Matlab Notes Part 2

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Summary

- Last week we learned:
  - How to do basic arithmetic
  - plotting
  - Discretizing the real line
  - writing our first function
  - outputting text to the screen
  - (HW) Plotting multiple items on the same figure
- Today we will:
  - Learn control sequences
  - How to use built in matlab functions
  - More plotting!
  - How to create your own function in matlab

Control Sequences

- If we want to automate a task these tools are how we do it!
- (for, while, if) are the words used to describe the different types of control we have over a given sequence of commands.
- In general a for loop is executed as follows:

for (conditionals, generally a sequence of numbers),

   body to be executed

end

Examples

Here is pseudo code which counts!

```
i=0
for i<10,
        print i
        i = i+1
end
```

What does this do? Now try it!

Nested for loops

Say we are given a matrix and we want to step through the values. Given: mxn matrix A :

```
for i = 1: m,
      for j = 1:n,
            disp(A(i,j))
      end
end
```

This will print out each row of the matrix A, how do we print out the columns?

Examples of other types

If statements only execute the body "if" a certain criteria is met:

```
i=0

for i<10,
      if i==2,
             print i
      end
      i = i+1

end
```

See what this does, if statements can have a wide variety of conditionals, use your imagination!

Using "While" loops

I would say that while loops are most useful in scientific computing to execute the body till a certain criteria is met:

```
while err > 0.1,

        Execute root finding algorithm
        Need expression for error here

end
```
Lets try and use a while loop to make a root finding algorithm!

Functions in Matlab

There are two ways to define functions in matlab:

- "anonymous" functions (which can be used to define analytical functions in scripts)
- High level functions which require their own script.

"anonymous" functions:

$$f = @(arglist)expression$$

Example:

$$y = @(x) \ x^2$$

This produces a function (y) which takes in a domain (x) and outputs x^2 to the variable y.

Make sense? Best if we try it out!

Functions

There are programs which can take a given number of inputs and output what you want them to (very useful).
You must "feed" it all the inputs you want it to compute with because any outside variables will not be passed into it:

function[*outputs*] = *functionname*(*inputs*)

Body to be executed

end

Note that functions can have multiple functions in the same script and can use all of the self contained programs!

Let's Try it

Create a function which takes a number, n as its input and counts up to n.

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```
function[] = function_count(n)

    for i = 1:n,
        disp(i)
    end

end
```

We can use this function by making sure we are in the same directory as it (current folder in Matlab).
then creating a number $n = 10$ on the command line
typing function_count(n)

Euler's Method

We want to write a function to solve (approximate) the solution to:

$$y'(x) = f(x, y)$$
$$y_0 = y(x_0)$$

Given an initial point of the solution curve (x_0, y_0) and a step size $h = dx$ we can approximate the solution to this equation at $x_0, x_1 = x_0 + h, x_2 = x_0 + 2h....$

$$y_1 = y_0 + hf(x_0, y_0)$$
$$y_2 = y_1 + hf(x_1, y_1)...$$

Planning to write a function

What items do we need to create a function which will approximate this ODE using Eulers Method?

- Step size h
- initial value (x_0, y_0)
- The right hand side of the equation: $f(x, y)$
- A discretized domain, x
- An array which is size(x) to store the approximate values of our function

Then the question to ask is if I were to make a function which of these would I want to input into the function? (up to you!)

- Step size h
- initial value (x_0, y_0)
- The right hand side of the domain, $f(x, y)$
- (maybe) discretized domain and empty array?

Homework 2

1) Make a function which uses Euler's method to approximate a given ODE:

$$y'(x) = f(x, y)$$

It MUST:

- It must take in at least three variables.
- To be handed in with the code (separate document):
  - print out the maximum error between the approximate solution and the actual solution (ex: make $f(x, y) = y$, then you have an actual solution
  - A graph of the error as a function of step size, h
  - graph the actual solution and the approximate solution over a given domain (ex x=[0,2])

2) Make a function which takes in a matrix and outputs its upper triangular form (use nested for loops, not built in matlab functions)

Homework 2

Also read chapter 5 of the Matlab book. It will help a lot with the homework. Also the wikipedia article on Eulers method can be helpful...