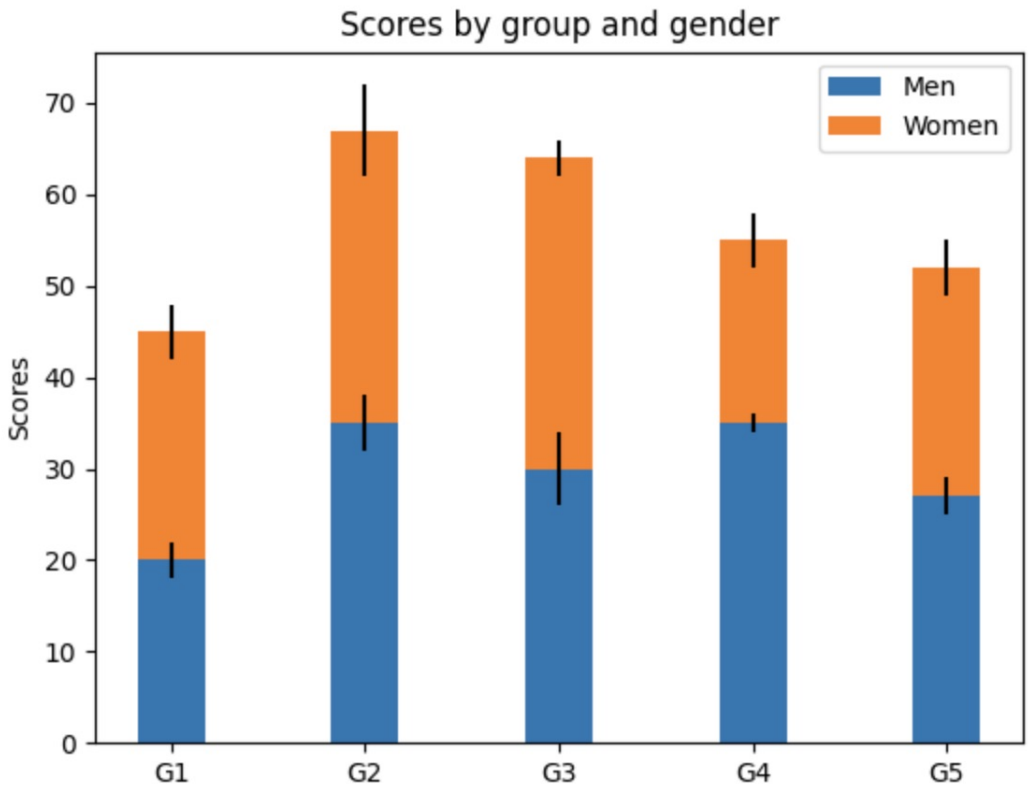
Matplotlib数据可视化

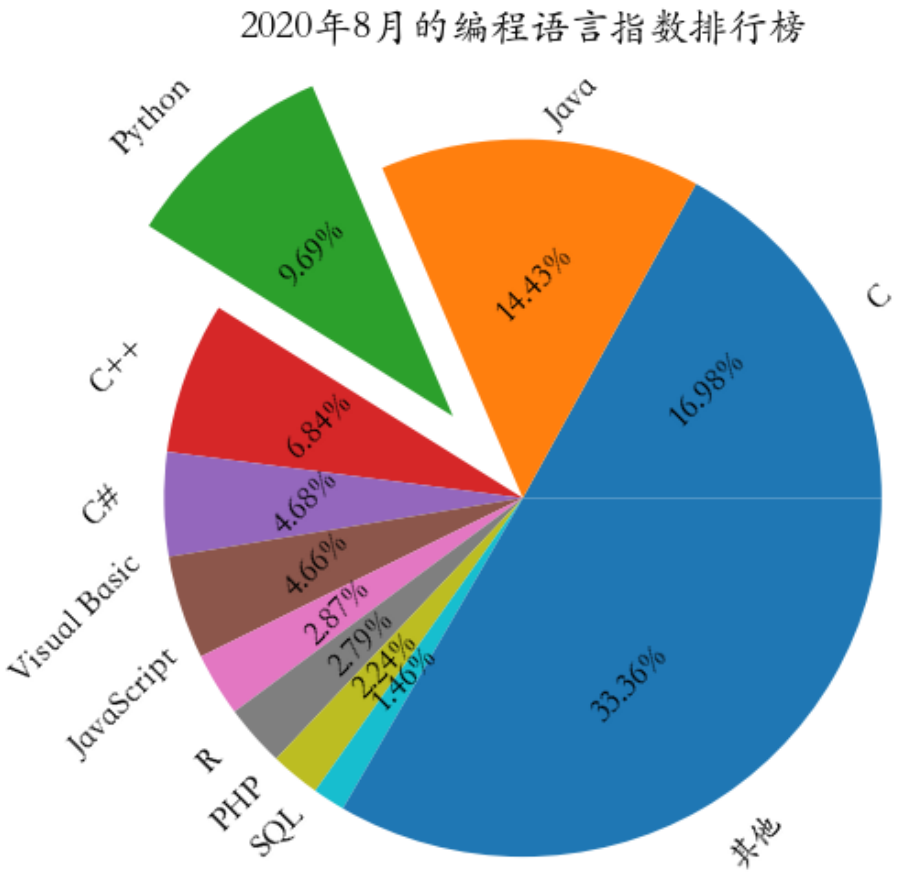
第一部分 课程介绍

pip install matplotlib -i https://pypi.tuna.tsinghua.edu.cn/simple

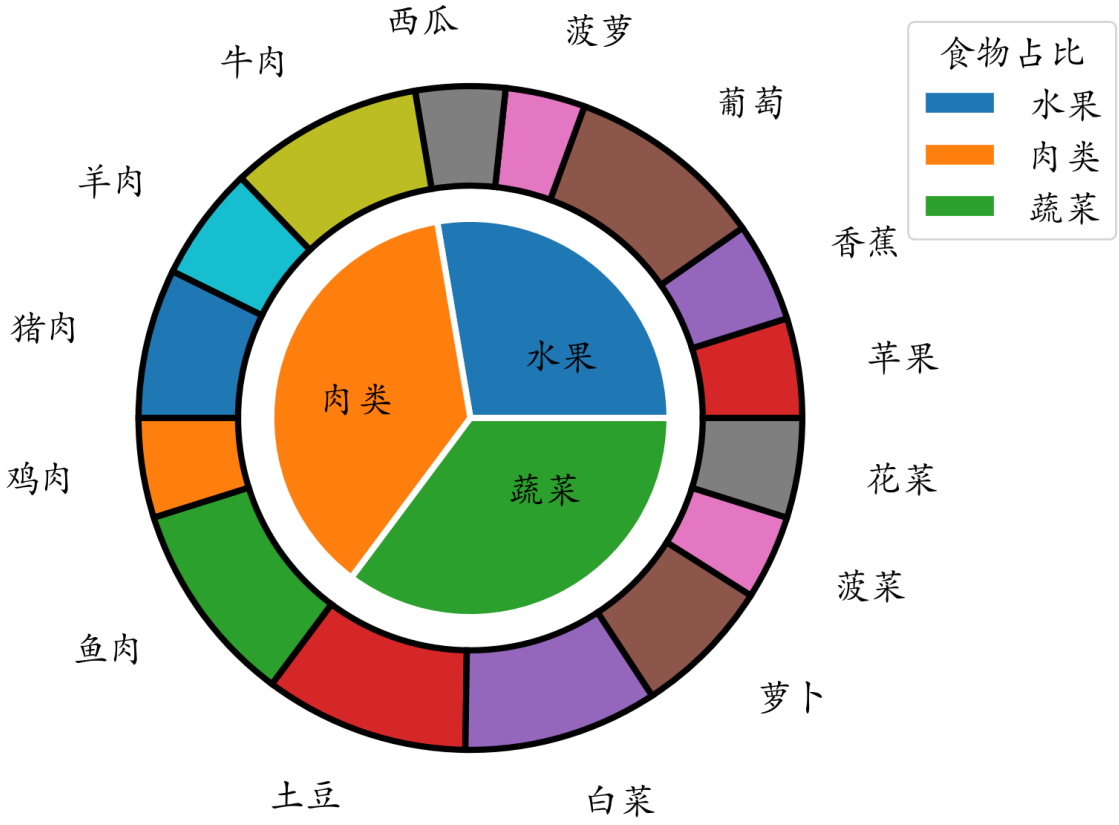
在数据分析与机器学习中，我们经常要用到大量的可视化操作。一张制作精美的数据图片，可以展示大量的信息，一图顶千言。



而在可视化中，Matplotlib算得上是最常用的工具。Matplotlib 是 python 最著名的绘图库，它提供了一整套 API，十分适合绘制图表，或修改图表的一些属性，如字体、标签、范围等。

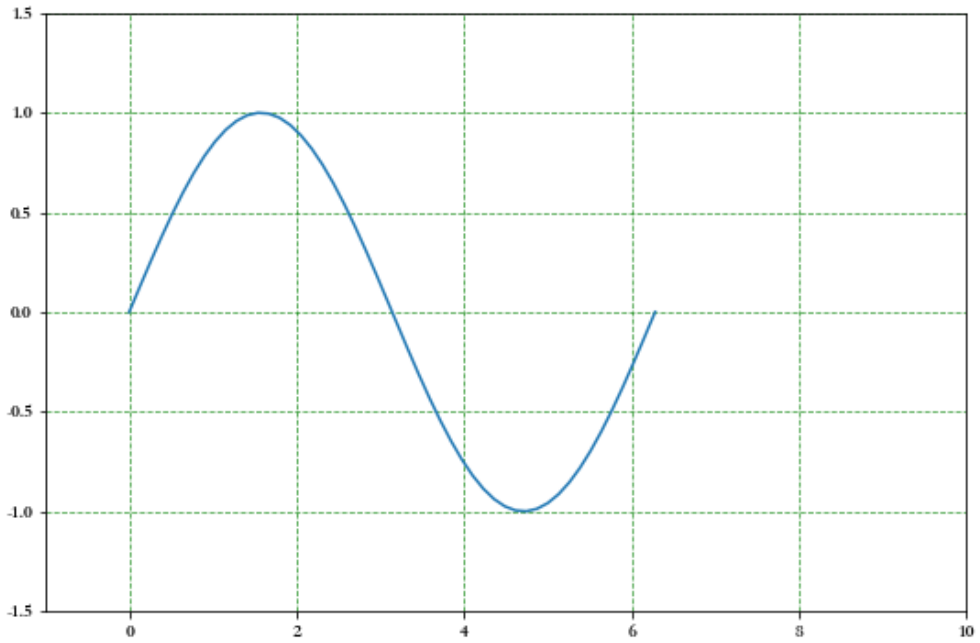


Matplotlib 是一个 Python 的 2D 绘图库，它交互式环境生成出版质量级别的图形。通过 Matplotlib这个标准类库，开发者只需要几行代码就可以实现生成绘图，折线图、散点图、柱状图、饼图、直方图、组合图等数据分析可视化图表。



