Interactive Visualization with Plotly.

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1   Learning Objectives.

1. **Data Exploration & Analytical Thinking:**

   - Students will be able to load, inspect, and interpret multi-dimensional datasets (like the World Happiness Index), identify key indicators, and formulate meaningful research questions relating to well-being and socio-economic development.

2. **Visualization Skills (Static & Interactive):**

   - Students will be able to create publication-quality static visualizations using Matplotlib/Seaborn and interactive, exploratory visualizations using Plotly, including bubble charts, parallel coordinates plots, and dynamic bar charts with dropdowns/sliders.

   - They will learn to choose appropriate visualization types to highlight patterns, trends, and correlations in data.
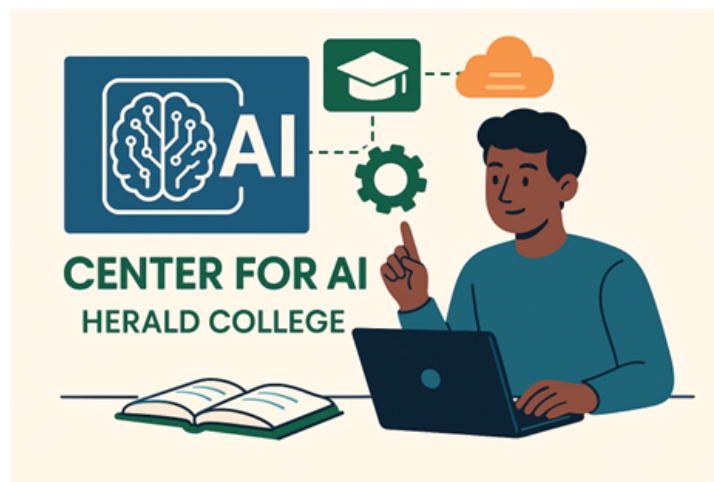

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2 Data Visualization Worksheet: World Happiness Index.

2.1 Part A: Data Familiarization.

1. **Dataset Overview:**

   - Load the dataset (CSV).
   - Inspect the first 10 rows.

2. **Questions:**

   - What variables are available?
     - For example: `"Country name", "score", "Log GDP per capita" etc.`
   - What do these variables measure?
   - Which two indicators besides **score** might be most important for understanding happiness?

2.2 Part B: Static Visualizations (Matplotlib/Seaborn):

1. **Country Comparison:**

   - Plot the top 10 countries by Happiness Score.
   - **Q: Which country ranks highest, and which lags behind?**

2. **Variable Comparison:**

   - **Q: Which countries achieve higher happiness relative to their life expectancy, and which ones under-perform compared to expectations?**
   - For example, choose two indicators (e.g., Happiness Score vs Healthy life expectancy) and compare how different countries position themselves on these dimensions.

3. **Distribution:**

   - **Q: Are countries mostly clustered around average values, or are there sharp differences between the happiest and least happy?**
   - **Hint:** Plot the distribution of Happiness Scores across all countries.

4. **Correlation (Scatterplot + Regression):**

   - **Q: Is there evidence that wealthier countries are also happier?**
   - **Hint:** Plot Log GDP per capita (x-axis) vs Happiness Score (y-axis) and Add a regression line.

2.3 Part C: Interactive Visualizations (Plotly):

1. **Interactive Bubble Chart:**

    - **Q: Do wealthier countries with higher life expectancy also report higher happiness?**
    - **Hint:**
        - `"X-axis = Log GDP per capita"`
        - `"Y-axis = Happiness Score"`
        - `"Bubble size = Healthy life expectancy"`
        - `"Bubble color = Social support"`
        - `"Hover = country name"`

2. **Interactive Bar Chart with Dropdown:**

    - **Q: Which variable shows the strongest differences between countries?**
    - **Hint:**
        - Horizontal bar chart of Happiness Score.
        - Add dropdown to switch x-axis variable (GDP, Freedom, Life expectancy, etc.).

3. **Interactive Radar/Spider Plot (Grouped):**

    - **Q: How do Nordic countries differ from Middle Eastern or Asian countries in happiness dimensions?**
    - **Hint:**
        - Use `plotly.express.line_polar` or `go.Scatterpolar`.
        - Compare two or more countries across indicators (GDP, social support, freedom, etc.).
        - Students can build a dropdown to choose which countries to compare.

4. **Interactive Scatter Matrix (Plotly scatter_matrix):**

    - **Q: Which variables show the strongest relationship with happiness?**
    - **Hint:**
        - Shows pairwise scatterplots between multiple variables (score, GDP, social support, etc.).
        - Users can hover to see country points.

3   Open - Ended Exploration and Dashboard (Mini - Project).

1. **Research Question:**

   - Formulate your own research-style question using the World Happiness dataset.
   - **Examples:**
     - How do happiness-related indicators (e.g., life expectancy, social support) vary between high-income and low-income countries?
     - Which countries perform best in social support relative to GDP per capita?
     - Is there a link between healthy life expectancy and happiness across regions?

2. **Visualization Requirements:**

   - **Static Plots with Matplotlib/Seaborn:**
     - Create at least two static plots.
     - **Examples:**
       (a) Bar chart of top/bottom 10 countries by a selected indicator.
       (b) Scatter or line plot comparing two variables or trends for selected countries.
   - **Interactive Plots (Plotly):**
     - Create at least two interactive plots.
     - **Examples:**
       * Bubble chart of GDP vs Happiness Score with bubble size for life expectancy.
       * Parallel coordinates plot of multiple indicators with hover for country names.
       * Scatterplot with dropdown filter for choosing variables or regions.

3. **Build a Dashboard (Dash):**

   - **Setup:**
     - Create a Dash app (dash and optionally dash_bootstrap_components).
     - Use a clean layout with rows and columns.
   - **Embed Static Plots:**
     - Save Matplotlib/Seaborn figures as .png images.
     - Display them in the dashboard using html.Img(src=...).
   - **Embed Interactive Plots:**
     - Directly insert Plotly figures using dcc.Graph(figure=...).
   - **Add Interactivity:**
     - Dropdowns or sliders to select:
       * Year (if multi-year data)
       * Country or region
       * Indicator/variable
     - Optional: Tabs or buttons to switch between different indicators or plots.

4. **Deliverable:**

- Fully functional dashboard that combines static and interactive plots.
- Written interpretation of insights from the dashboard (3–5 sentences).

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