SEMESTER-VI

COURSE 14 B: DATA VISUALIZATION TOOLS

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

- Understand the foundations and effective principles of data visualization.
- Learn to build visualizations using Python's ecosystem.
- Gain proficiency in R's ggplot2 for rich and layered data visualization.
- Understand Tableau for building intuitive, shareable dashboards.
- Apply tools in real-world data scenarios for exploration and insight.

Course Outcomes:

At the end of the course the Students will be able to:

- Analyze and critique data visualizations for effectiveness and ethical integrity.
- Develop static and interactive plots to analyze datasets.
- Construct customized visualizations with ggplot2.
- Create interactive visual stories using Tableau.
- Demonstrate complete visualization workflows from raw data to insight.

Unit 1. Fundamentals of Data Visualization:
Importance of visualization in data science,Types of data (categorical, numerical, time-series, geospatial), Chart types: bar, line, histogram, box plot, heatmaps, maps, Design principles: clarity, simplicity, integrity, aesthetics, Misleading visualizations and ethical considerations

Unit 2. Data Visualization Using Python:
Introduction to matplotlib: plots, customization, styling, Seaborn for statistical data , visualization, Plotly for interactive charts and dashboards, Advanced plots: pairplots, violin plots, heatmaps, time-series plots, Integrating visualizations in Jupyter and web apps

Unit 3. Data Visualization Using R (ggplot2):
Introduction to ggplot2 grammar of graphics,Aesthetics, geometries, scales, themes,Faceting and layering techniques,Visualizing categorical and numerical data, Customizing and exporting plots

Unit 4. Basics of Tableau:
Tableau basics: interface, data connection, Charts, filters,

Aggregation, Calculated values and table calculations, Using the calculation dialog box to create, Building formulas using table calculations, Using table calculation functions.

Unit 5. Interactive Dashboards with Tableau:
Maps, tooltips, and trendlines, generating new data with forecasts, Storytelling with dashboards, providing self evidence adhoc analysis with parameters, Editing views in tableau Server, Publishing and sharing reports

Text Books

1. Data Visualization: A Practical Introduction, Kieran Healy, Princeton University Press, 2019.
2. Learning Tableau 2022, Ben Jones, Packt Publishing, 2022.
3. Python Data Science Handbook, Jake VanderPlas, 2nd Edition, O'Reilly, 2022.

Reference Books

1. Fundamentals of Data Visualization, Claus Wilke, O'Reilly, 2019.
2. Better Data Visualizations, Jonathan Schwabish, Columbia University Press, 2021.
3. ggplot2: Elegant Graphics for Data Analysis, Hadley Wickham, Springer, 3rd Edition, 2023.
4. Tableau eLearning & Public Gallery Resources (https://public.tableau.com)

Activities:

CO1: Analyze and critique data visualizations for effectiveness and ethical integrity

Activity:
Conduct a **visualization audit and critique assignment**. Students select a set of published visualizations (from news, dashboards, or social media) and analyze their design effectiveness, ethical considerations (e.g., misleading visuals, omitted context), and audience impact.

Evaluation Method:

Rubric-based assessment for depth of critique, identification of ethical flaws, clarity of reasoning, and suggestions for improvement - scored on a 10-point scale.

CO2: Develop static and interactive plots to analyze datasets

Activity:
Interactive lab + peer showcase - students create a combination of static (e.g., matplotlib/seaborn) and interactive (e.g., Plotly) plots for a real dataset. Then, participate in a **gallery walk** where students view each other's work and provide structured peer feedback using a guided rubric.
Evaluation Method:

Rubric includes technical accuracy, interactivity, design quality, peer feedback contribution, and clarity of explanation - scored out of 10.

CO3: Construct customized visualizations with ggplot2

Activity:
Mini project in R using ggplot2 - students work on a domain-based dataset (e.g., environmental, healthcare, or education) and apply advanced ggplot2 features like custom themes, annotations, faceting, scales, and coordinate systems to convey insights.

Evaluation Method:

Rubric-based code review and visualization quality evaluation (design, customization, clarity of message) - scored on a 10-point scale.

CO4: Create interactive visual stories using Tableau

Activity:
Storyboarding + Tableau design - students first sketch a **storyboard** outlining the flow of their data story (with objectives, key visuals, and user interaction paths), and then implement the story in Tableau using dashboards and interactive filters.

Evaluation Method:

Rubric evaluates storyboard planning, narrative flow, interactivity, design consistency, and insightfulness - scored on a 10-point scale.

CO5: Demonstrate complete visualization workflows from raw data to insight

Activity:
Capstone visualization project - students select a dataset of interest, perform data cleaning, transformation, EDA, and build a complete multi-tool workflow (e.g., preprocessing in Python, visualization in Tableau/R). They then **present their insights in a recorded video or classroom seminar**.
Evaluation Method:

Rubric includes workflow completeness, tool integration, clarity of insights, storytelling effectiveness, and presentation quality - evaluated on a 10-point scale.

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Practical **Credits: 1** **2 hrs/week**

List of Practicals

1. Use matplotlib to generate line, bar, pie, and scatter graphs.
2. Use Seaborn on statistical data visualization.
3. Implement interactive charts and dashboards using Plotly.
4. Generate pairplots, violin plots, heatmaps, time-series plots for data visualization.
5. Generate scatter graph , bar graph, and histogram using ggplot2.
6. Visualize categorical and numerical data using R.
7. On a sample data set(eg., Supermarket / Showroom spread across the states),
    a. Create visualizations
        i. Bar chart showing Sales by Region.
        ii. Line chart of Profit over time.
        iii. Add filters (e.g., by Category or Year).
    b. Aggregations
        i. Use SUM, AVG, and COUNT aggregations.
        ii. Show totals and subtotals on the chart.
    c. Deliverables
        i. Dashboard with at least two charts and interactive filters.
8. Implement the following inTableau
    a. Create Calculated fields like profit ratio
    b. Use Table Calculation functions like RUNNING_SUM(), WINDOW_AVG(), or RANK().
    c. Worksheet showing
        i. Calculated fields in use
        ii. Table calculation in a visualization (e.g., trend chart)
        iii. Proper labels and tooltips
9. Mini-project: Create dashboard for Semester Results Analysis using Python or R.