

Introduction to Matlab

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June 16, 2009



What is Matlab?

- Matlab (Matrix Laboratory) is a programming language optimized for linear algebra operations.
- It is very useful for numerical computation and is commonly used by mathematicians.
- After you program in Matlab, you probably won't want to go back to C++.

Basic Arithmetic

- If we type a calculation, when we press ENTER the result appears as ans.

```
2+3
ans =
    5
```

- Pressing the up arrow repeats the last input.
- In addition to basic + - * / there are basic mathematical functions

```
exp(2)    sin(pi)    asin(2)
```

- There may be round-off errors.
- Watch out for the values **Inf** and **NaN**.

Variables

- To assign a value to a variable, just type it. We don't need to declare variables first: `x=2`
- Matlab is weakly typed, which means the variable type is flexible.

```
x=2    x=2.3    x=2+4i    x='hello'
```

- To see what variables are available type: `who`
- To delete a variable x: `clear x`
- If you type just `clear`, all variables will be deleted.

Vectors & Matrices

- We enclose vector values in square brackets.
`v = [2 3 4 5 6]`
- We can look up a value at a position: `v(2)`
- The colon operator takes on a range of values
`v = 2:6`
- More generally we set `start:step:end` (default `step=1`)
- Ex Make a vector of even integers 2 through 100
`evens = 2:2:100`

Matrices

- To make a 2D matrix, the semi-colon skips to the next row:
`A = [2 3 4; 5 6 7]`
- We look up values by row,column: `A(2,3) = 7;`
- You can look up sections with the colon: `A(1:2,2:3)`
- Special matrices
`rand(10,20) eye(3) zeros(4,5) ones(3,2)`
- As matrices get large, you can suppress output with a semi-colon at the end.
`R = rand(20,20);`
- We can display matrix values graphically with `imagesc`.

Matrix Operations

- Matrix multiplication: $A*B$ A^3
- Component-wise operations: $A.*B$ $A.^3$
- Inverse: $\text{inv}(A)$
- Transpose: A'
- Look up matrix size: $\text{size}(A)$
- Eigenvalues: $[v,d] = \text{eig}(A);$
- Linear solver $Ax=b$: $x = \text{linsolve}(A,b);$
- Vectorize a matrix: $A(:)$
- Change matrix size: $\text{reshape}(A,[r,c]);$

Basic Flow Control

```
while i > 0
```

```
...
```

```
end
```

```
for i = 1:10
```

```
...
```

```
end
```

```
if x > 0
```

```
...
```

```
elseif x < 0
```

```
...
```

```
else
```

```
...
```

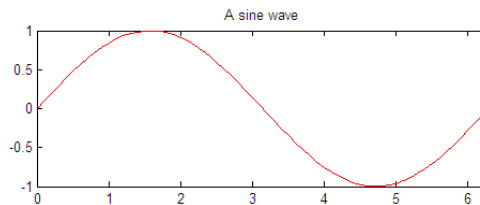
```
end
```

Basic Plotting

- The plot function takes two vectors as input. The first goes on the horizontal axis (x) and the second is the vertical (y).

- Ex Plot a sine wave.

```
x=0:0.1:2*pi;  
y=sin(x);  
plot(x,y,'r')  
axis([0,2*pi,-1,1])  
title('A sine wave')
```



- You can reset the axis and tick marks manually too.
- You can add text to the plot:

```
xlabel   ylabel   title   legend   gtext
```

Loading & Saving Data

- You can navigate directories by pressing the ... button at top.
- Check current position: `pwd` `ls`
- `imread` - Read an image into a matrix. You may have to convert between `uint8` and `double` formats.
- `textread` - Read a text file.
- `xlsread` - Read an Excel file.
- We can save data to a .mat file
`save my_data x y z`
`load my_data`

m Files

- We can create programs with extension .m
- We essentially define new functions for Matlab to use.
- The first line is:
function [out1, out2] = function_name (in1, in2)
- Comments are denoted by the % sign.
- Ex Write a function that computes the average band of a 3-band color image.

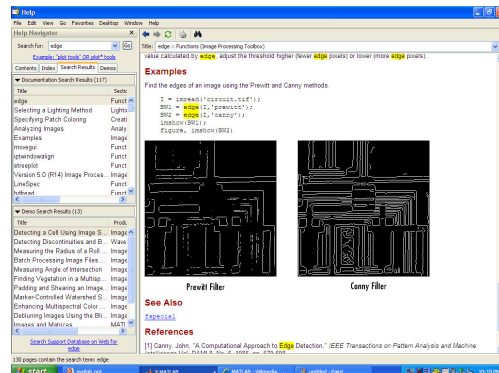
Symbolic Variables

- To do symbolic computation, we create symbolic variables with `syms`. Then we can do symbolic integration and differentiation.

```
syms x;  
diff(3*x^2+6*x-4)  
ans =  
    6*x+6  
int(exp(2*x))  
ans =  
    1/2*exp(2*x)
```

The Matlab Help

- Matlab has awesome Help documentation.
- It usually provides examples of how to use functions.
- If you need to do a standard math calculation, there is probably a Matlab calculation that will do it for you.



For More Information...

- Pascal Getreuer has a nice image processing oriented tutorial at www.math.ucla.edu/~getreuer/matlabimaging.html
- For a summary of what we've covered, watch the Youtube video by Stuart McGarrity. <http://www.youtube.com/watch?v=MdrShPzHeYg>
- Mathworks also has some video demos at: <http://www.mathworks.com/products/matlab/demos.html>