

# Data Visualization: Principles and Practice

Computational Data Science

November 24, 2025

## **Abstract**

This document explores comprehensive data visualization techniques, including various plot types for different data characteristics, color palette design with accessibility considerations, perceptual principles, and dashboard composition. We demonstrate best practices for effective visual communication of quantitative information.

## 1 Introduction

Effective data visualization transforms raw data into visual insights. The choice of visualization depends on:

- Data type (continuous, categorical, temporal)
- Relationship being shown (comparison, distribution, composition, relationship)
- Audience and communication goals
- Accessibility requirements

## 2 Computational Environment

### 3 Basic Plot Types

#### 3.1 Distribution Visualizations

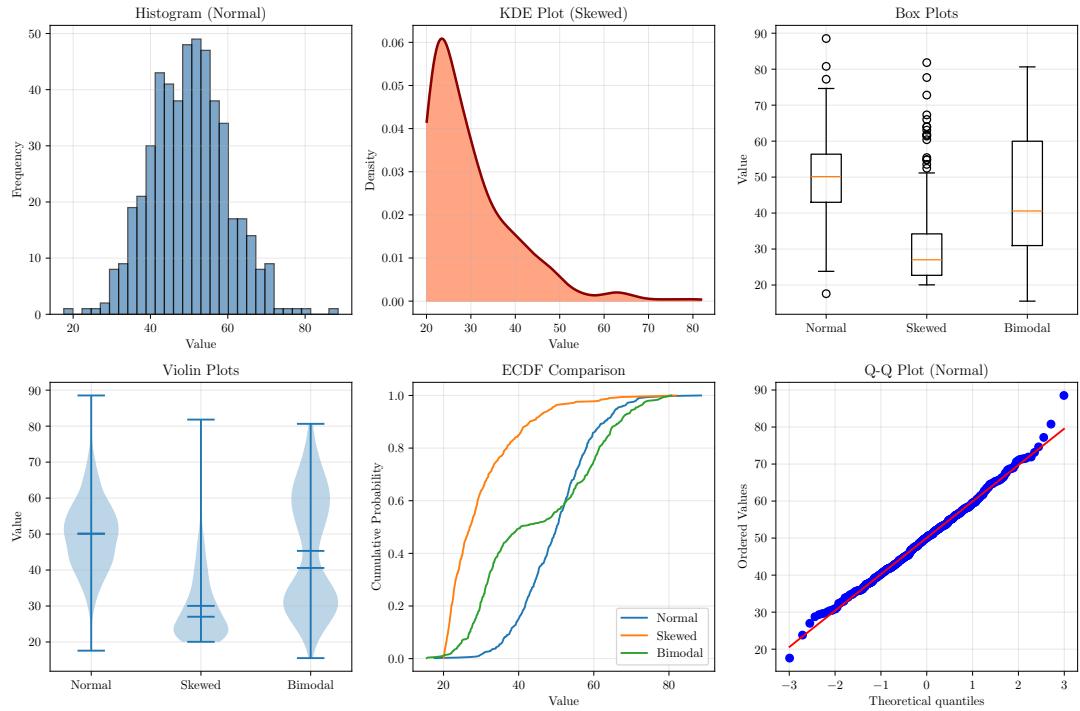


Figure 1: Various visualization types for showing data distributions.

