Object-Oriented Matplotlib Challenge

Mastering the Four Stages of Data Visualization

Object-Oriented Matplotlib Challenge - The Four Stages of Data Visualization

> **!** Challenge Requirements
>
> - Complete all discussion questions for the four stages of visualization
> - Create professional visualizations using object-oriented matplotlib
> - Demonstrate mastery of the Grammar of Graphics
> - See Student Analysis Section for detailed requirements

The Problem: Mastering Object-Oriented Matplotlib Through the Four Stages

Core Question: How can we create compelling, professional data visualizations using object-oriented matplotlib and the four stages of visualization?

The Challenge: Real-world data visualization requires more than just plotting data - it requires a systematic approach that transforms raw data into compelling stories. The four stages framework provides a proven methodology for creating visualizations that inform, persuade, and inspire action.

Our Approach: We'll work with baseball stadium data to investigate whether Coors Field in Denver, Colorado is truly the most run-friendly ballpark in Major League Baseball. This investigation will take us through all four stages of visualization, demonstrating object-oriented matplotlib techniques along the way.

> ⚠ AI Partnership Required
>
> This challenge pushes boundaries intentionally. You'll tackle problems that normally require weeks of study, but with Cursor AI as your partner (and your brain keeping it

honest), you can accomplish more than you thought possible.
The new reality: The four stages of competence are Ignorance → Awareness → Learning → Mastery. AI lets us produce Mastery-level work while operating primarily in the Awareness stage. I focus on awareness training, you leverage AI for execution, and together we create outputs that used to require years of dedicated study.

The Four Stages of Data Visualization

The four essential stages for creating effective visualizations are:

1. **Stage 1: Declaration of Purpose** - Define your message and audience
2. **Stage 2: Curation of Content** - Gather and create all necessary data
3. **Stage 3: Structuring of Visual Mappings** - Choose geometry and aesthetics
4. **Stage 4: Formatting for Your Audience** - Polish for professional presentation

Data and Business Context

We analyze Major League Baseball stadium data to investigate whether Coors Field in Denver, Colorado is truly the most run-friendly ballpark. This dataset is ideal for our analysis because:

- **Real Business Question:** Sports analysts and fans want to understand stadium effects on scoring
- **Clear Hypothesis:** High altitude should make Coors Field more run-friendly
- **Multiple Metrics:** We can analyze both total runs and home runs
- **Visualization Practice:** Perfect for demonstrating all four stages of visualization

Data Loading and Initial Exploration

Let's start by loading the baseball data and understanding what we're working with.

```
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
import seaborn as sns

# Load 2010 baseball season data
df2010 = pd.read_csv("baseball10.csv")

# Load 2021 baseball season data for comparison
```

```
df2021 = pd.read_csv("baseball21.csv")

print("2010 data shape:", df2010.shape)
print("2021 data shape:", df2021.shape)
print("\n2010 data columns:", df2010.columns.tolist())
print("\nFirst few rows of 2010 data:")
print(df2010.head())
```

```
2010 data shape: (2430, 7)
2021 data shape: (2429, 7)

2010 data columns: ['date', 'visiting', 'home', 'visScore', 'homeScore', 'visHR', 'homeHR']

First few rows of 2010 data:
       date visiting home  visScore  homeScore  visHR  homeHR
0  20100404      NYA  BOS         7          9      2       1
1  20100405      MIN  ANA         3          6      1       3
2  20100405      CLE  CHA         0          6      0       2
3  20100405      DET  KCA         8          4      0       1
4  20100405      SEA  OAK         5          3      1       0
```

> **Understanding the Data**
>
> **Baseball Game Data:** Contains information about each game, including: - `home`: Home team (3-letter code) - `visiting`: Visiting team (3-letter code) - `homeScore`: Runs scored by home team - `visScore`: Runs scored by visiting team - `homeHR`: Home runs by home team - `visHR`: Home runs by visiting team - `date`: Game date
> **Business Questions We'll Answer:** 1. Is Coors Field (COL) the most run-friendly ballpark in 2010? 2. How does this change in 2021? 3. What's the difference between total runs and home runs by stadium?

