Functions & Data Import/Export

Week 4

Loosely follows Chapters 3 & 4

What is a function?

- A computational expression that uses one or more input values to produce an output value.
- MATLAB functions have three components
  - input, output, and name
    - b = tan(x)
  - x is the input, b is the output, and tan is the name of a built-in function.
  - This is the tangent function and accepts input arguments in radians.

MATLAB Functions

- Functions take the form:
  - variable = function(argument, arguments)
- Many built in functions (sin(), tan(), input(), fprintf(), etc)
- You simply need to know the name and what the input values are
- For example, the square root function: sqrt()
- To find the square root of 9
  - a = sqrt(9)

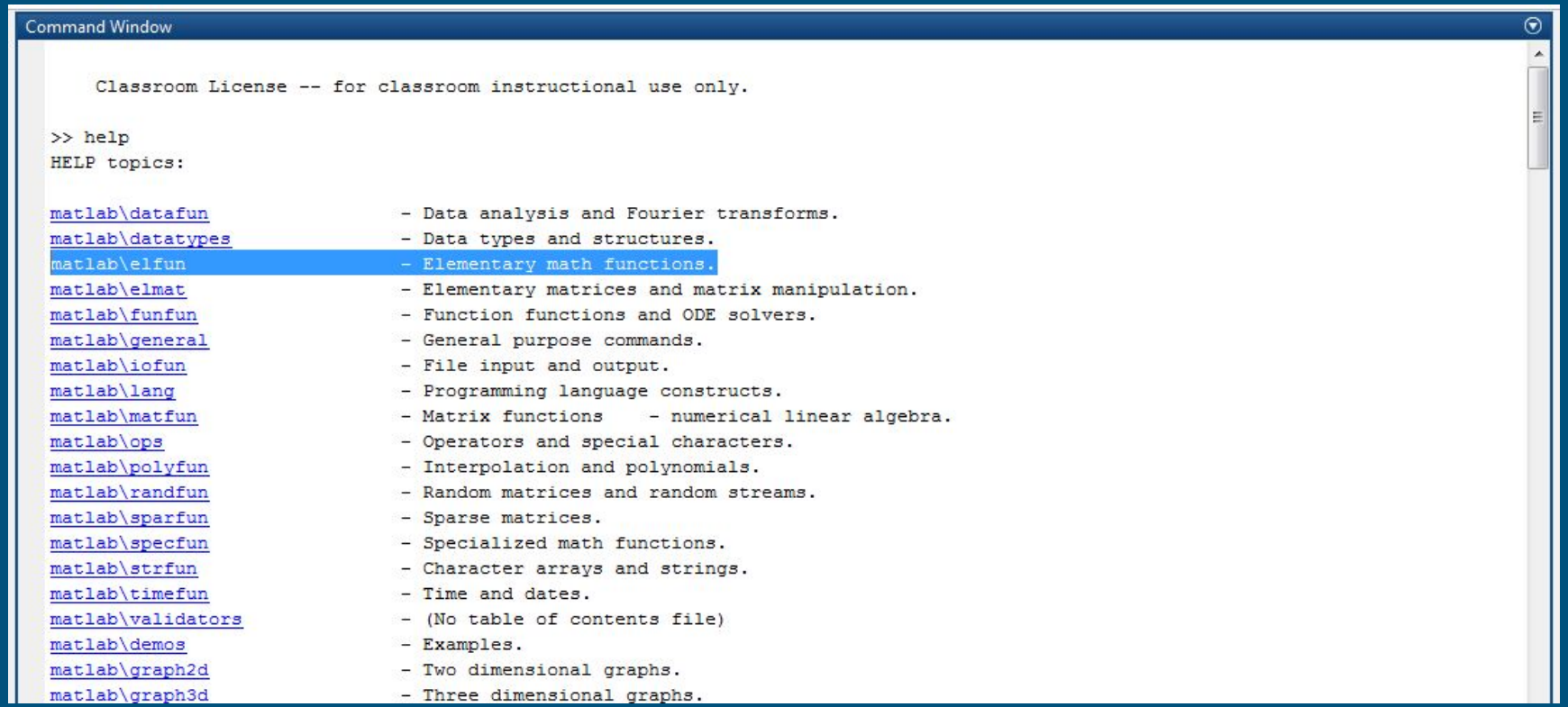
Help Feature

- The easiest way to determine what a function does and what possible argument(s) can be passed (also what output, if any, is given)
- You can type help into the command window to display a list of topics
- You can right click on a function and select help on a particular function

Help Exercise

- Type help in the command window
- If we're interested in the elementary math functions, we find it in the list of help topics (3rd down on R2017b) and click it.
- A list of commands will appear with a description of what each one does.