## 3.2 Relationship Visualizations

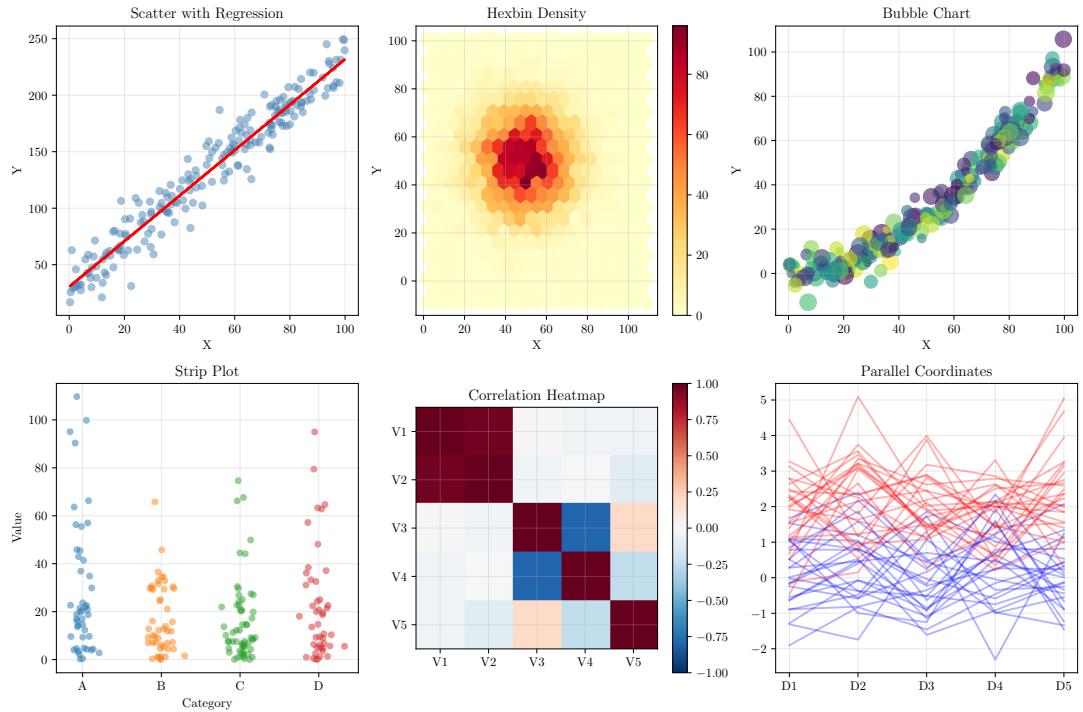


Figure 2: Visualization types for showing relationships between variables.