Stage 1: Declaration of Purpose

Mental Model: Start with a clear message and bold title that states your recommendation.

Our purpose is to investigate whether Coors Field in Denver, Colorado is truly the most run-friendly baseball stadium in Major League Baseball.

> ! Discussion Questions: Stage 1 - Declaration of Purpose
>
> **Question 1: Hypothesis Formation** - Why might high altitude affect baseball performance? Is Coors Field affected by high altitude?

Stage 2: Curation of Content

Mental Model: Gather and create all the data you need to support your message.

Let's aggregate the data to get average runs per stadium:

```
# Stage 2: Curation of Content
# Aggregate data to get average runs per stadium

# Process 2010 data
avgDF_2010 = (df2010
    .assign(totalRuns = lambda df: df.homeScore + df.visScore)
    .assign(totalHR = lambda df: df.homeHR + df.visHR)
    .drop(columns = ['date', 'visiting'])
    .groupby(['home'], as_index=False)
    .mean()
)

# Process 2021 data
avgDF_2021 = (df2021
    .assign(totalRuns = lambda df: df.homeScore + df.visScore)
    .assign(totalHR = lambda df: df.homeHR + df.visHR)
    .drop(columns = ['date', 'visiting'])
    .groupby(['home'], as_index=False)
    .mean()
)

print("2010 Stadium Averages (Top 5):")
print(avgDF_2010.head())
print("\n2021 Stadium Averages (Top 5):")
print(avgDF_2021.head())
```

```
2010 Stadium Averages (Top 5):
  home  visScore  homeScore     visHR    homeHR  totalRuns   totalHR
0  ANA  3.975309   3.938272  0.839506  0.851852   7.913580  1.691358
1  ARI  5.049383   4.740741  1.271605  1.209877   9.790123  2.481481
```

```
2  ATL  3.641975   4.827160  0.740741  0.913580   8.469136  1.654321
3  BAL  5.111111   3.975309  1.308642  0.888889   9.086420  2.197531
4  BOS  4.851852   5.172840  0.876543  1.209877  10.024691  2.086420

2021 Stadium Averages (Top 5):
  home  visScore  homeScore     visHR    homeHR  totalRuns   totalHR
0  ANA  4.925926   4.703704  1.283951  1.296296   9.629630  2.580247
1  ARI  5.456790   4.555556  1.246914  0.851852  10.012346  2.098765
2  ATL  4.400000   5.050000  1.200000  1.450000   9.450000  2.650000
3  BAL  6.259259   4.469136  1.913580  1.506173  10.728395  3.419753
4  BOS  4.962963   5.802469  1.111111  1.333333  10.765432  2.444444
```

! Discussion Questions: Stage 2 - Curation of Content

Question 1: Data Aggregation Strategy - How many games are in the dataset? Why do we aggregate individual games into stadium averages before we start the visualization process?

