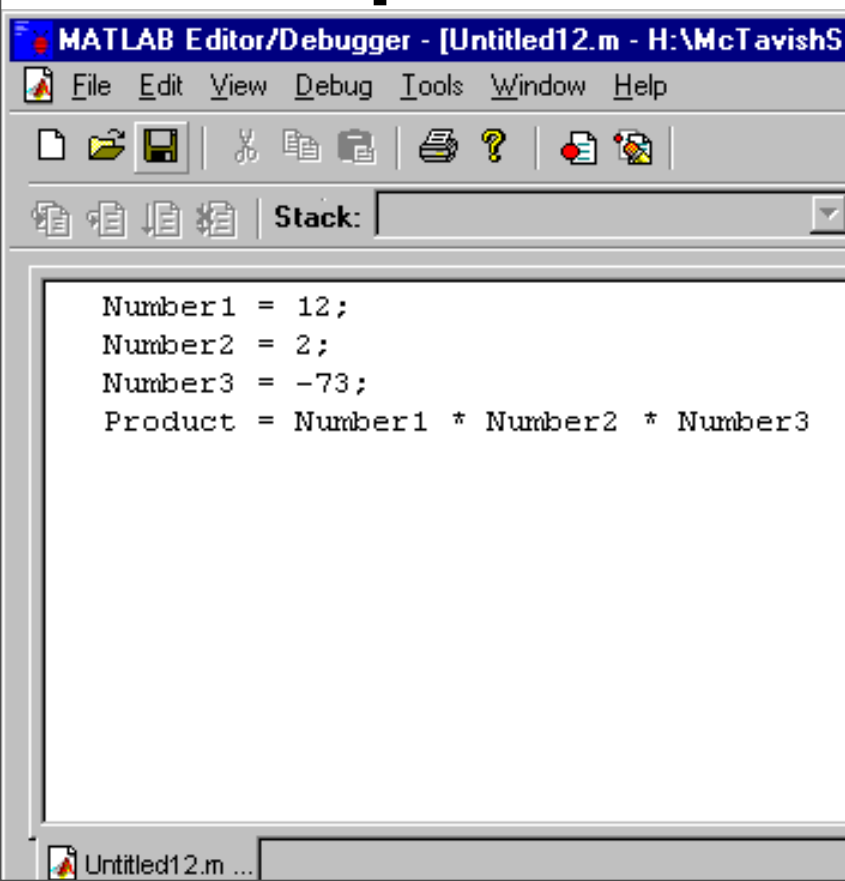
## Script m-file





# Script Vs. Function

## Script m-file

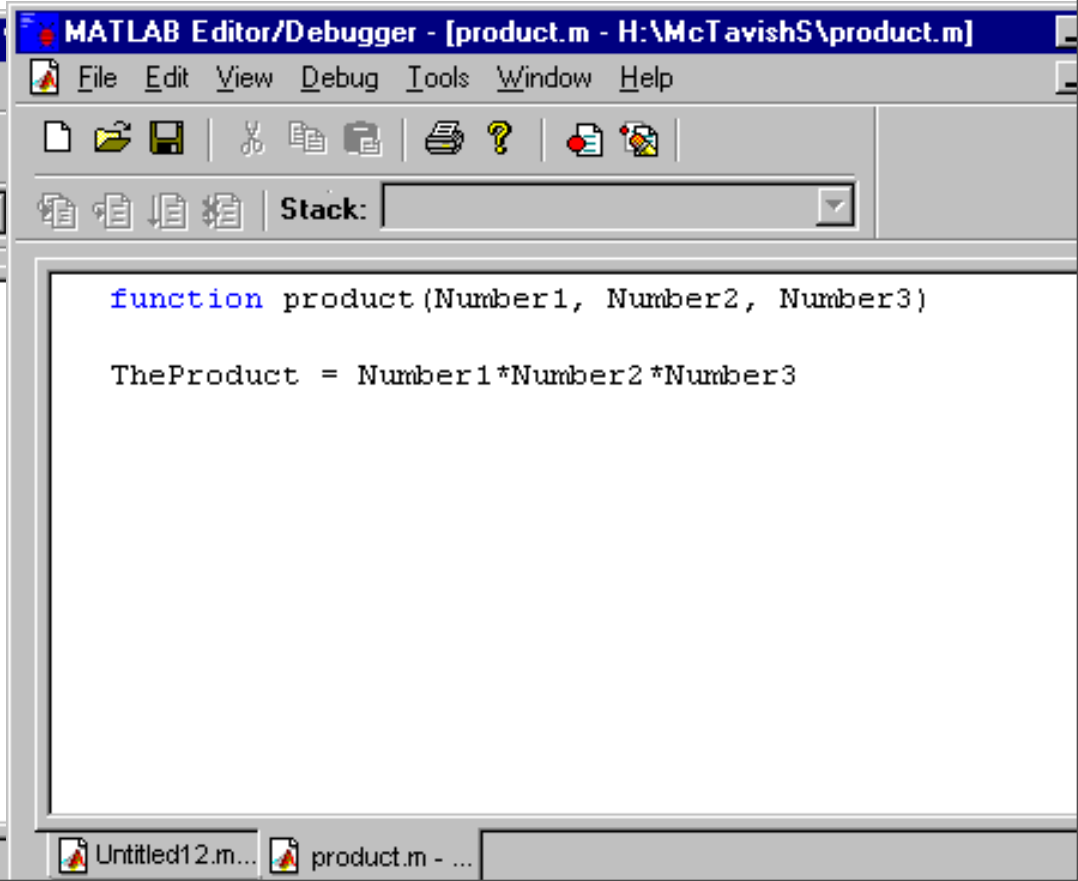


The screenshot shows the MATLAB Editor/Debugger interface for a script m-file. The title bar reads "MATLAB Editor/Debugger - [Untitled12.m - H:\McTavishS\...". The menu bar includes File, Edit, View, Debug, Tools, Window, and Help. The toolbar contains icons for file operations and a Stack window. The Stack window is currently empty. The main editor area contains the following code:

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

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

