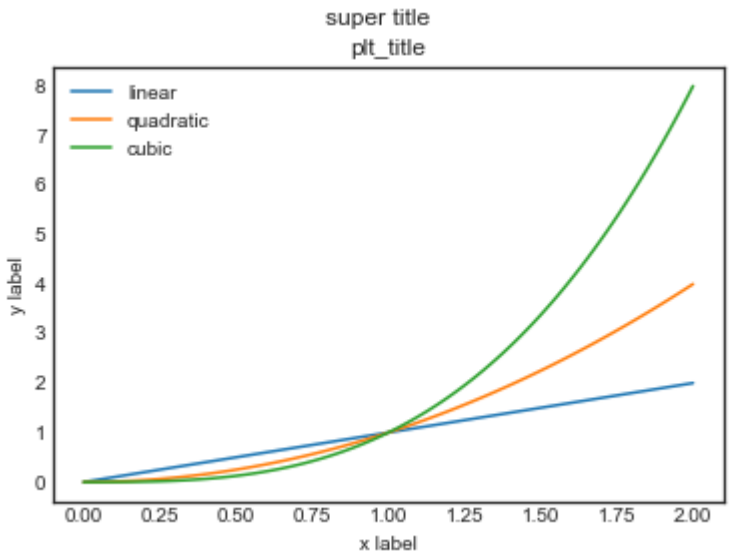
Matplotlib

一般概念

```
%matplotlib inline
import matplotlib as mpl
# mpl.style.available
# mpl.style.use("dark_background")
# mpl.style.use("fivethirtyeight")
# mplstyle.use(['dark_background', 'ggplot', 'fast'])
mpl.style.use("seaborn-white") #before import pyplot or have no effect

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

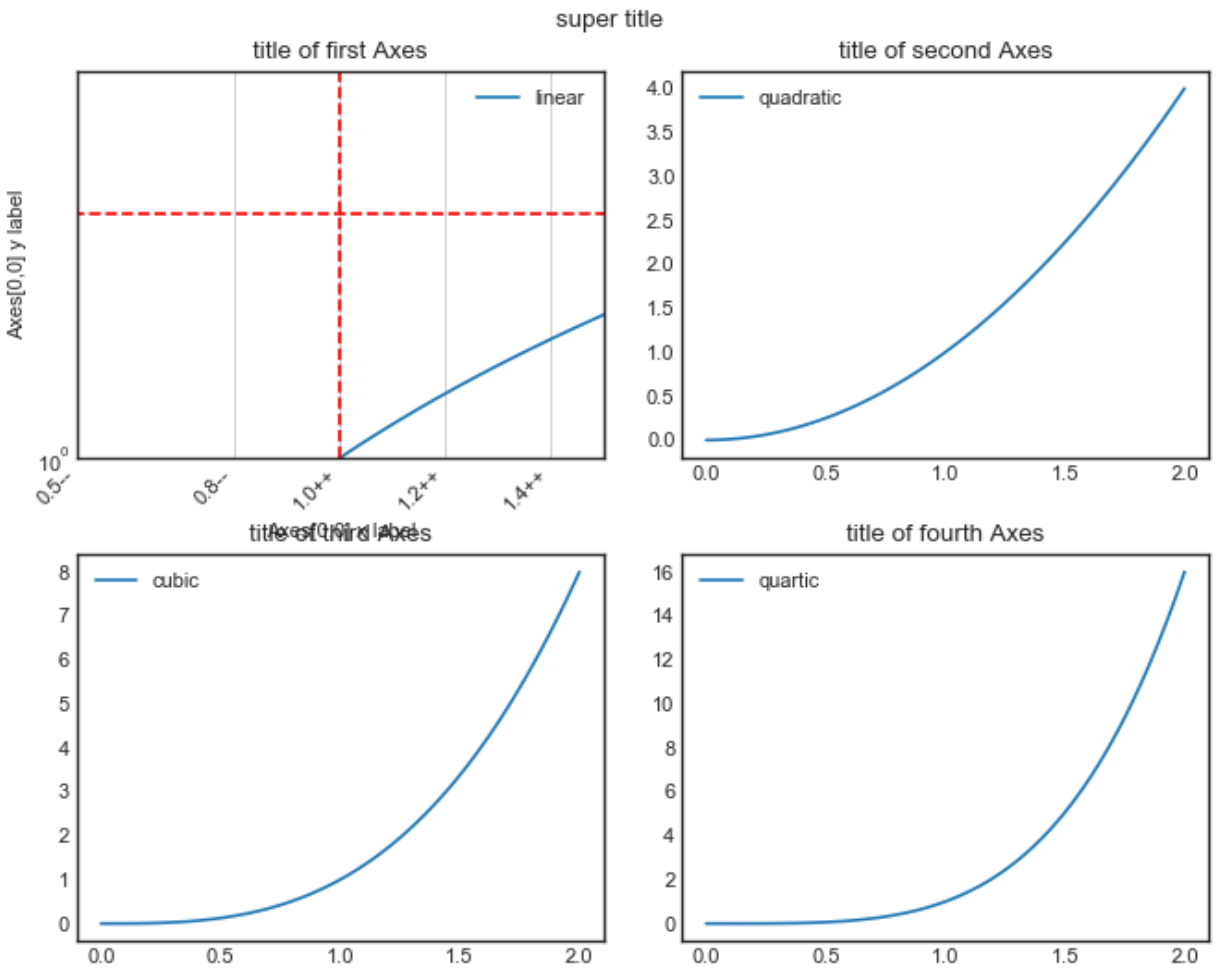
```
x = np.linspace(0, 2, 100)
fig = plt.figure() # 画布对象Figure ....<1>
fig.add_subplot() # 子图Axes对象     ....<2>
fig.suptitle('super title')

plt.plot(x, x, label='linear') #可直接调用plt,默认创建一个figure,一个subplot,则<1><2>可省略
plt.plot(x, x**2, label='quadratic')
plt.plot(x, x**3, label='cubic')
plt.xlabel('x label')
plt.ylabel('y label')
plt.title("plt_title")
plt.legend()
plt.show()
```



pyplot 式绘图

```
from matplotlib.ticker import NullFormatter,FuncFormatter

# simulate data
x = np.linspace(0., 2., 100)

fig = plt.figure(figsize=(9,7),facecolor='None',edgecolor='None',dpi=80)  # A figure can have any number of Axes, but should have at least one.
fig.suptitle('super title')
plt.title("plt_title")

# fig.add_subplot(2,2,1) # add one of four subplots on figure
plt.subplot(2,2,1) # 注意有一个区别：fig.add_subplot()所绘子图的外围边框是相连的
plt.plot(x, x, label='linear')
plt.title('title of first Axes')
# plt.xlim(0.5,1.5)
# plt.ylim(1,3) 等价于
plt.axis([0.5,1.5,1,3])
plt.xlabel("Axes[0,0] x label")
plt.xticks(rotation=45,horizontalalignment='right')
plt.ylabel("Axes[0,0] y label")
plt.yscale('log') # "linear"、"log"、"symlog"、"logit"、
plt.legend()
plt.grid(True)
plt.gca().yaxis.set_minor_formatter(NullFormatter())
plt.plot([1.]*len(x),np.exp(x),'r--') #垂直线
plt.plot(x,[2.]*len(x),'r--') # 水平线

def xticklabels(x, pos):
    """The two args are the value and tick position"""
    if x >= 1:
        s = '{:.1f}++'.format(x)
    else:
        s = '{:.1f}--'.format(x)
    return s
formatter = FuncFormatter(xticklabels)
plt.gca().xaxis.set_major_formatter(formatter)

# fig.add_subplot(2,2,2)
plt.subplot(2,2,2)
plt.plot(x, x**2, label='quadratic')
plt.title("title of second Axes")
plt.legend()

# fig.add_subplot(2,2,3)
plt.subplot(2,2,3)
plt.plot(x, x**3, label='cubic')
plt.title("title of third Axes")
plt.legend()

# fig.add_subplot(2,2,4)
```

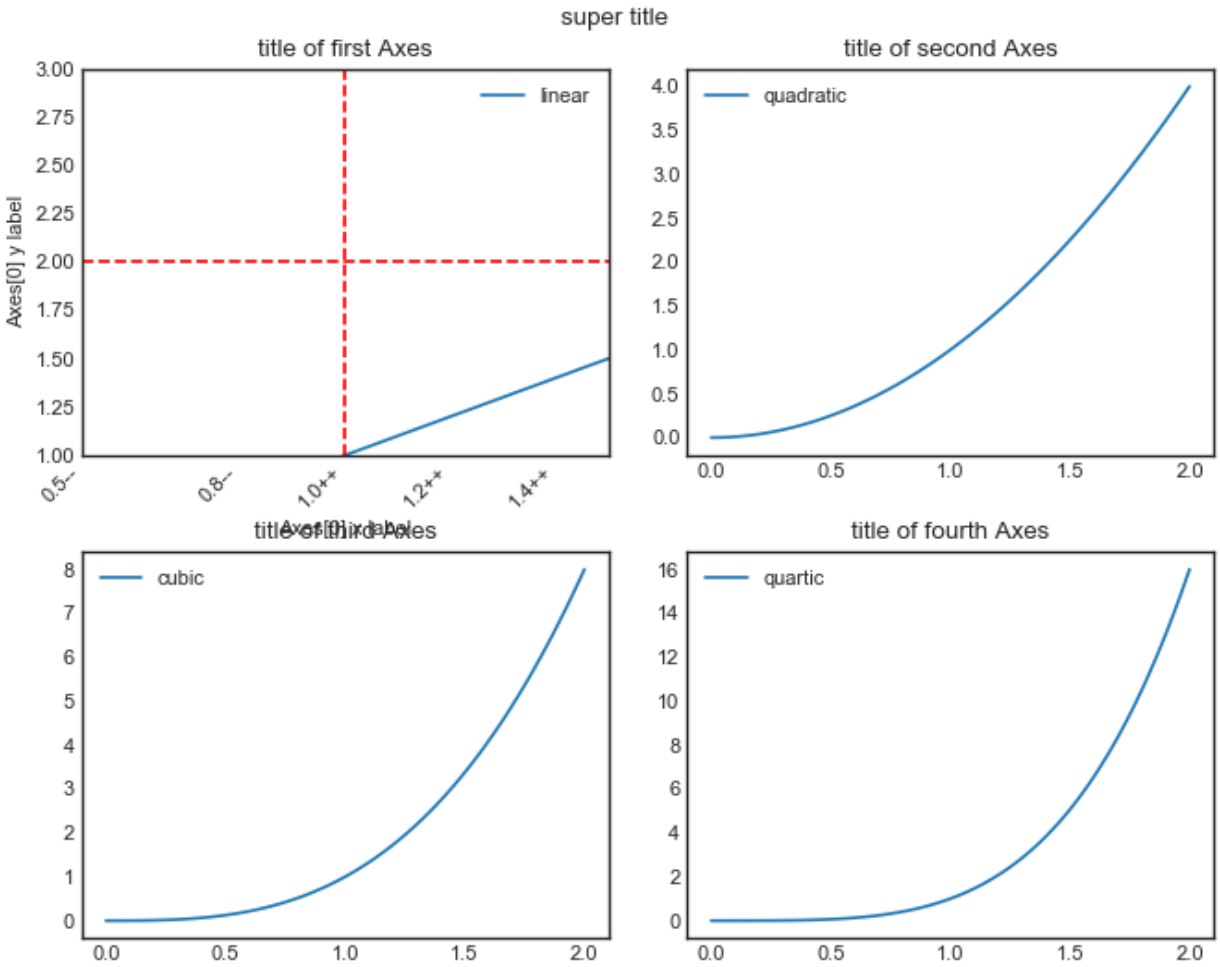
```
plt.subplot(2,2,4)
plt.plot(x, x**4, label='quartic')
plt.title("title of fourth Axes")
plt.legend()

#调整间距
plt.subplots_adjust(top=0.92, bottom=0.08, left=0.10, right=0.95, hspace=0.25,wspace=0.15)

plt.show()
```



OO（object-oriented）式绘图

```
from matplotlib.ticker import FuncFormatter
#写作一步
fig, axes = plt.subplots(2, 2,
                         figsize=(9,7), dpi=80, sharex=False,
                         sharey=False,facecolor='None', edgecolor='None')
# a figure with a 2x2 grid of Axes
# fig,(ax1,ax2,ax3,ax4) = plt.subplots(2,2) #axes[0,0]=ax1,axes[1,0]=ax3,...