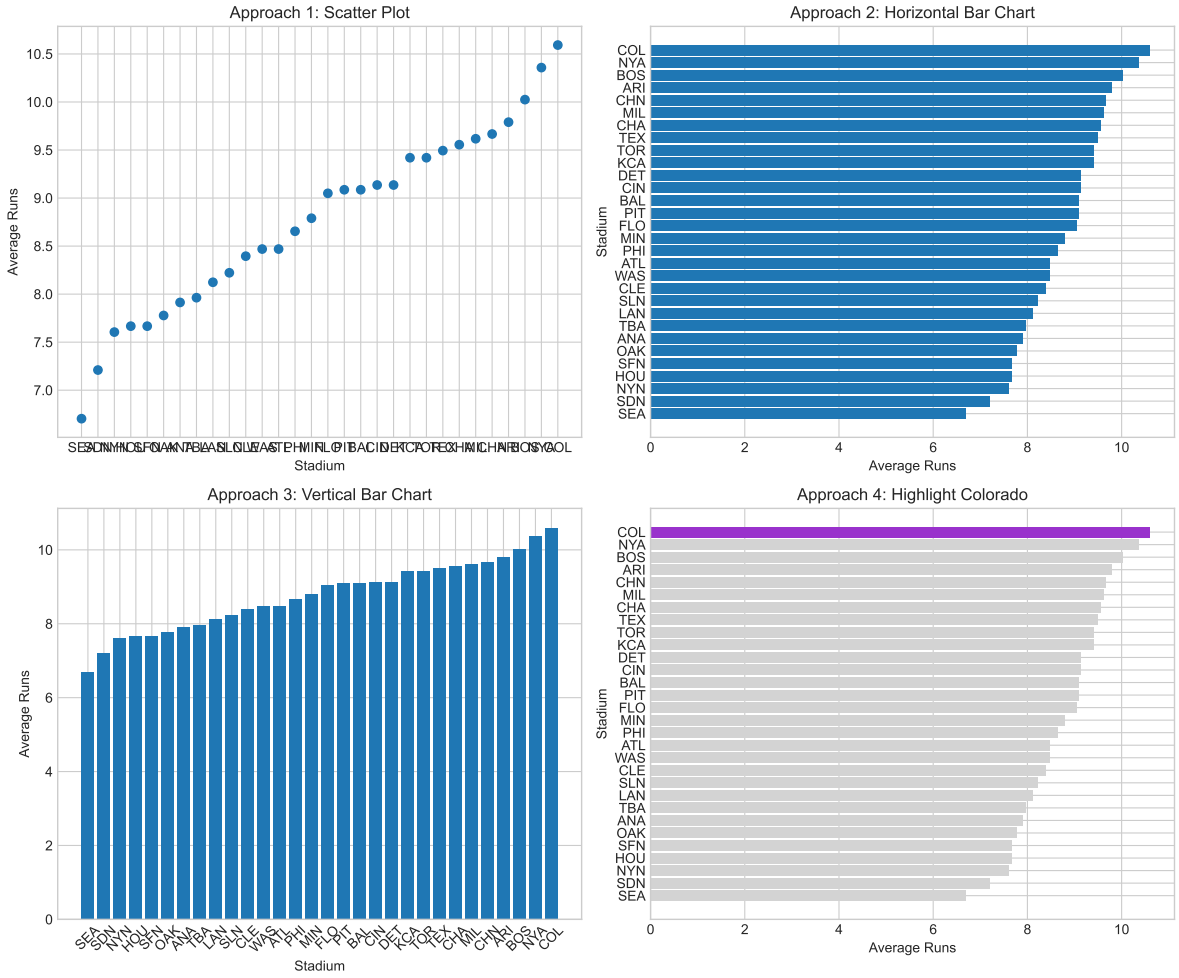
Stage 3: Structuring of Visual Mappings

Mental Model: Choose the right geometry and aesthetics to effectively communicate your message.

Let's explore different visual approaches:

```
# Stage 3: Structuring of Visual Mappings
# Explore different geometries and aesthetics

# Sort data for better visualization
avgDF_2010_sorted = avgDF_2010.sort_values('totalRuns', ascending=True)

# Create figure with subplots to compare approaches
fig, axes = plt.subplots(2, 2, figsize=(12, 10))

# Approach 1: Scatter plot (not ideal for categorical data)
axes[0,0].scatter(avgDF_2010_sorted.home, avgDF_2010_sorted.totalRuns)
axes[0,0].set_title("Approach 1: Scatter Plot")
axes[0,0].set_xlabel("Stadium")
axes[0,0].set_ylabel("Average Runs")

# Approach 2: Horizontal bar chart (better for categorical data)
axes[0,1].barh(avgDF_2010_sorted.home, avgDF_2010_sorted.totalRuns)
```

```
axes[0,1].set_title("Approach 2: Horizontal Bar Chart")
axes[0,1].set_xlabel("Average Runs")
axes[0,1].set_ylabel("Stadium")

# Approach 3: Vertical bar chart
axes[1,0].bar(avgDF_2010_sorted.home, avgDF_2010_sorted.totalRuns)
axes[1,0].set_title("Approach 3: Vertical Bar Chart")
axes[1,0].set_xlabel("Stadium")
axes[1,0].set_ylabel("Average Runs")
axes[1,0].tick_params(axis='x', rotation=45)

# Approach 4: Highlight Colorado
colorado_colors = ["darkorchid" if stadium == "COL" else "lightgrey"
                   for stadium in avgDF_2010_sorted.home]
axes[1,1].barh(avgDF_2010_sorted.home, avgDF_2010_sorted.totalRuns, color=colorado_colors)
axes[1,1].set_title("Approach 4: Highlight Colorado")
axes[1,1].set_xlabel("Average Runs")
axes[1,1].set_ylabel("Stadium")

plt.tight_layout()
plt.show()
```