## Function m-file



The screenshot shows the MATLAB Editor/Debugger interface for a function m-file. The title bar reads "MATLAB Editor/Debugger - [product.m - H:\McTavishS\product.m]". The menu bar includes File, Edit, View, Debug, Tools, Window, and Help. The toolbar contains icons for file operations and a Stack window. The Stack window is currently empty. The main editor area contains the following code:

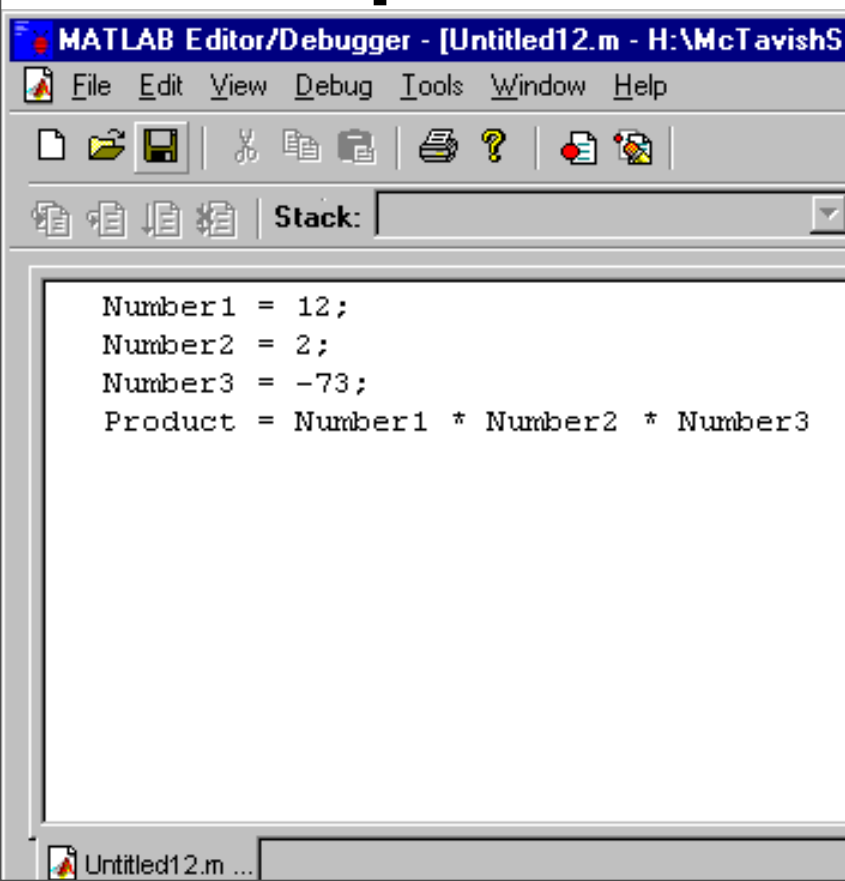
```
function product(Number1, Number2, Number3)  
  
TheProduct = Number1*Number2*Number3
```

The taskbar at the bottom shows the files "Untitled12.m ..." and "product.m - ...".