fig.suptitle('super title') # Add a title so we know which it is
plt.title("plt_title") #不奏效，此时会添加到最后一个子图上
```

```
#子图Axes1
axes[0,0].plot(x, x, label='linear')
axes[0,0].set_title('title of first Axes')
axes[0,0].set_xlim(0.5,1.5)
axes[0,0].set_ylim(1,3)
axes[0,0].set_xlabel("Axes[0] x label")
axes[0,0].set_ylabel("Axes[0] y label")
axes[0,0].set_xticks([0.5,0.8,1.,1.2,1.4])
#labels = axes[0,0].get_xticklabels()
#plt.setp(labels, rotation=45, horizontalalignment='right')
axes[0,0].set_xticklabels(labels=['a','b','c','d','e'],
                          rotation=45, horizontalalignment='right')
axes[0,0].legend()
# 属性可一起设置
# axes[0,0].set(xlim=[0.5, 1.5], xlabel="Axes[0] x label",
#               ylabel= "Axes[0] y label",title='title of first Axes',
#               xticks=[0.5,0.8,1.,1.2,1.4],xticklabels=['a','b','c','d','e'])
axes[0,0].axvline(1.,ls='--', color='r') #垂直线
axes[0,0].axhline(2.0,ls='--',color='r') #水平线


def xticklabels(x, pos):
    """The two args are the value and tick position"""
    if x >= 1:
        s = '{:.1f}++'.format(x)
    else:
        s = '{:.1f}--'.format(x)
    return s
formatter = FuncFormatter(xticklabels)
axes[0,0].xaxis.set_major_formatter(formatter)

#子图Axes2
axes[0,1].plot(x, x**2, label='quadratic')
axes[0,1].set_title('title of second Axes')
axes[0,1].legend()

#子图Axes3
axes[1,0].plot(x, x**3, label='cubic')
axes[1,0].set_title('title of third Axes')
axes[1,0].legend()

#子图Axes4
axes[1,1].plot(x,x**4,label='quartic')
axes[1,1].set_title('title of fourth Axes')
axes[1,1].legend()

# 调整间距
plt.subplots_adjust(top=0.92,bottom=0.08,left=0.10,right=0.95,hspace=0.25,wspace=0.15)

plt.show()
```



pyplot

line plot

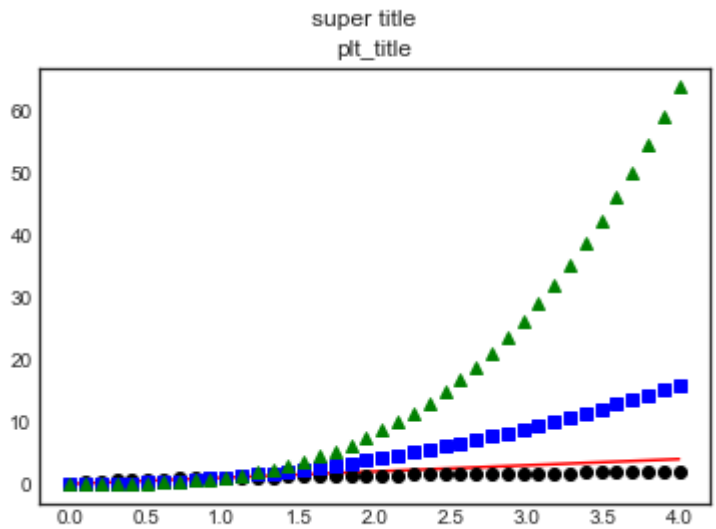
```
plt.plot(x1,y1,x2,y2,color='',label='',linestyle='',linewidth='',marker='',**kwargs)
#等价写法
lines = plt.plot(x1,y1,x2,y2)
plt.setp(lines,color='',label='',linestyle='',linewidth='',marker='',**kwargs)
# 可通过 plt.setp(lines)查看详细的绘图参数
```

`**kwargs` 包含以下内容:

properties	value
data	(np.array xdata, np.array ydata) 数据
xdata	np.array
ydata	np.array
color or c	str，颜色
label	str，标签
alpha	float，透明度
linestyle or ls	'-'|'--'|'-.'|'steps'|...
linewidth or lw	float
marker	'+'|','|'.'|'1'|'2'|'3'|'4'
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markersize or ms	float
markevery	None|integer|(startind,stride)
animated	True|False
clip_box	a matplotlib.transform.Bbox instance
clip_on	True|False
clip_path	a Path instance and a Transform instance
antialiased or aa	True|False
contains	the hit testing function
dash_capstyle	'butt'|'round'|'projecting'
dash_joinstyle	'miter'|'round'|'bevel'
dashes	sequence of on/off ink in points
lod	True|False
figure	a matplotlib.figure.Figure instance
picker	used in interactive line selection
pickradius	the line pick selection radius
solid_capstyle	'butt'|'round'|'projecting'

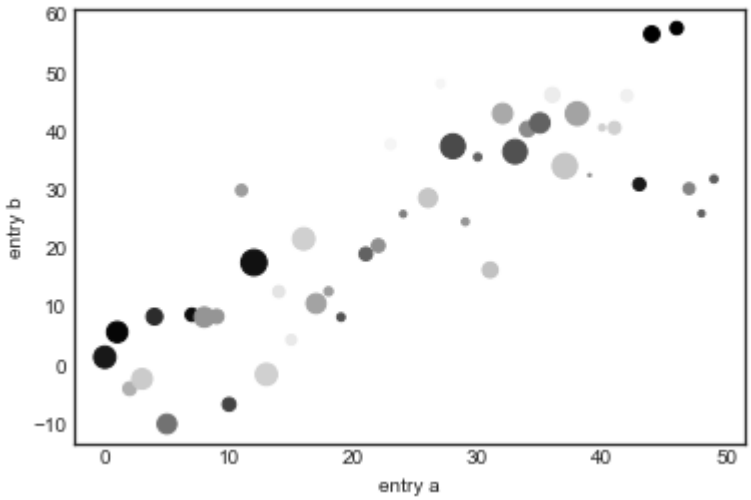
properties	value
solid_joinstyle	'miter'|'round'|'bevel'
transform	a matplotlib.transforms.Transform instance
visible	True|False
zorder	any number

```
x = np.linspace(0., 2., 100)

fig = plt.figure()
fig.suptitle('super title')
plt.title("plt_title")
plt.plot(x,x,color='red',linestyle='-',marker='') #'r--'
plt.plot(x,x**1/2,'ko', x, x**2, 'bs', x, x**3, 'g^')
'''
'ko'、'r--'、'bs'、'g^'为颜色color与线型linestyle的合并简写:
    #'ko' black circle;
    #'r--' red dash;
    #'bs' blue square;
    #'g^' green triangle
'''
plt.show()
```



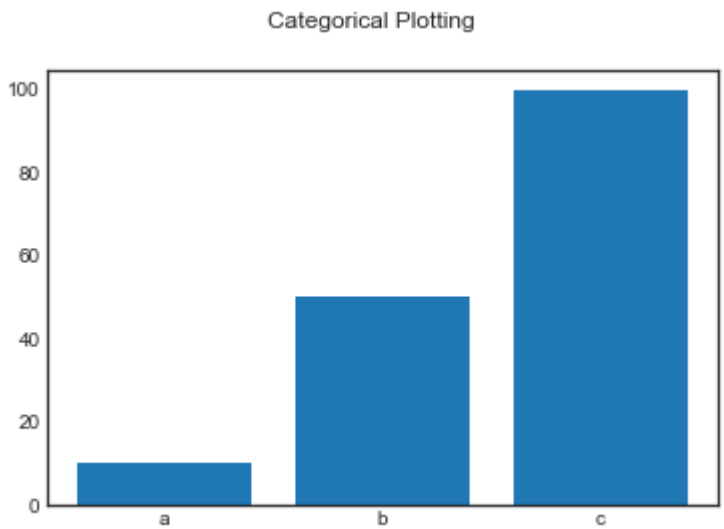
scatter plot

```
data = {'a': np.arange(50),
'c': np.random.randint(0, 50, 50),
'd': np.random.randn(50)}
data['b'] = data['a'] + 10 * np.random.randn(50)
data['d'] = np.abs(data['d']) * 100
plt.scatter('a', 'b', c='c', s='d', data=data)
plt.xlabel('entry a')
plt.ylabel('entry b')
plt.show()
```

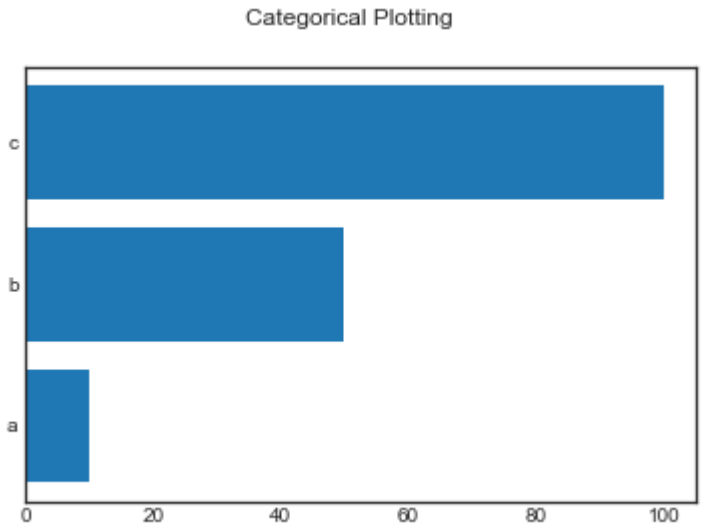


bar charts

```
names = ['a', 'b', 'c']
values = [10, 50, 100]
# bar
plt.bar(names, values)
plt.suptitle('Categorical Plotting')
plt.show()
```

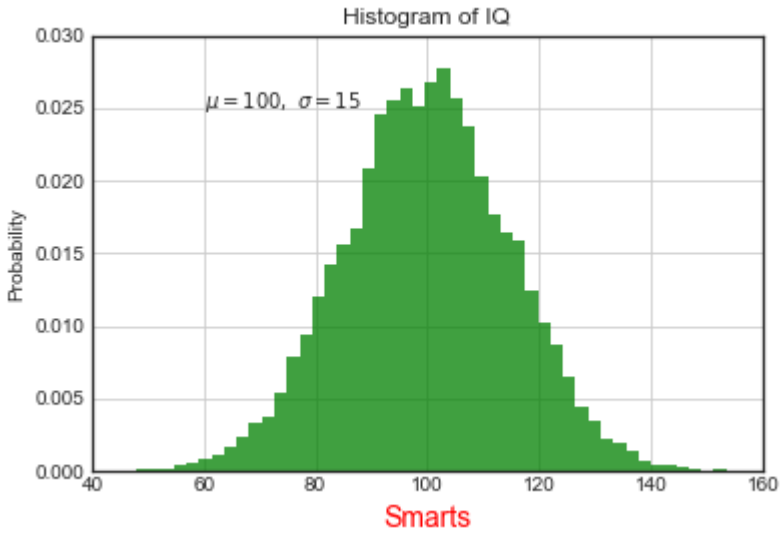


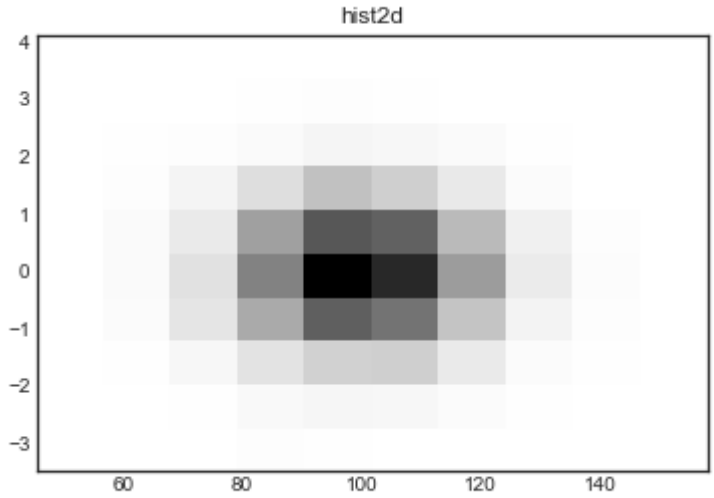
```
# barh
plt.bar(names, values)
plt.suptitle('Categorical Plotting')
plt.show()
```



histgrams

