MATH 3341 — Fall 2019
Lab 05: Formatting Output and LaTeX

Download `Math.3341.Lab.05.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_05_script` in the Command Window.

1 Formatting Numerical Values

(a) Define a variable `x`, of which the value is e^{π}.

(b) Define a cell array `format_types`, of which the entries are listed as follows:

  (1) `rat`

  (2) `longeng`

  (3) `longg`

  (4) `longe`

  (5) `long`

  (6) `shorteng`

  (7) `shortg`

  (8) `shorte`

  (9) `short`

(c) Use a for-loop to output `x` in the above formats (do not change the order).

2 Formatting Data using `fprintf`

(a) Define `x` to be column vector ranging from 0 to 2π with 25 entries, and define `y1`, `y2`, `y3` as follows

$$y_1 = \sin(x/2), \quad y_2 = \sin(x), \quad y_3 = \sin(2x).$$

(b) Concatenate column vectors `x`, `y1`, `y2`, `y3`, and store the new 2-D array to `data`. Store the size of `data` to `data_size`.

(c) Print out the heading using `fprintf`, where the heading of the output is `x`, `sin(x/2)`, `sin(x)`, `sin(2x)`, whose widths are 9. The heading should be right-justified.

(d) Then use a for-loop to print out the numerical values of `data`, which have width 9 with 6 decimal digits. All numerical values should be right-justified.

3 Formatting Data for LaTeX

This part we will format `data` (defined above) for LaTeX.

(a) Set the output filename to `sin.tex`, and the file open mode to `w` (write) in `fopen` and store the file handle to the variable `file_handle`.

(b) Use `fprintf` to print out the setup for `table` and `tabular` environments. The output should be as follows

```
\begin{table}[!hbtp]
\centering
\caption{Sine functions}
\label{tab:sine}
\begin{tabular}{lcrr}
\toprule
\midrule
\bottomrule
\end{tabular}
\end{table}
```

(c) Print out the heading of the data, whose column width is 11 between `\toprule` and `\midrule`. The expected output is as follows:

```
        $x$ & $\sin(x/2)$ &   $\sin(x)$ &  $\sin(2x)$ \\
```

(d) Print out the numerical values of `data` between `\midrule` and `\bottomrule` using a for-loop. Each number has width 9 and 6 decimal digits. Also each number should be enclosed by a pair of `$` and seperated by `&`. The expected output for one of the rows should be as follows

```
$ 0.000000$ & $ 0.000000$ & $ 0.000000$ & $ 0.000000$ \\
```

(e) Print the content of `sin.tex` by calling `type('sin.tex')`.

4 Plotting Multiple Functions using for-loop

(a) Define a cell array `styles`. The elements are plotting styles, i.e.,

   (1) solid line with circle as the marker;

   (2) dashdot line with diamond as the marker;

   (3) dashed line with triangle (up) as the marker.

(b) Define another cell array `y`, of which the entries are `y1`, `y2`, and `y3`.

(c) Then use a for-loop to plot each entries of `y` versus `x` with in the same figure window the above styles (in the same order).

(d) Set legend, labels, grid, and title. Change the range of x-axis to $[0, 2\pi]$, and that of y-axis to $[-1, 1]$. Set the following properties as you did in last lab. The expected result is shown in Figure 1.

   - `XTick` to `[0, pi / 2, pi, 3 * pi / 2, 2 * pi];`

- `XTickLabel` to `{'0', '$\pi/2$', '$\pi$', '$3 \pi/2$', '$2\pi$'}`;
- `GridLineStyle` to `'--'`;
- `Box` to `'on'`;
- `BoxStyle` to `'full'`.

(e) Then save the plot using the following lines of commands:

```
name = 'lab_05_plot';
fig = figure(1);                       % Set figure i as current figure window
set(fig, 'PaperPositionMode', 'auto');  % Set paper position mode to 'auto'
pos = get(fig, 'PaperPosition');        % Get figure window paper position
set(fig, 'PaperSize', [pos(3) pos(4)]); % Set figure paper size
print(fig, '-dpdf', name);              % Save figure
```

Type `diary('lab_05_output.txt')` in the Command Window, run the script file `lab_05_script.m`, and type `diary off` in the Command Window. Upload `lab_05_output.txt`, `sin.tex`, and `lab_05_script.m` to the folder `src` on Overleaf.
On Overleaf, open `body.tex` under the folder `LaTeX`. In the last section of the report, you will reproduce Section 5 using LaTeX. You may find the following helpful:

- You may use enviroments such as `align`, `itemize`, `enumerate`, `lstlisting`, `figure`, and `table`.
- You may use `\textbf`, `\textsc`, `\textit`, `\emph`, `\bfseries`, `\itshape`, `\scshape` for formatting plain text.
- You may use `\includegraphics[width=amount unit]{/path/to/figure.pdf}` to specify the width of a figure. In our case, the width of the figure is `0.75\textwidth`.
- You may use `\ref{labelName}` to refer to figures, tables; use `\eqref{labelName}` to refer to equations.
- For special characters, you may look them up in LaTeX.Mathematics.Symbols.pdf.
- You may use `\input{/path/to/sin.tex}` to include the table you got from MATLAB.

