matplotlib Cheat sheet

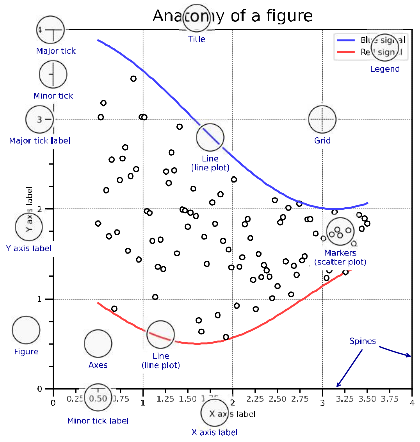
Version 3.5.0

Quick start

API

```
import numpy as np
import matplotlib as mpl
import matplotlib.pyplot as plt


X = np.linspace(0, 2*np.pi, 100)
Y = np.cos(X)

fig, ax = plt.subplots()
ax.plot(X, Y, color='green')

fig.savefig("figure.pdf")
fig.show()
```

Anatomy of a figure



Subplots layout

API

`subplot[s](rows,cols,…)` API
`fig, axs = plt.subplots(3, 3)`

`G = gridspec(rows,cols,…)` API
`ax = G[0,:]`

`ax.inset_axes(extent)` API

`d=make_axes_locatable(ax)` API
`ax = d.new_horizontal('10%')`

Getting help

- matplotlib.org
- github.com/matplotlib/matplotlib/issues
- discourse.matplotlib.org
- stackoverflow.com/questions/tagged/matplotlib

Basic plots

`plot([X],Y,[fmt],…)` API
X, **Y**, fmt, color, marker, linestyle

`scatter(X,Y,…)` API
X, **Y**, [s]izes, [c]olors, marker, cmap

`bar[h](x,height,…)` API
x, **height**, width, bottom, align, color

`imshow(Z,…)` API
Z, cmap, interpolation, extent, origin

`contour[f]([X],[Y],Z,…)` API
X, Y, **Z**, levels, colors, extent, origin

`pcolormesh([X],[Y],Z,…)` API
X, Y, **Z**, vmin, vmax, cmap

`quiver([X],[Y],U,V,…)` API
X, Y, **U**, **V**, C, units, angles

`pie(X,…)` API
Z, explode, labels, colors, radius

`text(x,y,text,…)` API
x, **y**, **text**, va, ha, size, weight, transform

`fill[_between][x](…)` API
X, **Y1**, Y2, color, where

Advanced plots

`step(X,Y,[fmt],…)` API
X, **Y**, fmt, color, marker, where

`boxplot(X,…)` API
X, notch, sym, bootstrap, widths

`errorbar(X,Y,xerr,yerr,…)` API
X, **Y**, xerr, yerr, fmt

`hist(X, bins, …)` API
X, bins, range, density, weights

`violinplot(D,…)` API
D, positions, widths, vert

`barbs([X],[Y], U, V, …)` API
X, Y, **U**, **V**, C, length, pivot, sizes

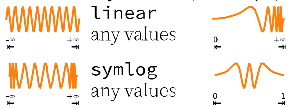
`eventplot(positions,…)` API
positions, orientation, lineoffsets

`hexbin(X,Y,C,…)` API

Scales

API

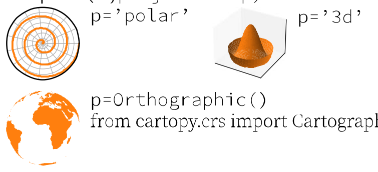
`ax.set_[xy]scale(scale,…)`



Projections

API

`subplot(…,projection=p)`



`p=Orthographic()` API
from cartopy.crs import Cartographic

Lines

API

`linestyle or ls`

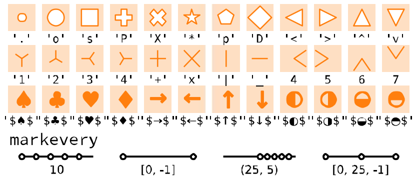
"-"	":"	"--"	"-."	(0,(0.01,2))