```
# normal hist
fig1 = plt.figure(1)
mu, sigma = 100, 15
x = mu + sigma * np.random.randn(10000)

n, bins, patches = plt.hist(x, 50, density=1, facecolor='g', alpha=0.75)
plt.xlabel('Smarts',fontsize=14, color='red')
plt.ylabel('Probability')
plt.title('Histogram of IQ')
plt.text(60, .025, r'$\mu=100,\ \sigma=15$')
plt.axis([40, 160, 0, 0.03])
plt.grid(True)

# hist2d
fig2 = plt.figure(2)
y = np.random.randn(10000)

plt.hist2d(x,y)
plt.title("hist2d")
plt.show()
```





pie charts

tables

log plots

polar plots

contouring and pseudocolor

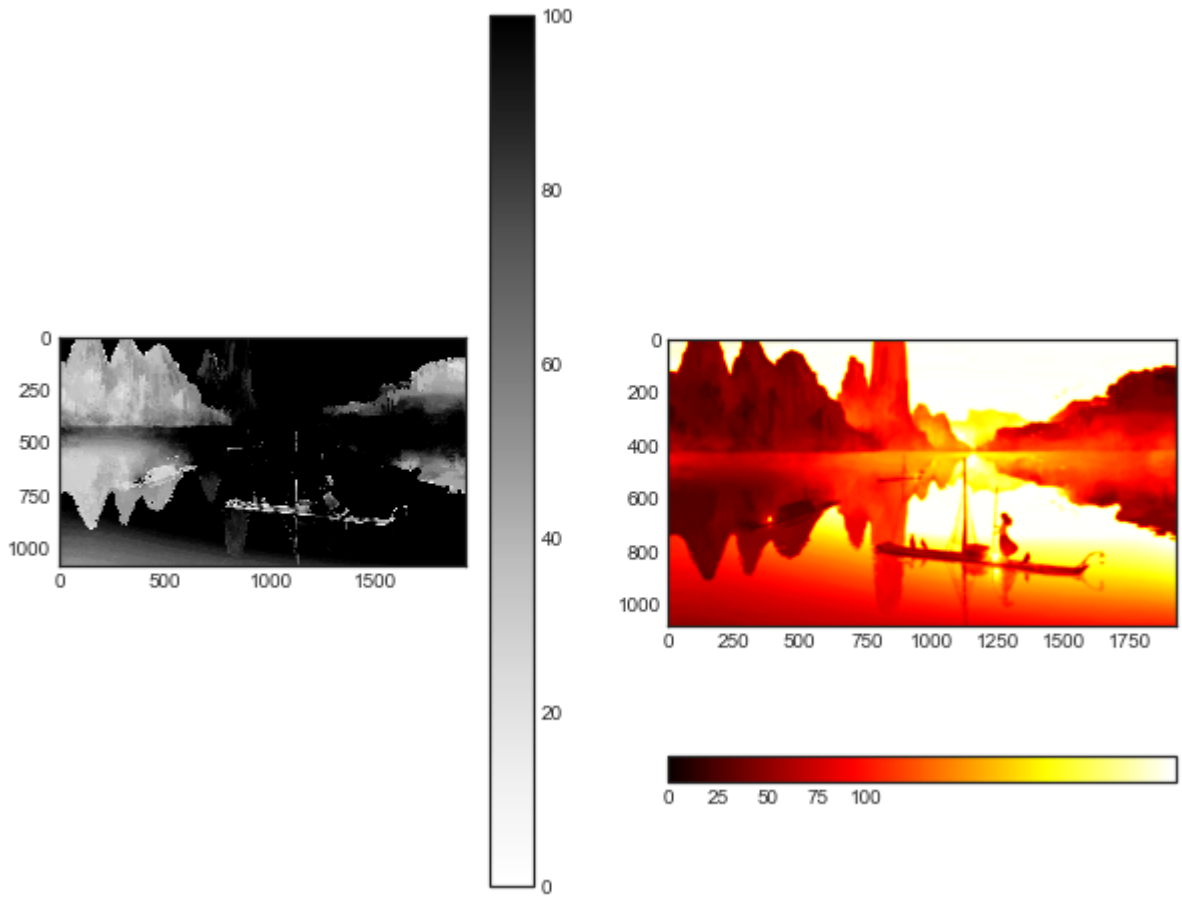
streamplot

ellipses

images

```
import matplotlib.image as mpimg
img = mpimg.imread("image.jpg")
# print(img)
# img为np.ndarray
# You can plot any numpy array
plt.imshow(img)
```

```
# luminosity images
plt.figure(figsize=(10,8))
plt.subplot(121)
lum_img = img[:,:,0]
plt.imshow(lum_img,clim=(0,100), interpolation="nearest")
plt.colorbar()

plt.subplot(122)
plt.imshow(lum_img,cmap='hot', interpolation="bicubic") # cmap:'nipy_spectral'、'hot'
# imgplot = plt.imshow(lum_img)
# imgplot.set_cmap('hot')
plt.colorbar(ticks=[0, 25, 50, 75,100], orientation='horizontal')
```



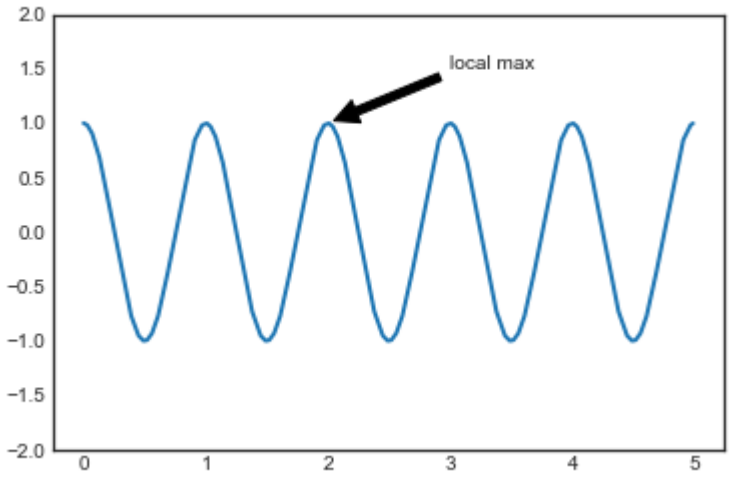
paths

Text and Annotate

```
plt.text(x,y,s='str')
```

```
plt.annotate('str',xy=(,),xytext=(,),arrowprops=dict(facecolor,shrink))
```

```
ax = plt.subplot(111)
t = np.arange(0.0, 5.0, 0.01)
s = np.cos(2*np.pi*t)
line, = plt.plot(t, s, lw=2)
plt.annotate('local max', xy=(2, 1), xytext=(3, 1.5),
             arrowprops=dict(facecolor='black', shrink=0.05)
            )
plt.ylim(-2, 2)
plt.show()
```



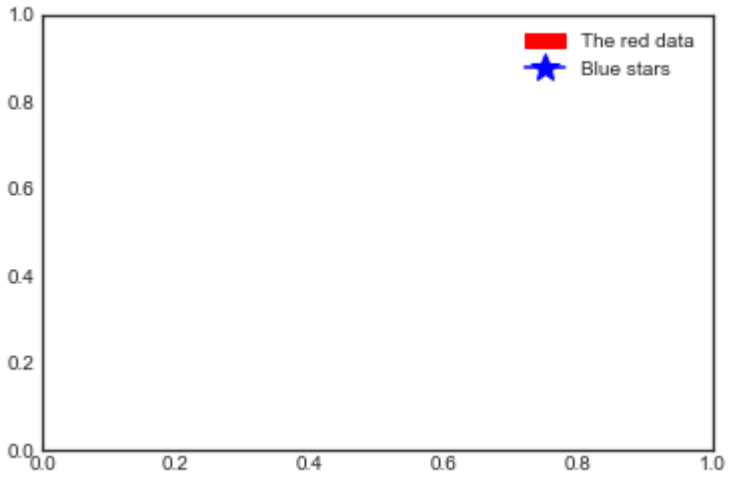
math text

Legend

```
plt.legend(handle=[],labels=[],bbox_to_anchor=(),loc='', borderaxespad=0.)
```

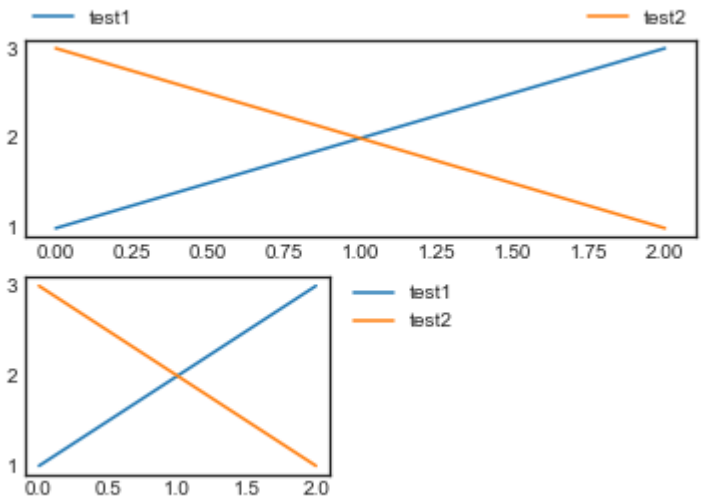
legend entry

```
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import matplotlib.lines as mlines

red_patch = mpatches.Patch(color='red', label='The red data')
blue_line = mlines.Line2D([], [], color='blue', marker='*',
                          markersize=15, label='Blue stars')

plt.legend(handles=[red_patch,blue_line])
plt.show()
```

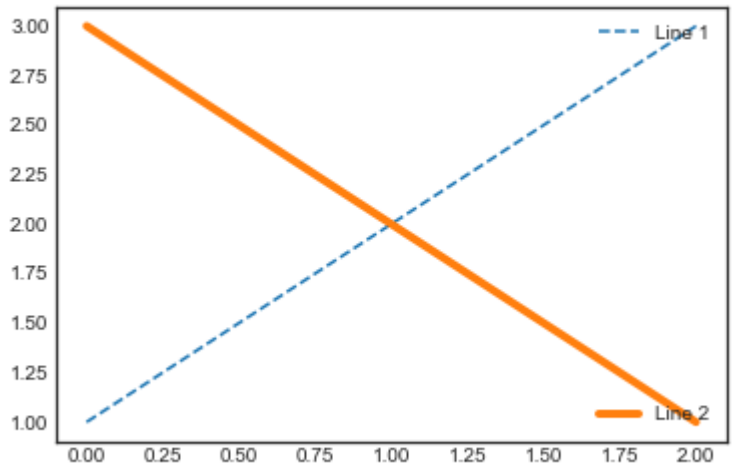


legend location

```
plt.subplot(211)
plt.plot([1, 2, 3], label="test1")
plt.plot([3, 2, 1], label="test2")
# Place a legend above this subplot, expanding itself to
# fully use the given bounding box.
plt.legend(bbox_to_anchor=(0., 1.02, 1., .102),
           loc='lower left',ncol=2, mode="expand", borderaxespad=0.)

plt.subplot(223)
plt.plot([1, 2, 3], label="test1")
plt.plot([3, 2, 1], label="test2")
# Place a legend to the right of this smaller subplot.
plt.legend(bbox_to_anchor=(1.05, 1),
           loc='upper left', borderaxespad=0.)

plt.show()
```



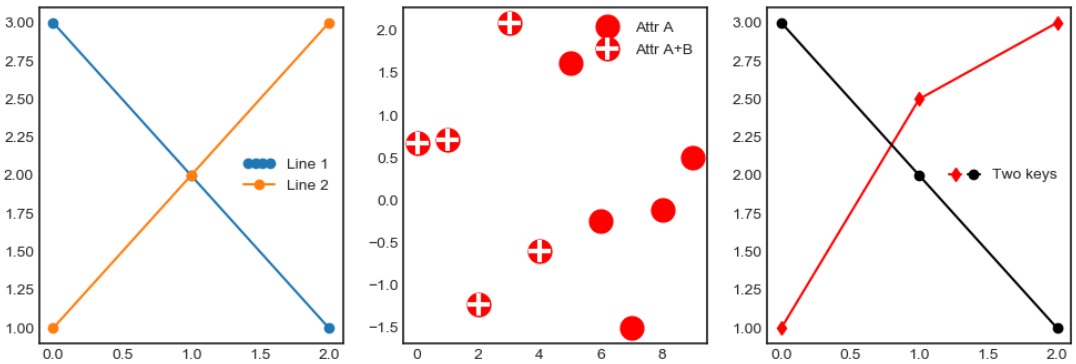
```
# multiple legends
line1, = plt.plot([1, 2, 3], label="Line 1", linestyle='--')
line2, = plt.plot([3, 2, 1], label="Line 2", linewidth=4)

