CS101: Intro to Computing
Fall 2015

Lecture 24

Administrivia

- Homework 14 released today
  - The last homework!
  - Counts as ***two*** assignments
  - Three parts (finish first two this week)
  - Due on the last day of class
- Final exam
  - December 15th 1:30pm-4:30pm (here)
  - Get approval for the conflict (email me)

REVIEW

Which of the following optimization techniques repeatedly moves to the best neighboring solution?

a. Global greedy search
b. Brute force
c. Steepest ascent hill-climbing
d. Hill climbing

How do we update a point using gradient descent?

a. $x_{new} = x_{old} - \gamma \nabla f(x_{old})$

b. $x_{new} = x_{old} + \gamma \nabla f(x_{old})$

c. $x_{old} = x_{new} - \gamma \nabla f(x_{new})$

d. $x_{old} = x_{new} + \gamma \nabla f(x_{new})$

OVERVIEW

Course Summary (so far…)

1. Python fundamentals
2. Data wrangling
3. Data visualization
4. Simulation
5. Random processes
6. Optimization

MATLAB FUNDAMENTALS

Matlab

- Programming language and numerical computing environment
- Proprietary (not free) owned and maintained by Mathworks
- First released as a commercial product in 1980’s
- Site license available for Illinois students
- Interpreted language (like Python)

Why Matlab?

- Designed for and used by engineers
- Excellent documentation
- Ideal applications
  - Linear algebra
  - Simulation
  - Numerical analysis
  - Image processing
- Many toolboxes available (e.g. PDEs)

Getting Started

- Matlab is a program with a GUI
- Interface displays:
  - Current working folder
  - Command window
  - Workspace
  - History (maybe)

MATLAB SYNTAX

Basics

- Literals, variables, and assignment:

```
a=3
```

- Expressions:

```
b=3+a
```

- Adding a semicolon suppresses output

```
b=3+a;
```

- disp only displays the value

```
disp(a);
```

Numeric Types

- Matlab implements
  - integers
  - floating points numbers
  - complex numbers
- 8, 16, 32, and 64 bit versions available
- Matlab also has unsigned integer
- whos displays the type of all variables in workspace

Comments

- The comment operator is %

```
a=3 % an assignment statement
```

- The multi-line comment operator

```
%{
all of this is a long comment
%}
```

Arrays

- Created using square brackets

```
a=[1, 2, 3]
```

- Indexed using parentheses

```
b=a(1)
```

- Indexed from 1, ***not 0!!!!***

Multidimensional arrays

- Created using square brackets and semicolons

```
A=[1, 2, 3 ; 4, 5, 6]
```

- Indexed using parentheses and commas

```
a=A(1,2)
```

- Can use functions to create them

```
B=ones(3,3)+eye(3,3)+zeros(3,3)
```

1	1	1
2	2	2

What will produce this array in Matlab?

a) `[1,1,1];[2,2,2]`

b) `[1,1,1;2,2,2]`

c) `[1,2];[1,2];[1,2]`

d) `[1,2;1,2;1,2]`

1	2
3	4
5	6

How can we index 5 in Matlab?

a) `a(1,3)`

b) `a(2,0)`

c) `a(3,1)`

d) `a(0,2)`

Array operations

- Add, subtract, multiply and divide scalars

```
A=(ones(3,3)+1)/2
```

- Can apply functions

```
A=sin(ones(3,3)*pi)
```

- Can transpose with ‘

```
A=eye(3,4)’
```

- Multiplying arrays is ***matrix multiplication***

```
A=eye(3,4)*ones(4,5)*pi
```

2	**1**
1	**2**

How can we produce this array in Matlab?

a) `ones(2,2)+eye(2,2)`

b) `3*ones(2,2)-2*eye(2,2)`

c) `2*ones(2,2)+eye(2,2)`

d) `3*ones(2,2)-eye(2,2)`

Array concatination

- Putting arrays inside square brackets can combine them

```
A=[eye(3,4), eye(3,5);
    ones(2,4), ones(2,5)]
```

1	**2**
3	**4**
5	**6**

How can we produce this array in Matlab?

a) `[ [1,3,5],[2,4,6] ]`

b) `[ [1,2],[3,4],[5,6] ]`

c) `[ [1,3,5];[2,4,6] ]`

d) `[ [1,2];[3,4];[5,6] ]`

Strings

- Indicated using ***SINGLE QUOTES ONLY!***

```
s='Hello!'
```

- Strings are arrays of characters
- Can print formatted strings with sprintf function

```
sprintf('%f %f',sin(pi),cos(pi))
```

Matlab scripts

- Matlab scripts are stored in .m files
- Very user friendly built-in editor
  - Can open the editor by clicking “New script”
  - Type your program in to the editor
  - Click “run” to start it

Writing functions

- **MUST BE STORED IN A FILE WITH THE NAME OF THE FUNCTION**
- Arguments go in parentheses
- Return values come before equals sign
- Block ends with end statement

```
function y=myfunction(x)
y=x^2;
end
```

Plotting

- plot function works exactly like plt.plot in Matplotlib
- figure creates a new figure

```
x=0:.1:2*pi
y=sin(x)
figure
plot(x,y,'o')
title('sin(x)')
xlabel('x values')
ylabel('y values')
```

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