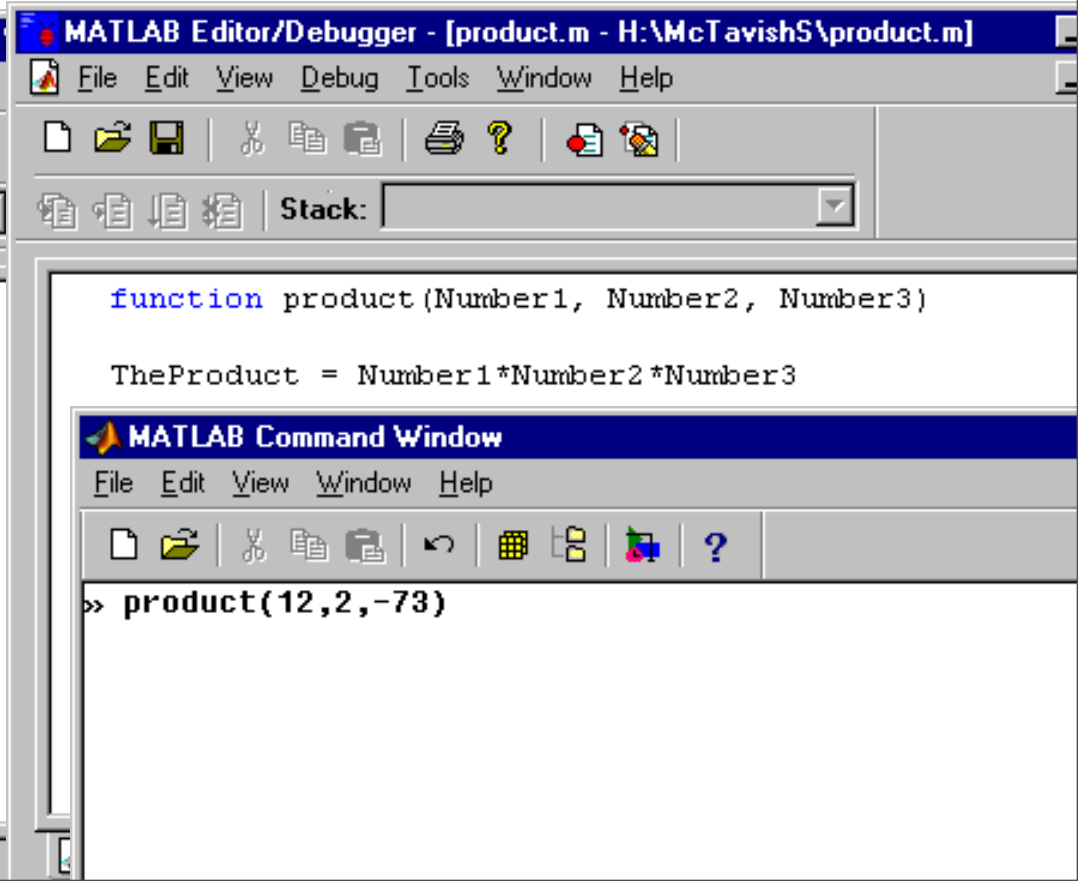


# Script Vs. Function

## Script m-file



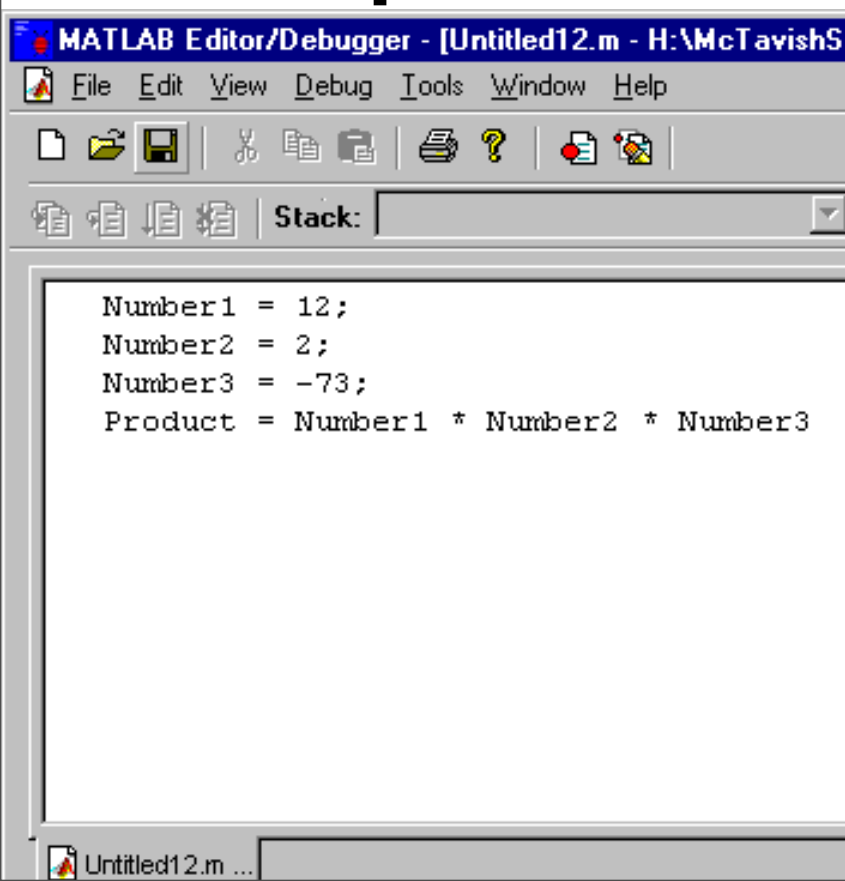
## Function m-file





# Script Vs. Function

## Script m-file

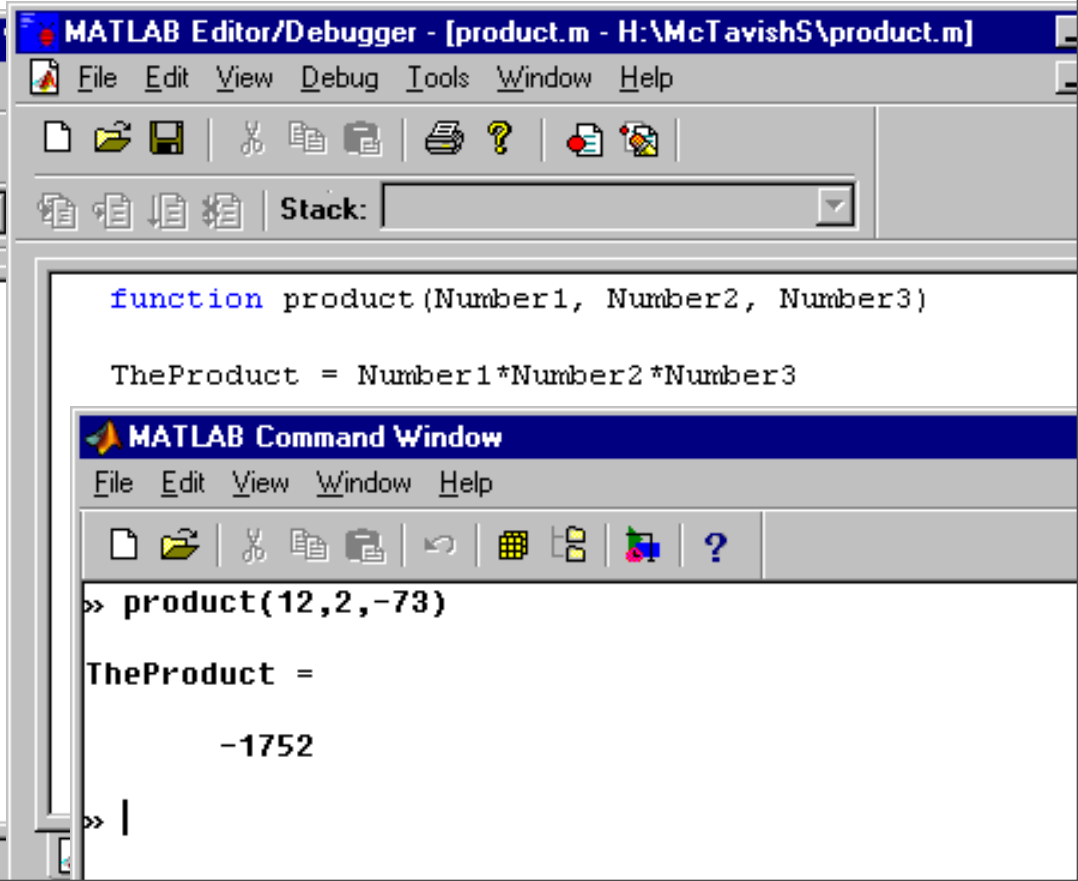


The screenshot shows the MATLAB Editor/Debugger window for an untitled script file. The menu bar includes