

SSIE-500: Homework 1 - My First L^AT_EX Report

Rahul Balamurugan

rb@binghamton.edu

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1 Introduction

The report is a basic documentation of the various platforms that we have explored and played with. We are going to explore L^AT_EX, Mathematica, R, Python, and Julia.

2 L^AT_EX

This section discusses L^AT_EX and includes screenshots of various computational tools. L^AT_EX is a document preparation system mainly used for high-quality typesetting.

1. Downloading L^AT_EX

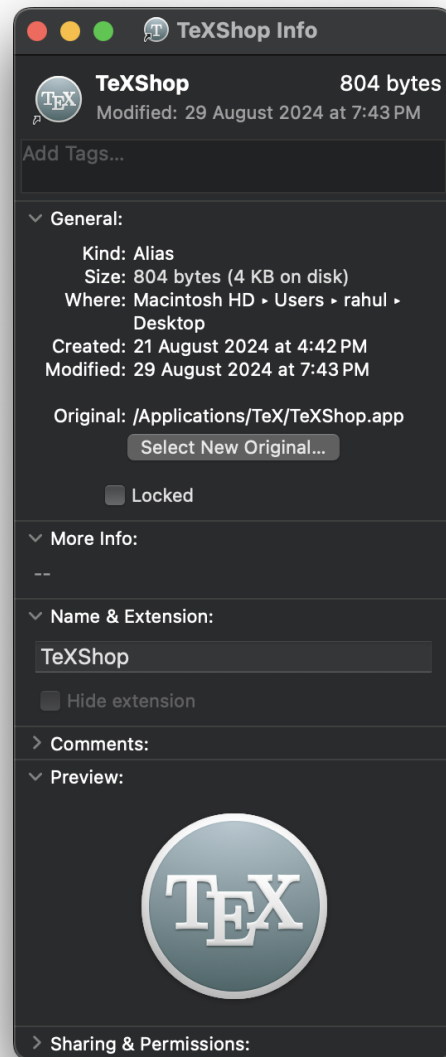


Figure 1: The path information of the L^AT_EX download

- **For macOS:** Install MacTeX from the following link: [MacTeX Download Page](#).
- **For Windows:** Install MiKTeX from the following link: [MiKTeX Download Page](#).

2. Creating L^AT_EX Document

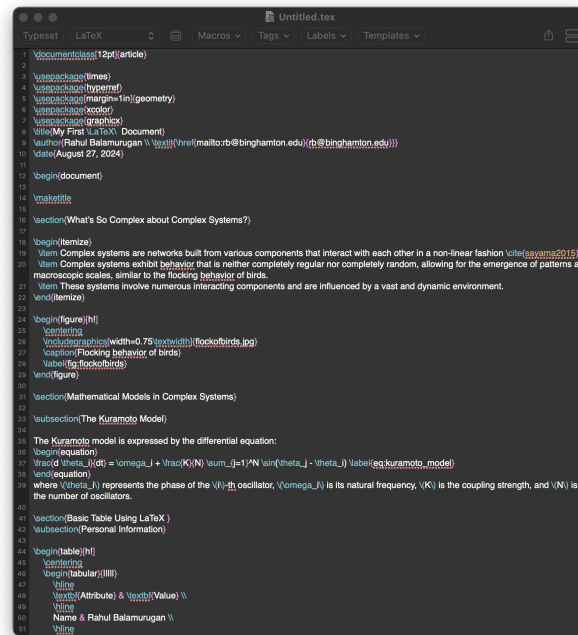


Figure 2: The `LATEX Document 1.png` image showing the initial commands.

The image above showcases a \LaTeX document created with a title, author, and date. It includes an itemized list discussing complex systems and uses several packages to enhance functionality and formatting. The references are added to the document using the `\cite` function, and there is a hyperlink where the email ID is reflected.

