MATH 3341 — Spring 2020

Lab 02: Variables, Arrays, and Scripts

Download `Math.3341.Lab.02.zip`, unzip it by following the Windows Instructions on WyoCourses. Change the current working directory of MATLAB to the unzipped folder, and type `edit lab_02_script` in the Command Window.

1 Defining Variables

(a) Define the variable `old_sin_pi = sin(pi)`, then define `pi = 1.25`, and compute `new_sin_pi = sin(pi)`. Compare `old_sin_pi` and `new_sin_pi`.

(b) Now define `sin = 2.1`. Use `who` and then `whos` to display the list of your currently used variables. Then, evaluate `sin(pi)` in the `try-catch` block.

(c) Assign `5 + i`, `6 + j` to `a`, `b`, respectively. Then perform summation to `a` and `b` and assign the result to `c`.

2 Arrays: Vectors & Matrices

(a) Use `clear` command to clear the variables in the Workspace.

(b) Use `linspace` to create a vector x with 10 entries ranging from 0 to 2π, then assign the transpose of `x` to the variable named `x_transpose` using either `'` or `transpose`. Then use the function `length` to find the length to `x_transpose`.

(c) Use either `:` or `colon` to create a column vector `v`, of which the range is from 2 to 25 with step size 2. Then use `reshape` to change `v` to a 3×4 matrix `V`. Find the size of `V` using `size`.

(d) Define the following two matrices,

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, \quad B = \begin{bmatrix} 5 & 6 \\ 7 & 8 \end{bmatrix}.$$

Then store the result of matrix multiplication `A * B` to `C` and the result of element-wise multiplication `A .* B` to `D`. Observe the difference between these two operations.

(e) Create a 5×5 magic square matrix `M`. Extract the submatrix of `M` (from row 2 to row 4 and from column 3 to column 5), and store the submatrix to `M_submatrix`. Then create a vector `M_last_col` by extracting the last column of `M`.

(f) Create a 4×4 identity matrix `I` using `eye`, a 6×3 all-one matrix `N` using `ones`, a 3×4 all-zero matrix `O` using `zeros`.

In the Command Window enter the command `diary('lab_02_output.txt')`, run the script file `lab_02_script.m`, then type `diary off` to store the output to `lab_02_output.txt`. Then upload the script file `lab_02_script.m` and output file `lab_02_output.txt` to Overleaf. Next open `body.tex` under the folder `LaTeX`. In the last section of the report, you will reproduce the following using LaTeX. Recompile, and submit the generated `.pdf` file to WyoCourses.

3 Basics of LaTeX

3.1 Sine functions

For given $x \in [0, 2\pi]$ with step size $\pi/12$, we can obtain the evaluations of (3.1) at x (see Table 1), and the corresponding plot (see Figure 1).

$$\begin{cases} y_1 = \sin(x/2) \\ y_2 = \sin(x) \\ y_3 = \sin(2x) \end{cases} \tag{3.1}$$

Table 1: Sine functions

x	$\sin(x/2)$	$\sin(x)$	$\sin(2x)$
0	0	0	0
$\pi/2$	$\sqrt{2}/2$	1	0
π	1	0	0
$3\pi/2$	$\sqrt{2}/2$	-1	0
2π	0	0	0

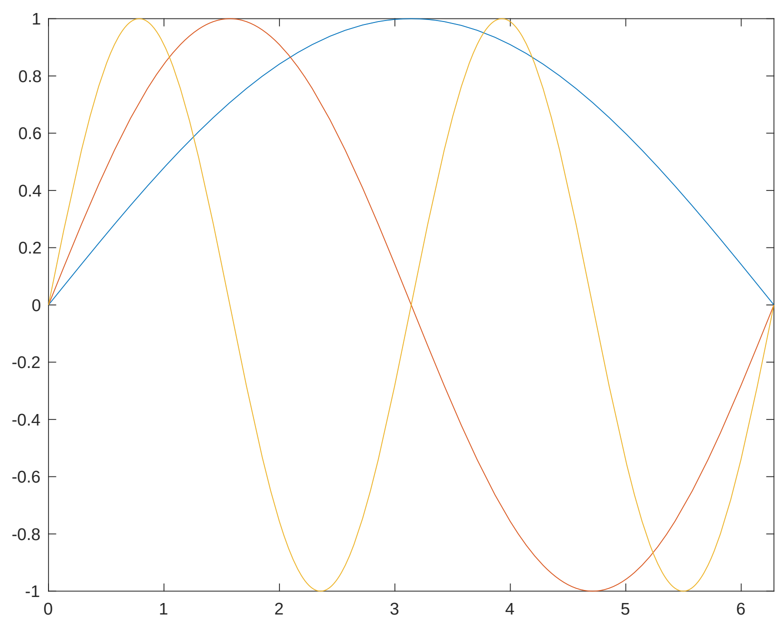

Figure 1: Sine functions

3.2 Goldbach's Conjecture

Pursuing this type of analysis more carefully, Hardy and Littlewood in 1923 conjectured (as part of their famous *Hardy–Littlewood prime tuple conjecture*) that for any fixed $c \geq 2$, the number of representations of a large integer n as the sum of c primes $n = p_1 + \cdots + p_c$ with $p_1 \leq \cdots \leq p_c$ should be asymptotically equal to

$$\left(\prod_p \frac{p\gamma_{c,p}(n)}{(p-1)^c}\right) \int_{2 \leq x_1 \leq \cdots \leq x_c : x_1 + \cdots + x_c = n} \frac{dx_1 \cdots dx_{c-1}}{\ln x_1 \cdots \ln x_c}, \tag{3.2}$$

where the product is over all primes p, and $\gamma_{c,p}(n)$ is the number of solutions to the equation $n = q_1 + \cdots + q_c \mod p$ in modular arithmetic, subject to the constraints $q_1, \ldots, q_c \neq 0 \mod p$. This formula (3.2) has been rigorously proven to be asymptotically valid for $c \geq 3$ from the work of Vinogradov, but is till only a conjecture when $c = 2$. In the latter case, the above formula simplifies to 0 when n is odd, and to

$$2\Pi_2 \left(\prod_{p|n;p\geq 3} \frac{p-1}{p-2}\right) \int_2^n \frac{dx}{(\ln x)^2} \approx 2\Pi_2 \left(\prod_{p|n;p\geq 3} \frac{p-1}{p-2}\right) \frac{n}{(\ln n)^2},$$

when n is even, where Π_2 is Hardy-Littlewood's twin prime constant

$$\Pi_2 := \prod_{p\geq 3}\left(1 - \frac{1}{(p-1)^2}\right) = 0.6601618158\ldots$$

This sometimes known as the extended Goldbach conjecture.
Reference: Goldbach's conjecture.