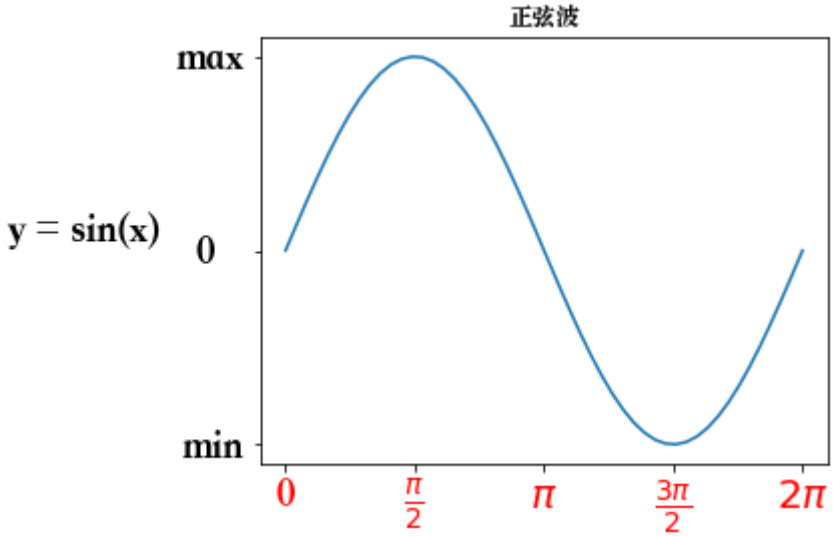
第二部分 基础知识

第一节 图形绘制



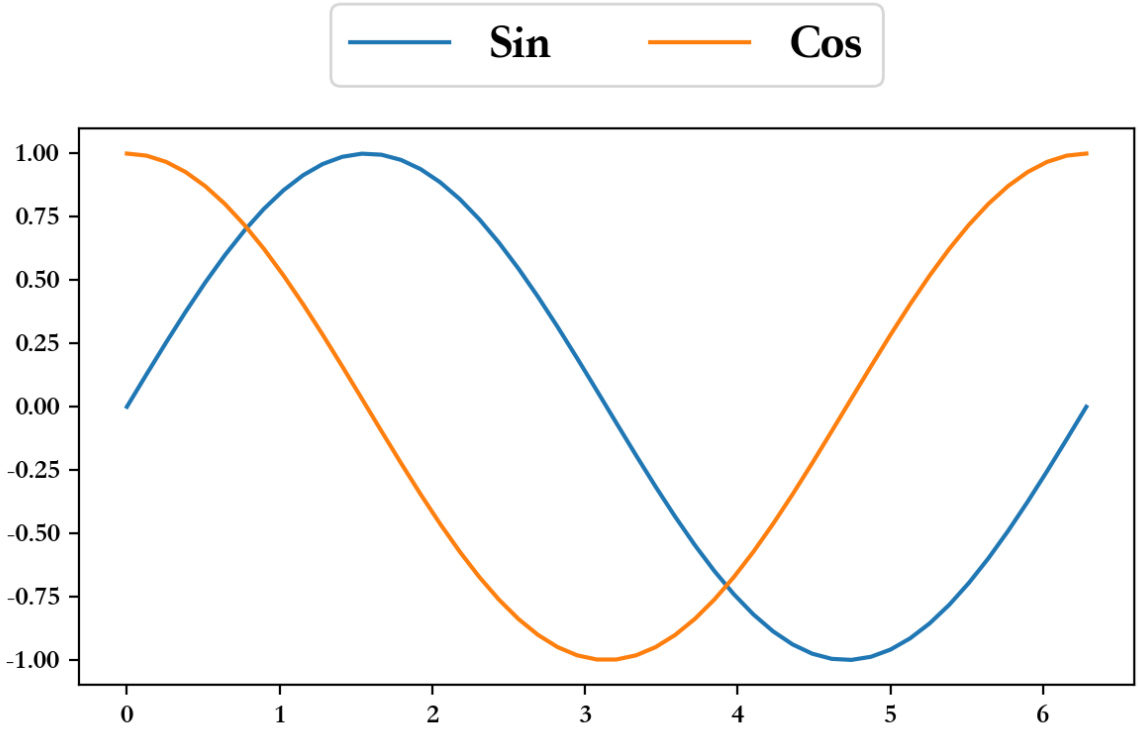

```
import numpy as np
import matplotlib.pyplot as plt
# 1、图形绘制
x = np.linspace(0,2*np.pi) # x轴
# y轴
y = np.sin(x) # 正弦
# 绘制线形图
# 调整尺寸
plt.figure(figsize=(9,6))
plt.plot(x,y)
# 继续调用plot绘制多条线形图
# 2、设置网格线
plt.grid(linestyle = '--',# 样式
         color = 'green',# 颜色
         alpha = 0.75) # 透明度
# 3、设置坐标轴范围
plt.axis([-1,10,-1.5,1.5])
plt.xlim([-1,10])
plt.ylim([-1.5,1.5])
```

第二节 坐标轴刻度、标签、标题



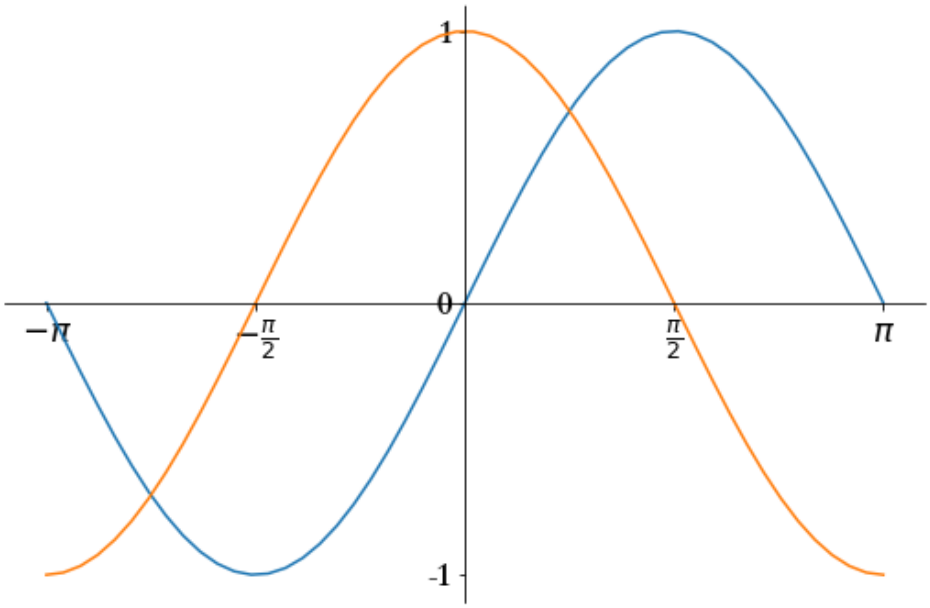

```
import numpy as np
import matplotlib.pyplot as plt
# 1、图形绘制
x = np.linspace(0,2*np.pi) # x轴
# y轴
y = np.sin(x) # 正弦
plt.plot(x,y)
# 2、设置x轴y轴刻度
plt.xticks(np.arange(0,7,np.pi/2))
plt.yticks([-1,0,1])
# 3、设置x轴y轴刻度标签
_ = plt.yticks(ticks = [-1,0,1],labels=['min','   0   ','max'],fontsize = 20,ha
= 'right')
font=
{'family':'serif','style':'italic','weight':'normal','color':'red','size':16}
_ = plt.xticks(ticks = np.arange(0,7,np.pi/2),
               # LaTex语法，输入格式为：r'$\sigma$'  #其中的sigma对应于希腊字母的σ
               labels = ['0',r'$\frac{\pi}{2}$',r'$\pi$',r'$\frac{3\pi}
{2}$',r'$2\pi$'],
               fontsize = 20,
               fontweight = 'normal',
               color = 'red')
# 4、坐标轴标签，标题
plt.ylabel('y = sin(x)',rotation = 0,
           horizontalalignment = 'right',fontstyle = 'normal',fontsize = 20)
# 获取电脑上的字体库
from matplotlib.font_manager import FontManager
fm = FontManager()
mat_fonts = set(f.name for f in fm.ttflist)
# print(mat_fonts)
plt.rcParams['font.sans-serif'] = 'Songti SC' # 设置宋体，显示中文
plt.title('正弦波')
```

第三节 图例



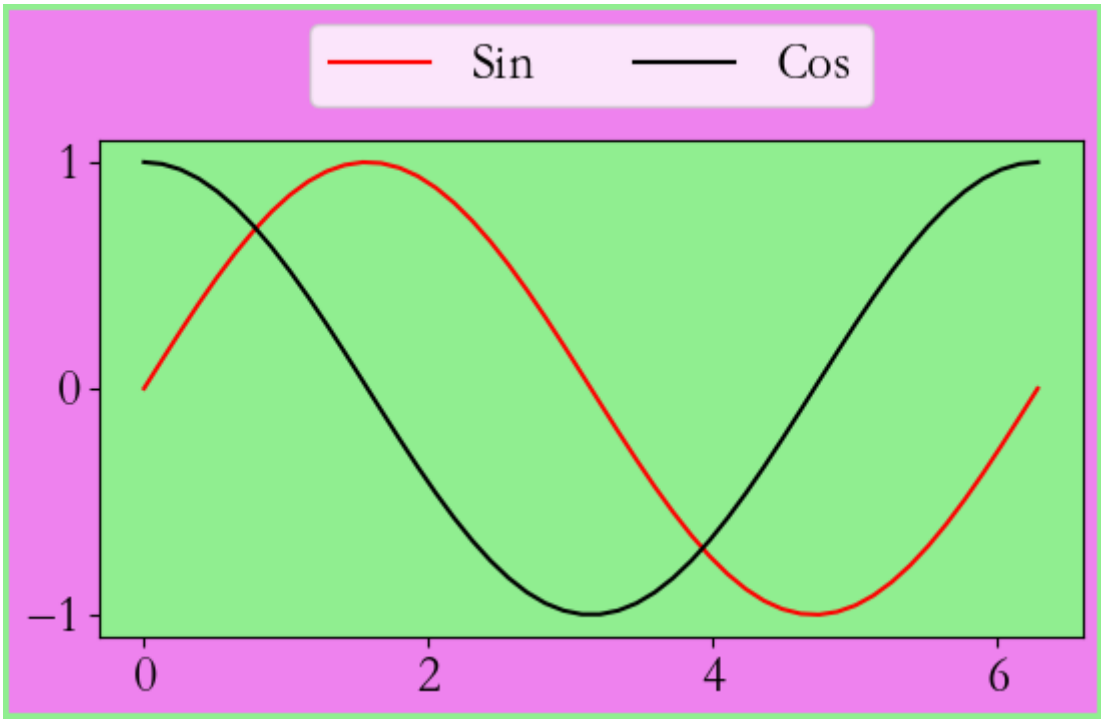

```
import numpy as np
import matplotlib.pyplot as plt

# 1、图形绘制
x = np.linspace(0,2*np.pi) # x轴
# y轴
y = np.sin(x) # 正弦
# 绘制线形图
# 调整尺寸
plt.figure(figsize=(9,6))
plt.plot(x,y)

# 2、图例
plt.plot(x,np.cos(x)) # 余弦波
plt.legend(['Sin','Cos'],fontsize = 18,loc = 'center',ncol = 2,bbox_to_anchor =
[0,1.05,1,0.2])
```

第四节 脊柱移动




```
import numpy as np
import matplotlib.pyplot as plt
x = np.linspace(-np.pi,np.pi,50)
plt.rcParams['axes.unicode_minus'] = False
plt.figure(figsize=(9,6))
plt.plot(x,np.sin(x),x,np.cos(x))
ax = plt.gca() # 获取当前视图
# 右边和上面脊柱消失
ax.spines['right'].set_color('white')
ax.spines['top'].set_color('#FFFFFF')

# 设置下面左边脊柱位置，data表示数据，axes表示相对位置0~1
ax.spines['bottom'].set_position(('data',0))
ax.spines['left'].set_position(('data',0))

plt.yticks([-1,0,1],labels=['-1','0','1'],fontsize = 18)
_ = plt.xticks([-np.pi,-np.pi/2,np.pi/2,np.pi],
           labels=[r'$-\pi$',r'$-\frac{\pi}{2}$',r'$\frac{\pi}{2}$',r'$\pi$'],
           fontsize = 18)
```

第五节 图片保存




```
import numpy as np
import matplotlib.pyplot as plt
# 1、图形绘制
x = np.linspace(0,2*np.pi) # x轴
# y轴
y = np.sin(x) # 正弦波
plt.figure(linewidth = 4)
plt.plot(x,y,color = 'red')
plt.plot(x,np.cos(x),color = 'k') # 余弦波

ax = plt.gca() # 获取视图
ax.set_facecolor('lightgreen') # 设置视图背景颜色
# 2、图例
plt.legend(['Sin','Cos'],fontsize = 18,loc = 'center',ncol = 2,bbox_to_anchor =
[0,1.05,1,0.2])
# plt.tight_layout() # 自动调整布局空间，就不会出现图片保存不完整
plt.savefig('./基础5.png', # 文件名：png、jpg、pdf
            dpi = 100, # 保存图片像素密度
            facecolor = 'violet', # 视图与边界之间颜色设置
            edgecolor = 'lightgreen', # 视图边界颜色设置
            bbox_inches = 'tight')# 保存图片完整
```

第三部分 风格和样式

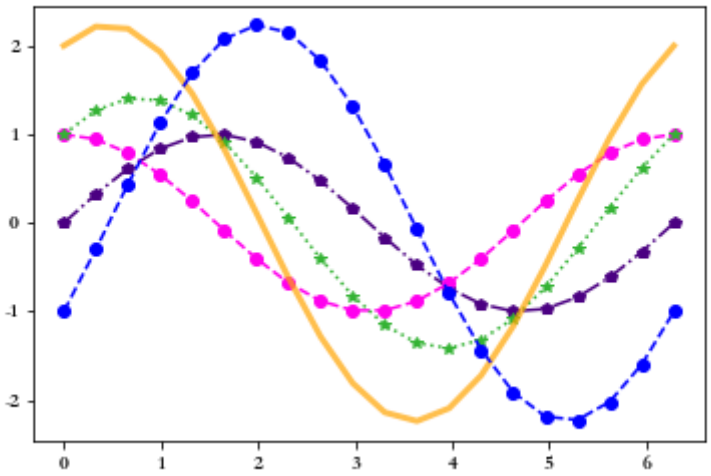
第一节 颜色、线形、点形、线宽、透明度

black
k
dimgray
dimgrey
grey
gray
darkgrey
darkgray
silver
lightgray
lightgrey
gainsboro
whitesmoke
white
w
snow
rosybrown
lightcoral
indianred
brown
firebrick
maroon
darkred
red
r
mistyrose
salmon
tomato
darksalmon
coral
orangered
lightsalmon
sienna
seashell
chocolate
saddlebrown
sandybrown
peachpuff
peru
linen

bisque
darkorange
burlywood
antiquewhite
tan
navajowhite
blanchedalmond
papayawhip
moccasin
orange
wheat
oldlace
floralwhite
darkgoldenrod
goldenrod
cornsilk
gold
lemonchiffon
khaki
palegoldenrod
darkkhaki
ivory
beige
lightyellow
lightgoldenrodyellow
olive
y
yellow
olivedrab
yellowgreen
darkolivegreen
greenyellow
chartreuse
lawngreen
sage
lightsage
darksage
honeydew
darkseagreen
palegreen

