Lesson 17: Matplotlib Basics

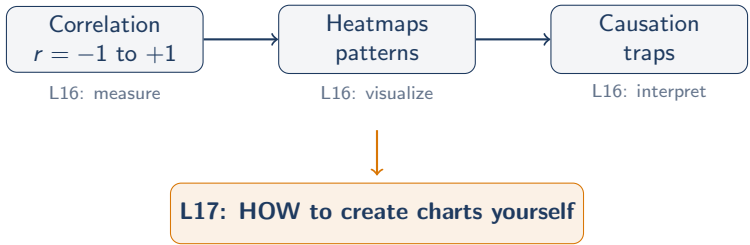
Data Science with Python – BSc Course

Data Science Program

BSc Course

45 Minutes

Previously on Data Science...



L16 showed you: correlation heatmaps, scatter plots, rolling charts. **L17 asks:** "How do I *build* those myself?"

You have been reading charts for 4 lessons – now you learn to write them

Learning Objectives

After this lesson, you will be able to:

1. Explain the figure/axes architecture in matplotlib
2. Create line, bar, scatter, and histogram charts from scratch
3. Customize styles, colors, labels, and annotations
4. Apply matplotlib to financial data (price, volume, returns)
5. Build multi-panel figures with subplots

Matplotlib is the foundation – every Python visualization library builds on it

From Chart Reader to Chart Writer

You have been READING charts. Now you learn to WRITE them.

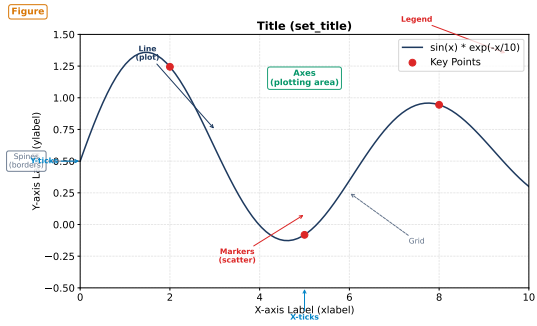
Think of matplotlib as learning to paint:

- The **figure** is your canvas
- The **axes** are the frames you paint inside
- **Colors, labels, annotations** are your brushes

Today's mission:
Master the 4 core chart types that cover 90% of data visualization needs.

Line, bar, histogram, scatter – four tools, infinite stories

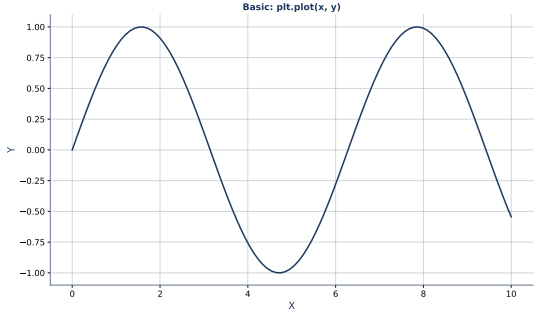
The Canvas: Figure and Axes



- **Figure** = entire window (canvas)
- **Axes** = one plot area (where data lives)
- `fig, ax = plt.subplots()` creates both at once

Always think: figure contains axes, axes contain your data

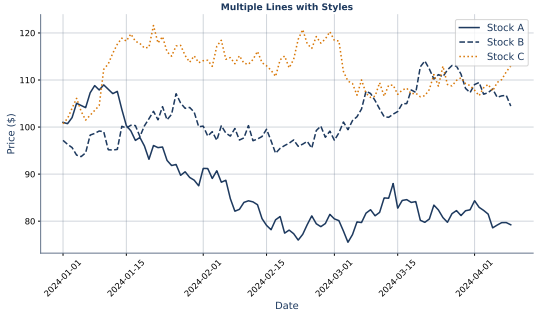
Line Plot: The Simplest Chart



`ax.plot(x, y)` – one line of code, one line on screen.