File, Edit, View, Debug, Tools, Window, and Help. The toolbar contains icons for file operations and a Stack pane. The main editor area contains the following code:

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

The status bar at the bottom shows the file name "Untitled12.m ...".

## Function m-file



The screenshot shows the MATLAB Editor/Debugger window for a function m-file and the MATLAB Command Window. The editor window title is "MATLAB Editor/Debugger - [product.m - H:\McTavishS\product.m]". The code in the editor is:

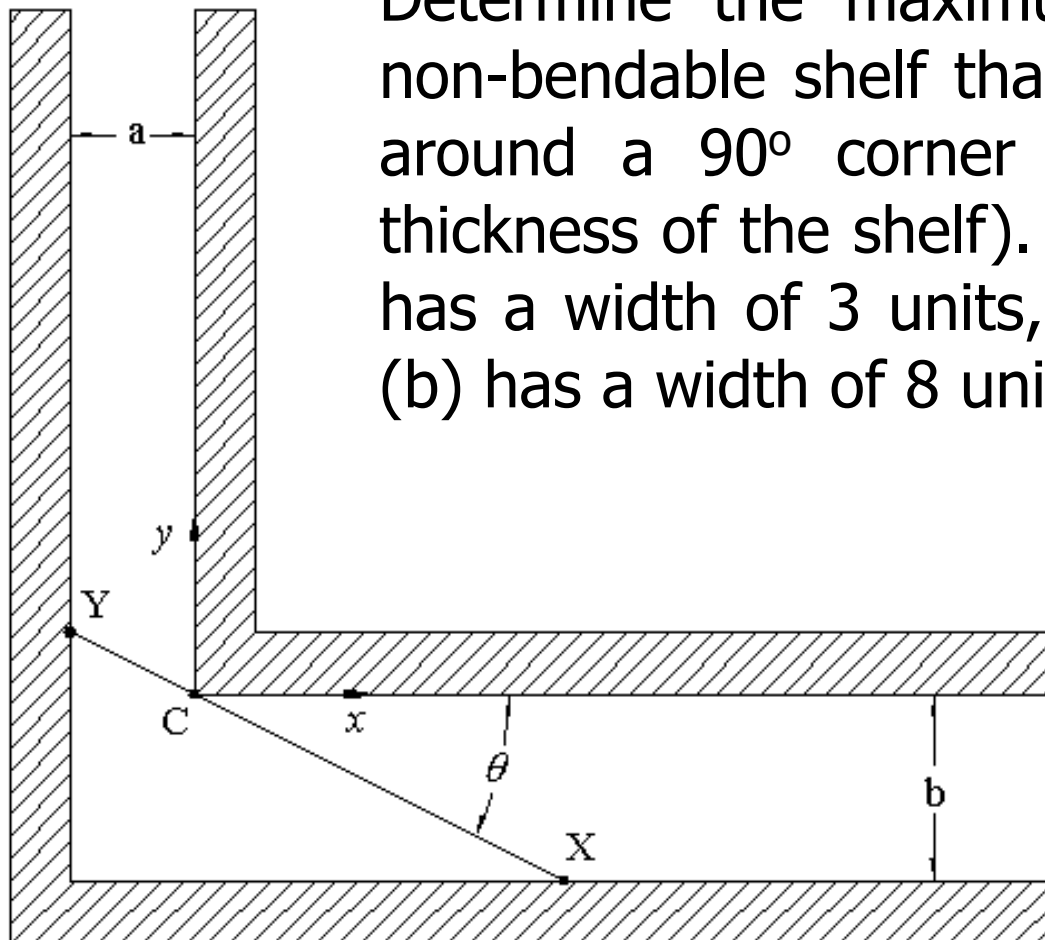
```
function product(Number1, Number2, Number3)  
  
TheProduct = Number1*Number2*Number3
```