`capstyle or dash_capstyle`

"butt"	"round"	"projecting"

Markers

API



Colors

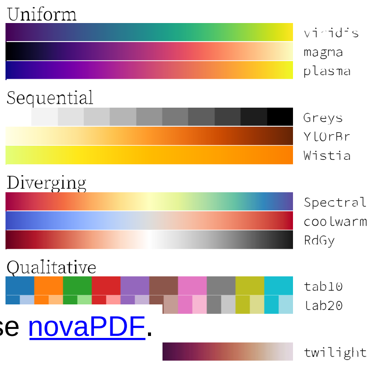
API

C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	'Cn'
b	g	r	c	m	y	k	w			'x'
DarkRed	Firebrick	Crimson	IndianRed	Salmon						'name'
(1,0,0)	(1,0,0,0.75)	(1,0,0,0.5)	(1,0,0,0.25)							(R,G,B[,A])
#FF0000	#FF0000BB	#FF000088	#FF000044							'#RRGGBB[AA]'
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0 'x.y'

Colormaps

API

`plt.get_cmap(name)`



Tick locators

API

```
from matplotlib import ticker
ax.[xy]axis.set_[minor|major]_locator(locator)
```

```
ticker.NullLocator()

ticker.MultipleLocator(0.5)
0.0  0.5  1.0  1.5  2.0  2.5  3.0  3.5  4.0  4.5  5.0
ticker.FixedLocator([0, 1, 5])
0    1                                            5
ticker.LinearLocator(numticks=3)
0.0                      2.5                      5.0
ticker.IndexLocator(base=0.5, offset=0.25)
  0.25  0.75  1.25  1.75  2.25  2.75  3.25  3.75  4.25  4.75
ticker.AutoLocator()
0         1         2         3         4         5
ticker.MaxNLocator(n=4)
0.0            1.5            3.0            4.5
ticker.LogLocator(base=10, numticks=15)
10^3  10^4  10^5  10^6  10^7  10^8  10^9  10^10
```

Tick formatters

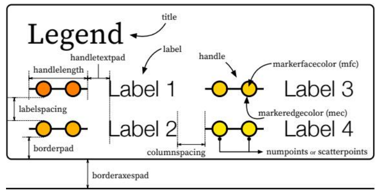
API

```
from matplotlib import ticker
ax.[xy]axis.set_[minor|major]_formatter(formatter)
```

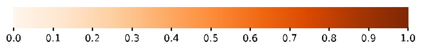
```
ticker.NullFormatter()

ticker.FixedFormatter(['zero', 'one', 'two', …])
zero      one      two      three      four      five
ticker.FuncFormatter(lambda x, pos: "[%.2f]" % x)
[0.00]    [1.00]    [2.00]    [3.00]    [4.00]    [5.00]
ticker.FormatStrFormatter('>%d<')
>0<       >1<       >2<       >3<       >4<       >5<
ticker.ScalarFormatter()
0         1         2         3         4         5
ticker.StrMethodFormatter('{x}')
0.0       1.0       2.0       3.0       4.0       5.0
ticker.PercentFormatter(xmax=5)
0%        20%       40%       60%       80%       100%
```

Ornaments

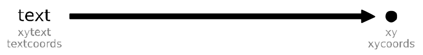
`ax.legend(…)` API
handles, labels, loc, title, frameon



`ax.colorbar(…)` API
mappable, ax, cax, orientation



`ax.annotate(…)` API
text, **xy**, **xytext**, xycoords, textcoords, arrowprops



Event handling

API

```
fig, ax = plt.subplots()
def on_click(event):
    print(event)
fig.canvas.mpl_connect(
    'button_press_event', on_click)
```