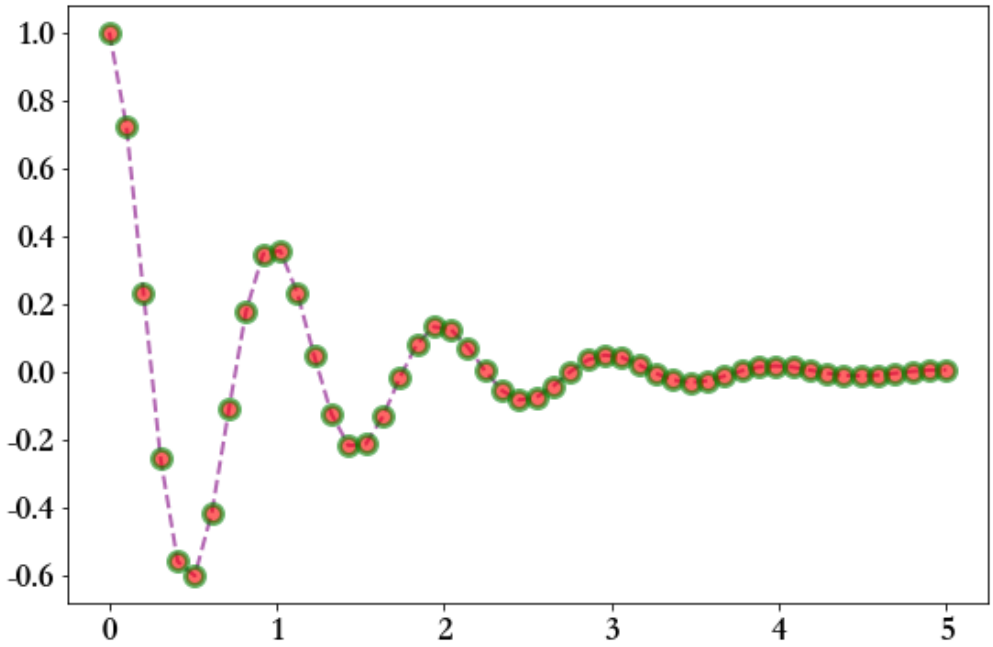
lightgreen
forestgreen
limegreen
darkgreen
green
g
lime
seagreen
mediumseagreen
springgreen
mintcream
mediumspringgreen
mediumaquamarine
aquamarine
turquoise
lightseagreen
mediumturquoise
azure
lightcyan
paleturquoise
darkslategray
darkslategrey
teal
darkcyan
c
cyan
aqua
darkturquoise
cadetblue
powderblue
lightblue
deepskyblue
skyblue
lightskyblue
steelblue
aliceblue
dodgerblue
lightslategrey
lightslategray
slategray

slategrey
lightsteelblue
cornflowerblue
royalblue
ghostwhite
lavender
midnightblue
navy
darkblue
mediumblue
blue
b
slateblue
darkslateblue
mediumslateblue
mediumpurple
blueviolet
indigo
darkorchid
darkviolet
mediumorchid
thistle
plum
violet
purple
darkmagenta
m
fuchsia
magenta
orchid
mediumvioletred
deeppink
hotpink
lavenderblush
palevioletred
crimson
pink
lightpink



```
import numpy as np
import matplotlib.pyplot as plt
x = np.linspace(0,2*np.pi,20)
y1 = np.sin(x)
y2 = np.cos(x)

# 设置颜色，线型，点型
plt.plot(x,y1,color = 'indigo',ls = '-.',marker = 'p')
plt.plot(x,y2,color = '#FF00EE',ls = '--',marker = 'o')
plt.plot(x,y1 + y2,color = (0.2,0.7,0.2),marker = '*',ls = ':')
plt.plot(x,y1 + 2*y2,linewidth = 3,alpha = 0.7,color = 'orange') # 线宽、透明度
plt.plot(x,2*y1 - y2,'bo--') # 参数连用
```

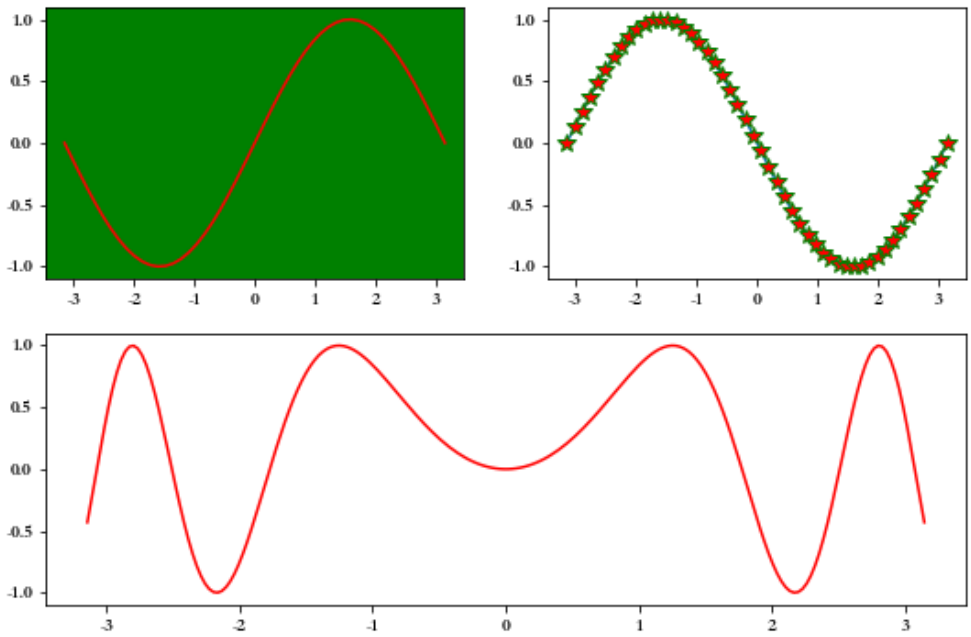
第二节 更多属性设置




```
import numpy as np
import pandas as pd
def f(x):
    return np.exp(-x) * np.cos(2*np.pi*x)
x = np.linspace(0,5,50)
plt.figure(figsize=(9,6))
plt.plot(x,f(x),color = 'purple',
         marker = 'o',
         ls = '--',
         lw = 2,
         alpha = 0.6,
         markerfacecolor = 'red',# 点颜色
         markersize = 10,# 点大小
         markeredgecolor = 'green',#点边缘颜色
         markeredgewidth = 3)#点边缘宽度
plt.xticks(size = 18) # 设置刻度大小
plt.yticks(size = 18)
```

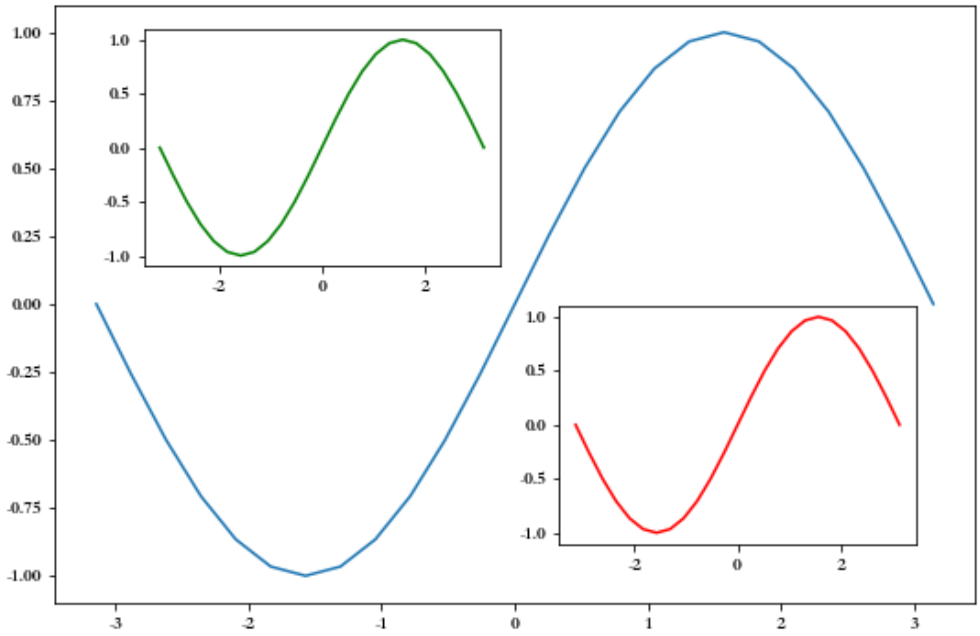
第四部分 多图布局

第一节 子视图



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

x = np.linspace(-np.pi,np.pi,50)
y = np.sin(x)

# 子视图1
plt.figure(figsize=(9,6))
ax = plt.subplot(221) # 两行两列第一个子视图
ax.plot(x,y,color = 'red')
ax.set_facecolor('green') # 调用子视图设置方法，设置子视图整体属性
# 子视图2
ax = plt.subplot(2,2,2) # 两行两列第二个子视图
line, = ax.plot(x,-y) # 返回绘制对象
line.set_marker('*') # 调用对象设置方法，设置属性
line.set_markerfacecolor('red')
line.set_markeredgecolor('green')
line.set_markersize(10)
# 子视图3
ax = plt.subplot(2,1,2) # 两行一列第二行视图
plt.sca(ax) # 设置当前视图
x = np.linspace(-np.pi,np.pi,200)
plt.plot(x,np.sin(x*x),color = 'red')
```

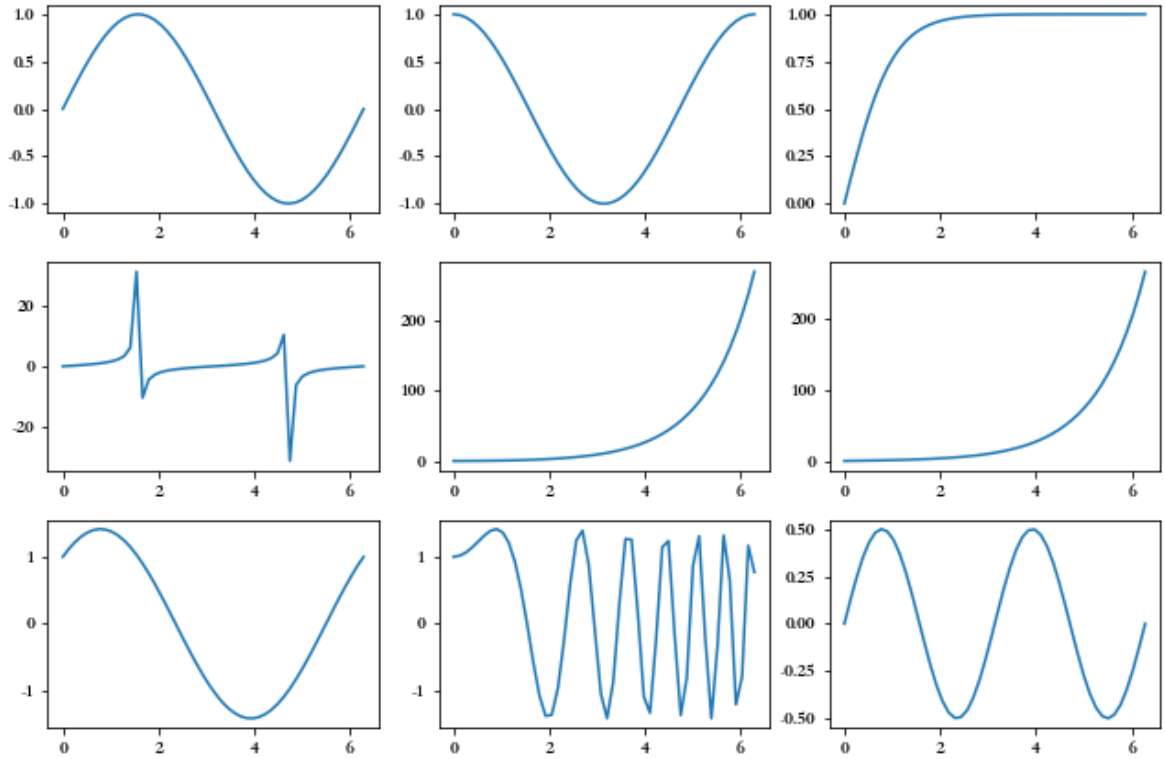
第二节 嵌套




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

x = np.linspace(-np.pi,np.pi,25)
y = np.sin(x)
fig = plt.figure(figsize=(9,6)) # 创建视图

plt.plot(x,y)

# 嵌套方式一，axes轴域（横纵坐标范围），子视图
ax = plt.axes([0.2,0.55,0.3,0.3]) # 参数含义[left, bottom, width, height]
ax.plot(x,y,color = 'g')

# 嵌套方式二
ax = fig.add_axes([0.55,0.2,0.3,0.3]) # 使用视图对象添加子视图
ax.plot(x,y,color = 'r')
```

