

Advanced Exercises — Matplotlib (with Keywords)

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Exercise 1 Scatter plot

- Generate two random vectors of size 100 for coordinates x and y .
- Add a random color and size to each point.
- Display a colorful, semi-transparent scatter plot.
- Add a title, a colorbar, and try different color maps.
- **Keywords:** `plt.scatter()`, `np.random`, `alpha`, `c=`, `s=`, `colorbar()`, `cmap`

Exercise 2 Histogram with density curve

- Generate a vector of 1000 values following a normal distribution.
- Plot a histogram.
- Overlay a density curve (using Seaborn or another library).
- Add a title and label the axes.
- **Keywords:** `plt.hist()`, `density=True`, `seaborn.kdeplot()`, `np.random.normal()`

Exercise 3 Multiple plots with subplot

- Create a 2x2 grid of subplots.
- Plot the following functions: $\sin(x)$, $\cos(x)$, $\tan(x)$, and $\exp(x/3)$.
- Adjust the y -axis limits for $\tan(x)$ to avoid discontinuities.
- Add a title to each subplot.
- **Keywords:** `plt.subplots()`, `ax.plot()`, `ax.set_title()`, `ax.set_ylim()`, `np.linspace()`

Exercise 4 Sinusoid animation

- Create a figure with a sinusoidal curve.
- Animate the phase shift using `FuncAnimation`.
- The curve should shift gradually over time.
- Set the frame interval and number of frames.
- **Keywords:** `matplotlib.animation`, `FuncAnimation`, `init_func`, `frames`, `interval`

Exercise 5 3D surface plot

- Generate a meshgrid (X, Y) using `np.meshgrid`.
- Compute the function $Z = \sin(\sqrt{X^2 + Y^2})$.
- Plot the surface in 3D with a color gradient.
- Add a title and experiment with different color maps.
- **Keywords:** `from mpl_toolkits.mplot3d import Axes3D`, `ax.plot_surface()`, `cmap`, `projection='3d'`

Exercise 6 Bonus: Interactivity with Slider

- Create a plot with a sinusoid of variable frequency.
- Add a horizontal slider that controls the frequency.
- The plot must update in real time.
- Add a dynamic title that displays the slider value.
- **Keywords:** `matplotlib.widgets.Slider`, `on_changed`, `update()`, `ax.text()`, `set_ydata()`

General Instructions

- All exercises should be completed in a Jupyter notebook.
- Each plot must have a title and properly labeled axes.
- Save your figures using `plt.savefig("filename.png")` if needed.
- To go further, explore the modules `widgets`, `seaborn`, and `animation`.