Help Exercise



More Specific Help

- For more specific help use help <topic>
- Try entering the following
  - help sin
- It takes you to the short description we saw previously

Exercise

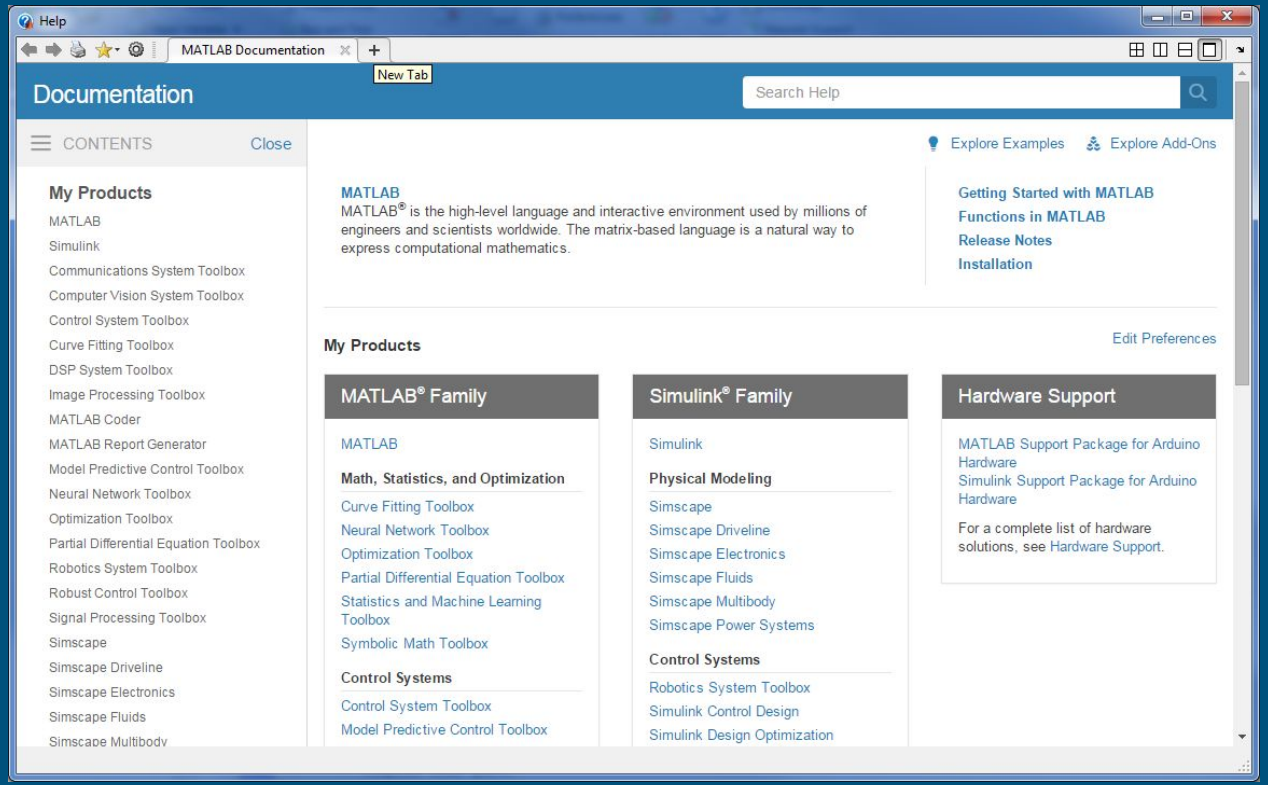
- Use MATLAB help to find the correct algorithms for the following

• Calculate e^7	exp(7)
• Calculate natural log of 4	log(4)
• Calculate $\log_2$ of 12	log2(12)

Help Navigator

- Click on the Help (?) icon in the toolbar.
- A dialog window appears
- Here you can search for topics
- (There should also be a search field in the upper right)

Help Navigator Window



Rounding Functions

- Many times there are multiple functions that perform similar tasks
- Enter the following into matlab

```
x=16.3
y=3.9

round(x)
fix(x)
floor(x)
ceil(x)
```

- What do each of them do?

Discrete Math functions

factor(10)

rats(4.2)

factorial(3)

gcd(20, 10)

lcm(4, 6)

- What do each of these functions do?
- If you aren’t sure, use the help feature (help <topic>)

Trigonometric Functions

- MATLAB can compute trig functions in angles or radians.
- To convert degrees to radians, use the relationship
  - 180 degrees = pi * radians
  - Or use deg2rad(var)

Exercise

- Open a new M-File
- Use MATLAB to find the sine of 360 degrees
- Use MATLAB to find the arccosine of -1 in degrees (use help if necessary)
- Use MATLAB to find the inverse tangent of x as x ranges from -1 to 1 in increments of 0.1

Data Analysis Functions

- MATLAB has many statistical functions built-in:

max()
min()
mean()
median()
covar()

sum()
prod()
sort()
sortrows()

size()
length()
std()
var()

