12.010 Computational Methods of Scientific Programming

Matlab Lecture 2

Lecturers

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Summary of Introduction to Matlab

- Looked at the basic features of Matlab:
  - Getting help
  - Variable definitions and usage
  - Math operators
  - Control statements: Syntax is available through the online help
  - M-files: Script and function types
    - Variable number of input and output arguments

Today's Lecture

- Continue examining Matlab operations
- path and addpath commands
- Variables and constants
- IO using fopen, scanf etc.
- Formats
- Dialog boxes

Multidimensional cells and structures

- Cell arrays are similar to multidimensional arrays except that the all the cells do not need to be same
- e.g., a{1,1} = [1 2 ; 4 5]; a{1,2} = 'Name'; a{2,1} = 2-4i;
- Structure arrays also exist and are accessed and created similar to C (i.e., elements are referred to by . construction patient.name = 'John Doe'; patient.age = 32;
- These are recent features added to Matlab and can be useful in many applications but we will not discuss further.

Program Layout

- Matlab can be run interactively; with script M-files as we have been doing; and/or function M-files
- It is possible to execute C-compiled routines called MEX files (for speed) but we will not cover this (system dependent)
- PC Matlab supports Word Notebooks but not available on Unix or Mac.
- `helpwin` on all systems invokes the help system
- `tour` and `demo` give a tour and demo of Matlab

Function M-files

- Function M-files can have multiple inputs and outputs
- The generic construction is (in an M-file whose name is that of the function.m)

```
function y = flipud(x)
% FLIPUD Flip a matrix up/down
% Comments about function
.. Actual code
```

- Name must begin with a letter
- First line is function declaration line
- First set of contiguous comment lines are for help
- First comment (H1 line) is searched with the `lookfor` command

Function M-files 02

- Usually name is capitalized in H1 line
- Functions can invoke M-file scripts (executed in function workspace)
- M-file can contain multiple functions that are sub-functions of main function in mfile
- Functions can have zero inputs and outputs
- `nargin` tells number of arguments passed in call
- `nargout` tells how many outputs given
- Normally input variables are not copied to function workspace but made readable. However, if there values are changed then they are copied

Function M-files 03

- Functions can accept variable and unlimited numbers of input variables by using `varargin` as the last argument
- Functions can have variable numbers of outputs used `varargout`.
- Use the command `global` to have variables shared between base workspace and function workspace (must be declared global in both places).
- Matlab lets you reach another workspace with the `evalin` function
- You can also use `assignin` to assign values in a workspace (not recommended)

Path controls

- Matlab uses a path structure to tell it where to look for M-files
- In simple cases, all the m-file needed are in the directory from which Matlab runs but in more complex cases this is not possible
- The path command lists the current path
- The addpath command adds a new directory to the path (the current directory is always seached first)
- The pwd command can be used in the addpath command e.g., addpath(pwd)
- M-files can contain multiple functions but additional functions in M-file are available only to the main function of the M-file.
- In complex systems of analysis, where functions are put in M-files should be carefully considered.

Variables and constants

- In Matlab variables are passed into functions by address unless the values are changed, in which case they are copied in to the function workspace.
- Although most variables are stored as double precision in Matlab, they can be referred to as different types e.g., complex, logical.
- To create non-double precession array, the data type can be specificed in the ones, zeros functions e.g. IA=zeros(20,'int8')
- `whos` shows the type of variable
- `all`, `any`, `find` implement logical expressions in array indexing. (See `ops` for more details)
- `logical` can be used to select elements from an array

IO: fopen, scanf, printf

- `fopen` opens a file and returns a file ID number (FID):
  Syntax is
  `[fid,message]=`
  `fopen('filename','permissions')`
- If the open is not successful, fid returns as -1
- http://geoweb.mit.edu/~tah/12.010/Matlab/Lec02_01_file.m gives a simple example of reading and plotting a data file. Data files used here are MIT GPS data processing. Example allows a number different features in Matlab to be explored.
- This M-file also shows the use of logical and plotting functions in Matlab.

FORMATS for scan and print

- The format structure in Matlab is very similar to C (and unix programs such as awk)
- Mostly these are used for outputting values
- Basic types (see details in Matlab On-line help)
- %f, %e, %g — floating point numbers
- %d — integer values
- %s, %c — String and single characters
- \n —newline (needed often at ends of format)
- \r — carriage return

Dialog boxes

- We can make the File selection even better in the example using a dialog box.
- The Matlab M-file http://geoweb.mit.edu/~tah/12.010/Matlab/Lec02_02_db.m shows an example of how we might do this.
- This example shows ways to get file names from a directory listing.
- At this point we try these features on Athena
- In the next two lectures, you will develop a Matlab program to manipulate data of this type.

Summary of Today's class

- Continued examining Matlab operations
- path and addpath commands
- Variables and constants
- IO using fopen, scanf etc.
- Formats
- Dialog boxes
- Much of the lecture is spent actually using these features in the M-files that are included with the lecture.

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