! Discussion Questions: Stage 3 - Structuring of Visual Mappings

Question 1: Geometry Choices - Why is a horizontal bar chart better than a scatter plot for this data? - When would you choose a vertical bar chart over horizontal?
Question 2: Aesthetic Mappings - What does the color highlighting accomplish in Approach 4? - How does position (x/y) compare to color for encoding data?

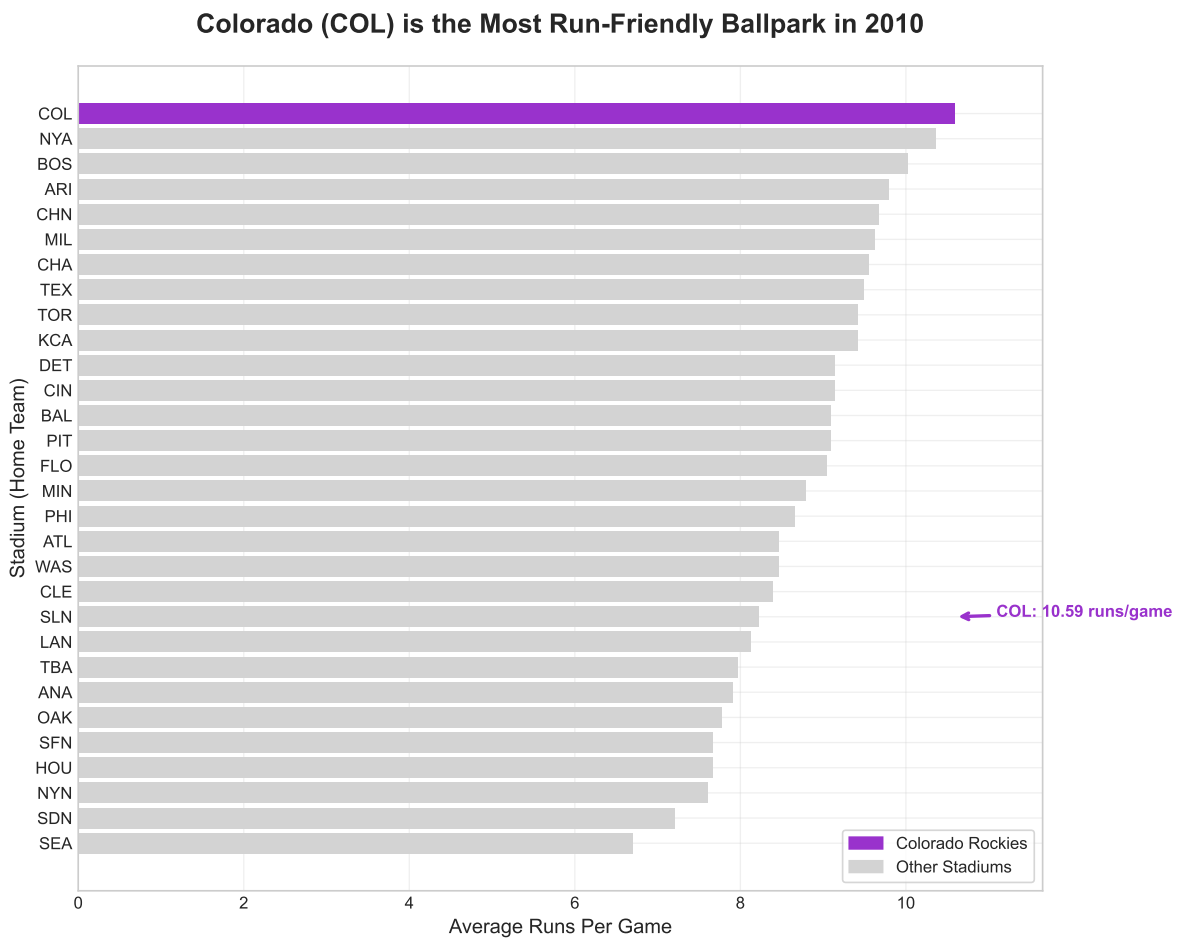
Stage 4: Formatting for Your Audience

Mental Model: Polish your visualization for professional presentation.