## 4 Color Palettes and Accessibility

### 4.1 Color Palette Types

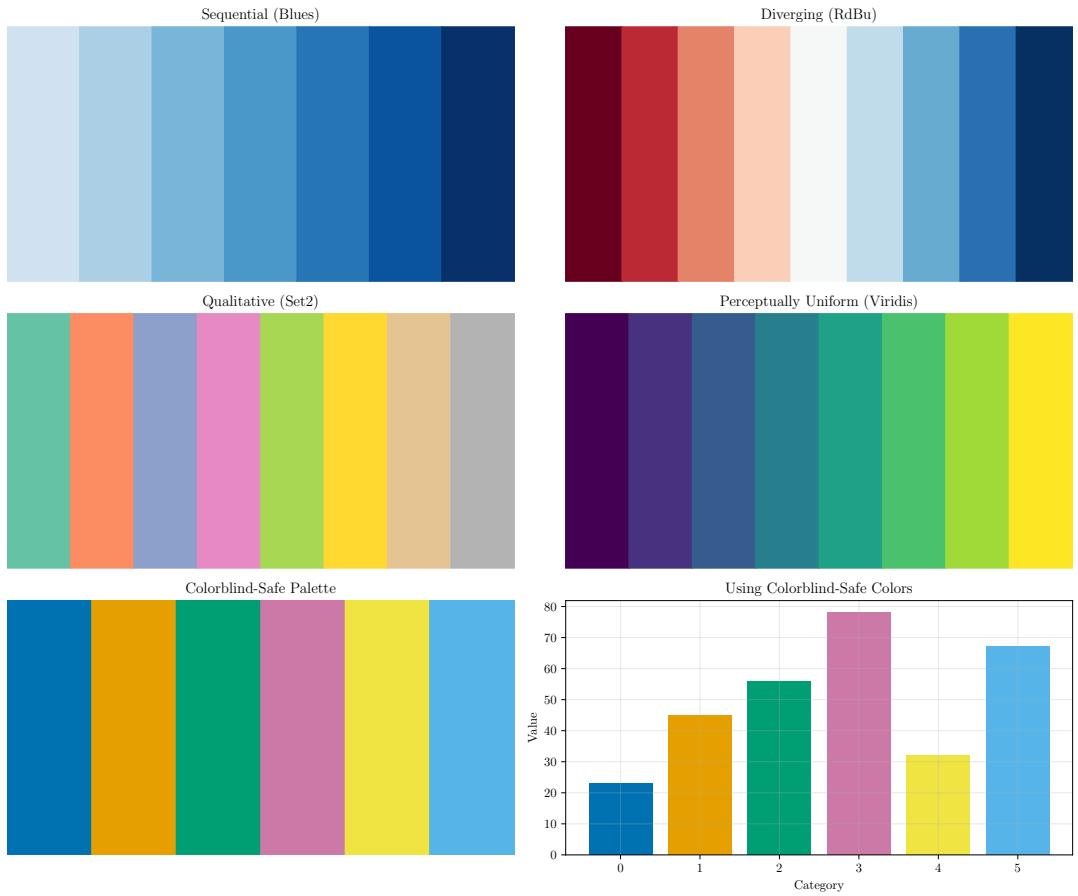


Figure 3: Different color palette types for various visualization needs.

### 4.2 Accessibility Guidelines

Key principles for accessible visualizations:

- Use colorblind-safe palettes (avoid red-green combinations)
- Ensure sufficient contrast (WCAG 2.1 guidelines)
- Include redundant encoding (shape, pattern, labels)
- Provide alt-text descriptions
- Use appropriate font sizes ( $\geq 12$  pt)

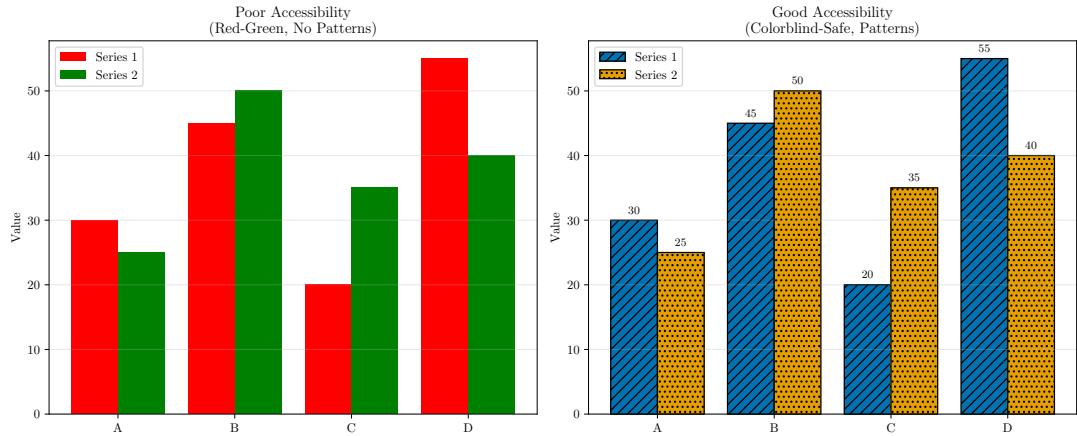


Figure 4: Comparison of poor vs good accessibility in chart design.