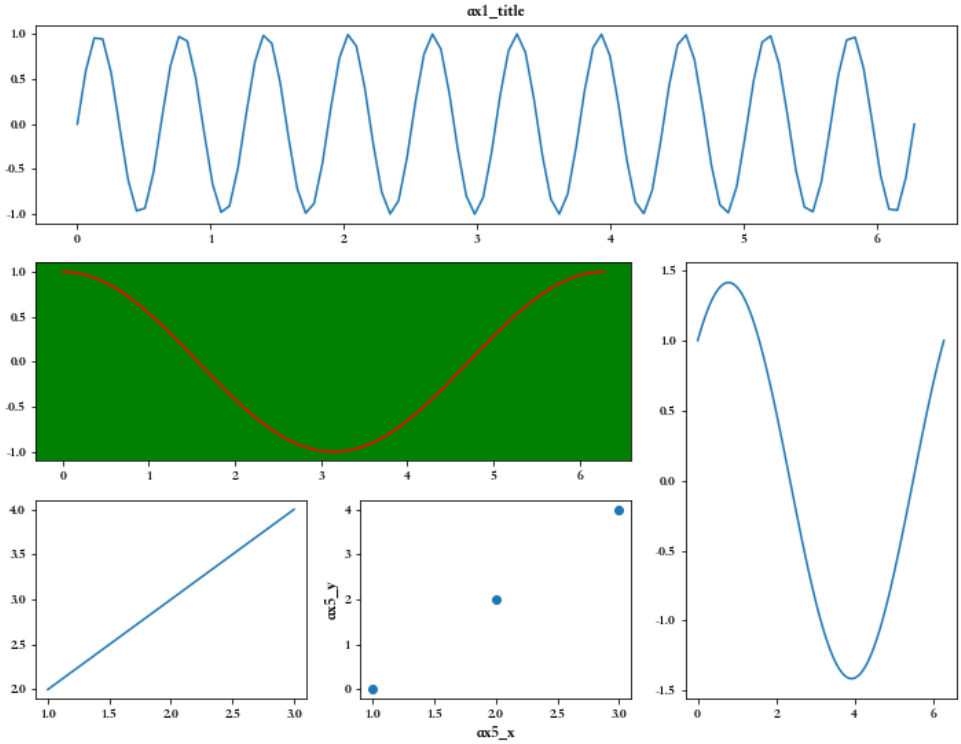
第三节 多图布局分格显示

3.3.1 均匀布局



```
import numpy as np
import matplotlib.pyplot as plt
x = np.linspace(0,2*np.pi)
# sharex:所有小图共享x轴  sharey:表示所有小图共享y轴  坐标轴以所有小图中范围最大的进行显示
fig, ((ax11,ax12,ax13), (ax21,ax22,ax23),(ax31,ax32,ax33)) = plt.subplots(3, 3)
# 也可通过plt.subplot() 一个个添加子视图
fig.set_figwidth(9)
fig.set_figheight(6)
ax11.plot(x,np.sin(x))
ax12.plot(x,np.cos(x))
ax13.plot(x,np.tanh(x))
ax21.plot(x,np.tan(x))
ax22.plot(x,np.cosh(x))
ax23.plot(x,np.sinh(x))
ax31.plot(x,np.sin(x) + np.cos(x))
ax32.plot(x,np.sin(x*x) + np.cos(x*x))
ax33.plot(x,np.sin(x)*np.cos(x))
# 紧凑显示，边框会比较小，可以注释掉该行查看效果
plt.tight_layout()
plt.show()
```

3.3.2 不均匀分布



方式一

```
import numpy as np
import matplotlib.pyplot as plt
# 需要导入gridspec模块
x = np.linspace(0,2*np.pi,200)
fig = plt.figure(figsize=(12,9))
# 使用切片方式设置子视图
ax1 = plt.subplot(3,1,1) # 视图对象添加子视图
ax1.plot(x,np.sin(10*x))
# 设置ax1的标题，xlim、ylim、xlabel、ylabel等所有属性现在只能通过set_属性名的方法设置
ax1.set_title('ax1_title')  # 设置小图的标题
ax2 = plt.subplot(3,3,(4,5))
ax2.set_facecolor('green')
ax2.plot(x,np.cos(x),color = 'red')
ax3 = plt.subplot(3,3,(6,9))
ax3.plot(x,np.sin(x) + np.cos(x))
ax4 = plt.subplot(3,3,7)
ax4.plot([1,3],[2,4])
ax5 = plt.subplot(3,3,8)
ax5.scatter([1,2,3], [0,2, 4])
ax5.set_xlabel('ax5_x',fontsize = 12)
ax5.set_ylabel('ax5_y',fontsize = 12)
plt.show()
```

方式二

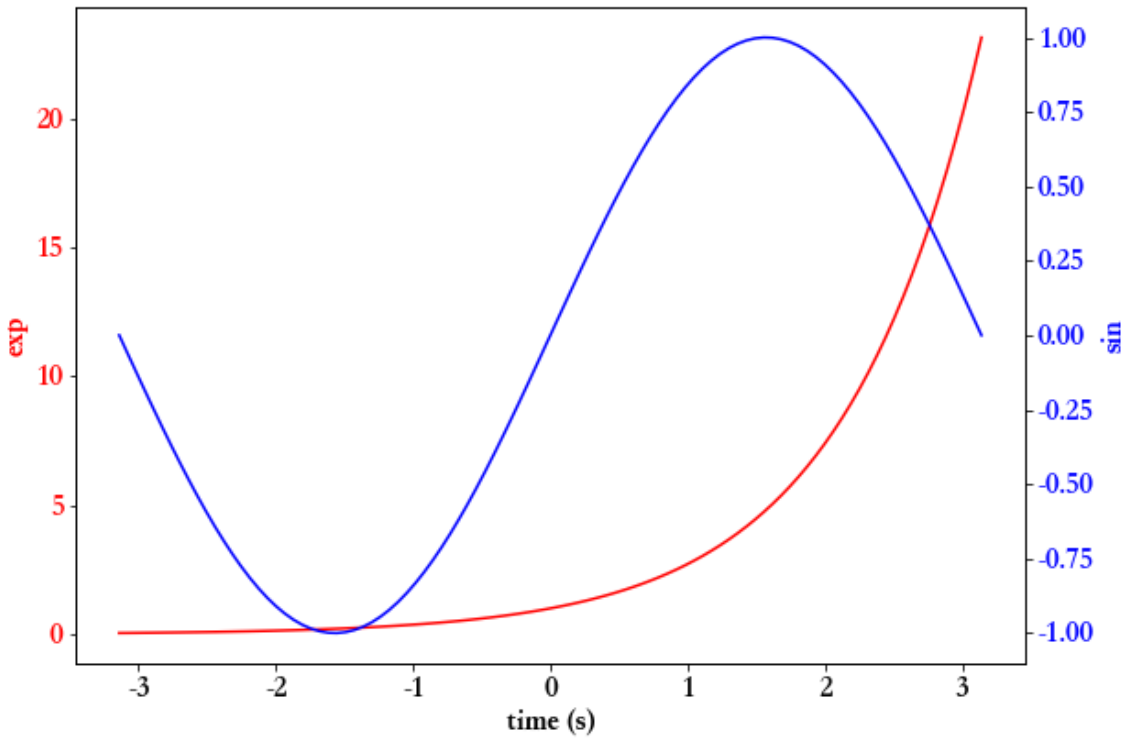
```
import numpy as np
import matplotlib.pyplot as plt
x = np.linspace(0,2*np.pi,100)
plt.figure(figsize=(12,9))
```

```
# 子视图1
ax1 = plt.subplot2grid(shape = (3, 3),# 布局形状
                       loc =  (0, 0), # 布局绘制位置
                       colspan=3) # 跨几列
ax1.plot(x,np.sin(10*x))
# 设置ax1的标题，xlim、ylim、xlabel、ylabel等所有属性现在只能通过set_属性名的方法设置
ax1.set_title('ax1_title')  # 设置小图的标题
# 子视图2
ax2 = plt.subplot2grid((3, 3), (1, 0), colspan=2) # 跨两列
ax2.set_facecolor('green')
ax2.plot(x,np.cos(x),color = 'red')
# 子视图3
ax3 = plt.subplot2grid((3, 3), (1, 2), rowspan=2) # 跨两行
ax3.plot(x,np.sin(x) + np.cos(x))
# 子视图4
ax4 = plt.subplot2grid((3, 3), (2, 0))
ax4.plot([1,3],[2,4])
# 子视图5
ax5 = plt.subplot2grid((3, 3), (2, 1))
ax5.scatter([1,2,3], [0,2, 4])
ax5.set_xlabel('ax5_x',fontsize = 12)
ax5.set_ylabel('ax5_y',fontsize = 12)
```

方式三

```
import numpy as np
import matplotlib.pyplot as plt
# 需要导入gridspec模块
import matplotlib.gridspec as gridspec
x = np.linspace(0,2*np.pi,200)
fig = plt.figure(figsize=(12,9))
# 将整个视图分成3x3布局
gs = gridspec.GridSpec(3, 3)
# 使用切片方式设置子视图
ax1 = fig.add_subplot(gs[0,:]) # 视图对象添加子视图
ax1.plot(x,np.sin(10*x))
# 设置ax1的标题，xlim、ylim、xlabel、ylabel等所有属性现在只能通过set_属性名的方法设置
ax1.set_title('ax1_title')  # 设置小图的标题
ax2 = plt.subplot(gs[1, :2]) # 模块调用
ax2.set_facecolor('green')
ax2.plot(x,np.cos(x),color = 'red')
# 从第一行到最后，占1、2两行，后面的2表示只占用第二列，也就是最后的一列
ax3 = plt.subplot(gs[1:, 2])
ax3.plot(x,np.sin(x) + np.cos(x))
# 倒数第一行，只占第0列这一列
ax4 = plt.subplot(gs[-1, 0])
ax4.plot([1,3],[2,4])
# 倒数第一行，只占倒数第二列，由于总共三列，所以倒数第二列就是序号1的列
ax5 = plt.subplot(gs[-1, -2])
ax5.scatter([1,2,3], [0,2, 4])
ax5.set_xlabel('ax5_x',fontsize = 12)
ax5.set_ylabel('ax5_y',fontsize = 12)
plt.show()
```

第四节 双轴显示




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

x = np.linspace(-np.pi,np.pi,100)
data1 = np.exp(x)
data2 = np.sin(x)

plt.figure(figsize=(9,6))
plt.rcParams['font.size'] = 16 # 设置整体字体大小

ax1 = plt.gca() # 获取当前轴域

ax1.set_xlabel('time (s)') # 设置x轴标签
ax1.set_ylabel('exp', color='red') # 设置y轴标签
ax1.plot(t, data1, color='red') # 数据绘制
ax1.tick_params(axis='y', labelcolor='red') # 设置y轴刻度属性

ax2 = ax1.twinx()  # 创建新axes实例，共享x轴，并设置
ax2.set_ylabel('sin', color='blue')
ax2.plot(t, data2, color='blue')
ax2.tick_params(axis='y', labelcolor='blue')

plt.tight_layout() # 紧凑布局
```

第五部分 文本、注释、箭头

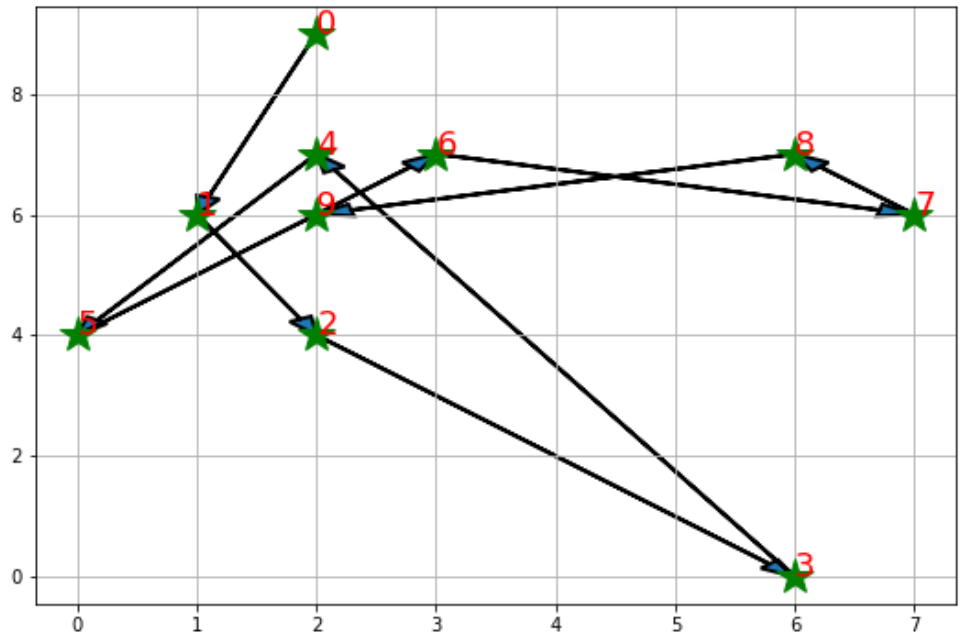
常用函数如下：

Pyplot函数	API方法	描述
text()	mpl.axes.Axes.text()	在Axes对象的任意位置添加文字
xlabel()	mpl.axes.Axes.set_xlabel()	为X轴添加标签
ylabel()	mpl.axes.Axes.set_ylabel()	为Y轴添加标签
title()	mpl.axes.Axes.set_title()	为Axes对象添加标题
legend()	mpl.axes.Axes.legend()	为Axes对象添加图例
annnotate()	mpl.axes.Axes.annotate()	为Axes对象添加注释（箭头可选）
figtext()	mpl.figure.Figure.text()	在Figure对象的任意位置添加文字
suptitle()	mpl.figure.Figure.suptitle()	为Figure对象添加中心化的标题

第一节 文本

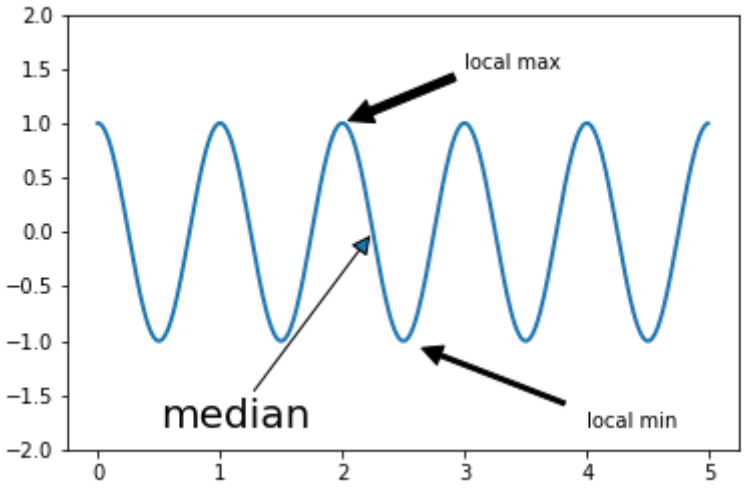
```
import numpy as np
import matplotlib.pyplot as plt

