CMPSC 200 Programming for Engineers with MATLAB
Lecture 3 Outline

Related Reading: Chapters 2 and 3.

Array Operations
1) MATLAB stores arrays of data as matrices
2) Equivalent statements to write $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$
   a. $A = \{1 2; 3 4\}$
   b. $A = \{1.2; 3,4\}$
   c. $A = \{1 2; \\ 3 \ 4\}$
   d. $A = \{1.2; \\ 3,4\}$
3) The $i$th row and $j$th column of a matrix can be found as $A(i,j)$.
4) Shortcut for creating a row of regularly spaced sets of numbers
   a. Start at $a$, increment in steps of $b$ until you get to $c$
   b. $a:b:c$ or $[a:b:c]$(MATLAB accepts both notations)
   c. If no $b$ is indicated, default is $a:1:b$

Built-in MATLAB Functions – Part I
1) Common Math Operations
   a. Absolute value: $\text{abs}(x)$
   b. Square root: $\text{sqrt}(x)$ (compare it against $x^{0.5}$)
   c. $n$th root: $\text{nthroot}(x,n)$
   d. Sign or Signum Function: $\text{sign}(x)$, which returns:
      i. 1 if the corresponding element of $x$ is greater than zero
      ii. 0 if the corresponding element of $x$ equals zero
      iii. -1 if the corresponding element of $x$ is less than zero
   e. Remainder: $\text{rem}(x,y)$ (remainder of $x$ divided by $y$)
   f. Powers
      i. Exponents: $5 \times 10^{10}$ can be calculated as $5*10^{10}, 5*(10^{10})$ or $5E10$
      ii. Exponential: $\text{exp}(x)$ calculates $e^x$
   g. Logarithms
      i. $\ln(x)$: $\log(x)$ (tricky to remember – many languages do this, though)
      ii. $\log_{10}(x)$: $\log10(x)$
      iii. Change of base formula to get others: $\log_b(x) = \frac{\log_d(x)}{\log_d(b)}$
2) Rounding functions
   a. Rounding: $\text{round}(x)$
   b. Truncation: $\text{fix}(x)$
   c. Floor (rounds to nearest integer towards $-\infty$): $\text{floor}(x)$
   d. Ceiling (rounds to nearest integer towards $\infty$): $\text{ceil}(x)$
3) Discrete Math
   a. Prime factors of a number \( x \): \textit{factor}(x)
   b. Greatest common denominator of \( x \) and \( y \): \textit{gcd}(x, y)
   c. Least common multiple of \( x \) and \( y \): \textit{lcm}(x, y)
   d. Convert decimal number to fraction: \textit{rats}(x)
   e. Factorial \((n! = n \times (n - 1) \times (n - 2) \times \ldots \times 2 \times 1)\): \textit{factorial}(n)
   f. Prime Numbers
      i. Find all prime numbers less than or equal to some number: \textit{primes}(x)
      ii. Check if a number is a prime number: \textit{isprime}(x). \textit{isprime} returns 1 if the number is prime, or returns 0 if the number isn’t prime (this choice of true/false representations is typical in computer science).

4) Trig Functions: default is radians vs. degrees (if it is available)
   a. Sine
      i. \( \sin(x) \): \textit{sin}(x) vs. \textit{sind}(x)
      ii. \( \sin^{-1}(x) \): \textit{asin}(x) vs. \textit{asind}(x)
      iii. \( \sinh(x) \): \textit{sinh}(x)
      iv. \( \sinh^{-1}(x) \): \textit{asinh}(x)
   b. Cosine
      i. \( \cos(x) \): \textit{cos}(x) vs. \textit{cosd}(x)
      ii. \( \cos^{-1}(x) \): \textit{acos}(x) vs. \textit{acosd}(x)
      iii. \( \cosh(x) \): \textit{cosh}(x)
      iv. \( \cosh^{-1}(x) \): \textit{acosh}(x)
   c. Tangent
      i. \( \tan(x) \): \textit{tan}(x) vs. \textit{tand}(x)
      ii. \( \tan^{-1}(x) \): \textit{atan}(x) vs. \textit{atand}(x)
      iii. \( \tanh(x) \): \textit{tanh}(x)
      iv. \( \tanh^{-1}(x) \): \textit{atanh}(x)
   d. Secant
      i. \( \sec(x) \): \textit{sec}(x) vs. \textit{secd}(x)
      ii. \( \sec^{-1}(x) \): \textit{asec}(x) vs. \textit{asecd}(x)
      iii. \( \sech(x) \): \textit{sech}(x)
      iv. \( \sech^{-1}(x) \): \textit{asech}(x)
   e. Cosecant
      i. \( \csc(x) \): \textit{csc}(x) vs. \textit{cscd}(x)
      ii. \( \csc^{-1}(x) \): \textit{acsc}(x) vs. \textit{acscd}(x)
      iii. \( \csch(x) \): \textit{csch}(x)
      iv. \( \csch^{-1}(x) \): \textit{acsch}(x)
   f. Cotangent
      i. \( \cot(x) \): \textit{cot}(x) vs. \textit{cotd}(x)
      ii. \( \cot^{-1}(x) \): \textit{acot}(x) vs. \textit{acotd}(x)
      iii. \( \coth(x) \): \textit{coth}(x)
      iv. \( \coth^{-1}(x) \): \textit{acoth}(x)
5) Language Help:
   a. Built-in Help
      i. help, or help _____ (where _____ is item of interest)
      ii. doc, or doc _____ (where _____ is item of interest)

In-Class Practice Exercises

1) Use the help and/or doc commands to determine what the following commands are and how to use them; in addition to the above commands, I want you to know these too:
   a. diary
   b. linspace
   c. logspace

2) Write a script to do the following:
   a. Write your name and section number on separate lines at the top of the script; use separate comments to do this.
   b. Define a variable \( x = [1 \ 3 \ 5 \ 2] \) and a variable \( y = [2 \ 7 \ 5 \ 4] \).
   c. Add \( \pi \) to each element of \( x \) and store the new result as \( x \); Add \( e \) to each element of \( y \) and store the new result as \( y \). Hint: Don’t look up the value of \( e \); \( e \approx e^1 \).
   d. Find \( \cos(x) \) and \( \cot(y) \).
   e. Find the element-by-element product \( z = x * y \).
   f. What element is in the first row, third column? Use a command to find this value.

3) Write a separate script to do the following:
   a. Write your name and section number on separate lines at the top of the script; use a block comment to do this.
   b. Find the sign of \( a = [5 \ -2] \). Write it as one succinct command and store the result in an array of data.
   c. What are the prime factors of 24? Does it match what you’d expect?
   d. Is 13 a prime number? How many prime numbers are there less than 27?
   e. Find the floor of \( x \); store the value as \( b \). Find the ceiling of \( y \) and store it as \( c \).
   f. Round \( b \) and call the result \( d \); truncate \( c \) and call the result \( e \).
   g. What is the numeric value of \( \log_5(5) \)?
   h. Find the fractional form of the number 2.3.
   i. Find the values of \( f = 5! \), \( g = 8! \) and \( h = 15! \) and store them in variables of those names.
   j. What is the 5\textsuperscript{th} root of \( g \)?
   k. What is the least common multiple of 5 and 6?

For next class: Read Chapter 3; we’ll continue on Wednesday with more built-in functions.

Next Week:
1) No class on Monday (Labor Day holiday – University is closed)
2) Quiz 1 due on ANGEL: Tuesday at 5 p.m.
3) Wednesday: Built-In MATLAB Functions – Part II (lecture format similar to today)
4) Lab 1: In-class on Friday, September 5\textsuperscript{th}