# Create a legend for the first line.
first_legend = plt.legend(handles=[line1], loc='upper right')
# Add the legend manually to the current Axes.
ax = plt.gca().add_artist(first_legend)

# Create another legend for the second line.
plt.legend(handles=[line2], loc='lower right')
plt.show()
```



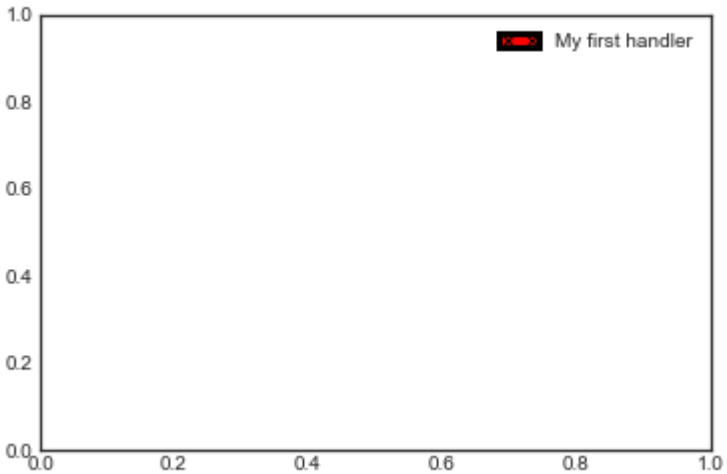
legend Handlers

```
from matplotlib.legend_handler import HandlerLine2D,HandlerTuple
fig = plt.figure()
# 改变其中一个
plt.subplot(131)
line1, = plt.plot([3, 2, 1], marker='o', label='Line 1')
line2, = plt.plot([1, 2, 3], marker='o', label='Line 2')
plt.legend(handler_map={line1: HandlerLine2D(numpoints=4)})

# 拼合其中一个
plt.subplot(132)
z = np.random.randn(10)
red_dot, = plt.plot(z, "ro", markersize=15)
# Put a white cross over some of the data.
white_cross, = plt.plot(z[:5], "w+", markeredgewidth=3, markersize=15)
plt.legend([red_dot, (red_dot, white_cross)], ["Attr A", "Attr A+B"])

# 二合一
plt.subplot(133)
p1, = plt.plot([1, 2.5, 3], 'r-d')
p2, = plt.plot([3, 2, 1], 'k-o')
```

```
plt.legend([(p1, p2)], ['Two keys'], numpoints=1,
               handler_map={tuple: HandlerTuple(ndivide=None)})
plt.show()
```

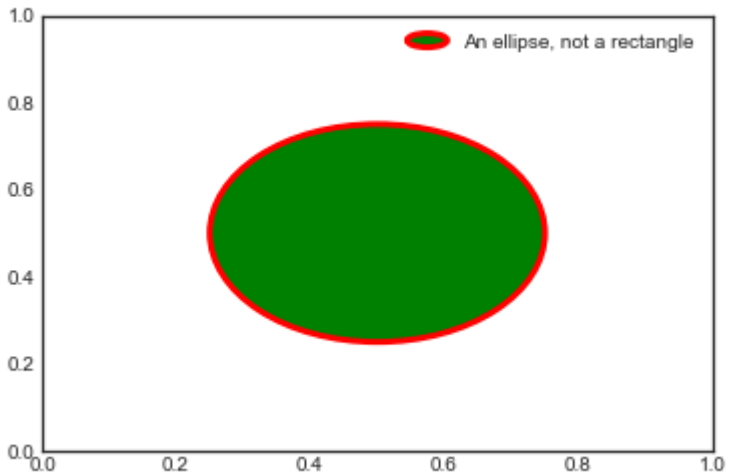



```
# custom legend handler
import matplotlib.patches as mpatches
class AnyObject(object):
    pass
class AnyObjectHandler(object):
    def legend_artist(self, legend, orig_handle, fontsize, handlebox):
        x0, y0 = handlebox.xdescent, handlebox.ydescent
        width, height = handlebox.width, handlebox.height
        patch = mpatches.Rectangle([x0, y0], width,
height,facecolor='red',edgecolor='black',
                                   hatch='xx', lw=3,transform=handlebox.get_transform())
        handlebox.add_artist(patch)
        return patch
plt.legend([AnyObject()], ['My first handler'],
           handler_map={AnyObject: AnyObjectHandler()})
```



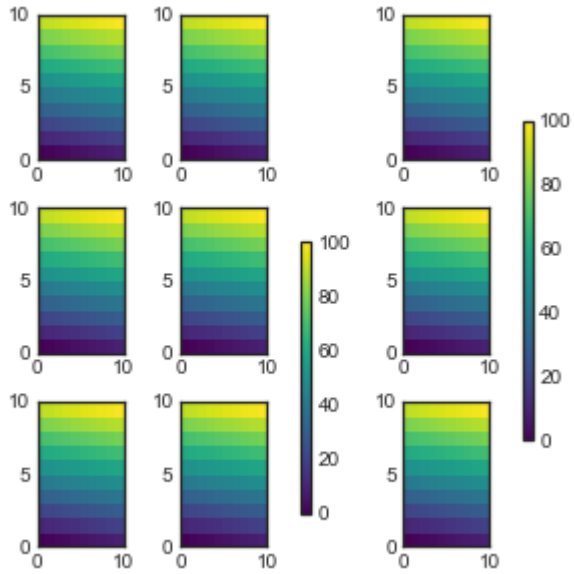

```
from matplotlib.legend_handler import HandlerPatch
class HandlerEllipse(HandlerPatch):
```

```
    def create_artists(self, legend, orig_handle,xdescent,
                       ydescent, width, height, fontsize, trans):
        center = 0.5 * width - 0.5 * xdescent, 0.5 * height - 0.5 * ydescent
        p = mpatches.Ellipse(xy=center, width=width + xdescent,height=height + ydescent)
        self.update_prop(p, orig_handle, legend)
        p.set_transform(trans)
        return [p]

c = mpatches.Circle((0.5, 0.5), 0.25, facecolor="green",edgecolor="red", linewidth=3)
plt.gca().add_patch(c)
plt.legend([c], ["An ellipse, not a rectangle"],
           handler_map={mpatches.Circle: HandlerEllipse()})
```

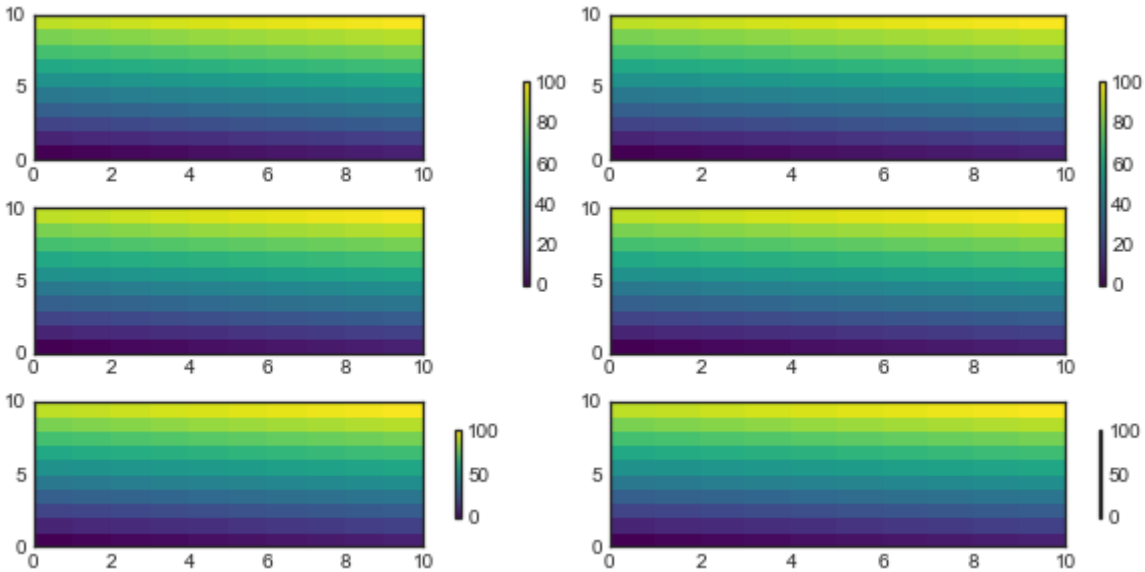


Colorbars

```
import matplotlib.colors as mcolors
arr = np.arange(100).reshape((10, 10))
norm = mcolors.Normalize(vmin=0., vmax=100.)
# see note above: this makes all pcolormesh calls consistent:
pc_kwargs = {'rasterized': True, 'cmap': 'viridis', 'norm': norm}
fig, axs = plt.subplots(3, 3, figsize=(4, 4), constrained_layout=True)
for ax in axs.flatten():
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[1:, ][:, 1], shrink=0.8)
fig.colorbar(im, ax=axs[:, -1], shrink=0.6)
```



```
fig, axs = plt.subplots(3, 1, figsize=(4, 4), constrained_layout=True)
for ax in axs[:2]:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[:2], shrink=0.6)
im = axs[2].pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[2], shrink=0.6) #

fig, axs = plt.subplots(3, 1, figsize=(4, 4), constrained_layout=True)
for ax in axs[:2]:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[:2], shrink=0.6)
im = axs[2].pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=[axs[2]], shrink=0.6) #The API to make a single-axes behave like a list of axes is to specify it as a list (or other iterable container)
```



GUI widgets

Filled curves

Date handling

mplot3D

自定义对象（customizing objects）

对象属性（properties）

Artist instances are stored as member variables `Figure.patch` and `Axes.patch` (”Patch” is a name inherited from MATLAB, and is a 2D ”patch” of color on the figure, e.g., rectangles, circles and polygons). Every matplotlib Artist has many [properties][](pyplot=>line plot)

```
[In] matplotlib.artist.getp(fig.patch)
[Out]
    alpha = 1.0
    animated = False
    antialiased or aa = True
    axes = None
    clip_box = None
    clip_on = False
    clip_path = None
    contains = None
    edgecolor or ec = w
    facecolor or fc = 0.75
    figure = Figure(8.125x6.125)
    fill = 1
    hatch = None
    height = 1
    label =
    linewidth or lw = 1.0
    picker = None
    transform = <Affine object at 0x134cca84>
    verts = ((0, 0), (0, 1), (1, 1), (1, 0))
    visible = True
    width = 1
    window_extent = <Bbox object at 0x134acbcc>
    x = 0
    y = 0
    zorder = 1
```

对象容器（object container）

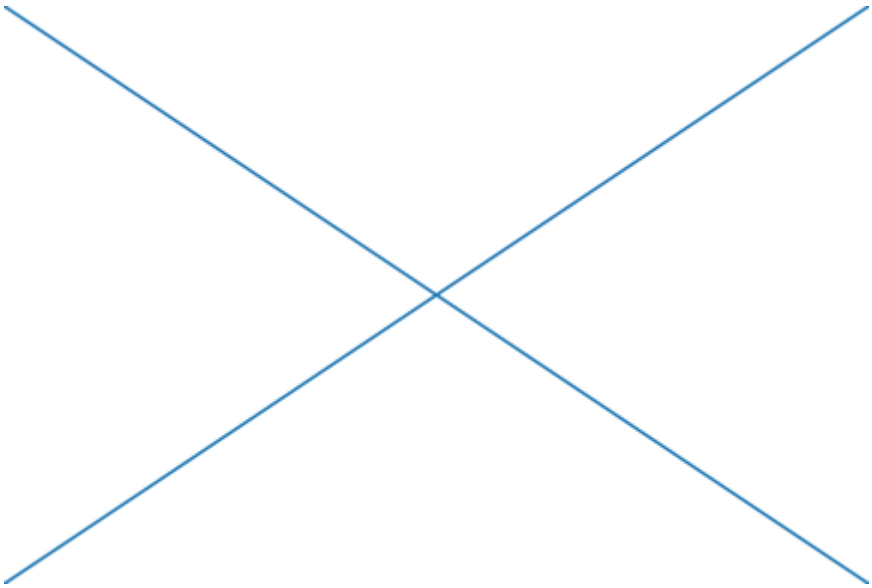
Figure container

- `matplotlib.figure.Figure`是顶层容器，包含一切对象。
- 其背景是一个`Rectangle`，存储在`Figure.patch`中。
- `fig.add_subplot()`以及`fig.add_axes()`均被添加进了`Figure.axes`中。