# 字体属性
font = {'fontsize': 20,
        'family': 'Kaiti SC',
        'color':  'red',
        'weight': 'bold'}

x = np.linspace(0.0, 5.0, 100)
y = np.cos(2*np.pi*x) * np.exp(-x)

plt.figure(figsize=(9,6))
plt.plot(x, y, 'k')
plt.title('exponential decay',fontdict=font)
plt.suptitle('指数衰减',y = 1.05,fontdict = font,fontsize = 30)
plt.text(x = 2, y = 0.65, # 横纵坐标位置
         s = r'$\cos(2 \pi t) \exp(-t)$') # 文本内容
plt.xlabel('time (s)')
plt.ylabel('voltage (mV)')
plt.show()
```

第二节 箭头



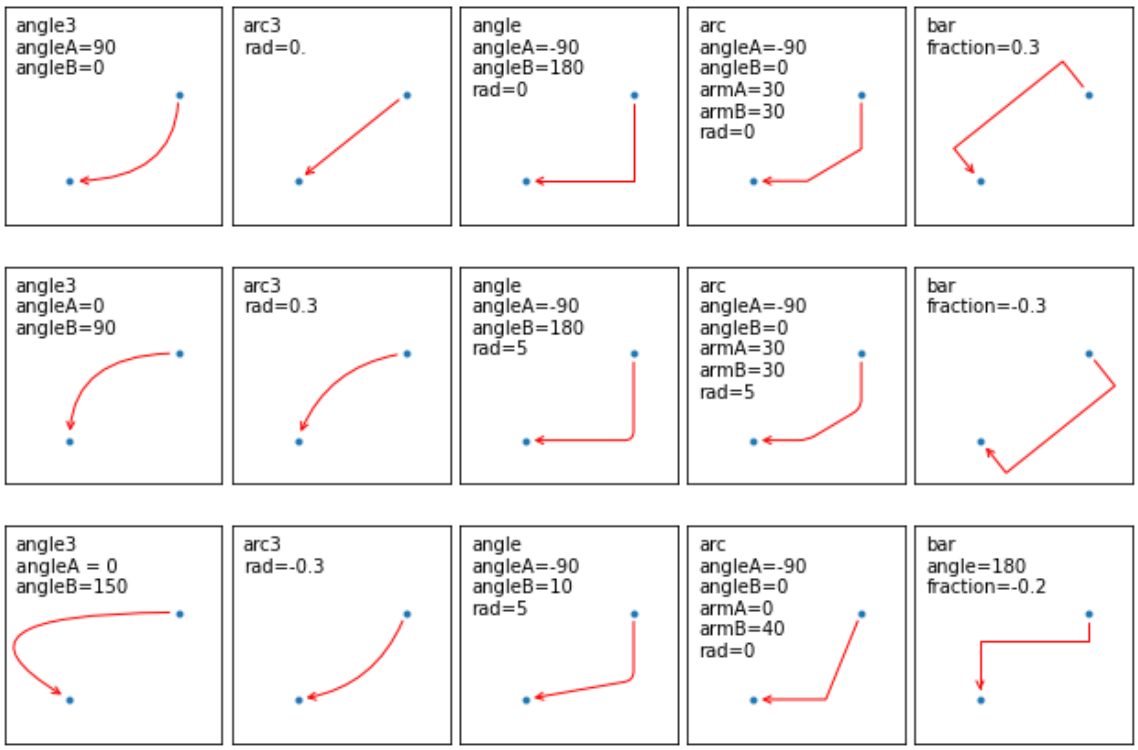

```
import matplotlib.pyplot as plt
import numpy

loc = np.random.randint(0,10,size = (10,2))
plt.figure(figsize=(10, 10))
plt.plot(loc[:,0], loc[:,1], 'g*', ms=20)
plt.grid(True)

# 路径
way = np.arange(10)
np.random.shuffle(way)

for i in range(0, len(way)-1):
    start = loc[way[i]]
    end = loc[way[i+1]]
    plt.arrow(start[0], start[1], end[0]-start[0], end[1]-start[1], # 坐标与距离
              head_width=0.2, lw=2,#箭头长度，箭尾线宽
              length_includes_head = True) # 长度计算包含箭头箭尾
    plt.text(start[0],start[1],s = i,fontsize = 18,color = 'red') # 文本
    if i == len(way) - 2: # 最后一个点
        plt.text(end[0],end[1],s = i + 1,fontsize = 18,color = 'red')
```

第三节 注释




```
import numpy as np
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
x = np.arange(0.0, 5.0, 0.01)
y = np.cos(2*np.pi*x)
line, = ax.plot(x,y,lw=2)
ax.annotate('local max', # 文本内容
            xy=(2, 1),  # 箭头指向位置
            xytext=(3, 1.5), # 文本位置
            arrowprops=dict(facecolor='black', shrink=0.05)) # 箭头
ax.annotate('local min',
            xy = (2.5,-1),
            xytext = (4,-1.8),
            arrowprops = dict(facecolor = 'black',
                              width = 2, # 箭头宽度
                              headwidth = 10,# 箭头头部宽度
                              headlength = 10, # 箭头头部长度
                              shrink = 0.1)) # 箭头两端收缩的百分比（占总长）
ax.annotate('median',
            xy = (2.25,0),
            xytext = (0.5,-1.8),
            arrowprops = dict(arrowstyle = '-|>'), # 箭头样式
            fontsize = 20)
ax.set_ylim(-2, 2)
```

第四节 注释箭头连接形状

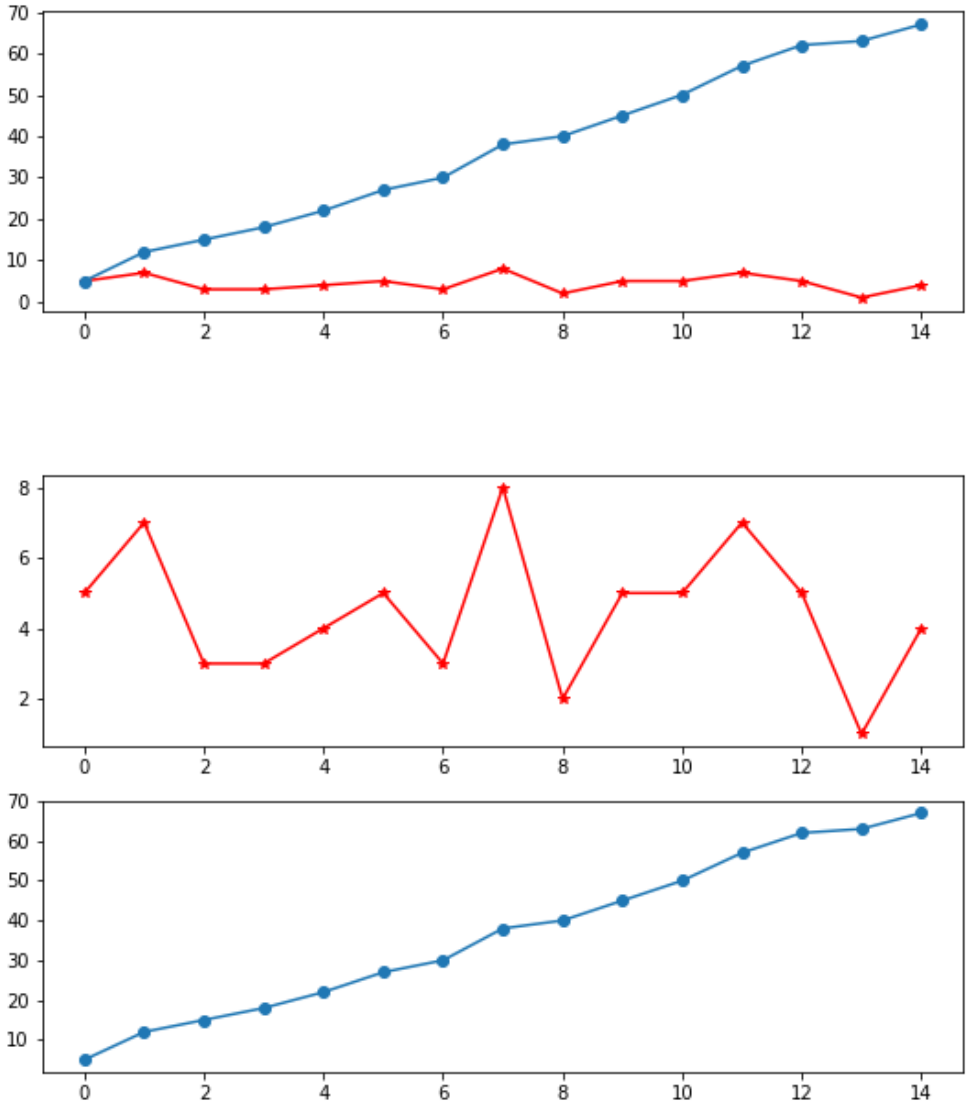



```python
import matplotlib.pyplot as plt

def annotate_con_style(ax, connectionstyle):
    x1, y1 = 3,2
    x2, y2 = 8,6
    ax.plot([x1, x2], [y1, y2], ".")
    ax.annotate(s = '',
                xy=(x1, y1), # 相当于B点，arrow head
                xytext=(x2, y2), # 相当于A点，arrow tail
                arrowprops=dict(arrowstyle='->', color='red',
                                shrinkA = 5,shrinkB = 5,
                                connectionstyle=connectionstyle))

    ax.text(.05, 0.95, connectionstyle.replace(",", "\n"),
            transform=ax.transAxes, # 相对坐标
            ha="left", va="top")# 指定对齐方式

# 常用箭头连接样式
fig, axs = plt.subplots(3, 5, figsize=(9,6))
annotate_con_style(axs[0, 0], "angle3,angleA=90,angleB=0")
annotate_con_style(axs[1, 0], "angle3,angleA=0,angleB=90")
annotate_con_style(axs[2, 0], "angle3,angleA = 0,angleB=150")
annotate_con_style(axs[0, 1], "arc3,rad=0.")
annotate_con_style(axs[1, 1], "arc3,rad=0.3")
annotate_con_style(axs[2, 1], "arc3,rad=-0.3")
annotate_con_style(axs[0, 2], "angle,angleA=-90,angleB=180,rad=0")
annotate_con_style(axs[1, 2], "angle,angleA=-90,angleB=180,rad=5")
annotate_con_style(axs[2, 2], "angle,angleA=-90,angleB=10,rad=5")
annotate_con_style(axs[0, 3], "arc,angleA=-90,angleB=0,armA=30,armB=30,rad=0")
annotate_con_style(axs[1, 3], "arc,angleA=-90,angleB=0,armA=30,armB=30,rad=5")
annotate_con_style(axs[2, 3], "arc,angleA=-90,angleB=0,armA=0,armB=40,rad=0")
annotate_con_style(axs[0, 4], "bar,fraction=0.3")
annotate_con_style(axs[1, 4], "bar,fraction=-0.3")
annotate_con_style(axs[2, 4], "bar,angle=180,fraction=-0.2")
```

```
for ax in axs.flat:
    # 设置轴域刻度
    ax.set(xlim=(0, 10), ylim=(0, 10),xticks = [],yticks = [],aspect=1)
fig.tight_layout(pad=0.2)
```

第六部分 常用视图

第一节 折线图

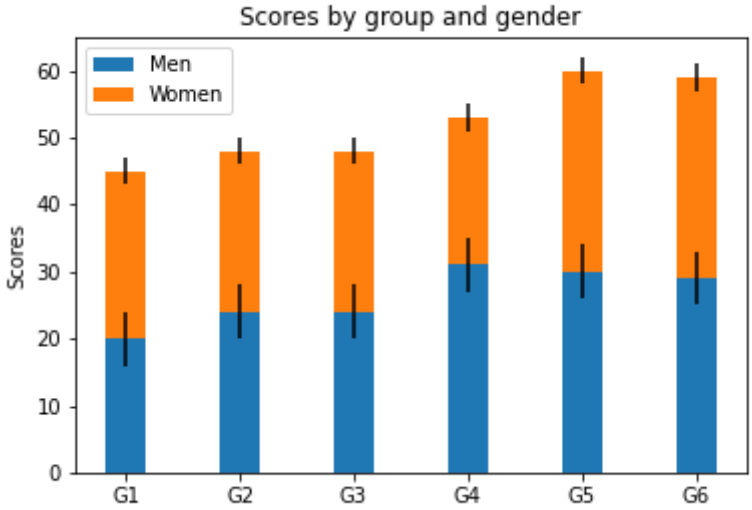



```
import numpy as np
import matplotlib.pyplot as plt
x = np.random.randint(0,10,size = 15)
# 一图多线
plt.figure(figsize=(9,6))
plt.plot(x,marker = '*',color = 'r')
plt.plot(x.cumsum(),marker = 'o')

