Matplotlib for intermediate users

A matplotlib figure is composed of a hierarchy of elements that forms the actual figure. Each element can be modified.

**Anatomy of a figure**

- **Figure**: The root element in the hierarchy.
- **Axes**: The main area of the figure where plots are drawn.
- **Spines**: The edges of the axes.

**Figure, axes & spines**

```python
fig, axs = plt.subplots(3, 3)
axs[0, 0].set_facecolor("#ddffdd")
axs[2, 2].set_facecolor("#ffffdd")

gs = fig.add_gridspec(3, 3)
ax = fig.add_subplot(gs[0, :])
ax.set_facecolor("#ffffff")
```

**Ticks & labels**

```python
from mpl.ticker import MultipleLocator as ML
from mpl.ticker import ScalarFormatter as SF
ax.xaxis.set_minor_locator(ML(0.2))
ax.xaxis.set_minor_formatter(SF())
ax.tick_params(axis='x', which='minor', rotation=90)
```

**Lines & markers**

```python
X = np.linspace(0.1, 10*np.pi, 1000)
Y = np.sin(X)
ax.plot(X, Y, "C0", label="Sine")
ax.plot(X, np.cos(X), "C1", label="Cosine")
ax.legend(box_to_anchor=(0, 1, 1, .1), ncol=2, mode="expand", loc="lower left")
```

**Scales & projections**

```python
fig, ax = plt.subplots()
ax.set_xscale("log")
ax.plot(X, Y, "C0", markevery=25, mec="1.0")
```

**Text & ornaments**

```python
ax.text(0, -1, r"Period $\Phi$", ha="center", va="center", arrowprops = {
    "arrowstyle" : "->", "color": "C1"})
```

**Legend**

```python
ax.plot(X, np.sin(X), "C0", label="Sine")
ax.plot(X, np.cos(X), "C1", label="Cosine")
ax.legend(box_to_anchor=(0, 1, 1, .1), ncol=2, mode="expand", loc="lower left")
```

**Annotation**

```python
ax.annotate("A", (X[250], Y[250]), (X[250], -1), ha="center", va="center", arrowprops = {
    "arrowstyle" : "->", "color": "C1"})
```

**Colors**

Any color can be used, but Matplotlib offers sets of colors:

- C0: [0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0]

**Size & DPI**

Consider a square figure to be included in a two-columns A4 paper with 2cm margins on each side and a column separation of 1cm. The width of a figure is (21 - 2*2 - 1)/2 = 8cm. One inch being 2.54cm, figure size should be 3.15 × 3.15 in.

```python
fig = plt.figure(figsize=(3.15, 3.15), dpi=50)
plt.savefig("figure.pdf", dpi=600)
```

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