## 5 Dashboard Composition

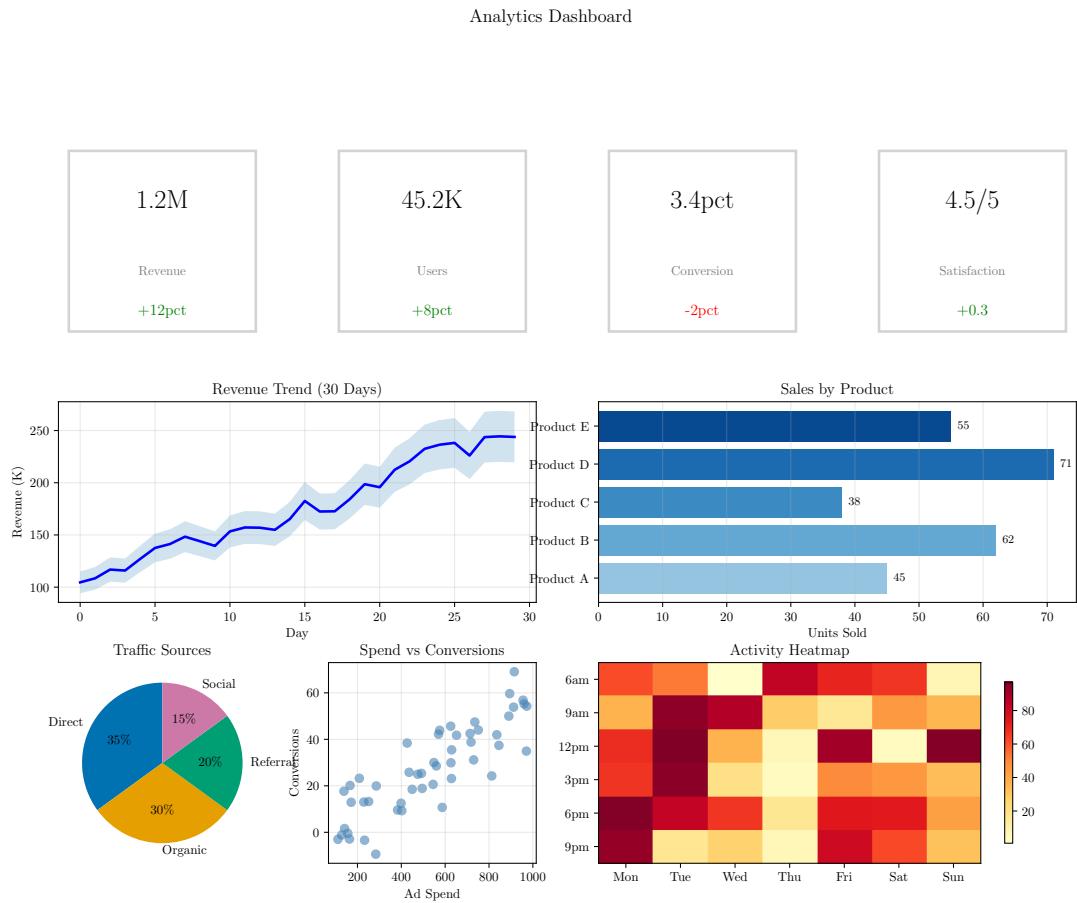


Figure 5: Example dashboard layout with multiple visualization components.

## 6 Chart Selection Guide

Table 1: Choosing the Right Visualization

Purpose	Data Type	Recommended Charts
Distribution	Continuous	Histogram, KDE, Box plot, Violin
Comparison	Categorical	Bar chart, Dot plot, Lollipop
Trend	Time series	Line chart, Area chart
Relationship	Two continuous	Scatter, Hexbin, Contour
Composition	Parts of whole	Pie, Stacked bar, Treemap
Correlation	Multiple variables	Heatmap, Parallel coordinates

## 7 Advanced Techniques

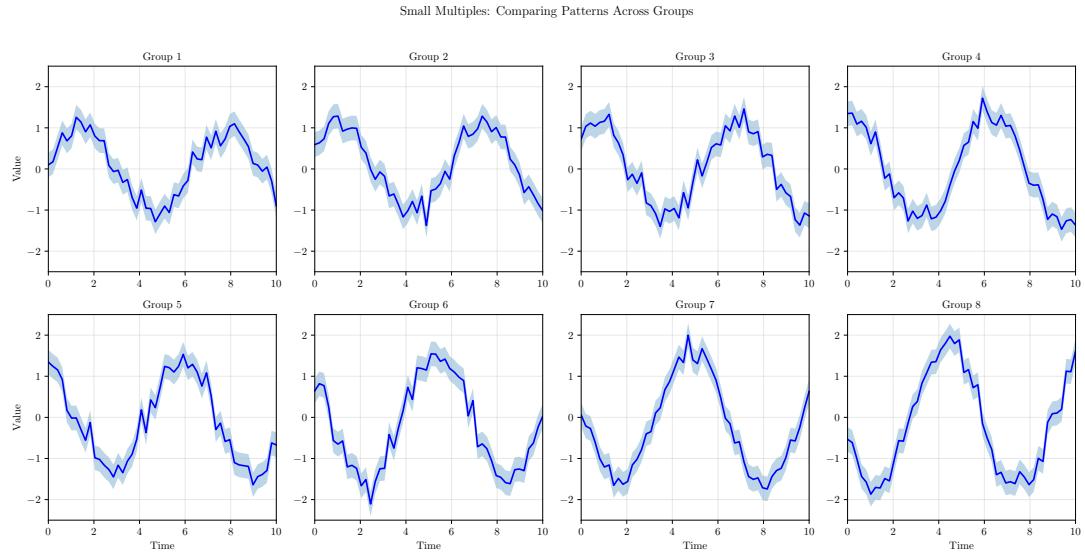


Figure 6: Small multiples technique for comparing patterns across groups.