Let's create a publication-ready visualization:

```
# Stage 4: Formatting for Your Audience
# Create a professional, publication-ready visualization

# Set style for professional appearance
plt.style.use("seaborn-v0_8-whitegrid")

# Create the main visualization
fig, ax = plt.subplots(figsize=(10, 8))

# Create color array for highlighting Colorado
colorado_colors = ["darkorchid" if stadium == "COL" else "lightgrey"
                   for stadium in avgDF_2010_sorted.home]

# Create horizontal bar chart
bars = ax.barh(avgDF_2010_sorted.home, avgDF_2010_sorted.totalRuns, color=colorado_colors)

# Add title and labels
ax.set_title("Colorado (COL) is the Most Run-Friendly Ballpark in 2010",
             fontsize=16, fontweight='bold', pad=20)
ax.set_xlabel("Average Runs Per Game", fontsize=12)
ax.set_ylabel("Stadium (Home Team)", fontsize=12)

# Add legend
colorado_bar = plt.Rectangle((0,0),1,1, color="darkorchid", label="Colorado Rockies")
other_bar = plt.Rectangle((0,0),1,1, color="lightgrey", label="Other Stadiums")
ax.legend(handles=[colorado_bar, other_bar], loc='lower right', frameon=True)

# Add annotation for Colorado
colorado_index = avgDF_2010_sorted[avgDF_2010_sorted.home == "COL"].index[0]
colorado_runs = avgDF_2010_sorted[avgDF_2010_sorted.home == "COL"]["totalRuns"].iloc[0]
ax.annotate(f"COL: {colorado_runs:.2f} runs/game",
            xy=(colorado_runs, colorado_index),
            xytext=(colorado_runs + 0.5, colorado_index),
            arrowprops=dict(arrowstyle='->', color='darkorchid', lw=2),
            fontsize=10, fontweight='bold', color='darkorchid')

# Set x-axis to start from 0 for better comparison
ax.set_xlim(0, max(avgDF_2010_sorted.totalRuns) * 1.1)

# Add grid for easier reading
ax.grid(True, alpha=0.3)
```

```
plt.tight_layout()
plt.show()

# Print summary statistics
print(f"\nSummary Statistics for 2010:")
print(f"Colorado (COL) average runs per game: {colorado_runs:.2f}")
print(f"League average runs per game: {avgDF_2010_sorted.totalRuns.mean():.2f}")
print(f"Colorado is {((colorado_runs / avgDF_2010_sorted.totalRuns.mean()) - 1) * 100:.1f}% a
```




```
Summary Statistics for 2010:
Colorado (COL) average runs per game: 10.59
League average runs per game: 8.77
Colorado is 20.8% above league average
```

> **!** Discussion Questions: Stage 4 - Formatting for Your Audience
>
> **Question 1: Professional Formatting** - What elements make this visualization suitable for a business presentation? - How does the color scheme and layout guide the viewer's attention?

Advanced Object-Oriented Techniques

Mental Model: Use object-oriented matplotlib to create complex, reusable visualizations.

Let's create a comprehensive comparison between 2010 and 2021:

```
# Advanced Object-Oriented Techniques
# Create a comprehensive comparison visualization

# Prepare data for comparison
comparison_data = pd.merge(
    avgDF_2010[['home', 'totalRuns']].rename(columns={'totalRuns': 'runs_2010'}),
    avgDF_2021[['home', 'totalRuns']].rename(columns={'totalRuns': 'runs_2021'}),
    on='home', how='inner'
)

## TODO: Create the visualization
```

> **!** Discussion Questions: Advanced Object-Oriented Techniques
>
> **Question 1: Using Subplot Layout** - Create a two-facet visualization that shows the total runs for 2010 and 2021 for each stadium in a single figure. Highlight Colorado in the visualization.
> **Question 2: Explanation of the Visualization** - Ask AI To Add A Paragraph Here To Explain The Visualization - Does AI come to the right conclusion? If not, why not?