Exercise

- Open another M-File, given:
  - x = [5, 3, 7, 10, 4]
- What is the largest number in vector x and where is it located?
  - [value, position] = max(x)
  - value = 10
  - position = 4
- What is the median of the vector x?
  - median(x)
  - ans = 5
- What is the sum of vector x?
  - sum(x)
  - ans = 29

Exercise

- Open another M-File, given:
  - v = [2, 24, 53, 7, 84, 9]
  - y = [2, 4, 56; 3, 6, 88]
- Sort v in descending order
- Find the size of y
- Find the standard deviation of v
- Find the cumulative product of v
- Sort the rows of y based on the 3rd column

Generating Random Numbers

- rand(n) produces an nxn matrix of random numbers from 0 to 1
- rand(n,m) produces an nxm matrix of random numbers from 0 to 1

- To produce a random number between *x* and *y* use the following formula:
  - x + (y - x) .* rand(1)
- That means to produce a rand between 0 and *y* use the following formula:
  - y .* rand(1)

Complex Numbers

- Recall that complex numbers are represented by a+b*i or a+bi
  - a is the real part
  - b is the imaginary part
- Complex number can be assigned using the constant *i* or the function for complex numbers.
  - `a = 2; b = 3;` `% Given some values a and b`
  - `c = a + b*i;` `% Assign c with the constant i`
  - `c = complex(a,b);` `% OR Assign c with the function complex()`

More Complex Number Functions

- To find the real and imaginary components of a complex number:
  - real(c)
  - imag(c)
- To find the absolute value or modulus of a complex number:
  - abs(c)
- To find the angle or argument expressed in radians of a complex number:
  - angle(c)

Useful Constants

- clock produces an array with the year, month, day, hour, min, sec
- date tells the date
- pi the number pi (3.141592653589…)
- i imaginary number (i = sqrt(-1))
- j imaginary number (j = sqrt(-1))

- Remember, you should not use variable names that share names with constants built into MATLAB.

Importing & Exporting

- Many programs deal with data
- Sometimes data needs to be shared

Importing and Exporting

Typical Data File Types

Binary

- Machine Language
- Fast & Efficient
- Not readable
- Usually proprietary
- Examples
  - .xlsx
  - .docx
  - .mat

ASCII (Plain Text)

- “Text File”
- Easily read in any text reader
- Good for sharing
- Examples
  - .txt
  - .dat
  - .csv

Import Wizard

- Feature that determines
  - The type of data file
  - The way to extract and display information
- Can extract from ASCII and Binary files
- Simply double click on a file in the Directory Window

Import Wizard Functions

- The import wizard can be called using various functions
  - uiimport('filename.ext')
  - xlsread('filename')
  - csvread('filename')/readmatrix('filename')
  - textread('filename')

NOTES:

- The file must be in the current path in order to simply use the filename
- Excel must be installed for MATLAB to read/write Excel data

Exporting to Excel

- An array in MATLAB can be exported to Excel
- The following is an example
  - xlswrite(‘filename.xlsx’, someArray)

Exercise

Open an M-file and write a program that does the following

- Create an array of odd numbers from 1 to 19
- Save the array to an excel document
- Clear your workspace variables
- Import the array from the Excel file you just created.

Import Text Files

- Another function that is used to import data is textread().
- textread() can only read ASCII files
- The file must be formatted into columns but each column can be different
  - [a, b, c, d] = textread('filename.ext', '%f %d %d %d', n)
- a, b, c, and d represent the names of each variable
- Filename is the name of the file
- '%f %d %d %d' is the formatspec string indicating the format of each column
- n is the number of rows to be read

NOTE: The formatspec and n are optional (see help for more info)

Example

- Assume a file ‘sports.dat’ contains:

```
University, Soccer, 12, 7, 2
University, Hockey, 15, 7, 3
```

- To read it you would enter
  - [sport, wins, losses, ties] = textread(‘sports.dat’, ‘%*s, %s, %d, %d, %d’, 2)
- %s denotes the column contains strings
- %d denotes the column contains integers
- %*s or %*d means the column will not be read into matlab

Binary Matlab .mat Files

- You may save or load variables into your matlab workspace
  - save filename var1 var2 var3
  - load filename
- Filename is the name of the file and var1, var2, and var3 are the variables to be saved in a binary MATLAB file.
- If no variables are listed, all workspace variables are saved
- The data is saved into a file with a .mat extension
- Load variables from .mat files with a simple load command

Exercise

- In the command window…
- Define x as 6, t as 14.5 and r as 22
- Save these variables into a file titled “work_data”.
- Clear the workspace and reload the variables from the work_data file

Key Takeaways

- Help Features
- Basic Math Functions
- Rounding Functions
- Discrete Math Functions
- Trigonometric Functions
- Data Analysis/Statistical Functions
- Random Numbers
- Complex Numbers