## 8 Perceptual Principles

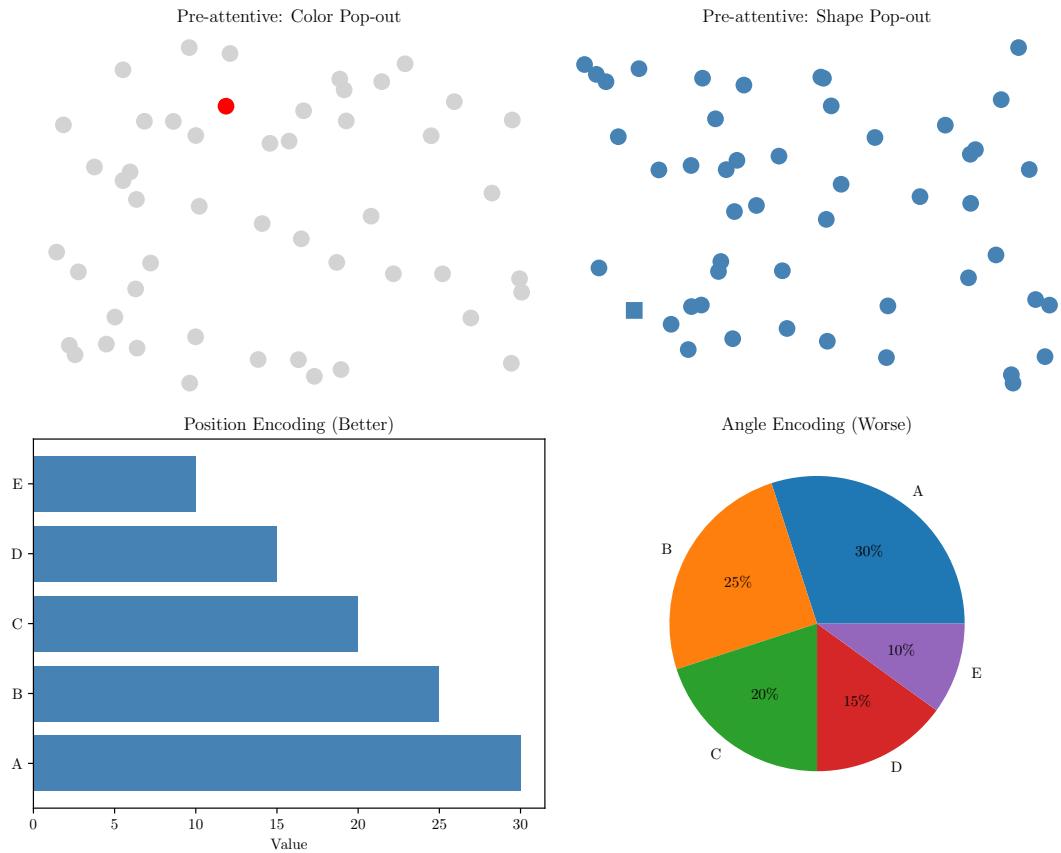


Figure 7: Perceptual principles in data visualization.

Cleveland's hierarchy ranks visual encodings by accuracy:

1. Position along common scale
2. Position along non-aligned scales
3. Length, direction, angle
4. Area
5. Volume, curvature
6. Shading, color saturation

## 9 Summary Statistics

Table 2: Visualization Guide Summary

Metric	Count
Total Figures	7
Chart Types Demonstrated	25
Color Palettes Shown	6
Accessibility Examples	2
Dashboard Components	6

## 10 Conclusion

Effective data visualization requires understanding:

- Appropriate chart selection based on data type and purpose
- Color palette design for both aesthetics and accessibility
- Perceptual principles that affect interpretation accuracy
- Dashboard composition for multi-faceted data communication
- Small multiples and faceting for comparative analysis

The techniques demonstrated provide a foundation for creating clear, accessible, and informative visualizations that effectively communicate quantitative insights.