The MATLAB Command Window is open below the editor. Its menu bar includes File, Edit, View, Window, and Help. The command history shows the following interaction:

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

# An Example

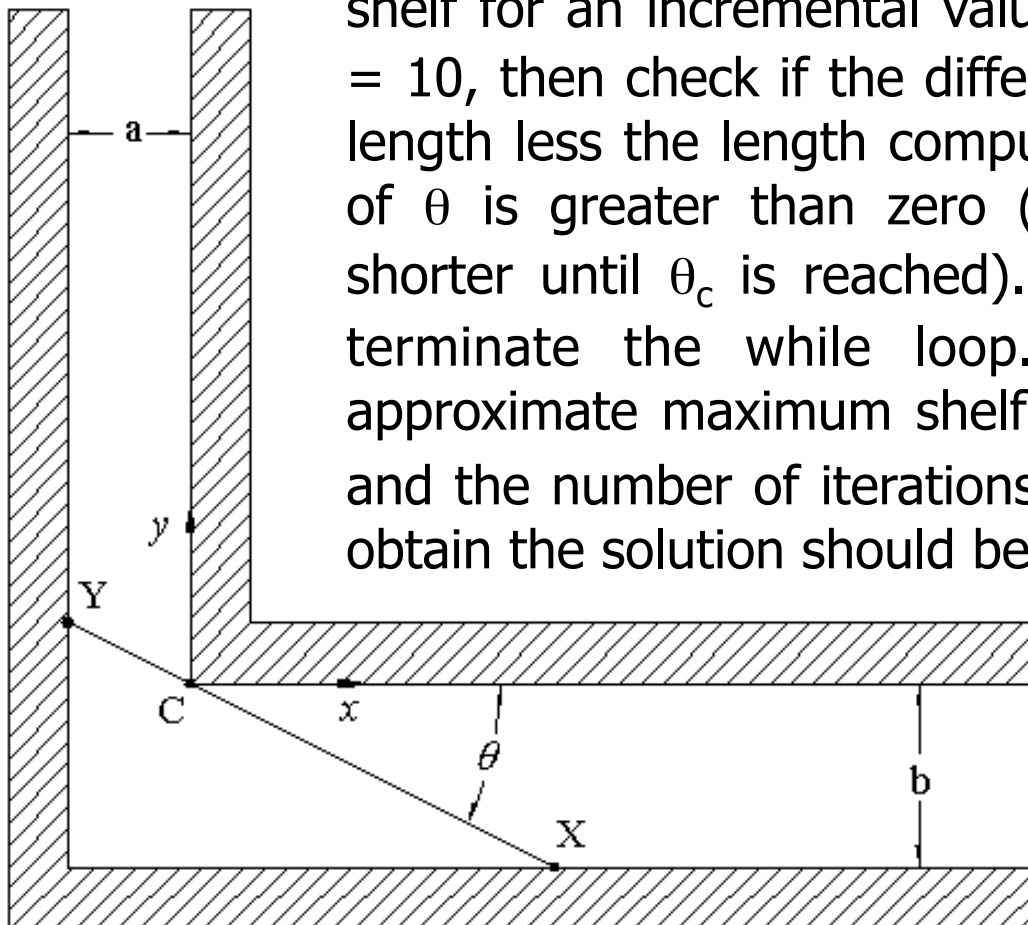
Determine the maximum length of a non-bendable shelf that can be carried around a  $90^\circ$  corner (neglecting the thickness of the shelf). One hallway (a) has a width of 3 units, while the other (b) has a width of 8 units.