```
for ax in fig.axes: #可以给每一个子图添加网格线
    ax.grid(True)
```

- `Figure`有其自己的`text, lines, patches and images`，可以直接添加这些对象。

```
import matplotlib.lines as lines
fig = plt.figure()
l1 = lines.Line2D([0, 1], [0, 1], transform=fig.transFigure, figure=fig)
l2 = lines.Line2D([0, 1], [1, 0], transform=fig.transFigure, figure=fig)
fig.lines.extend([l1, l2])
plt.show()
```



- `Figure`的属性

Figure attribute	Description
axes	A list of Axes instances (includes Subplot)
patch	The Rectangle background
images	A list of Figure Images patches - useful for raw pixel display
legends	A list of Figure Legend instances (different from Axes.legends)
lines	A list of Figure Line2D instances (rarely used, see Axes.lines)
patches	A list of Figure patches (rarely used, see Axes.patches)
texts	A list Figure Text instances

Axes container

- `matplotlib.axes.Axes`是matploblib的核心。
- 包含一个`Rectangle patch`用于笛卡尔坐标系以及一个`Circle patch`用于极坐标系。

```
ax = fig.add_subplot(111)
rect = ax.patch # a Rectangle instance
rect.set_facecolor('green')

ax.plot() # 创建了个 matplotlib.lines.Line2D() 实例，并加入了Axes.lines container
```

- `Axes`的属性

Axes attribute	Description
artists	A list of Artist instances
patch	Rectangle instance for Axes background
collections	A list of Collection instances
images	A list of AxesImage
legends	A list of Legend instances
lines	A list of Line2D instances
patches	A list of Patch instances
texts	A list of Text instances
xaxis	matplotlib.axis.XAxis instance
yaxis	matplotlib.axis.YAxis instance

Axis containers

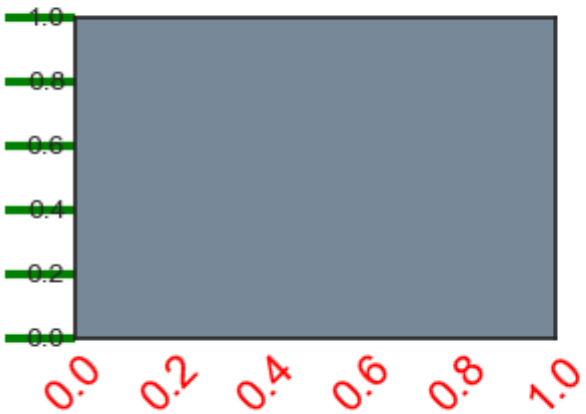
- `matplotlib.axis.Axis`处理`the tick lines, the grid lines, the tick labels and the axis label`.

```
fig, ax = plt.subplots()
ax.xaxis.set_major_formatter()
ax.xaxis.get_major_locator()
ax.xaxis.get_major_formatter()
ax.xaxis.get_minor_locator()
ax.xaxis.get_minor_formatter()
ax.xaxis.get_major_ticks()
ax.xaxis.get_minor_ticks()

ax.xaxis.get_ticklocs()
ax.xaxis.get_ticklabels()
ax.xaxis.get_ticklines() #major ticks
```

```
ax.xaxis.get_ticklines(minor=True)

ax.xaxis.get_scale()
ax.xaxis.get_label()
ax.xaxis.get_view_interval()
ax.xaxis.get_data_interval()

ax.xaxis.get_gridlines()
ax.xaxis.grid()
```

- **example:**

```
fig = plt.figure()
rect = fig.patch # a rectangle instance
rect.set_facecolor('lightgoldenrodyellow')
ax1 = fig.add_axes([0.1, 0.3, 0.4, 0.4])
rect = ax1.patch
rect.set_facecolor('lightslategray')
for label in ax1.xaxis.get_ticklabels():
# label is a Text instance
label.set_color('red')
label.set_rotation(45)
label.set_fontsize(16)
for line in ax1.yaxis.get_ticklines():
# line is a Line2D instance
line.set_color('green')
line.set_markersize(25)
line.set_markeredgewidth(3)
plt.show()
```



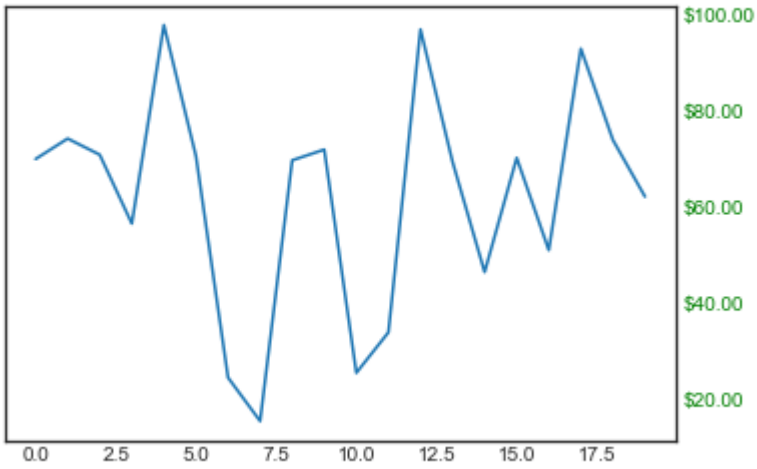
Tick containers

- `matplotlib.axis.Tick` 包含 `tick` 、 `grid line` 和 `label` 实例。
- `Tick` 的属性

Tick attribute	Description
tick1line	Line2D instance
tick2line	Line2D instance
gridline	Line2D instance
label1	Text instance
label2	Text instance
gridOn	boolean which determines whether to draw the gridline
tick1On	boolean which determines whether to draw the 1st tickline
tick2On	boolean which determines whether to draw the 2nd tickline
label1On	boolean which determines whether to draw the 1st tick label
label2On	boolean which determines whether to draw the 2nd tick label

- **example:**

```
import matplotlib.ticker as ticker
# Fixing random state for reproducibility
np.random.seed(19680801)
fig, ax = plt.subplots()
ax.plot(100*np.random.rand(20))
formatter = ticker.FormatStrFormatter('$%1.2f')
ax.yaxis.set_major_formatter(formatter)
for tick in ax.yaxis.get_major_ticks():
tick.label1On = False
tick.label2On = True
tick.label2.set_color('green')
plt.show()
```



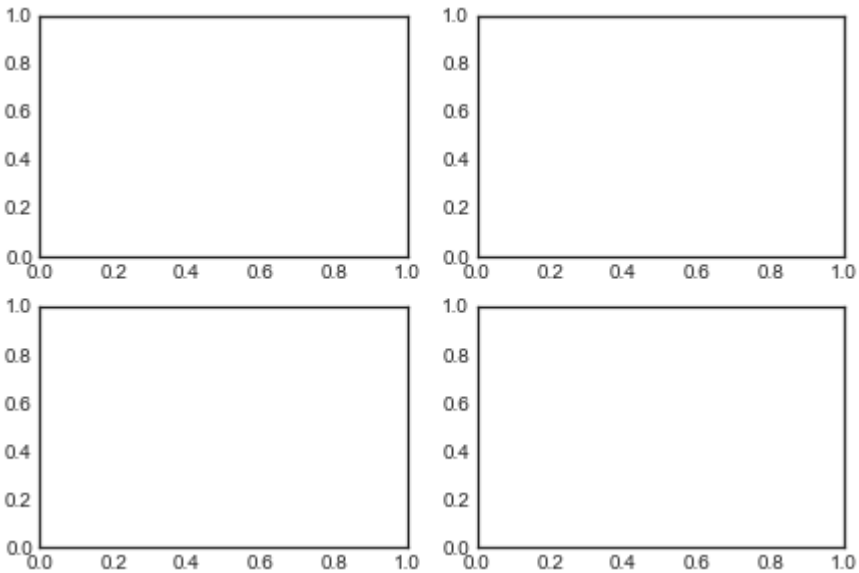
自定义图形层叠(Customizing Figure Layouts)

fig.add_subplot(spec[,])

```
fig, axes = plt.subplots(ncols=2, nrows=2, constrained_layout=True)
```

等价于:

```
import matplotlib.gridspec as gridspec
fig = plt.figure(constrained_layout=True)
spec = gridspec.GridSpec(ncols=2, nrows=2, figure=fig)
ax1 = fig.add_subplot(spec[0, 0])
ax2 = fig.add_subplot(spec[0, 1])
ax3 = fig.add_subplot(spec[1, 0])
ax4 = fig.add_subplot(spec[1, 1])
```



```
fig = plt.figure(constrained_layout=True)
gs = fig.add_gridspec(3, 3)
ax1 = fig.add_subplot(gs[0, :])
ax1.set_title('gs[0, :]')
ax2 = fig.add_subplot(gs[1, :-1])
ax2.set_title('gs[1, :-1]')
ax3 = fig.add_subplot(gs[1:, -1])
ax3.set_title('gs[1:, -1]')
ax4 = fig.add_subplot(gs[-1, 0])
ax4.set_title('gs[-1, 0]')
ax5 = fig.add_subplot(gs[-1, -2])
ax5.set_title('gs[-1, -2]')
```

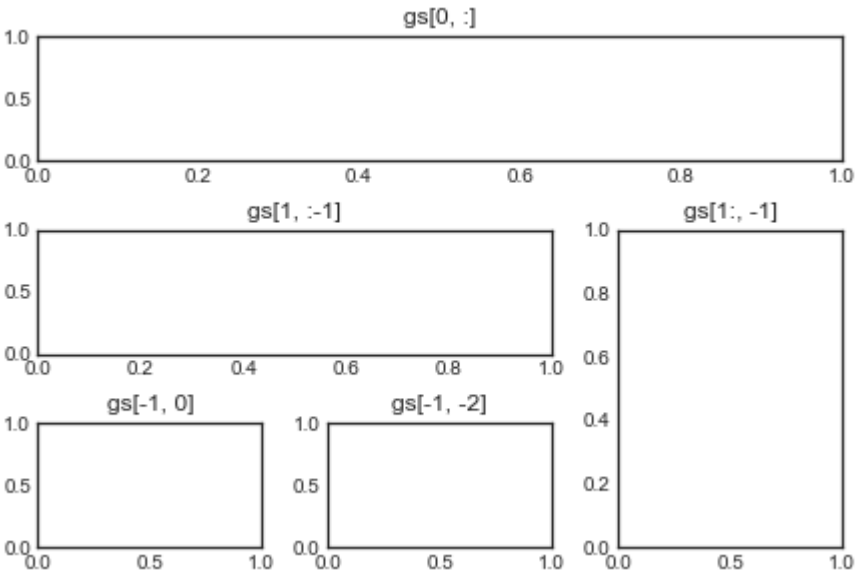
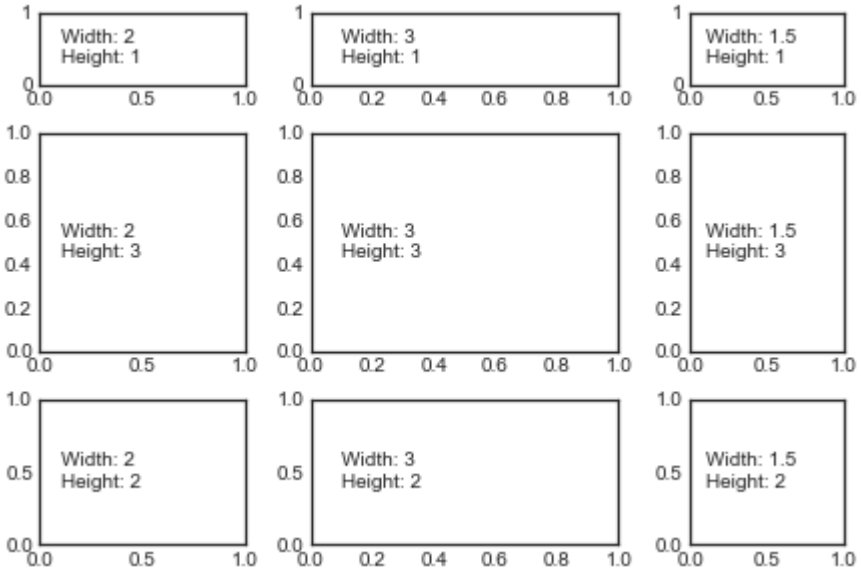


fig.add_gridspec()

