MTH 459, LaTeX Tutorial #5, Spring 2025

One of the technical aspects of this course will be to learn some basic elements of working with LaTeX. LaTeX is a markup language for documents that can handle mathematical code, styles, citations and bibliographies, graphs and more. But working with the code language does take some practice. We are going to start by setting up an account on Overleaf, a free website for working with LaTeX that can compile your documents for you and convert them into pdfs. Each assignment will build on previous assignments to add more functionality to your document.

1. **Creating Mathematical Graphs with TikZ**
   Objective
   Learn how to:
   1. Use the TikZ package to create mathematical graphs.
   2. Plot a 2D function graph.
   3. Render a 3D surface graph.
   4. Design a small network graph.

   Steps
   1. **Set Up the Document**
      Begin with the following LaTeX template:

```
\documentclass[12pt]{article}
\usepackage[utf8]{inputenc}
\usepackage{pgfplots} % For creating 2D and 3D graphs
\pgfplotsset{compat=1.18} % Ensure compatibility with recent versions of TikZ

\title{Mathematical Graphs with TikZ}
\author{Your Name}
\date{\today}

\begin{document}

\maketitle

\section{2D Function Plot}
Below is a plot of the function \(y = \sin(x)\):

\begin{tikzpicture}
  \begin{axis}[
    axis lines = middle,
    xlabel = {$x$},
    ylabel = {$y$},
    samples = 100,
    domain = 0:2*pi,
    ]
    \addplot[color=blue] {sin(deg(x))};
    \addlegendentry{$y = \sin(x)$}
  \end{axis}
\end{tikzpicture}
```

```
\section{3D Surface Plot}
Here is a 3D surface plot of \(z = x^2 - y^2\):

\begin{tikzpicture}
  \begin{axis}[
    view={45}{30},
    xlabel = {$x$},
    ylabel = {$y$},
    zlabel = {$z$},
    ]
    \addplot3[surf, domain=-2:2, domain y=-2:2] {x^2 - y^2};
  \end{axis}
\end{tikzpicture}

\section{Network Graph}
Below is a small network graph:

\begin{tikzpicture}
  % Nodes
  \node[circle, draw] (A) at (0, 0) {A};
  \node[circle, draw] (B) at (2, 0) {B};
  \node[circle, draw] (C) at (1, 1.5) {C};

  % Edges
  \draw[-] (A) -- (B);
  \draw[-] (A) -- (C);
  \draw[-] (B) -- (C);
\end{tikzpicture}

\section{Conclusion}
Write a brief reflection on how creating these graphs in LaTeX can benefit your work in data science.

\end{document}
```

2. **Customize Each Graph**
   - For the 2D plot, choose a different function (e.g., y=cos(x) or y=e^−x).
   - Modify the 3D surface plot to a different equation (e.g., z=sin(xy)).
   - Expand the network graph by adding at least three more nodes and edges.
   - Add some appropriate labeling elements (using the resources listed below), such as a title, a legend, changing the axis labels, the coloring, etc.

3. **Resources for TikZ and PGFPlots**
   - **PGFPlots Manual**: https://pgfplots.net/
   - **TikZ Examples Repository**: https://www.overleaf.com/learn/latex/TikZ_package
   - **TikZ Network Graph Library**: https://ctan.org/pkg/tikz-network

4. Include a short paragraph explaining potential use cases for each type of graph in data science. Why might you want to use a TikZ graph rather than one constructed in R?

5. **Submission**: Once the document has been customized to your satisfaction, submit the pdf in the dropbox for the assignment in Blackboard.