3. Importing Image into L^AT_EX

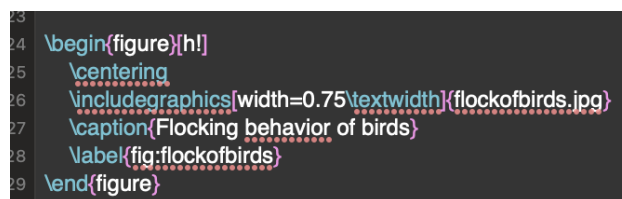


Figure 3: The LaTeX Document 2.png shows how to import an image into LaTeX.

The image showcases the command for alignment and adding a caption to the imported image along with the size in terms of width. It's an image of a flock of birds that represents how I view complex systems.

4. How does the Output look

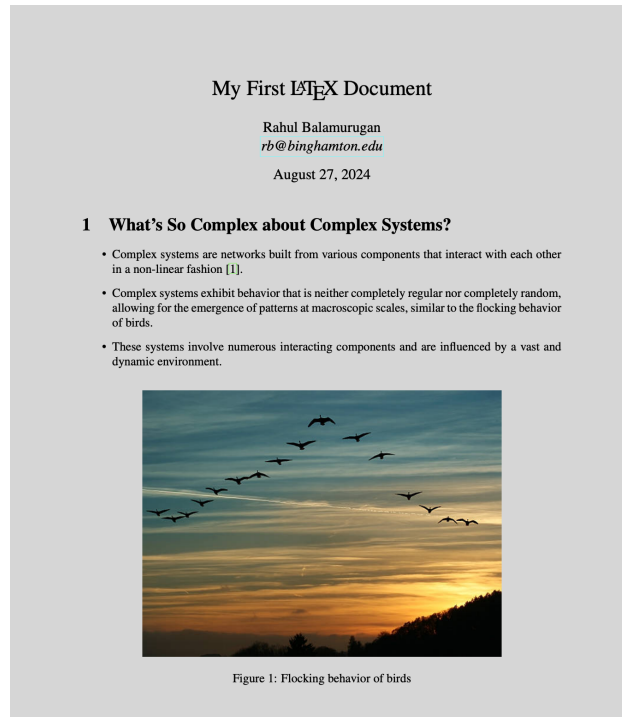


Figure 4: The above image shows the look of the overall output discussed so far.

5. Mathematics and Tables using L^AT_EX

```
31 \section{Mathematical Models in Complex Systems}
32
33 \subsection{The Kuramoto Model}
34
35 The Kuramoto model is expressed by the differential equation:
36 \begin{equation}
37 \frac{d\theta_i}{dt} = \omega_i + K \sum_{j=1}^N \sin(\theta_j - \theta_i) \label{eq:kuramoto_model}
38 \end{equation}
39 where  $\theta_i$  represents the phase of the  $i$ -th oscillator,  $\omega_i$  is its natural frequency,  $K$  is the coupling strength, and  $N$  is
40 the number of oscillators.
41 \section{Basic Table Using LaTeX}
42 \subsection{Personal Information}
43
44 \begin{table}[ht]
45 \centering
46 \begin{tabular}{ll}
47 \textbf{Attribute} & \textbf{Value} \\
48 \hline
49 Name & Rahul Balamurugan \\
50 \hline
51 B-Number & B01103043 \\
52 \hline
53 City & Binghamton \\
54 \hline
55 Place of Birth & Vellore \\
56 \hline
57 \end{tabular}
58 \caption{Personal Information}
59 \label{tab:personal_info}
60 \end{table}
61
62
63 \newpage
64
65 \bibliographystyle{plain}
66 \bibliography{my-reference}
67
68 \end{document}
```

Figure 5: The above image showcases the second half of the L^AT_EX document created, which includes math and tables.

The equation environment centers the equation on its own line and automatically numbers it. This helps in presenting the equation clearly and allows you to refer to it easily later in your document. The fractions, summations, and labeling are included accordingly. The table values are assigned using the begin command which initiates the table environment as shown above.

6. Reference using \LaTeX (Output)

As shown in the previous image there is a citation of Dr. Hiroki Sayama's book.