```
fig = plt.figure(constrained_layout=True)
widths = [2, 3, 1.5]
heights = [1, 3, 2]
spec5 = fig.add_gridspec(ncols=3, nrows=3, width_ratios=widths,height_ratios=heights)
for row in range(3):
    for col in range(3):
        ax = fig.add_subplot(spec5[row, col])
        label = 'Width: {}\nHeight: {}'.format(widths[col], heights[row])
        ax.annotate(label, (0.1, 0.5), xycoords='axes fraction', va='center')
```



axes.get_gridspec()

```
fig, axs = plt.subplots(ncols=3, nrows=3)
gs = axs[1, 2].get_gridspec()
# remove the underlying axes
for ax in axs[1:, -1]:
    ax.remove()
    axbig = fig.add_subplot(gs[1:, -1])
    axbig.annotate('Big Axes \nGridSpec[1:, -1]', (0.1, 0.5),
    xycoords='axes fraction', va='center')

fig.tight_layout()
```

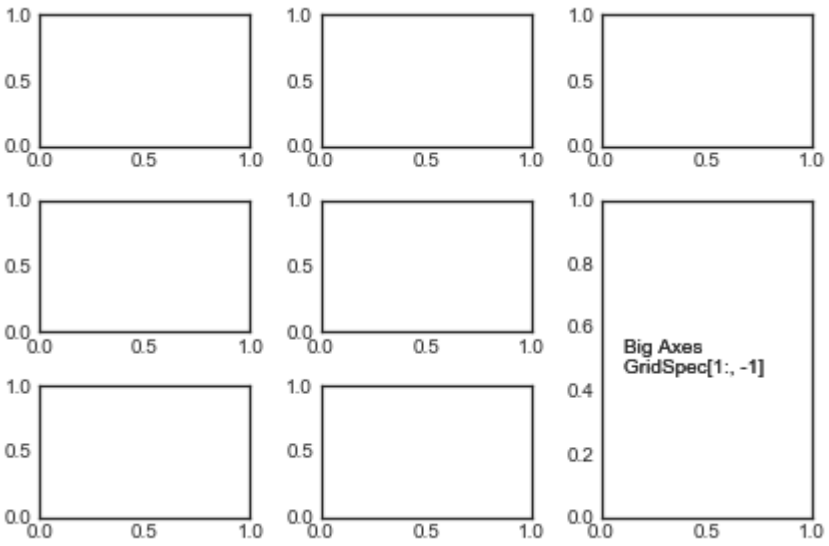
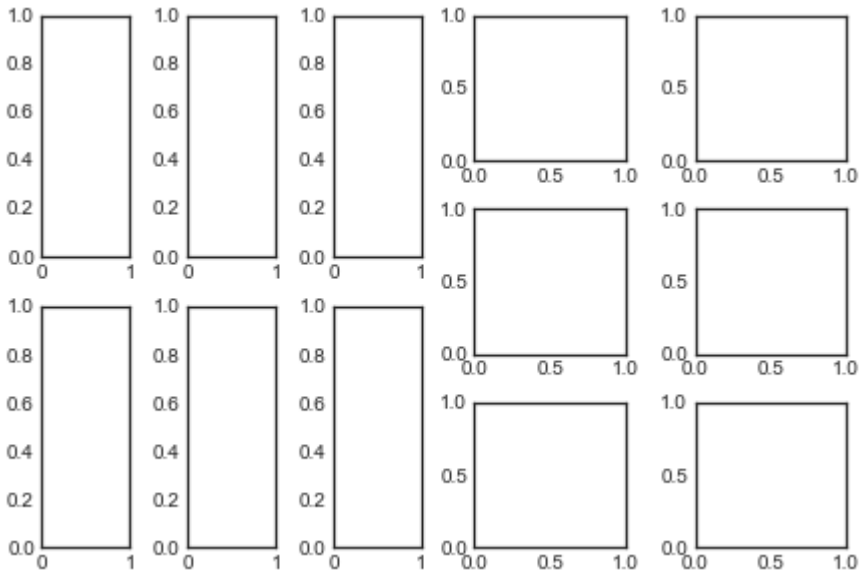


fig.add_gridspec().subgridspec()

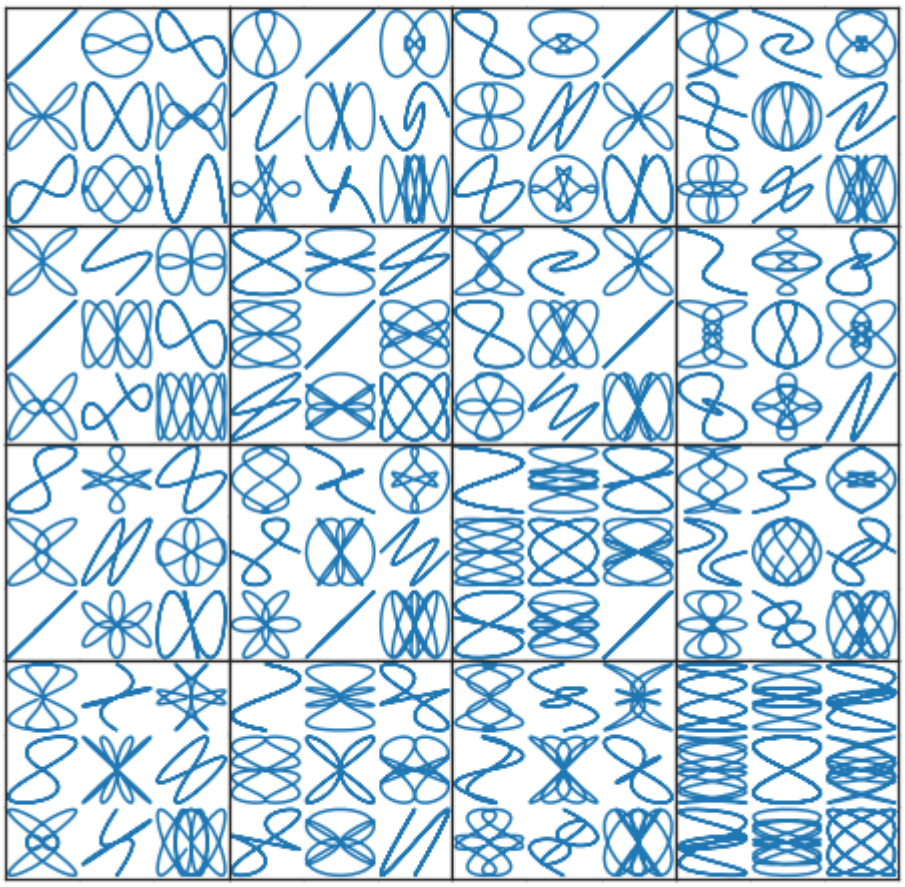
```
fig = plt.figure(constrained_layout=True)
gs0 = fig.add_gridspec(1, 2)
gs00 = gs0[0].subgridspec(2, 3)
gs01 = gs0[1].subgridspec(3, 2)
for a in range(2):
    for b in range(3):
        fig.add_subplot(gs00[a, b])
        fig.add_subplot(gs01[b, a])
```



Complex SubplotSpec.subgridspec

```
from itertools import product
def squiggle_xy(a, b, c, d, i=np.arange(0.0, 2*np.pi, 0.05)):
    return np.sin(i*a)*np.cos(i*b), np.sin(i*c)*np.cos(i*d)
fig = plt.figure(figsize=(8, 8), constrained_layout=False)
# gridspec inside gridspec
outer_grid = fig.add_gridspec(4, 4, wspace=0.0, hspace=0.0)
for i in range(16):
    inner_grid = outer_grid[i].subgridspec(3, 3, wspace=0.0, hspace=0.0)
    a, b = int(i/4)+1, i % 4+1
    for j, (c, d) in enumerate(product(range(1, 4), repeat=2)):
        ax = plt.Subplot(fig, inner_grid[j])
        ax.plot(*squiggle_xy(a, b, c, d))
        ax.set_xticks([])
        ax.set_yticks([])
        fig.add_subplot(ax)

all_axes = fig.get_axes()
# show only the outside spines
for ax in all_axes:
    for sp in ax.spines.values():
        sp.set_visible(False)
    if ax.is_first_row():
        ax.spines['top'].set_visible(True)
    if ax.is_last_row():
```

```
        ax.spines['bottom'].set_visible(True)
    if ax.is_first_col():
        ax.spines['left'].set_visible(True)
    if ax.is_last_col():
        ax.spines['right'].set_visible(True)
plt.show()
```



constrained_layout

- constrained_layout automatically adjusts subplots and decorations like legends and colorbars.
- constrained_layout needs to be activated before any axes are added to a figure.

params setting

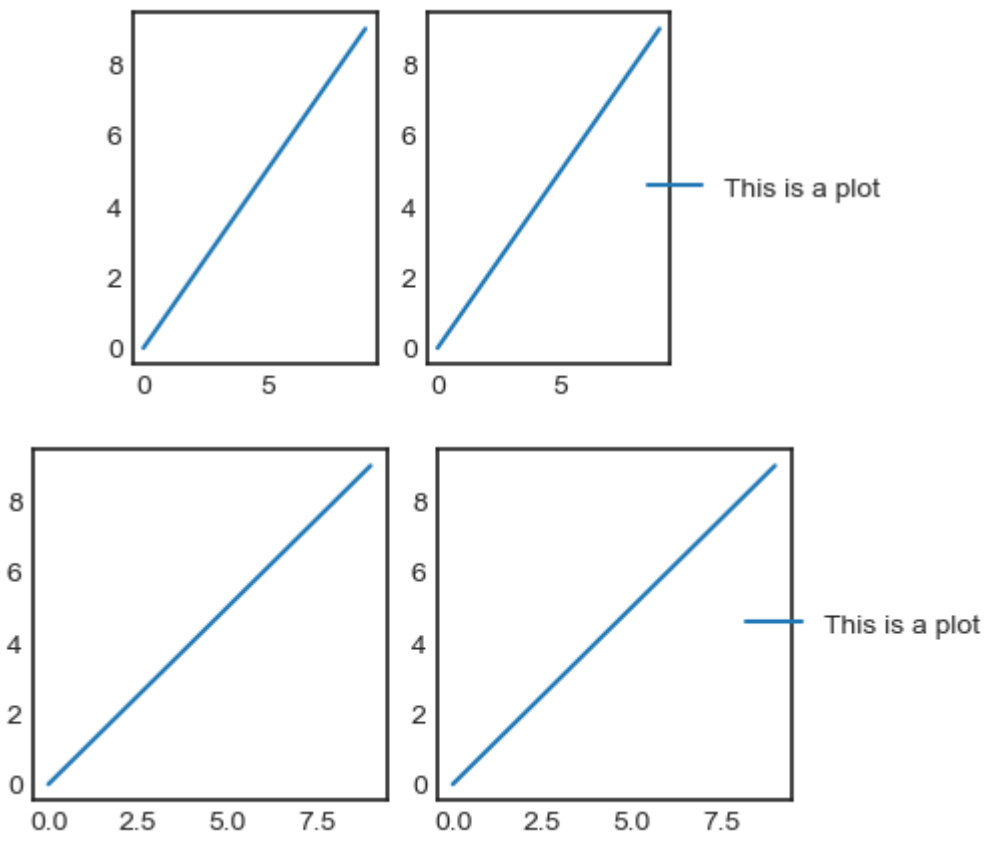
```
plt.subplots(constrained_layout=True)
plt.figure(constrained_layout=True)

