Matlab review

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Matlab

- Available at:
  http://www.cmu.edu/computing/software/all/matlab/download.html
- Need to be on either CMU network or VPN
  - Cisco AnyConnect
    http://www.cmu.edu/computing/network/vpn/
- Very helpful for scientific prototyping
  - Many built-in functions
    - Matrix operations, plots, etc.
  - Libraries for signal/image processing

Basics

- Lines starting with % are comments
- Use ; to suppress output
- End lines with ... to wrap

```
>>  ((1+2)*3 - 2^2 - 1)/2
   ans:  2
>>  ((1+2)*3 - 2^2 - 1)/2;
>>  1 + 2 + 3 + 4 + 5 ...
     + 6 + 7 + 8 + 9
   ans:  45
```

Logics and Assignment

- Variable assignment: =
- Logical tests: >, <, >=, <=, ~=
- Logical operators: &, &&, |, ||, …

Making Arrays

- v = [1 2 3 4]; % row vector
- v = [1; 2; 3; 4]; % column vector
- 1:5 % row vector [1,2,3,4,5]
- 1:3:10 % row vector [1,4,7,10]

- Max/min

  [val, ind] = max(*array*)
- sum, prod, median, ….

Making Matrices (1)

- Which one(s) of the followings would make a different matrix?
  - m = [1 2 3; 4 5 6; 7 8 9]
  - m = [1,2,3; 4,5,6; 7,8,9]
  - m = [[1 2; 4 5; 7 8] [3; 6; 9]]
  - m = [[1 2 3; 4 5 6]; [7 8 9]]
  - B = [1 2 3; 4 5 6]; C = [7 8 9];
    A = [B; C];

Making Matrices(2)

- Creating all ones, zeros, or identity matrices
  - zeros(rows, cols), ones(rows, cols), eye(rows, cols)
- Creating random matrices
  - rand(rows, cols) draws from Unif[0, 1]
  - randn(rows, cols) draws from N(0, 1)
- Getting the size
  - [rows, cols] = size(matrix);

Accessing elements

- Individual elements
  - A(r, c)
    % index starts from 1!
- Accessing n-th row/ column
  - A(n, :) or A(:, n)

- Other tricks
  - A([1,3,5])
  - A([1,3], 2:end)
  - A(1, logical([1,0,1]))
  - A(mod(A, 2)==0)
  - A(:)’
    - Access in column-major order
    - sum(A)?

Accessing elements

- X(X>0) = -X(X>0)

- X = [3 2 0 4 5]; Y = [1 1 1 1 1];
  q = zeros(1, length(Y));
  q(X~=0) = Y(X~=0) ./ X(X~=0);

Matrix math

- Transpose: A’
- Inverse: inv(a)
- Matrix multiplication
  vs. Element by Element multiplication
  - A * A
  - A .* A
- Same for divisions (/ vs ./)

Functions

- Operates in a separate workspace
- Function name = filename
- function *return_value = function_name (params)*

my_func.m

```
function [y,x] = my_func(x)
y = x^2;
x = x+3;
end;
```

Scripts vs Functions

my_script.m

```
y = x^2;
x = x+3;
```

```
>> x = 2; my_script;
>> x
   ans:   5
>> y
   ans:   4
```

my_func.m

```
function [y,x] = my_func(x)
y = x^2;
x = x+3;
end;
```

```
>> x = 2; [y, xp] = my_func(x);
>> x
   ans:    2
>> y
   ans:    4
>> xp
   ans:    5
```

Anonymous functions

```
>>  c = 4;
>>  f = @(x) x + c;
>>  f(3)
ans:  7
>>  c = 5;
>>  f(3)
ans:  7
```

- One use case:

  f = @(x) x.^2 + 3*x + 1;

  quad(f, 0, 1) % integral of f from x=0 to 1

Cells

- Like arrays, but can have different types
  - x = {‘hello’, 2, 3};
  - x{1}
  - x{2}
  - x{5} = @(x) x + 1
  - x{5}(2)

Plotting

```
x = 0 : pi/20 : 4*pi;
plot(x, sin(x))
```

```
axis on / off
grid on / off
box on / off
whitebg(gcf, [0, 0, 0])
clf
clf reset
xlabel('Angle \theta')
ylabel('y = sin(\theta)')
title('The Sine Function')
```

Multiple plots?

```
clf
hold on

plot(x, sin(x))
plot(x, cos(x), 'm')
plot(x, x, 'go')

legend('sin', 'cos', 'x')
axis([0, 2*pi, -1, 1])
```

- Colors: r, g, b, w, c, m, y, k
- Symbols: . o x + * s(quare) d(iamond) etc.
- Line type: - (solid), -- (dashed), : (dotted), -. (dash-dot)
- [xmin, xmax, ymin, ymax]

Other commands

- List names of variables in the environment
  - whos
- Clear the environment
  - clear
- Edit functions and scripts
  - edit <filename>

ONE COMMAND

YOU SHOULD NEVER FORGET

help

Other things to know

- Useful operators

  >, <, >=, <=, ==, &, |, &&, ||, +, -, /, *, ^, …, ./, ‘, .*, .^, \

- Useful Functions
  - sum, mean, var, not, min, max, find, exists, clear, clc, pause, exp, sqrt, sin, cos, reshape, sort, sortrows, length, size, length, setdiff, ismember, isempty, intersect, plot, hist, title, xlabel, ylabel, legend, rand, randn, zeros, ones, eye, inv, diag, ind2sub, sub2ind, find, logical, repmat, num2str, disp, ...

Extra materials

- Prof. Touretzky's tutorial:
  - http://www.cs.cmu.edu/~dst/Tutorials/Matlab/day1.pdf
  - http://www.cs.cmu.edu/~dst/Tutorials/Matlab/day2.pdf
  - http://www.cs.cmu.edu/~dst/Tutorials/Matlab/day3.pdf
- MIT's Matlab tutorial
  - http://www.cs.cmu.edu/~tom/10601_fall2012/recitations/MATLAB_tutorial.html