Recompile and submit the PDF file generated by Overleaf to WyoCourses.

5 Basics of LaTeX

5.1 Sine functions

For given $x \in [0, 2\pi]$ with step size $\pi/12$, we can obtain the evaluations of (1), (2), (3) at x (see Table 1), and the corresponding plot (see Figure 1).

$$y_1 = \sin(x/2) \tag{1}$$
$$y_2 = \sin(x) \tag{2}$$
$$y_3 = \sin(2x) \tag{3}$$

Table 1: Sine functions

x	$\sin(x/2)$	$\sin(x)$	$\sin(2x)$
0.000000	0.000000	0.000000	0.000000
0.261799	0.130526	0.258819	0.500000
0.523599	0.258819	0.500000	0.866025
0.785398	0.382683	0.707107	1.000000
1.047198	0.500000	0.866025	0.866025
1.308997	0.608761	0.965926	0.500000
1.570796	0.707107	1.000000	0.000000
1.832596	0.793353	0.965926	−0.500000
2.094395	0.866025	0.866025	−0.866025
2.356194	0.923880	0.707107	−1.000000
2.617994	0.965926	0.500000	−0.866025
2.879793	0.991445	0.258819	−0.500000
3.141593	1.000000	0.000000	−0.000000
3.403392	0.991445	−0.258819	0.500000
3.665191	0.965926	−0.500000	0.866025
3.926991	0.923880	−0.707107	1.000000
4.188790	0.866025	−0.866025	0.866025
4.450590	0.793353	−0.965926	0.500000
4.712389	0.707107	−1.000000	0.000000
4.974188	0.608761	−0.965926	−0.500000
5.235988	0.500000	−0.866025	−0.866025
5.497787	0.382683	−0.707107	−1.000000
5.759587	0.258819	−0.500000	−0.866025
6.021386	0.130526	−0.258819	−0.500000
6.283185	0.000000	−0.000000	−0.000000

5.2 The Millennium Prize Problems

The Millennium Prize Problems are seven problems in mathematics that were stated by the **Clay Mathematics Institute** on May 24, 2000. The problems are

(1) Birch and Swinnerton-Dyer conjecture,

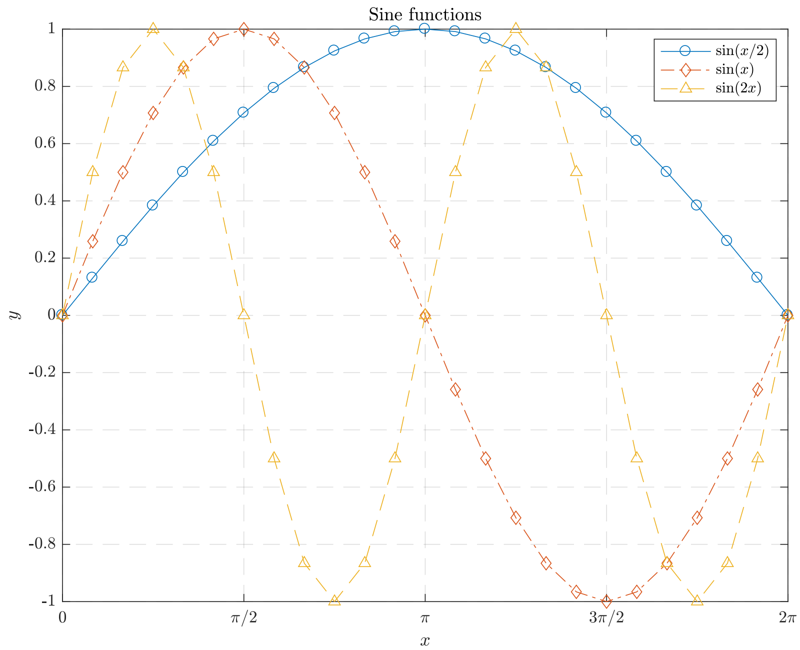

Figure 1: Sine functions

(2) Hodge conjecture,

(3) Navier–Stokes existence and smoothness,

(4) P versus NP problem,

(5) Poincaré conjecture,

(6) Riemann hypothesis,

(7) Yang–Mills existence and mass gap.

The Riemann zeta function is defined for complex s with real part greater than 1 by the absolutely convergent infinite series

$$\zeta(s) = \sum_{n=1}^{\infty} \frac{1}{n^s} = \frac{1}{1^s} + \frac{1}{2^s} + \frac{1}{3^s} + \cdots$$

The practical uses of the Riemann hypothesis include many propositions known true under the Riemann hypothesis, and some that can be shown to be equivalent to the Riemann hypothesis:

- Distribution of prime numbers,
- Growth of arithemtic functions,
- Large prime gap conjecture,
- Criteria equivalent to the Riemann hypothesis.

5.3 Factorial MATLAB Implementation

Here are two ways of implementing factorial in MATLAB:

(a) Recursive version:

```
function f = factorial(n)
    if n == 1
        f = 1;
    end
    f = n * factorial(n - 1);
end
```

(b) Non-recursive version:

```
function f = factorial(n)
    f = 1;
    for i = 1:n
        f = f * i;
    end
end
```