plt.rcParams['figure.constrained_layout.use'] = True

fig.set_constrained_layout(False) # turn off
plt.set_constrained_layout(False)
```

- constrained_layout can also make room for suptitle.

legend problem

- constrained-layout does not handle legends being created via Figure.legend() (yet).

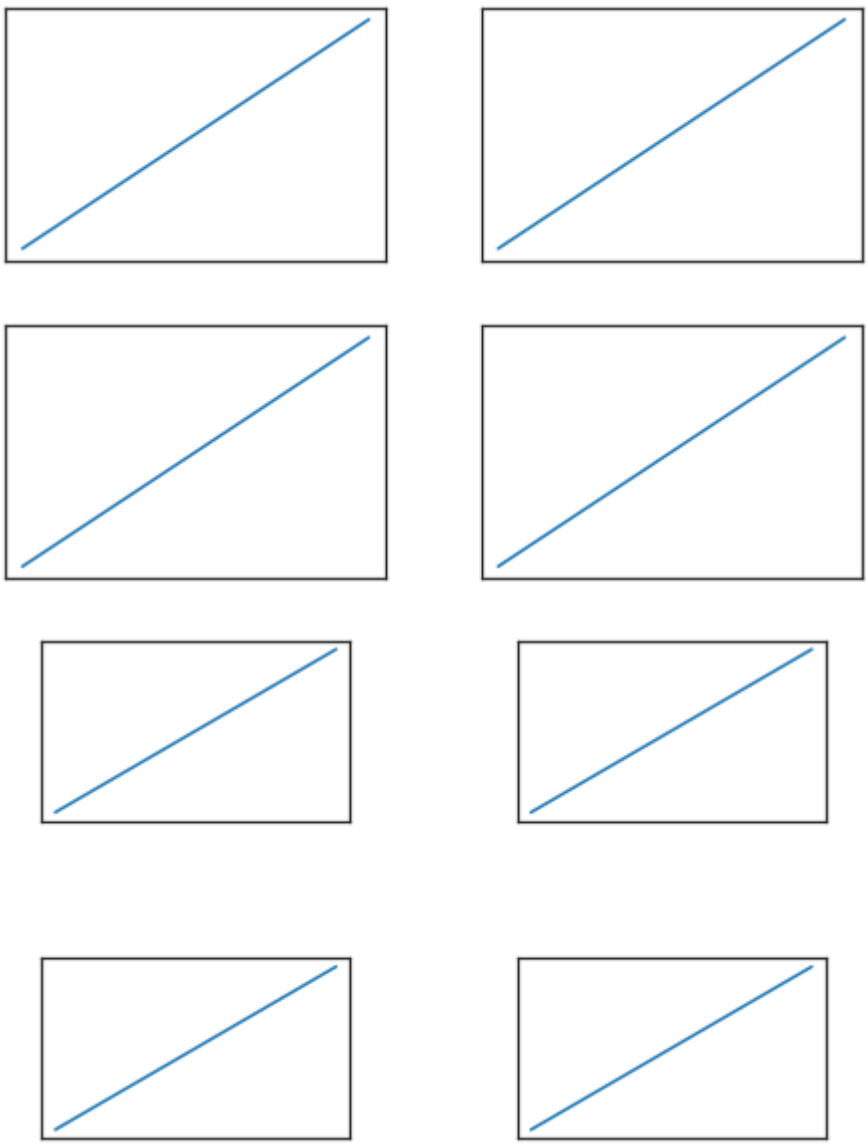
```
fig, axs = plt.subplots(1, 2, figsize=(4, 2), constrained_layout=True)
axs[0].plot(np.arange(10))
axs[1].plot(np.arange(10), label='This is a plot')
axs[1].legend(loc='center left', bbox_to_anchor=(0.8, 0.5))

# better way
fig, axs = plt.subplots(1, 2, figsize=(4, 2), constrained_layout=True)
axs[0].plot(np.arange(10))
lines = axs[1].plot(np.arange(10), label='This is a plot')
labels = [l.get_label() for l in lines]
leg = fig.legend(lines, labels, loc='center left',
bbox_to_anchor=(0.8, 0.5), bbox_transform=axs[1].transAxes)
```



spacing and padding

> set_constrained_layout_pads()

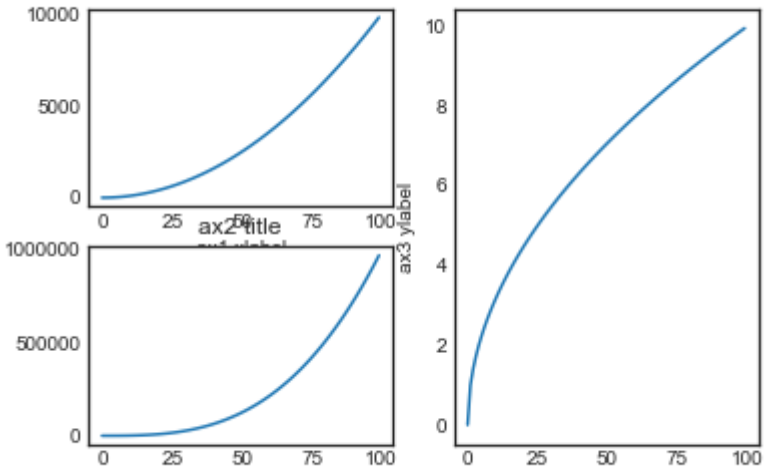
```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flatten():
    ax.plot([1,2,3],[1,2,3])
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=2./72., h_pad=2./72.,hspace=0.2, wspace=0.2) #

fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flatten():
    ax.plot([1,2,3],[1,2,3])
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=8./72., h_pad=8./72.,hspace=0.2, wspace=0.2) #
```



subplot problem

- constrained_layout will not work on subplots created via the subplot command. The reason is that each of these commands creates a separate GridSpec instance and constrained_layout uses (nested) gridspecs to carry out the layout. (that is,using gridspec directly will work well,)
- So the following fails to yield a nice layout:

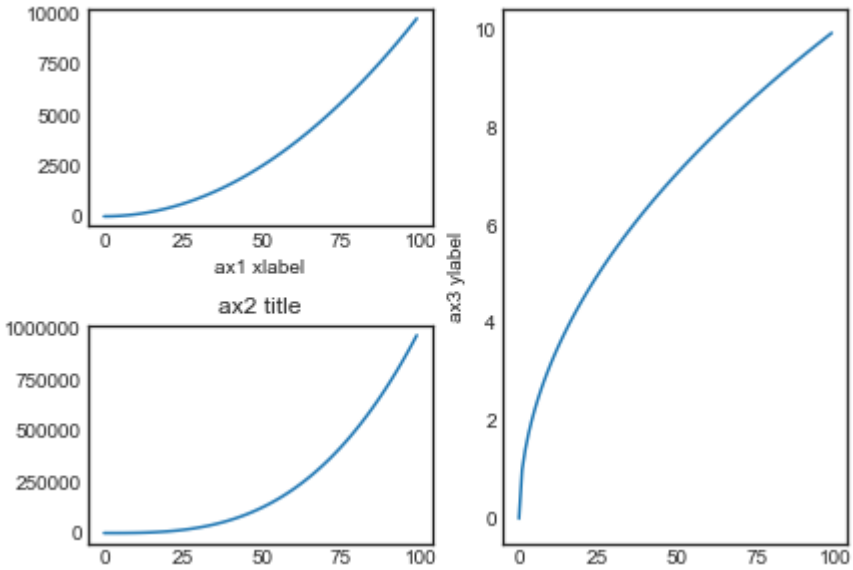
```
x = np.arange(100)
fig = plt.figure()
ax1 = plt.subplot(221)
ax2 = plt.subplot(223)
ax3 = plt.subplot(122)
ax1.plot(x,x**2)
ax1.set_xlabel('ax1 xlabel')
ax2.plot(x,x**3)
ax2.set_title('ax2 title')
ax3.plot(x,x**0.5)
ax3.set_ylabel('ax3 ylabel')
```



tight_layout

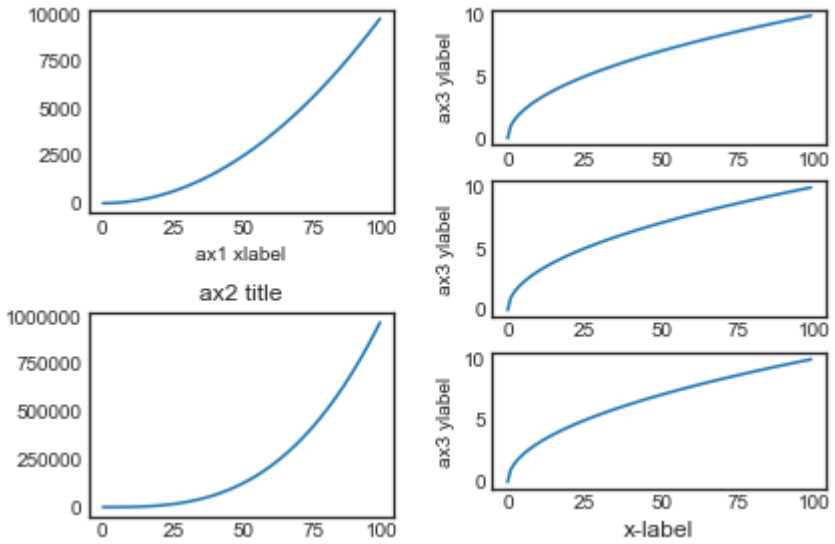
- use to deal with problems that axis labels or titles (or sometimes even ticklabels) go outside the figure area.

```
x = np.arange(100)
fig = plt.figure()
ax1 = plt.subplot(221)
ax2 = plt.subplot(223)
ax3 = plt.subplot(122)
ax1.plot(x,x**2)
ax1.set_xlabel('ax1 xlabel')
ax2.plot(x,x**3)
ax2.set_title('ax2 title')
ax3.plot(x,x**0.5)
ax3.set_ylabel('ax3 ylabel')
plt.tight_layout(pad=0.4, w_pad=0.5, h_pad=1.0)
```



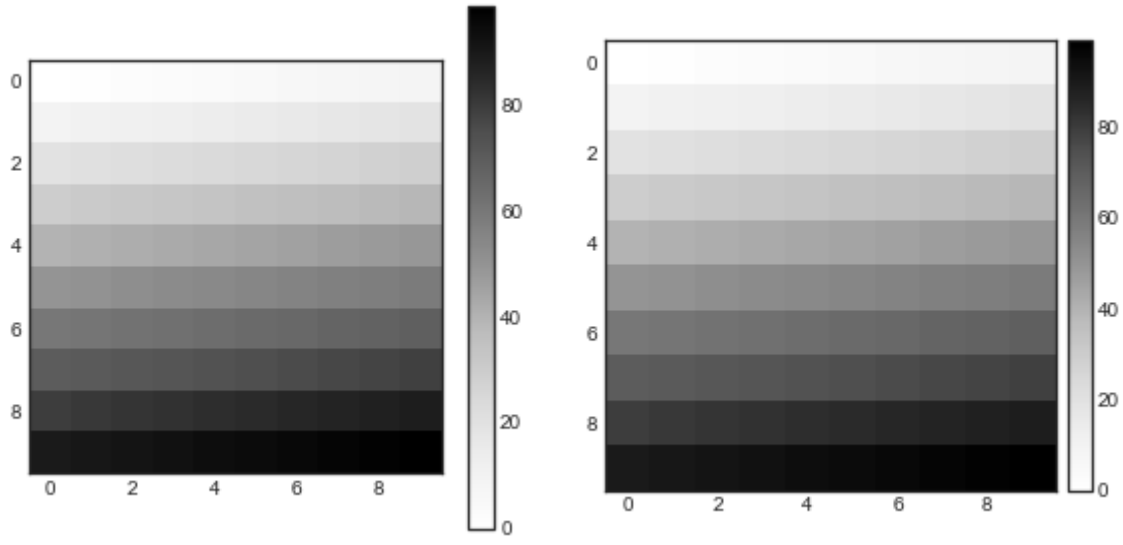
- GridSpec has its own tight_layout() method (the pyplot api tight_layout() also works).