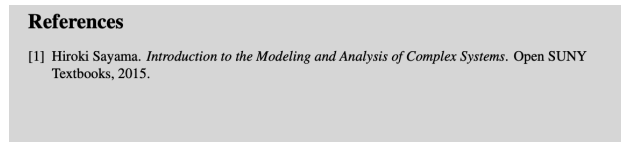


Figure 6: The image shows the reference page.

This is an outcome of the cite function used beside the content which was cited along with the BibTeX reference used by utilizing the bibliography function.

3 Python (Anaconda)

This section discusses the Python Programming Language in Anaconda's Jupyter environment and includes screenshots.

1. Downloading Anaconda Navigator and Jupyter Notebook Anaconda Navigator Download page.

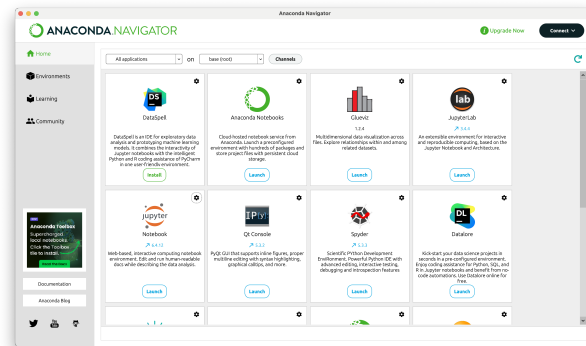


Figure 7: Anaconda Navigator Home Page

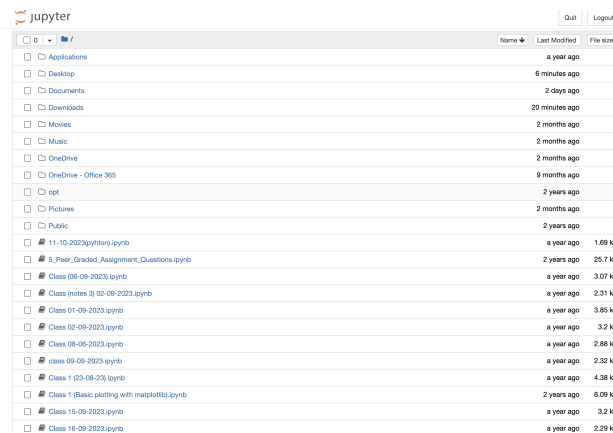


Figure 8: Jupyter Notebook home page

2. Python Initial Coding

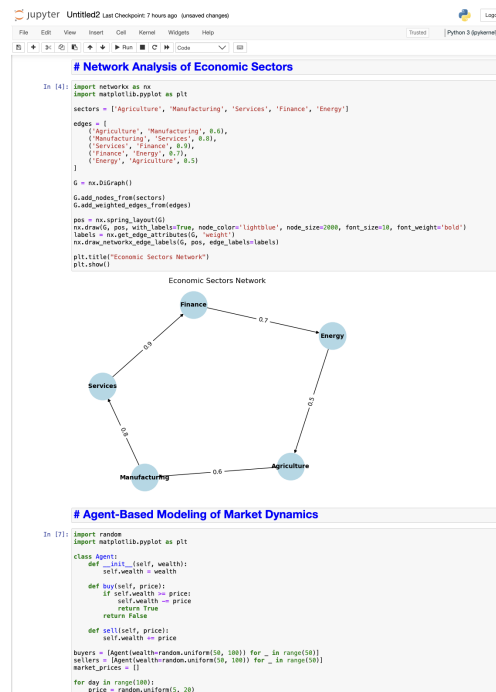


Figure 9: Network Analysis of Economic Sectors using Python

This Python code creates a directed graph of economic sectors by providing weights to it and visualizing the connections.