Animation

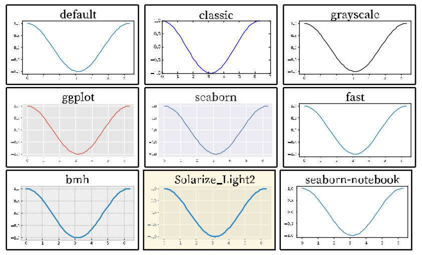
API

```
import matplotlib.animation as mpla

T = np.linspace(0, 2*np.pi, 100)
S = np.sin(T)
line, = plt.plot(T, S)
def animate(i):
    line.set_ydata(np.sin(T+i/50))
anim = mpla.FuncAnimation(
    plt.gcf(), animate, interval=5)
plt.show()
```

Styles

API

`plt.style.use(style)`



Quick reminder

```
ax.grid()
ax.set_[xy]lim(vmin, vmax)
ax.set_[xy]label(label)
ax.set_[xy]ticks(ticks, [labels])
ax.set_[xy]ticklabels(labels)
ax.set_title(title)
ax.tick_params(width=10, …)
ax.set_axis_[on|off]()

fig.suptitle(title)
fig.tight_layout()
plt.gcf(), plt.gca()
mpl.rc('axes', linewidth=1, …)
[fig|ax].patch.set_alpha(0)
text=r'$\frac{-e^{i\pi}}{2^n}$'
```

Keyboard shortcuts

API

ctrl + s	Save	ctrl + w	Close plot
r	Reset view	f	Fullscreen 0/1
f	View forward	b	View back
p	Pan view	o	Zoom to rect
x	X pan/zoom	y	Y pan/zoom
g	Minor grid 0/1	G	Major grid 0/1
l	X axis log/linear	L	Y axis log/linear

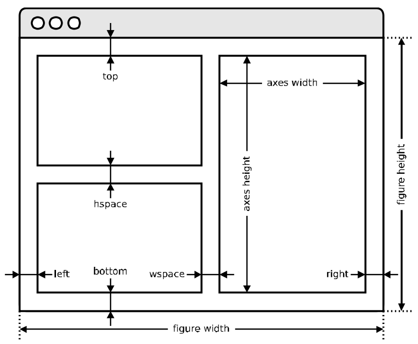
Ten simple rules

READ

1. Know Your Audience
2. Identify Your Message
3. Adapt the Figure
4. Captions Are Not Optional
5. Do Not Trust the Defaults
6. Use Color Effectively
7. Do Not Mislead the Reader
8. Avoid "Chartjunk"
9. Message Trumps Beauty
10. Get the Right Tool

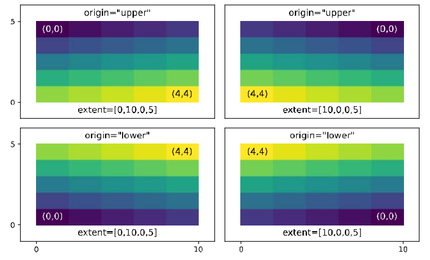
Axes adjustments API

plt.subplots_adjust(...)



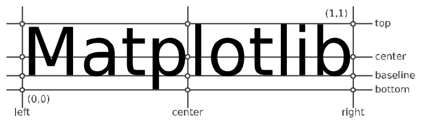
Extent & origin API

ax.imshow(extent=..., origin=...)



Text alignments API

ax.text(..., ha=... , va=..., ...)



Text parameters API

ax.text(..., family=..., size=..., weight=...)
ax.text(..., fontproperties=...)