# 多图布局
fig,axs = plt.subplots(2,1)
fig.set_figwidth(9)
fig.set_figheight(6)
```

```
axs[0].plot(x,marker = '*',color = 'red')
axs[1].plot(x.cumsum(),marker = 'o')
```

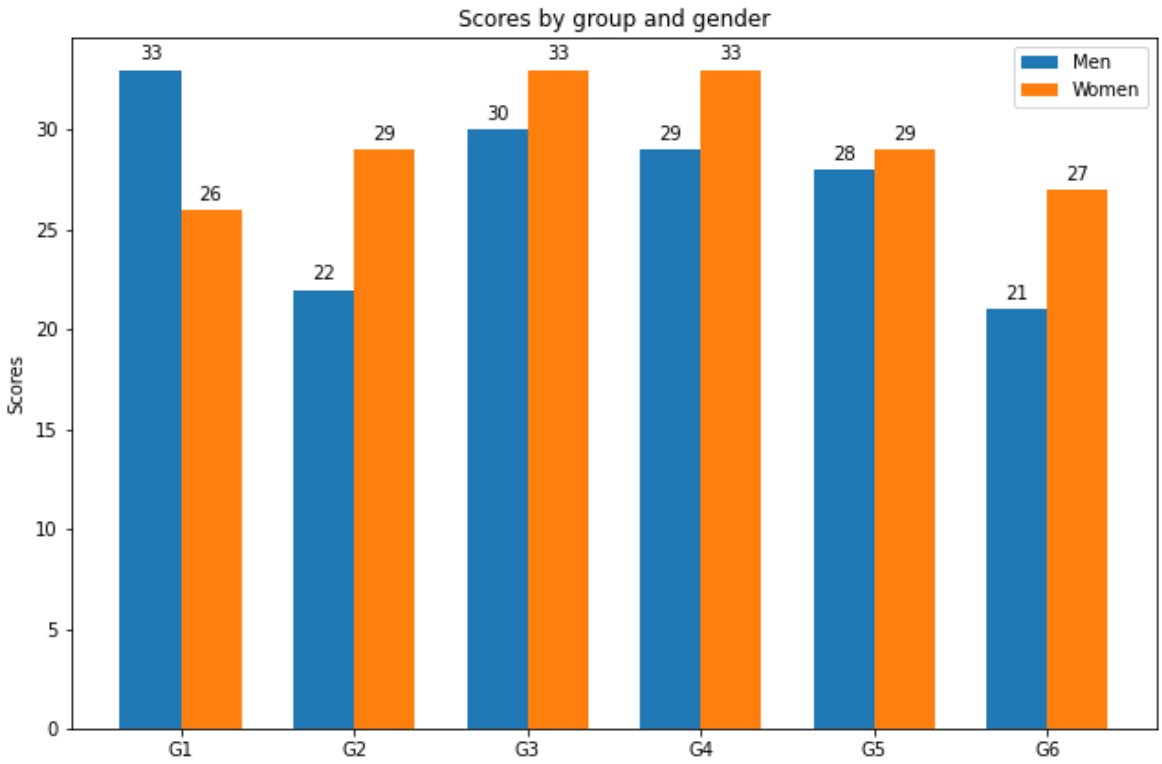
第二节 柱状图

堆叠柱状图




```
import numpy as np
import matplotlib.pyplot as plt
labels = ['G1', 'G2', 'G3', 'G4', 'G5','G6'] # 级别
men_means = np.random.randint(20,35,size = 6)
women_means = np.random.randint(20,35,size = 6)
men_std = np.random.randint(1,7,size = 6)
women_std = np.random.randint(1,7,size = 6)
width = 0.35
plt.bar(labels, # 横坐标
        men_means, # 柱高
        width, # 线宽
        yerr=4, # 误差条
        label='Men')#标签
plt.bar(labels, women_means, width, yerr=2, bottom=men_means,
       label='Women')
plt.ylabel('Scores')
plt.title('Scores by group and gender')
plt.legend()
```

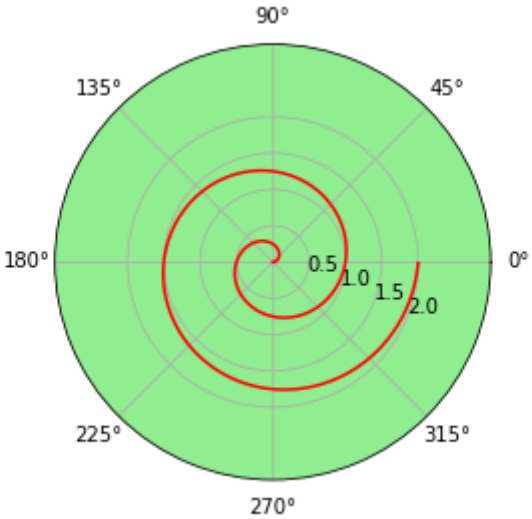
分组带标签柱状图




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

labels = ['G1', 'G2', 'G3', 'G4', 'G5','G6'] # 级别
men_means = np.random.randint(20,35,size = 6)
women_means = np.random.randint(20,35,size = 6)
x = np.arange(len(men_means))
plt.figure(figsize=(9,6))
rects1 = plt.bar(x - width/2, men_means, width) # 返回绘图区域对象
rects2 = plt.bar(x + width/2, women_means, width)

# 设置标签标题，图例
plt.ylabel('Scores')
plt.title('Scores by group and gender')
plt.xticks(x,labels)
plt.legend(['Men','Women'])

# 添加注释
def set_label(rects):
    for rect in rects:
        height = rect.get_height() # 获取高度
        plt.text(x = rect.get_x() + rect.get_width()/2, # 水平坐标
                 y = height + 0.5, # 竖直坐标
                 s = height, # 文本
                 ha = 'center') # 水平居中

set_label(rects1)
set_label(rects2)
plt.tight_layout() # 设置紧凑布局
plt.savefig('./分组带标签柱状图.png')
```

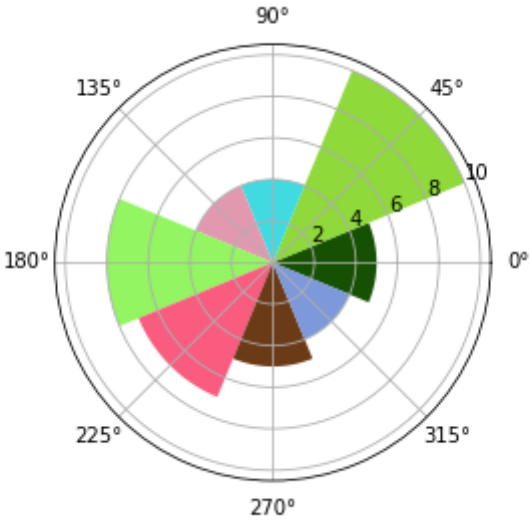
第三节 极坐标图

极坐标线形图



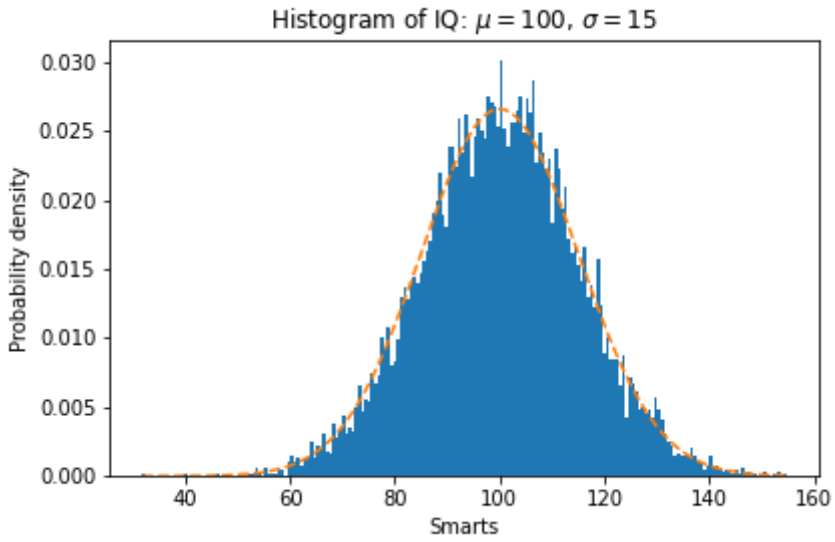

```
import numpy as np
import matplotlib.pyplot as plt

r = np.arange(0, 4*np.pi, 0.01) # 弧度值
y = np.linspace(0,2,len(r)) # 目标值

ax = plt.subplot(111,projection = 'polar',facecolor = 'lightgreen') # 定义极坐标
ax.plot(r, y,color = 'red')
ax.set_rmax(3) # 设置半径最大值
ax.set_rticks([0.5, 1, 1.5, 2])  # 设置半径刻度
ax.set_rlabel_position(-22.5)  # 设置半径刻度位置
ax.grid(True) # 网格线

ax.set_title("A line plot on a polar axis", va='center',ha = 'center',pad = 30)
```

极坐标柱状图



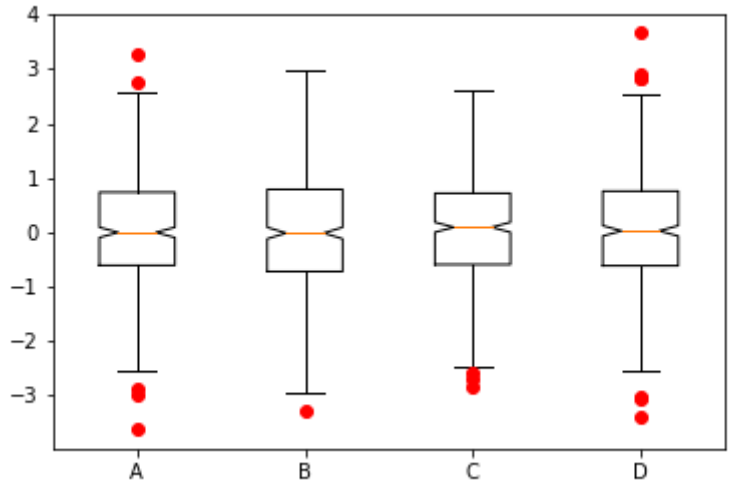
```
import numpy as np
import matplotlib.pyplot as plt
N = 8 # 分成8份
theta = np.linspace(0.0, 2 * np.pi, N, endpoint=False)
radii = np.random.randint(3,15,size = N)
width = np.pi / 4
colors = np.random.rand(8,3) # 随机生成颜色
ax = plt.subplot(111, projection='polar') # polar表示极坐标
ax.bar(theta, radii, width=width, bottom=0.0,color = colors)
```

第四节 直方图




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

mu = 100 # 平均值
sigma = 15 # 标准差
x = np.random.normal(loc = mu,scale = 15,size = 10000)
fig, ax = plt.subplots()

n, bins, patches = ax.hist(x, 200, density=True) # 直方图

# 概率密度函数
y = ((1 / (np.sqrt(2 * np.pi) * sigma)) *
     np.exp(-0.5 * (1 / sigma * (bins - mu))**2))
plt.plot(bins, y, '--')
plt.xlabel('Smarts')
plt.ylabel('Probability density')
plt.title(r'Histogram of IQ: $\mu=100$, $\sigma=15$')

# 紧凑布局
fig.tight_layout()
plt.savefig('./直方图.png')
```

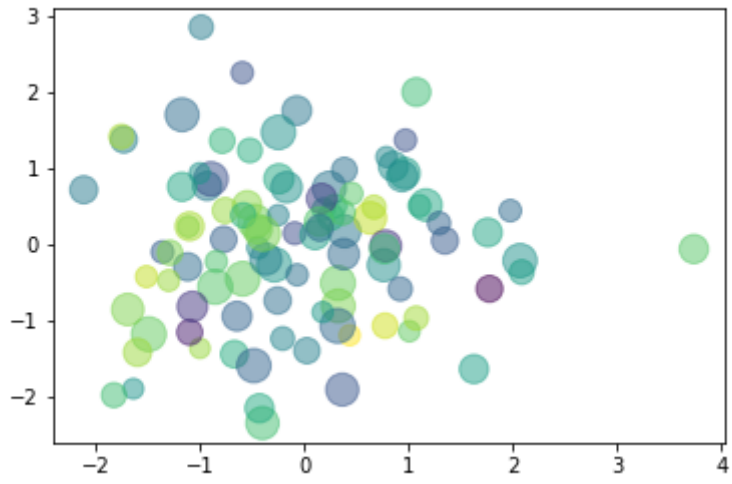
第五节 箱形图




```
import numpy as np
import matplotlib.pyplot as plt
data=np.random.normal(size=(500,4))
lables = ['A','B','C','D']
# 用Matplotlib画箱线图
plt.boxplot(data,1,'gD',labels=lables) # 红色的圆点是异常值
```

第六节 散点图

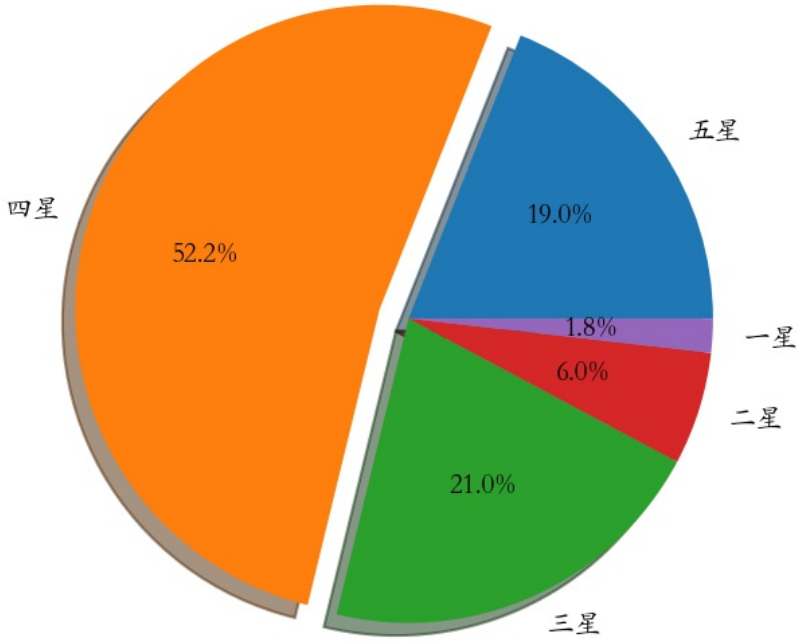
散点图的英文叫做 scatter plot，它将两个变量的值显示在二维坐标中，非常适合展示两个变量之间的关系