Student Analysis Section: Mastering Object-Oriented Matplotlib

Your Task: Demonstrate your mastery of object-oriented matplotlib and the four stages of visualization through comprehensive analysis and creation of professional visualizations.

Core Challenge: Four Stages Analysis

For each stage, provide: - Clear, concise answers to all discussion questions - Code examples when asked to do so - Demonstration of object-oriented matplotlib techniques

Professional Visualizations (For 100% Grade)

Your Task: Create a professional visualization and narrative that builds towards and demonstrates mastery of object-oriented matplotlib and the four stages framework.

Create visualizations showing: - Stadium run-friendliness comparison between 2010 and 2021 - Focus on Colorado's performance relative to other stadiums - Use object-oriented matplotlib techniques throughout

Your visualizations should: - Use clear labels and professional formatting - Demonstrate all four stages of visualization - Be appropriate for a business audience - Show mastery of object-oriented matplotlib - Do not `echo` the code that creates the visualizations

Getting Started: Repository Setup

! Getting Started

Step 1: Fork and clone this challenge repository: `https://github.com/flyaflya/dataVizChallenge` - Fork it to your GitHub account, then clone it from your GitHub account to your local machine
Step 2: Set up your Python environment - **Recommended:** Use your existing virtual environment from Tech Setup Challenge Part 2 - Press `Ctrl+Shift+P` → "Python: Select Interpreter" - Navigate to your existing virtual environment (e.g., `your-previous-project/venv/Scripts/python.exe`) - Install additional packages: `pip install pandas numpy matplotlib seaborn` - **Alternative:** Create a new virtual environment following Quarto documentation
Step 3: You're ready to start! The data loading code and starter code for the visualizations are already provided in this file.
Note: This challenge uses the same `index.qmd` file you're reading right now - you'll edit it to complete your analysis.

⚠ Cloud Storage Warning

Avoid using Google Drive, OneDrive, or other cloud storage for Python projects! These services can cause issues with package installations and virtual environment corruption. Keep your Python projects in a local folder like `C:\Users\YourName\Documents\` instead.

Object-Oriented Matplotlib Philosophy

Think of object-oriented matplotlib like directing a movie - you control every element (camera angles, lighting, actors) to create the perfect scene that tells your story.

Important: Save Your Work Frequently!

Before you start: Make sure to commit your work often using the Source Control panel in Cursor (Ctrl+Shift+G or Cmd+Shift+G). This prevents the AI from overwriting your progress and ensures you don't lose your work.
Commit after each major step: - After completing each stage section - After adding your visualizations - After completing your advanced object-oriented techniques - Before asking the AI for help with new code
How to commit: 1. Open Source Control panel (Ctrl+Shift+G) 2. Stage your changes (+ button) 3. Write a descriptive commit message 4. Click the checkmark to commit
Remember: Frequent commits are your safety net!

Grading Rubric

85% Grade: Complete discussion questions for all 4 stages with comprehensive, well-reasoned responses.

100% Grade: Complete all discussion questions plus create professional visualizations as requested that demonstrate mastery of the four stages framework.

Submission Checklist

Minimum Requirements (Required for Any Points):

- ☐ Fork repository named "dataVizChallenge" to your GitHub account
- ☐ Clone repository locally using Cursor (or VS Code)
- ☐ Completed discussion questions for at least 3 of the 4 stages
- ☐ Document rendered to HTML successfully
- ☐ HTML files uploaded to your repository
- ☐ GitHub Pages enabled and working
- ☐ Site accessible at `https://[your-username].github.io/dataVizChallenge/`

85% Grade Requirements:

- ☐ Complete discussion questions for all 4 stages
- ☐ Comprehensive, well-reasoned responses showing deep understanding

100% Grade Requirements:

- ☐ All discussion questions completed with professional quality
- ☐ Professional visualization as requested demonstrating four stages framework

Report Quality (Critical for Higher Grades):

- ☐ Professional writing style (no AI-generated fluff)
- ☐ Concise analysis that gets to the point
- ☐ Clear demonstration of object-oriented matplotlib