```
import matplotlib.gridspec as gridspec
x = np.arange(100)

fig = plt.figure()
gs1 = gridspec.GridSpec(2, 1)
ax1 = fig.add_subplot(gs1[0])
ax2 = fig.add_subplot(gs1[1])
ax1.plot(x,x**2)
ax1.set_xlabel('ax1 xlabel')
ax2.plot(x,x**3)
ax2.set_title('ax2 title')

gs1.tight_layout(fig, rect=[0, 0, 0.5, 1])
gs2 = gridspec.GridSpec(3, 1)
for ss in gs2:
    ax = fig.add_subplot(ss)
    ax.plot(x,x**0.5)
    ax.set_ylabel('ax3 ylabel')
    ax.set_xlabel("")
ax.set_xlabel("x-label", fontsize=12)
gs2.tight_layout(fig, rect=[0.5, 0, 1, 1], h_pad=0.5)
```



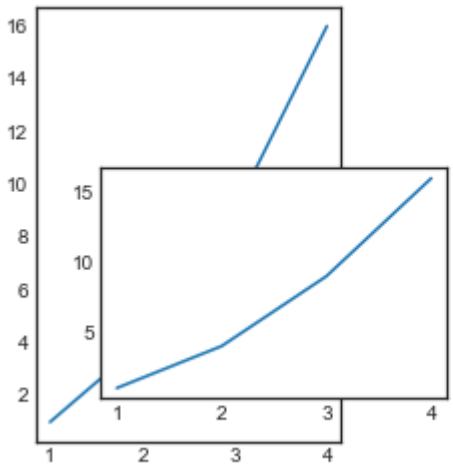
- create a colorbar as a subplot using the gridspec.
- use AxesGrid1 toolkit to explicitly create an axes for colorbar.

```
plt.close('all')
arr = np.arange(100).reshape((10, 10))
fig = plt.figure(figsize=(4, 4))
im = plt.imshow(arr, interpolation="none")
plt.colorbar(im, use_gridspec=True)
plt.tight_layout()

from mpl_toolkits.axes_grid1 import make_axes_locatable
plt.close('all')
arr = np.arange(100).reshape((10, 10))
fig = plt.figure(figsize=(4, 4))
im = plt.imshow(arr, interpolation="none")
divider = make_axes_locatable(plt.gca())
cax = divider.append_axes("right", "5%", pad="3%")
plt.colorbar(im, cax=cax)
plt.tight_layout()
```



axes positions

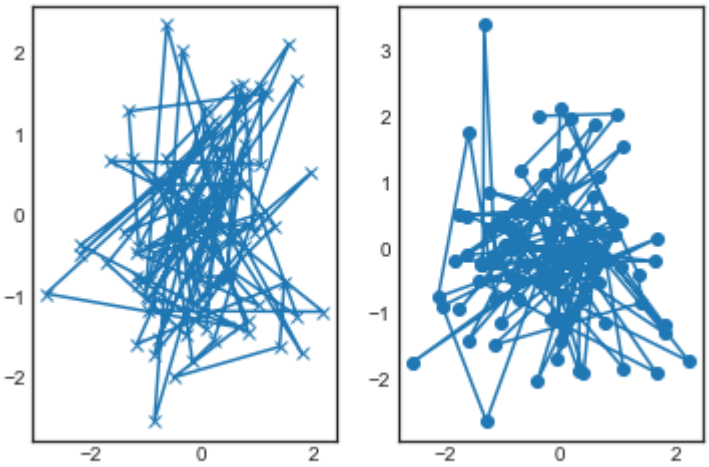
```
fig, axs = plt.subplots(1, 2)
for ax in axs:
    ax.plot([1,2,3,4],[1,4,9,16])
axs[1].set_position([0.2, 0.2, 0.4, 0.4])
```



推荐函数签名

```
def my_plotter(ax, data1, data2, param_dict):
    """
    A helper function to make a graph
    Parameters
    ----------
    ax : Axes
    The axes to draw to
    data1 : array
    The x data
    data2 : array
    The y data
    param_dict : dict
    Dictionary of kwargs to pass to ax.plot
    Returns
    -------
    out : list
    list of artists added
    """
    out = ax.plot(data1, data2, **param_dict)
    return out
# which you would then use as:
data1, data2, data3, data4 = np.random.randn(4, 100)
fig, (ax1, ax2) = plt.subplots(1, 2)
my_plotter(ax1, data1, data2, {'marker': 'x'})
```

```
my_plotter(ax2, data3, data4, {'marker': 'o'})
```



更改默认的图片格式

```
mpl.use('PS')
# "svg"、"png"、"jpg"、"pdf" 等
# must be done before importing matplotlib.pyplot or have no effect.
```

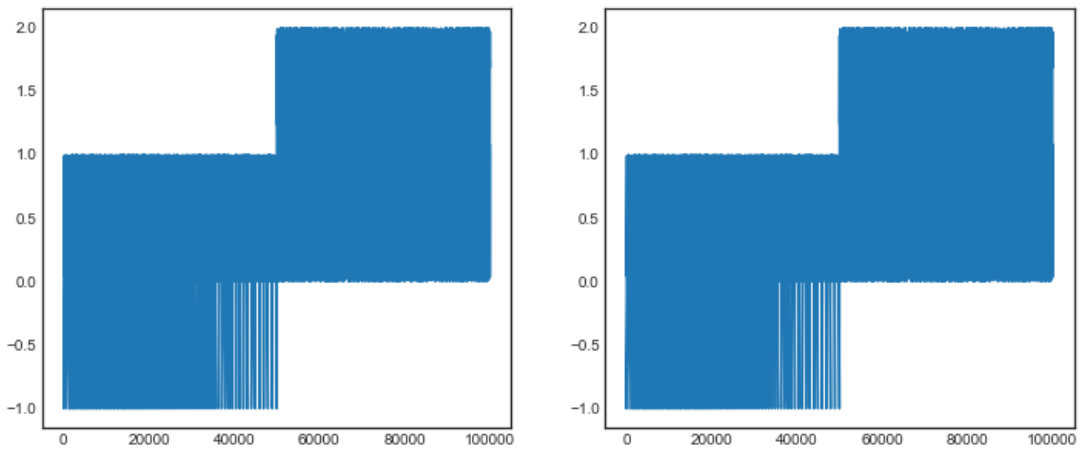
交互模式

```
mpl.interactive(Ture/False)
mpl.is_interactive() # query

# also set via
plt.ion()
plt.ioff()

plt.draw() # whenever you want to refresh the plot
```

简化

Line segment simplification

```
y = np.random.rand(100000)
y[50000:] *= 2
y[np.logspace(1, np.log10(50000), 400).astype(int)] = -1

fig,(ax1,ax2) = plt.subplots(1,2,figsize=(12,5))

mpl.rcParams['path.simplify'] = True
mpl.rcParams['path.simplify_threshold'] = 0.0
ax1.plot(y)
mpl.rcParams['path.simplify_threshold'] = 1.0
ax2.plot(y)

plt.show()
```

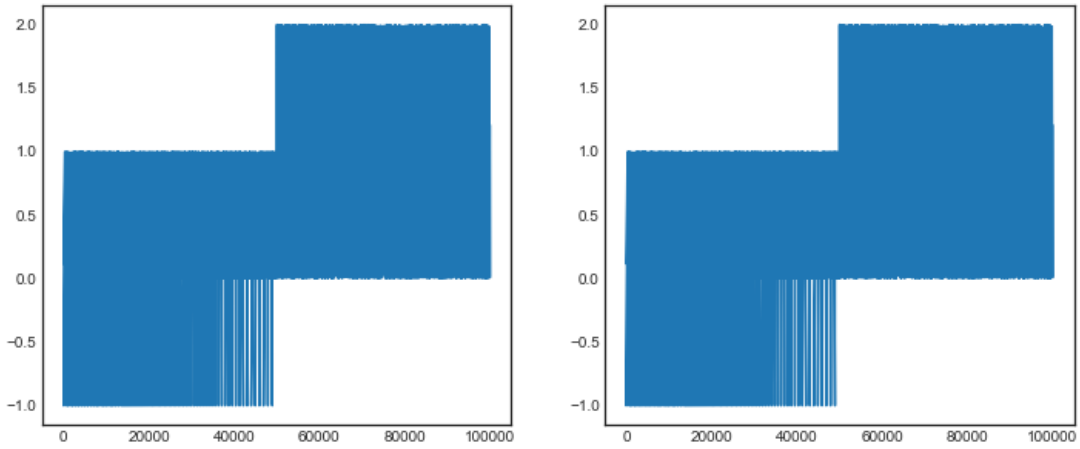


Marker simplification

```
plt.plot(x, y, markevery=1)
```

Splitting lines into smaller chunks

```
fig,(ax1,ax2) = plt.subplots(1,2,figsize=(12,5))
mpl.rcParams['path.simplify_threshold'] = 1.0
# Setup, and create the data to plot
y = np.random.rand(100000)
y[50000:] *= 2
y[np.logspace(1,np.log10(50000), 400).astype(int)] = -1

mpl.rcParams['path.simplify'] = True
mpl.rcParams['agg.path.chunksize'] = 0
ax1.plot(y)
mpl.rcParams['agg.path.chunksize'] = 10000
ax2.plot(y)

plt.show()
```



Use fast style

```
# The fast style can be used to automatically set simplification and chunking parameters to reasonable settings to speed up plotting large amounts of data.
mpl.style.use("fast")
```

其他有用的api

```
plt.clf() # clear the current figure
plt.cla() # clear the current axes

plt.rcParams.update({'figure.autolayout': True}) #当图形溢出时，可自动调整

fig.canvas.get_supported_filetypes() #list canvas support filetypes
```

自定义格式style

```
'''
# create mpl_configdir/stylelib/presentation.mplstyle
    axes.titlesize : 24
    axes.labelsize : 20
    lines.linewidth : 31
    ines.markersize : 10
    xtick.labelsize : 16
    ytick.labelsize : 16
'''
import matplotlib.pyplot as plt
plt.style.use('presentation')
plt.style.use(['dark_background', 'presentation']) #composing styles
```

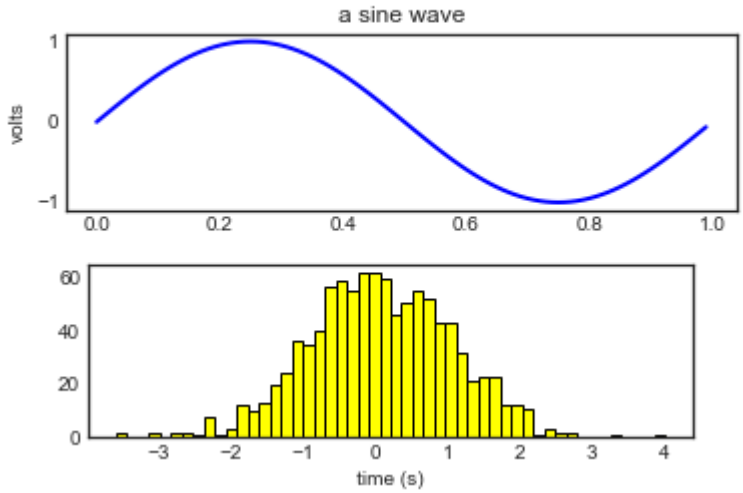
```
# 临时使用某一格式style
with plt.style.context(('dark_background')):
    plt.plot(np.sin(np.linspace(0, 2 * np.pi)), 'r-o')
plt.show()
```

自定义参数

```
# matplotlib.rcParams is global to the matplotlib package.
mpl.rcParams['lines.linewidth'] = 2
mpl.rcParams['lines.color'] = 'r'
plt.plot(data)

# convenience functions for modifying rc settings.
mpl.rc('lines', linewidth=4, color='g')
plt.plot(data)

# restore the standard matplotlib default setting
matplotlib.rcdefaults()
```

fig.add_axes

```
'''
fig.add_subplot() # 是Axes的一个特例，具有默认的行列位置
fig.add_axes([left, bottom, width, height]) # 可在任意位置创建子图，参数是相对于画布figure的0-1的数字
fig.delaxes() #删除子图
'''
fig = plt.figure()
fig.subplots_adjust(top=0.8)
ax1 = fig.add_subplot(211)
ax1.set_ylabel('volts')
ax1.set_title('a sine wave')
t = np.arange(0.0, 1.0, 0.01)
s = np.sin(2*np.pi*t)
line, = ax1.plot(t, s, color='blue', lw=2)
# Fixing random state for reproducibility
np.random.seed(19680801)
ax2 = fig.add_axes([0.15, 0.1, 0.7, 0.3])
n, bins, patches = ax2.hist(np.random.randn(1000), 50,
facecolor='yellow', edgecolor='k')
ax2.set_xlabel('time (s)')
plt.show()
```


a sine wave
volts
1
0
−1
0.0
0.2
0.4
0.6
0.8
1.0
60
40
20
0
−3
−2
−1
0
1
2
3
4
time (s)