```
import numpy as np
import matplotlib.pyplot as plt
data = np.random.randn(100,2)
s = np.random.randint(100,300,size = 100)
color = np.random.randn(100)
plt.scatter(data[:,0], # 横坐标
            data[:,1], # 纵坐标
            s = s, # 尺寸
            c = color, # 颜色
            alpha = 0.5) # 透明度
```

第六节 饼图

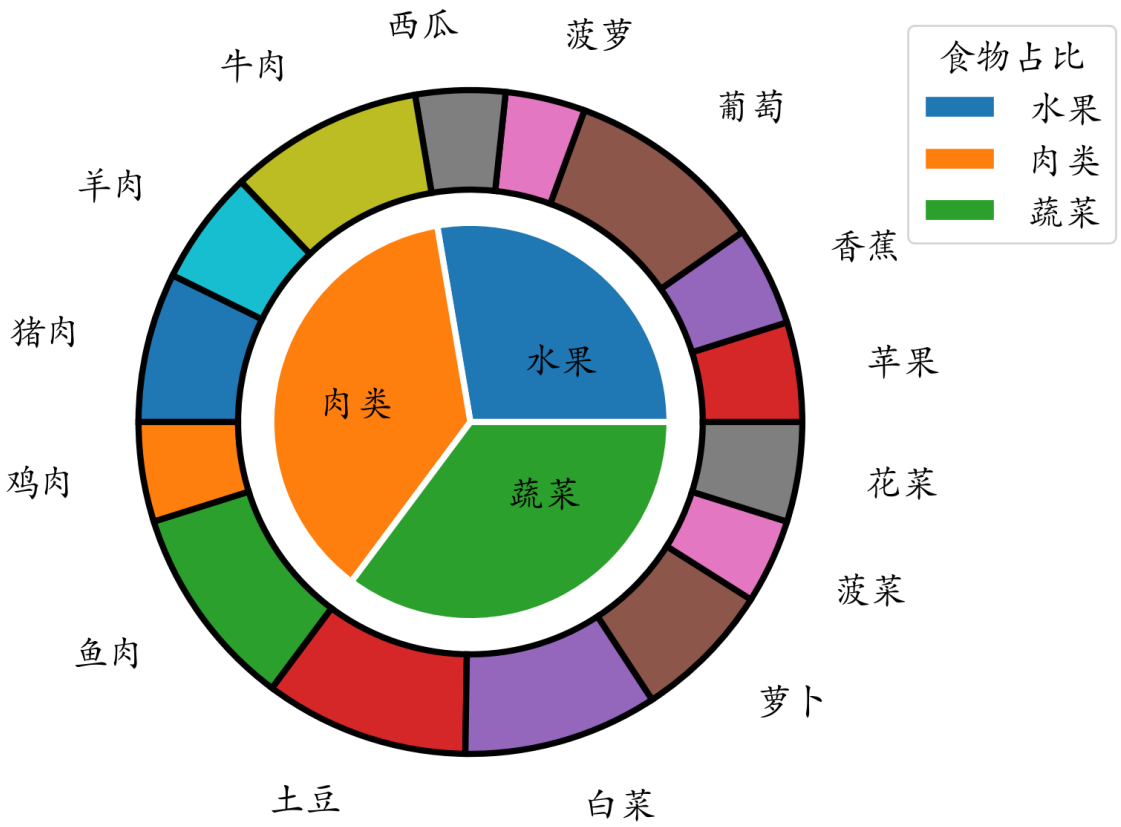
一般饼图




```
import numpy as np
import matplotlib.pyplot as plt
# 解决中文字体乱码的问题
matplotlib.rcParams['font.sans-serif']='Kaiti SC'

labels =["五星","四星","三星","二星","一星"] # 标签
percent = [95,261,105,30,9] # 某市星级酒店数量

# 设置图片大小和分辨率
fig=plt.figure(figsize=(5,5), dpi=150)
# 偏移中心量，突出某一部分
```

```
explode = (0, 0.1, 0, 0, 0)
# 绘制饼图：autopct显示百分比，这里保留一位小数；shadow控制是否显示阴影
plt.pie(x = percent, # 数据
        explode=explode, # 偏移中心量
        labels=labels,  # 显示标签
        autopct='%0.1f%%', # 显示百分比
        shadow=True) # 阴影，3D效果
plt.savefig("./饼图.jpg")
```

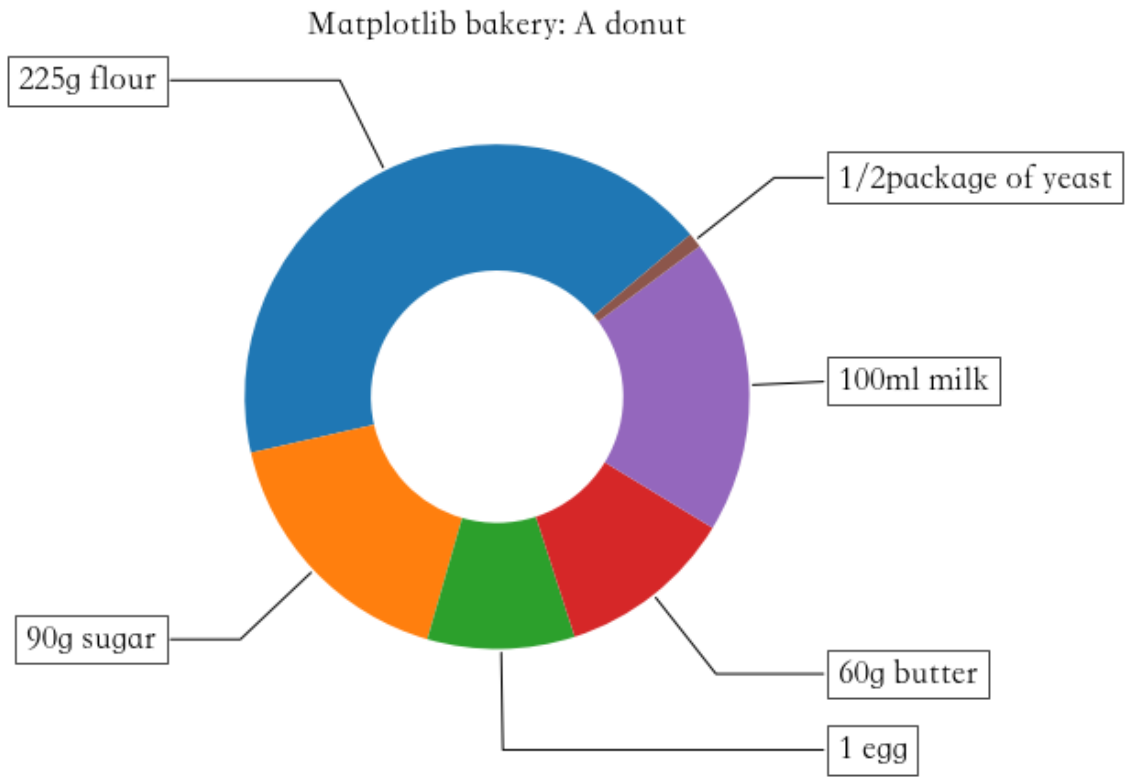
嵌套饼图




```
import pandas as pd
import matplotlib.pyplot as plt
food = pd.read_excel('./food.xlsx')
# 分组聚合，内圈数据
inner = food.groupby(by = 'type')['花费'].sum()
outer = food['花费'] # 外圈数据
plt.rcParams['font.family'] = 'Kaiti SC'
plt.rcParams['font.size'] = 18
fig=plt.figure(figsize=(8,8))
# 绘制内部饼图
plt.pie(x = inner, # 数据
        radius=0.6, # 饼图半径
```

```
        wedgeprops=dict(linewidth=3,width=0.6,edgecolor='w'),# 饼图格式：间隔线宽、
饼图宽度、边界颜色
        labels = inner.index, # 显示标签
        labeldistance=0.4) # 标签位置
# 绘制外部饼图
plt.pie(x = outer,
        radius=1, # 半径
        wedgeprops=dict(linewidth=3,width=0.3,edgecolor='k'),# 饼图格式：间隔线宽、
饼图宽度、边界颜色
        labels = food['食材'], # 显示标签
        labeldistance=1.2) # 标签位置

# 设置图例标题，bbox_to_anchor = (x, y, width, height)控制图例显示位置
plt.legend(inner.index,bbox_to_anchor = (0.9,0.6,0.4,0.4),title = '食物占比')
plt.tight_layout()
plt.savefig('./嵌套饼图.png',dpi = 200)
```

甜甜圈（自学）




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

plt.figure(figsize=(6,6))
# 甜甜圈原料
recipe = ["225g flour",
          "90g sugar",
          "1 egg",
          "60g butter",
          "100ml milk",
          "1/2package of yeast"]
# 原料比例
data = [225, 90, 50, 60, 100, 5]
wedges, texts = plt.pie(data,startangle=40)
bbox_props = dict(boxstyle="square,pad=0.3", fc="w", ec="k", lw=0.72)
```

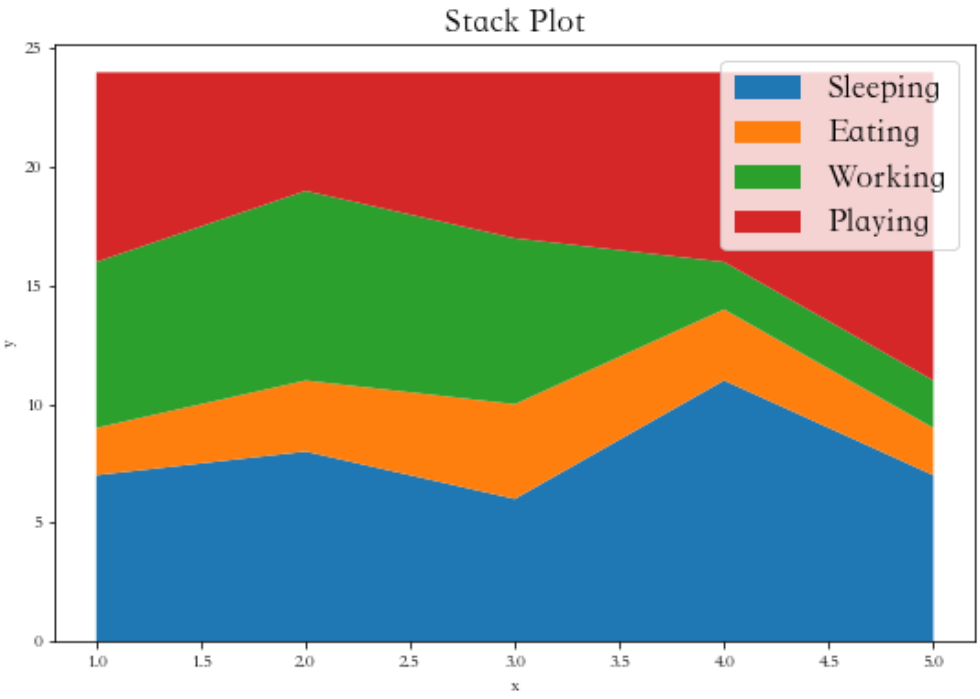
```
kw = dict(arrowprops=dict(arrowstyle="-"),
          bbox=bbox_props,va="center")

for i, p in enumerate(wedges):
    ang = (p.theta2 - p.theta1)/2. + p.theta1 # 角度计算
    # 角度转弧度----->弧度转坐标
    y = np.sin(np.deg2rad(ang))
    x = np.cos(np.deg2rad(ang))
    ha = {-1: "right", 1: "left"}[int(np.sign(x))] # 水平对齐方式
    connectionstyle = "angle,angleA=0,angleB={}".format(ang) # 箭头连接样式
    kw["arrowprops"].update({"connectionstyle": connectionstyle}) # 更新箭头连接方
式
    plt.annotate(recipe[i], xy=(x, y), xytext=(1.35*np.sign(x), 1.4*y),
                 ha=ha,**kw,fontsize = 18,weight = 'bold')
plt.title("Matplotlib bakery: A donut",fontsize = 18,pad = 25)
plt.tight_layout()
```

第七节 热力图


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

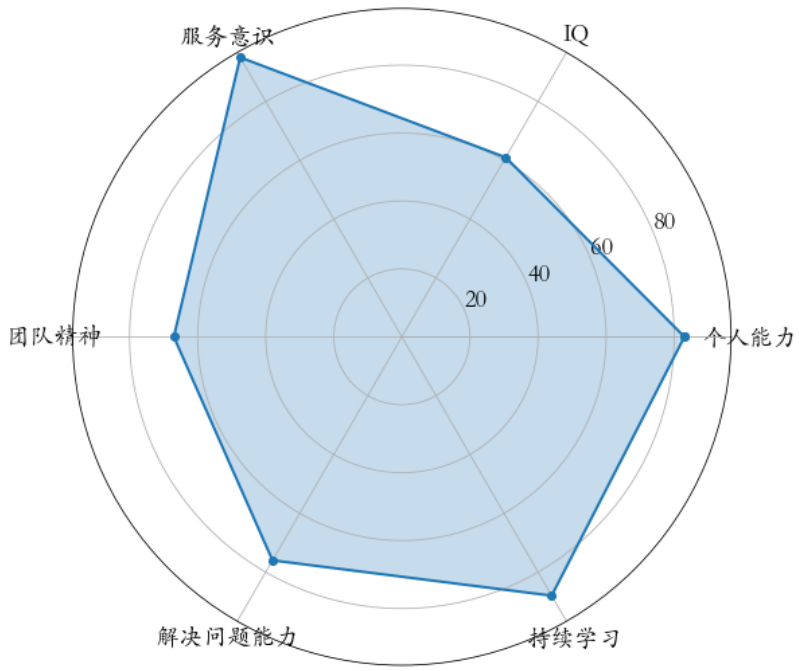
```
vegetables = ["cucumber", "tomato", "lettuce", "asparagus","potato", "wheat",
"barley"]
farmers = list('ABCDEFG')

harvest = np.random.rand(7,7)*5 # 农民丰收数据

plt.rcParams['font.size'] = 18
plt.rcParams['font.weight'] = 'heavy'
plt.figure(figsize=(9,9))
im = plt.imshow(harvest)

plt.xticks(np.arange(len(farmers)),farmers,rotation = 45,ha = 'right')
plt.yticks(np.arange(len(vegetables)),vegetables)

# 绘制文本
for i in range(len(vegetables)):
    for j in range(len(farmers)):
        text = plt.text(j, i, round(harvest[i, j],1),
                        ha="center", va="center", color='r')
plt.title("Harvest of local farmers (in tons/year)",pad = 20)
fig.tight_layout()
plt.savefig('./热力图.png')
```