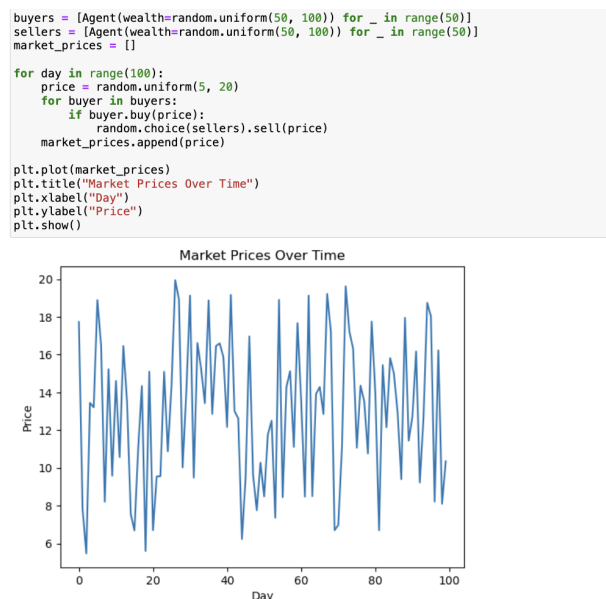


Figure 10: Agent-Based Modeling of Market Dynamics

This code simulates a simple market where buyers and sellers trade on prices that are generated randomly over 100 days in a dynamic manner; and it has been plotted, also has used various loops utilizing Python in the Jupyter Notebook.

4 Mathematica

- This section explains Mathematica which is a computational software used for various purposes in many fields.
- You can Download Mathematica from Wolfram for Mathematica.

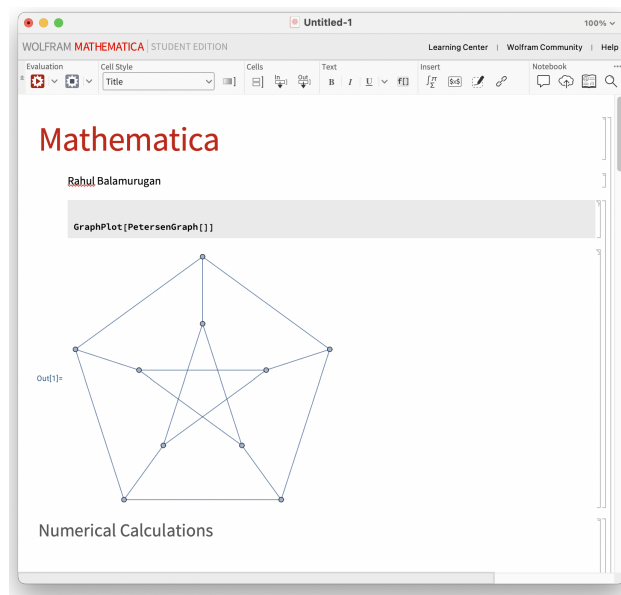


Figure 11: Shows the initial function used in Mathematica

The above diagram shows the Graphplot function used in the Petersen graph and its output.

3. Basic Mathematics

```

In[37]:= (*Basic Arithmetic*)
a = 5 + 3
b = 10 - 4
c = 7 * 2
d = 16 / 4

(*Solving Equations*)
eq = x^2 + 3 x + 2 == 0;
sol = Solve[eq, x]

(*Numerical Integration*)
f[x_] := Sin[x] + x^2;
integral = NIntegrate[f[x], {x, 0, 5}]

(*Numerical Differentiation*)
diff = D[f[x], x] /. x -> 2

(*Matrix Operations*)
mat1 = {{1, 2}, {3, 4}};
mat2 = {{5, 6}, {7, 8}};
matProduct = mat1.mat2
matInverse = Inverse[mat1]
matDet = Det[mat1]

(*Finding Numerical Solutions*)
eq2 = x^3 - 7 x + 6 == 0;
numericalSol = NSolve[eq2, x]

(*Finding Roots of a Function*)
root = FindRoot[x^3 - 7 x + 6 == 0, {x, 2}]

Out[37]= 8
Out[38]= 6
Out[39]= 14
Out[40]= 4

```

Figure 12: Shows mathematical functions used in Mathematica

The above image shows the various mathematical functions that can be performed in Mathematica Software such as basic arithmetic, integration, matrix and more!