The quick brown fox	xx-large (1.73)
The quick brown fox	x-large (1.44)
The quick brown fox	large (1.20)
The quick brown fox	medium (1.00)
The quick brown fox	small (0.83)
The quick brown fox	x-small (0.69)
The quick brown fox	xx-small (0.58)
The quick brown fox jumps over the lazy dog	black (900)
The quick brown fox jumps over the lazy dog	bold (700)
The quick brown fox jumps over the lazy dog	semibold (600)
The quick brown fox jumps over the lazy dog	normal (400)
The quick brown fox jumps over the lazy dog	ultralight (100)
The quick brown fox jumps over the lazy dog	monospace
The quick brown fox jumps over the lazy dog	serif
The quick brown fox jumps over the lazy dog	sans
The quick brown fox jumps over the lazy dog	cursive
The quick brown fox jumps over the lazy dog	italic

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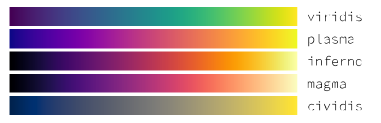
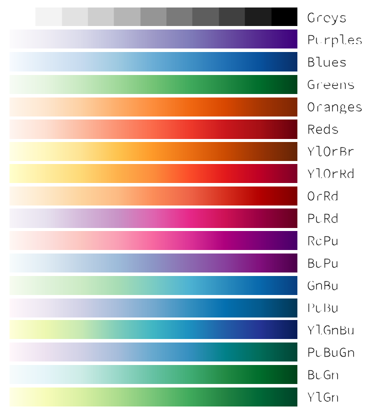
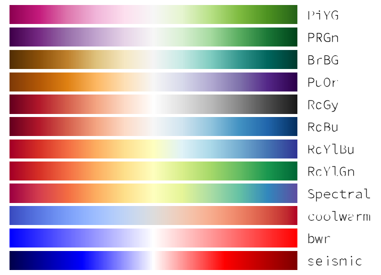
Uniform colormaps



