Project 4: Visualization with Matplotlib

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# Deliverable Table

The purpose of this table is to provide a complete view of the concepts covered in chapter 4 of *"Python Data Science Handbook"* (VanderPlas, 2016) and provide a general page location for where the topic was demonstrated.

|  |  |
| --- | --- |
| Deliverables | Location |
| Simple Line Plots |  |
| Simple Scatter Plots |  |
| Visualizing Errors |  |
| Density and Contour Plots |  |
| Histograms, Binnings, and Density |  |
| Customizing Plot Legends |  |
| Customizing Colorbars |  |
| Multiple Subplots |  |
| Text and Annotation |  |
| Customizing Ticks |  |
| Customizing Matplotlib: Configurations and Stylesheets |  |
| Three-Dimensional Plotting in Matplotlib |  |
| Geographic Data with Basemap |  |
| Visualization with Seaborn |  |

Additionally, here is a link to my GitHub were the datasets and the Jupyter Notebook for the project can be downloaded: https://github.com/jwmathis/SSE591\_Project3.git. In order to run the file, Python and Pandas package must be installed.

# 1. Introduction

Matplotlib provides a comprhensive and flexible interface for creating static, animated, and interactive visualizations in Python. While libraries like Pandas and NumPy are essential for data manipulation and numerical computations, Matplotlib excels at presenting this data in a visual format that can uncover insights and trends. Because of its wide range of plotting functions and customization options, it makes it an invaluable tool for data scientists who aim to present their data clearly and effectively. Additionally, its integration with Pandas and NumPy allows for seamless data visualization directly from the libraries respective data structures.

This report aims to demonstrate my proficiency in Python data visualization techniques as covered in Chapter 4 of the “Python Data Science Handbook” by Jake VanderPlas (2016). This report attempts to illustrate the core concepts and functionalities of the Pandas library by implementing the concepts into practical examples. The code presented in this report was developed using Visual Studio Code with Jupyter Notebook extensions. I will provide detailed explanations, highlighting key features and operations that make Matplotlib an essential tool for data analysis.

# 2. Adapting SIR Model for Visualization

Using my previous SIR model from Project 2 that covered using the NumPy library, I decided to revisit the project code to construct graphs for various scenarios using Matplotlib. I first began by transferring the necessary code from my modeling infection spread to recreate the simulated data. I also transerred the Monte Carlo simulation code to include in the visualization. First, I began by importing the necessary libraries that I would need for constructing the graphs for the entire project. Then I began constructing simple line plots. The first line plot demonstrates how to plot multiple sets of data on the same graph and how to annotate the graph and change the line styles and colors using appropriate parameters. Figure ## below shows the code and the output graph.

Figure and Code

To further demonstrate how to annotate a graph, I isolated the line plot for infected. Then I added a dashed vertical line along with the peak value to represent on the graph the peak infection day. Figure ## shows the code and output plot.

Figure and Code

I decided to run the Monte Carlo simulation. I made a scatter plot for this data to show the number of final infected individuals for each simulation number. Figure ## shows the code along with the resulting plot.

Figure and Code

Though the scatter plot was a good representation of the data, I felt that a histogram would be a better visual to display the frequency of the final infected individuals after each simulation.

Figure and Code

To demonstrate working with a 3D contour plot, I use the original SIR model and plot the relationship between the infected and recovered over time. Figure ## shows the code and the resulting plot. From this plot we are able to visualize the dynamics of disease spread. With this plot we can see how the number of infected and recovered individuals changes over time simultaneously.

Figure and Code

The SIR model is an excellent tool to simulate and learn about disease spread. Though it is limited, it is still widely used in the real world to model infections and in classroom environments to teach differential equations. For a fun experiment, I wanted to create a more interactive graph that would allow the user to have more control to explore the different parameters. For this, I imported the interact, Float slider, IntSlider, and BoundedIntText from iPywidgets. I constructed a new function that would be used to call the SIR model and update its values as parameters change. Figure ## shows the code and the output.

Figure and Code

Another important concept in studying parameter relationships in differential equations is the trajectory plot also known as the phase plot plane.

Figure and Code

# 3. Adapting Movie Analysis Model for Visualization

# 4. Conclusion

This report documents my journey in learning Pandas, a powerful data manipulation library in Python. Key concepts I explored include data structures essential for handling and analyzing structured data. I learned to perform various data operations, including data indexing, merging datasets, grouping data and more.

By using real data, I was able to explore how to go about cleaning the data up properly before beginning to analyze it. Many errors I encountered were related to missing values and data types, which are significantly different from syntax errors I encountered in previous projects. However, through practice and persistence, I was able to clean the data up and obtain datasets that could be analyzed properly using Pandas.

# References

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