Line plots show how a single variable changes over a continuous axis

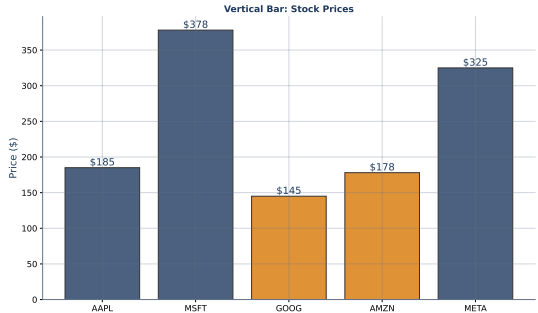
Overlaying Multiple Series



Call `ax.plot()` multiple times on the same axes to overlay data.

Add a legend so viewers know which line is which

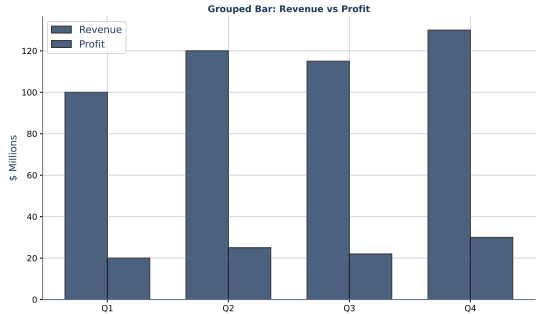
Bar Chart: Comparing Categories



`ax.bar(categories, values)` – one bar per category.

Bar charts answer: which category is biggest, smallest, or different?

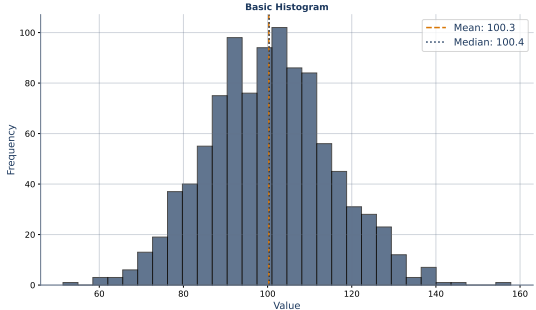
Grouped Bar Chart: Side-by-Side Comparison



Offset bar positions with `np.arange()` and width to group them.

Grouped bars compare multiple series across the same categories

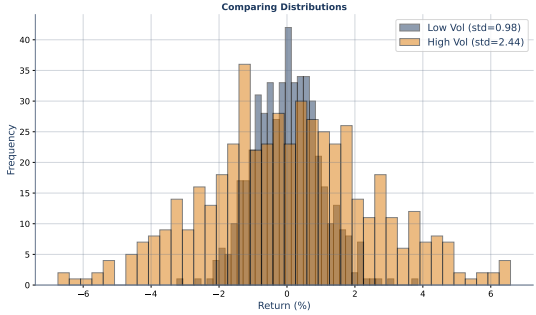
Histogram: Seeing Distributions



`ax.hist(data, bins=30)` – bins determine resolution.

Histograms answer: what is the shape of my data?

Overlaying Distributions



Use `alpha=0.5` for transparency when overlaying histograms.

Compare distributions by overlaying with different colors and transparency

Checkpoint: Which Chart?

Quick Check

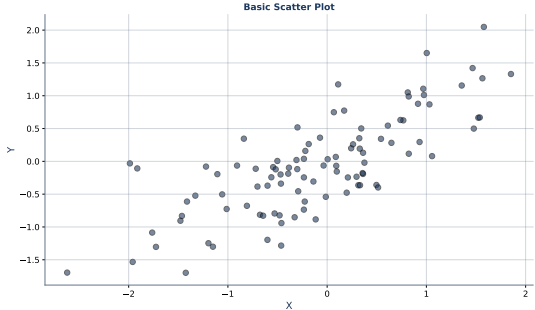
Match the goal to the chart type:

1. Show a trend over time → ?
2. Compare category sizes → ?
3. Show the shape of a distribution → ?

Answers: 1. Line 2. Bar 3. Histogram

Choosing the right chart type is half the battle

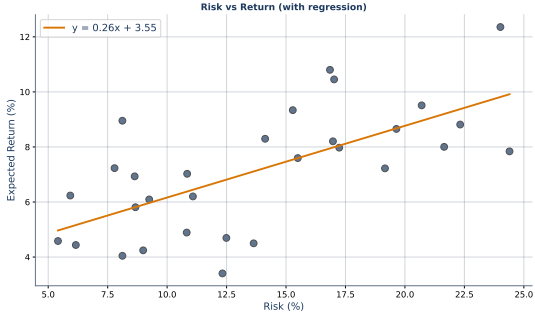
Scatter Plot: Relationships



`ax.scatter(x, y)` – each dot is one observation.

Scatter plots reveal relationships, clusters, and outliers

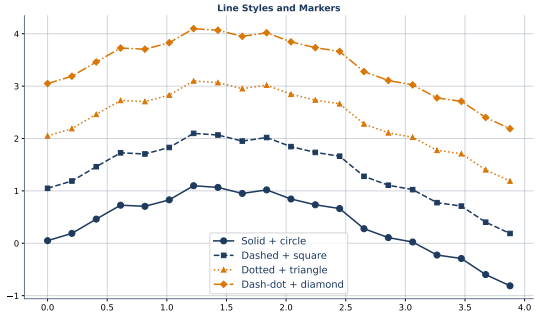
Scatter + Trend Line



Add `np.polyfit()` trend line to quantify the relationship.

A regression line turns a visual pattern into a number

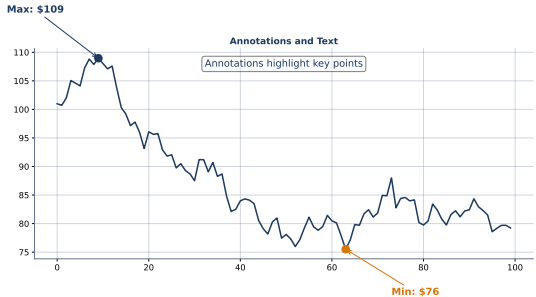
Customization: Styles, Colors, Markers



- `linestyle`: solid, dashed, dotted, dash-dot
- `color`: named, hex, or RGB
- `marker`: o, s, ^, D, and dozens more

Good defaults first, customize only when it adds clarity

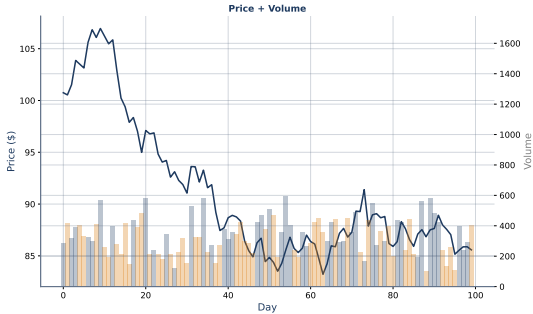
Annotations: Highlight What Matters




```
ax.annotate('text', xy=(...), arrowprops={...})
```

Annotations guide the viewer's eye to the insight

Finance: Price and Volume

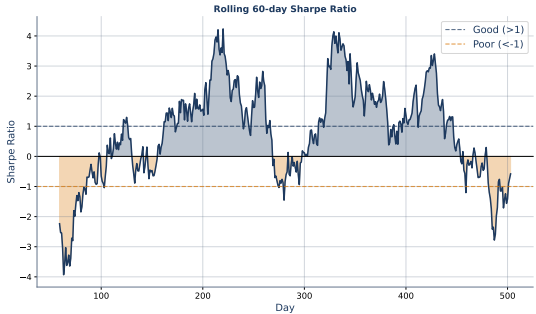


Dual-axis chart: price on left axis, volume bars on right axis.