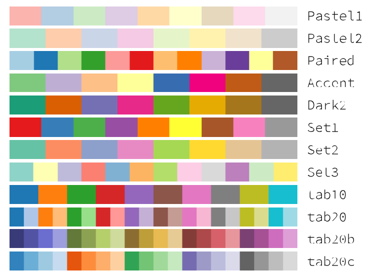
Sequential colormaps



Diverging colormaps



Qualitative colormaps



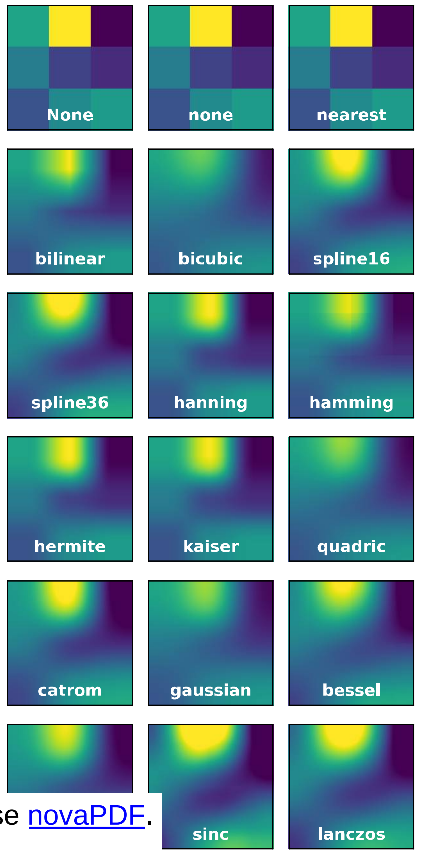
Miscellaneous colormaps

terrain
ocean

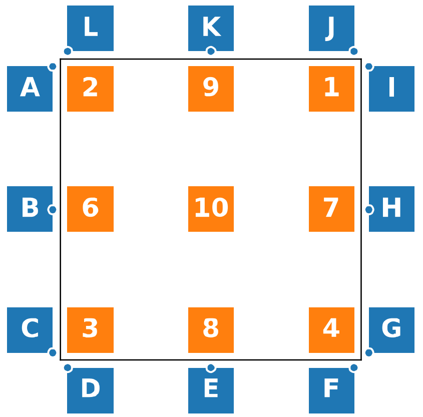
Color names API

⬛	black	⬜	floralwhite	🟦	darkturquoise
⬛	k	🟫	darkgoldenrod	🟦	cadetblue
⬛	dimgray	🟨	goldenrod	🟦	powderblue
⬛	dimgrey	⬜	cornsilk	🟦	lightblue
⬛	gray	🟨	gold	🟦	deepskyblue
⬛	grey	⬜	lemonchiffon	🟦	skyblue
⬜	darkgray	🟨	khaki	🟦	lightskyblue
⬜	darkgrey	🟨	palegoldenrod	🟦	steelblue
⬜	silver	🟨	darkkhaki	⬜	aliceblue
⬜	lightgray	⬜	ivory	🟦	dodgerblue
⬜	lightgrey	⬜	beige	⬛	lightslategray
⬜	gainsboro	⬜	lightyellow	⬛	lightslategrey
⬜	whitesmoke	⬜	lightgoldenrodyellow	⬛	slategray
⬜	w	🟩	olive	⬛	slategrey
⬜	white	🟨	y	🟦	lightsteelblue
⬜	snow	🟨	yellow	🟦	cornflowerblue
🟥	rosybrown	🟩	olivedrab	🟦	royalblue
🟥	lightcoral	🟩	yellowgreen	⬜	ghostwhite
🟥	indianred	🟩	darkolivegreen	⬜	lavender
🟥	brown	🟩	greenyellow	🟦	midnightblue
🟥	firebrick	🟩	chartreuse	🟦	navy
🟥	maroon	🟩	lawngreen	🟦	darkblue
🟥	darkred	⬜	honeydew	🟦	mediumblue
🟥	r	🟩	darkseagreen	🟦	b
🟥	red	🟩	palegreen	🟦	blue
⬜	mistyrose	🟩	lightgreen	🟪	slateblue
🟥	salmon	🟩	forestgreen	🟪	darkslateblue
🟥	tomato	🟩	limegreen	🟪	mediumslateblue
🟥	darksalmon	🟩	darkgreen	🟪	mediumpurple
🟧	coral	🟩	g	🟪	rebeccapurple
🟧	orangered	🟩	green	🟪	blueviolet
🟧	lightsalmon	🟩	lime	🟪	indigo
🟫	sienna	🟩	seagreen	🟪	darkorchid
⬜	seashell	🟩	mediumseagreen	🟪	darkviolet
🟫	chocolate	🟩	springgreen	🟪	mediumorchid
🟫	saddlebrown	⬜	mintcream	🟪	thistle
🟧	sandybrown	🟩	mediumspringgreen	🟪	plum
🟧	peachpuff	🟩	mediumaquamarine	🟪	violet
🟫	peru	🟩	aquamarine	🟪	purple
⬜	linen	🟦	turquoise	🟪	darkmagenta
🟧	bisque	🟦	lightseagreen	🟪	m
🟧	darkorange	🟦	mediumturquoise	🟪	fuchsia
🟫	burlywood	⬜	azure	🟪	magenta
⬜	antiquewhite	⬜	lightcyan	🟪	orchid
🟫	tan	🟦	paleturquoise	🟥	mediumvioletred
🟧	navajowhite	⬛	darkslategray	🟥	deeppink
⬜	blanchedalmond	⬛	darkslategrey	🟥	hotpink
⬜	papayawhip	🟦	teal	⬜	lavenderblush
🟧	moccasin	🟦	darkcyan	🟥	palevioletred
🟧	orange	🟦	c	🟥	crimson
🟧	wheat	🟦	aqua	🟥	pink
⬜	oldlace	🟦	cyan	🟥	lightpink

Image interpolation API



Legend placement

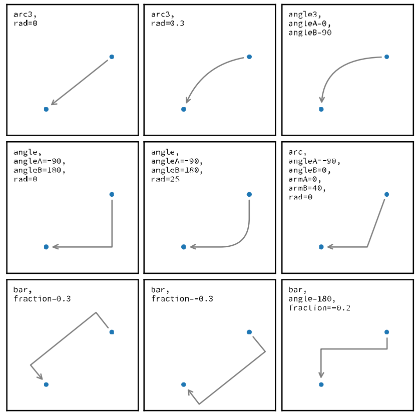


ax.legend(loc="string", bbox_to_anchor=(x,y))