# An Example

Use a while loop. Calculate the length,  $YX$ , of the shelf for an incremental value of  $\theta$ , starting with  $\theta = 10$ , then check if the difference of the computed length less the length computed for the next value of  $\theta$  is greater than zero (since the length gets shorter until  $\theta_c$  is reached). This condition should terminate the while loop. The value for the approximate maximum shelf length,  $\theta_c$  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

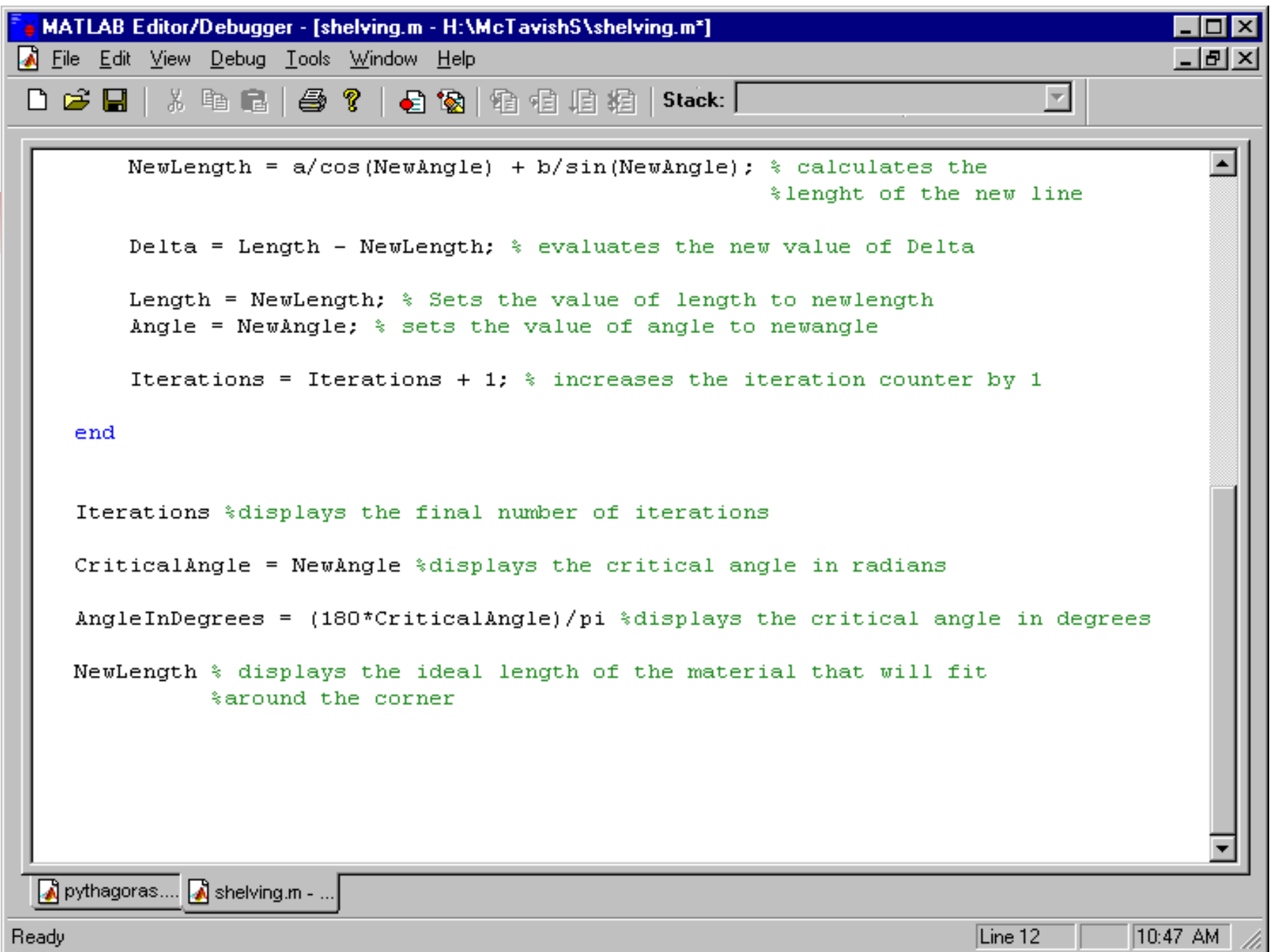
    NewAngle = Angle + Step; % Adds the step value to the angle

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

    Delta = Length - NewLength; % determines the difference between the
                                %length of the material and the new line

    Iterations = Iterations + 1; % increments the counter by 1

end % ends the while loop
```





Iterations =

7716

CriticalAngle =

0.94613292519935

AngleInDegrees =

54.20942347228946

NewLength =

14.99216511329710



# Help?

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



# Reading Assignment

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Chapters 18 and 19