4. Science using Mathematica

Science using Mathematica

Chemistry

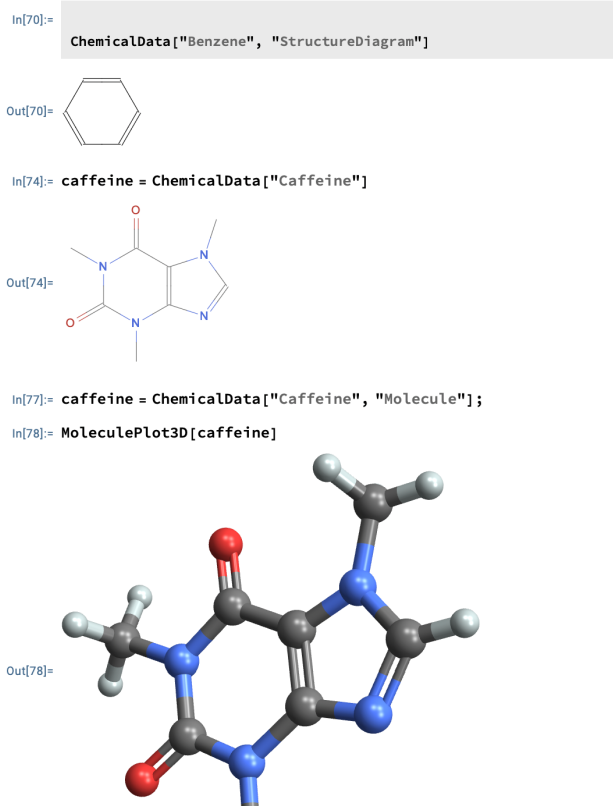


Figure 13: Shows how Mathematica can be utilized in the field of Chemistry

The command used in Mathematica showcased the molecular structure of Benzene and 3D plotting of Caffeine's molecular structure.

5. Can we also Integrate Audio? The answer is YES! :)

Here we can see how it's done

Audio



Figure 14: How Audio can be integrated with Mathematica and analyzed

Import the audio file into Mathematica, use the Audio Plot function to visualize the sound waves of the audio, then use sample rate and length functions to check the frequency and length of the audio.

5 R Programming (Rstudio)

R Programming Language is the apt tool for statistical computation.

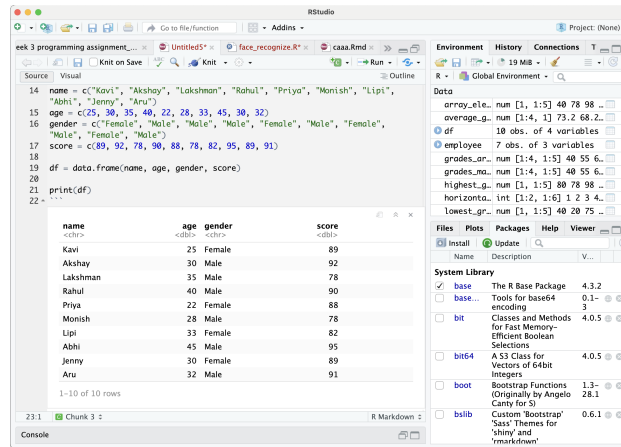


Figure 15: R sample coding in RStudio environment

The above figure shows the creation of a dataframe with name, age, gender, and score using R. There are 10 records; the dataframe has duplicate values for age and score.

6 Julia

The aim of Julia is to create a high-level programming language that is generic and clear.

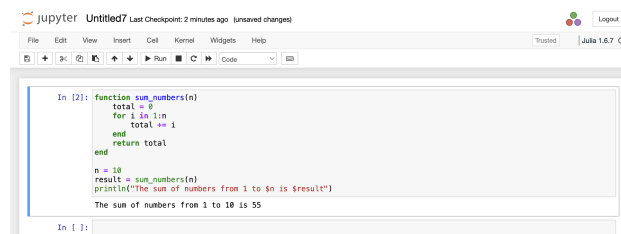


Figure 16: Sample code for Julia Programming language

The program calculates the sum of all numbers from 1 up to a specified number n . This was done using the Julia Programming language.

7 Conclusion

This report has utilized \LaTeX for the documentation of the report to explore the initial stages of downloading and exploring \LaTeX , Python, R, Mathematica, and Julia. Each tool provides distinct features, contributing to effective data analysis and comprehensive documentation.