2: upper left	9: upper center	1: upper right
6: center left	10: center	7: center right
3: lower left	8: lower center	4: lower right

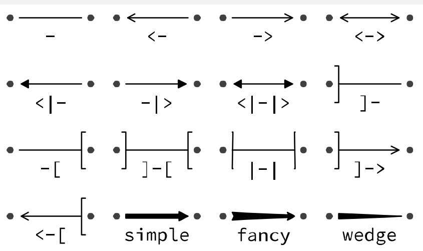
A: upper right / `(-0.1,0.9)`	B: center right / `(-0.1,0.5)`
C: lower right / `(-0.1,0.1)`	D: upper left / `(0.1,-0.1)`
E: upper center / `(0.5,-0.1)`	F: upper right / `(0.9,-0.1)`
G: lower left / `(1.1,0.1)`	H: center left / `(1.1,0.5)`
I: upper left / `(1.1,0.9)`	J: lower right / `(0.9,1.1)`
K: lower center / `(0.5,1.1)`	L: lower left / `(0.1,1.1)`

Annotation connection styles API



arc3, rad=0
arc3, rad=0.3
angle3, angleA=0, angleB=90
angle, angleA=-90, angleB=180, rad=0
angle, angleA=-90, angleB=180, rad=25
arc, angleA=-90, angleB=0, armA=0, armB=40, rad=0
bar, fraction=0.3
bar, fraction=-0.3
bar, angle=180, fraction=-0.2

Annotation arrow styles API



How do I ...

... resize a figure?
→ fig.set_size_inches(w, h)
... save a figure?
→ fig.savefig("figure.pdf")
... save a transparent figure?
→ fig.savefig("figure.pdf", transparent=True)
... clear a figure/an axes?
→ fig.clear() → ax.clear()
... close all figures?
→ plt.close("all")
... remove ticks?
→ ax.set_[xy]ticks([])
... remove tick labels ?
→ ax.set_[xy]ticklabels([])
... rotate tick labels ?
→ ax.set_[xy]ticks(rotation=90)
... hide top spine?
→ ax.spines['top'].set_visible(False)
... hide legend border?
→ ax.legend(frameon=False)
... show error as shaded region?
→ ax.fill_between(X, Y+error, Y-error)
... draw a rectangle?
→ ax.add_patch(plt.Rectangle((0, 0), 1, 1)
... draw a vertical line?
→ ax.axvline(x=0.5)
... draw outside frame?
→ ax.plot(..., clip_on=False)
... use transparency?
→ ax.plot(..., alpha=0.25)
... convert an RGB image into a gray image?
→ gray = 0.2989*R + 0.5870*G + 0.1140*B
... set figure background color?
→ fig.patch.set_facecolor("grey")
... get a reversed colormap?
→ plt.get_cmap("viridis_r")
... get a discrete colormap?
→ plt.get_cmap("viridis", 10)
... show a figure for one second?
→ fig.show(block=False), time.sleep(1)

Performance tips

```
scatter(X, Y)                                   slow
plot(X, Y, marker="o", ls="")                   fast
for i in range(n): plot(X[i])                   slow
plot(sum([x+[None] for x in X],[]))             fast
cla(), imshow(…), canvas.draw()                 slow
im.set_data(…), canvas.draw()                   fast
```

Beyond Matplotlib

Seaborn: Statistical Data Visualization
Cartopy: Geospatial Data Processing
yt: Volumetric data Visualization
mpld3: Bringing Matplotlib to the browser
Datashader: Large data processing pipeline
plotnine: A Grammar of Graphics for Python

NUMFOCUS
OPEN CODE = BETTER SCIENCE