---

twinx() creates a second y-axis sharing the same x-axis

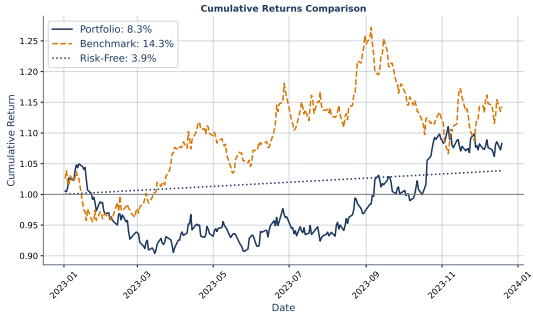
Finance: Rolling Sharpe Ratio



Rolling window calculations track performance stability over time.

A steady Sharpe above 1.0 is better than a volatile Sharpe averaging 2.0

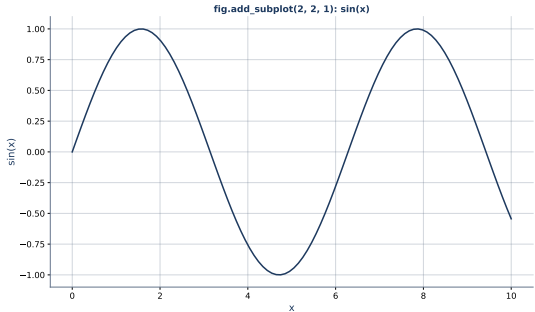
Finance: Cumulative Returns



`(1 + returns).cumprod()` turns daily returns into a growth curve.

Cumulative return charts are how investors compare strategies

Subplots: Multiple Charts in One Figure



`fig.add_subplot(rows, cols, index)` or
`fig, axes = plt.subplots(1, 2)` for a grid.

Subplots let you tell a multi-part story in one figure

Hands-On: Build Your First Dashboard

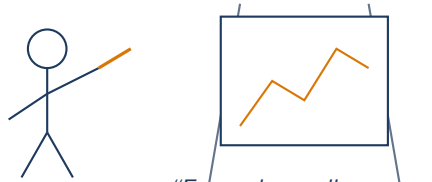
Task: Create a 4-panel financial dashboard.

1. Generate 252 days of random stock returns with `np.random.normal()`
2. **Panel 1:** Line plot of cumulative returns
3. **Panel 2:** Histogram of daily returns with mean line
4. **Panel 3:** Bar chart of monthly returns
5. **Panel 4:** Scatter plot of return vs volume (simulated)

Stretch goal: Add annotations marking the best and worst days.

Hands-on: 10 minutes – use plt.subplots(2, 2) for the grid

The Art of Showing Data



"A chart is not decoration. It is an argument made visible."

The best chart is the one your audience understands in 5 seconds

Key Takeaways

What you now know:

1. **Figure + Axes** = matplotlib's two-layer architecture
2. **Line plots** for trends, **bar charts** for categories, **histograms** for distributions, **scatter plots** for relationships
3. **Customization** (colors, styles, annotations) adds clarity, not decoration
4. **Finance charts** (price/volume, Sharpe, cumulative returns) use the same 4 tools
5. **Subplots** combine multiple views into one coherent story

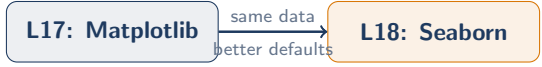
---

You now own the core toolkit – L18 adds statistical intelligence with seaborn

Coming Up: L18 – Seaborn Statistical Plots

Matplotlib is powerful but verbose. Seaborn adds elegance.

- Distribution plots (KDE, violin, box) in one line
- Statistical regression with confidence bands
- Correlation heatmaps with automatic formatting



Seaborn is matplotlib with a PhD in statistics and a sense of style