第八节 面积图



```
import matplotlib.pyplot as plt
plt.figure(figsize=(9,6))
days = [1,2,3,4,5]
sleeping =[7,8,6,11,7]
eating = [2,3,4,3,2]
working =[7,8,7,2,2]
playing = [8,5,7,8,13]
plt.stackplot(days,sleeping,eating,working,playing)
plt.xlabel('x')
plt.ylabel('y')
plt.title('Stack Plot',fontsize = 18)
plt.legend(['Sleeping','Eating','Working','Playing'],fontsize = 18)
```

第九节 蜘蛛图

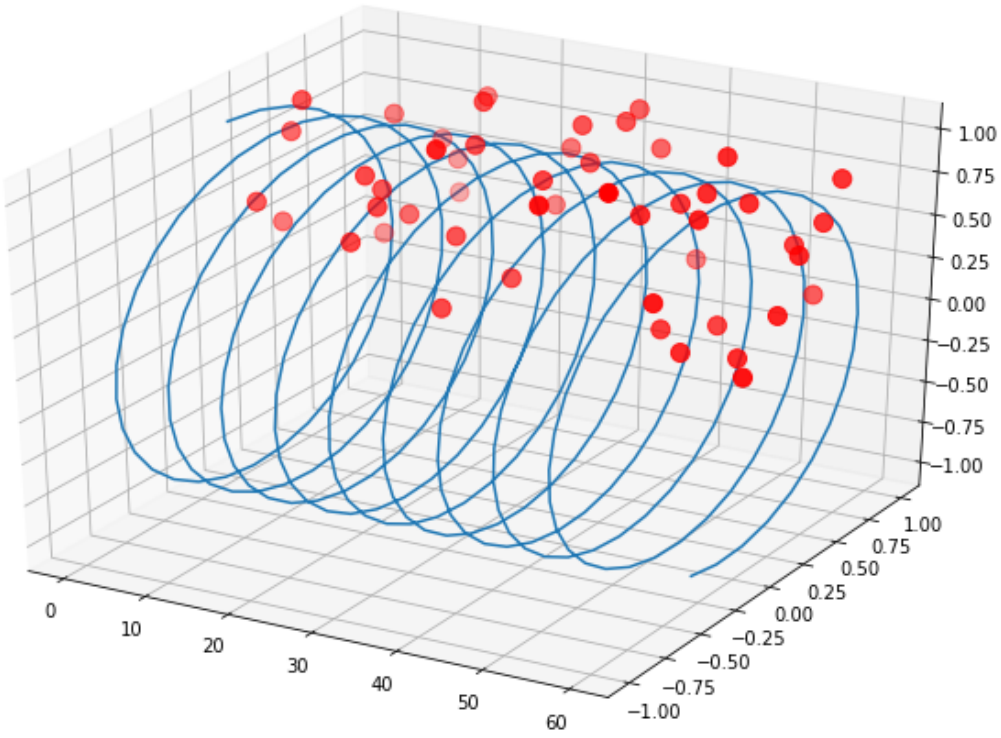



```
import numpy as np
import matplotlib.pyplot as plt
plt.rcParams['font.family'] = 'Kaiti SC'
labels=np.array(["个人能力","IQ","服务意识","团队精神","解决问题能力","持续学习"])
stats=[83, 61, 95, 67, 76, 88]
# 画图数据准备，角度、状态值
angles=np.linspace(0, 2*np.pi, len(labels), endpoint=False)
stats=np.concatenate((stats,[stats[0]]))
angles=np.concatenate((angles,[angles[0]]))
# 用Matplotlib画蜘蛛图
fig = plt.figure(figsize=(9,9))
ax = fig.add_subplot(111, polar=True)
ax.plot(angles, stats, 'o-', linewidth=2) # 连线
ax.fill(angles, stats, alpha=0.25) # 填充
# 设置角度
ax.set_thetagrids(angles*180/np.pi,#角度值
```

```
                    labels,
                    fontsize = 18)
ax.set_rgrids([20,40,60,80],fontsize = 18)
```

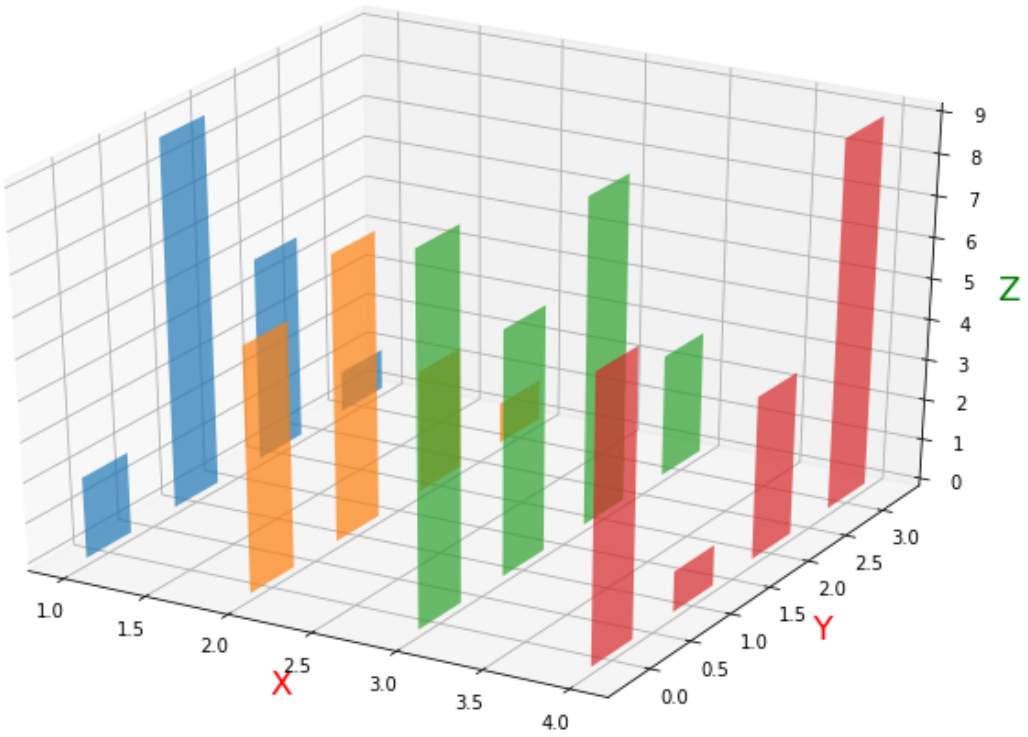
第七部分 3D图形

第一节 三维折线图散点图




```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d.axes3d import Axes3D # 3D引擎

x = np.linspace(0,60,300)
y = np.sin(x)
z = np.cos(x)

fig = plt.figure(figsize=(9,6)) # 二维图形
ax3 = Axes3D(fig) # 二维变成了三维
ax3.plot(x,y,z) # 3维折线图
# 3维散点图
ax3.scatter(np.random.rand(50)*60,np.random.rand(50),np.random.rand(50),
            color = 'red',s = 100)
```

第二节 三维柱状图



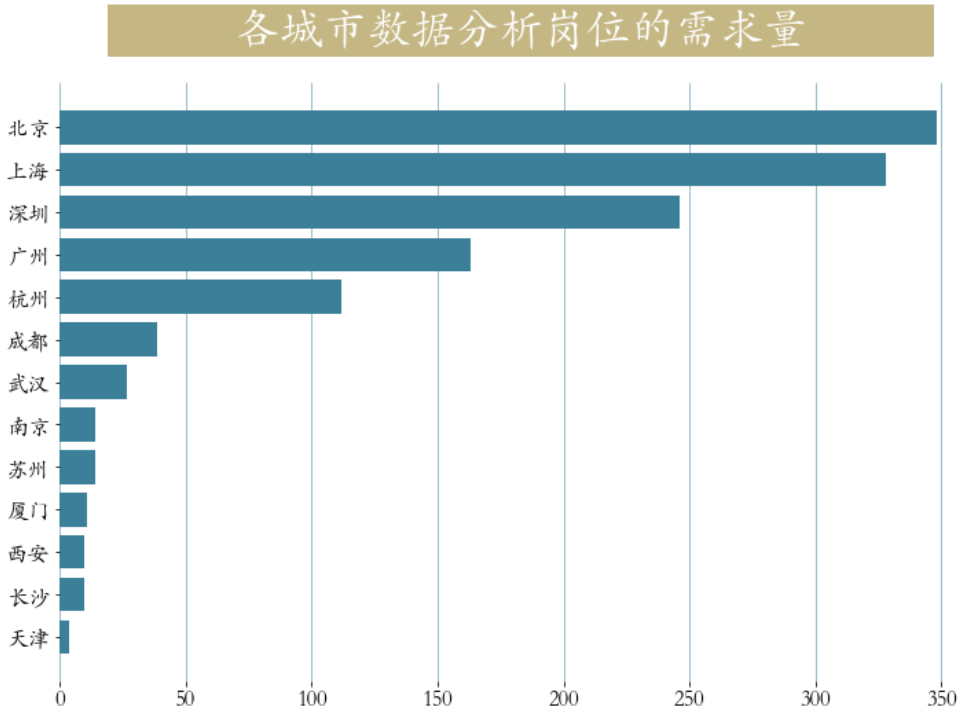

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d.axes3d import Axes3D # 3D引擎
month = np.arange(1,5)
# 每个月 4周 每周都会产生数据
# 三个维度：月、周、销量
fig = plt.figure(figsize=(9,6))
ax3 = Axes3D(fig)

for m in month:
    ax3.bar(np.arange(4),
            np.random.randint(1,10,size = 4),
            zs = m ,
            zdir = 'x',# 在哪个方向上，一排排排列
            alpha = 0.7,# alpha 透明度
            width = 0.5)
ax3.set_xlabel('X',fontsize = 18,color = 'red')
ax3.set_ylabel('Y',fontsize = 18,color = 'red')
ax3.set_zlabel('Z',fontsize = 18,color = 'green')
```

第八部分 实战-数据分析师招聘数据分析

十六进制颜色码

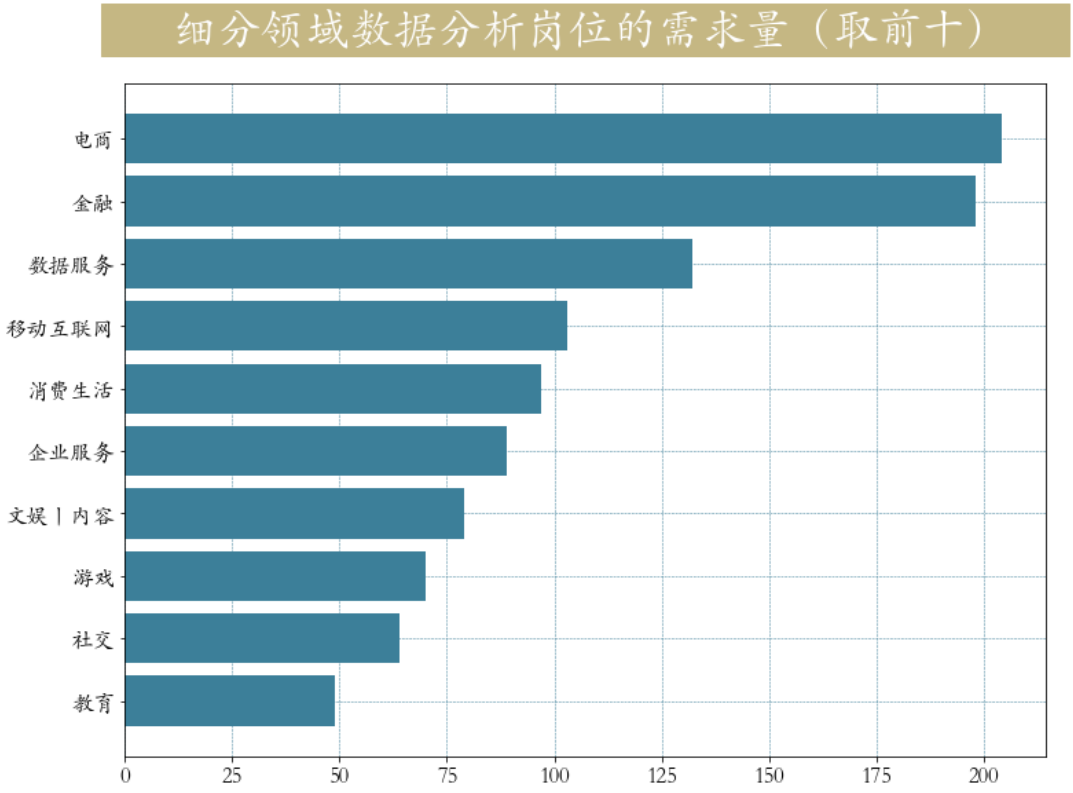
第一节 各城市对数据分析岗位的需求量

两种常用颜色：浅蓝色： #3c7f99 ， 淡黄色：#c5b783



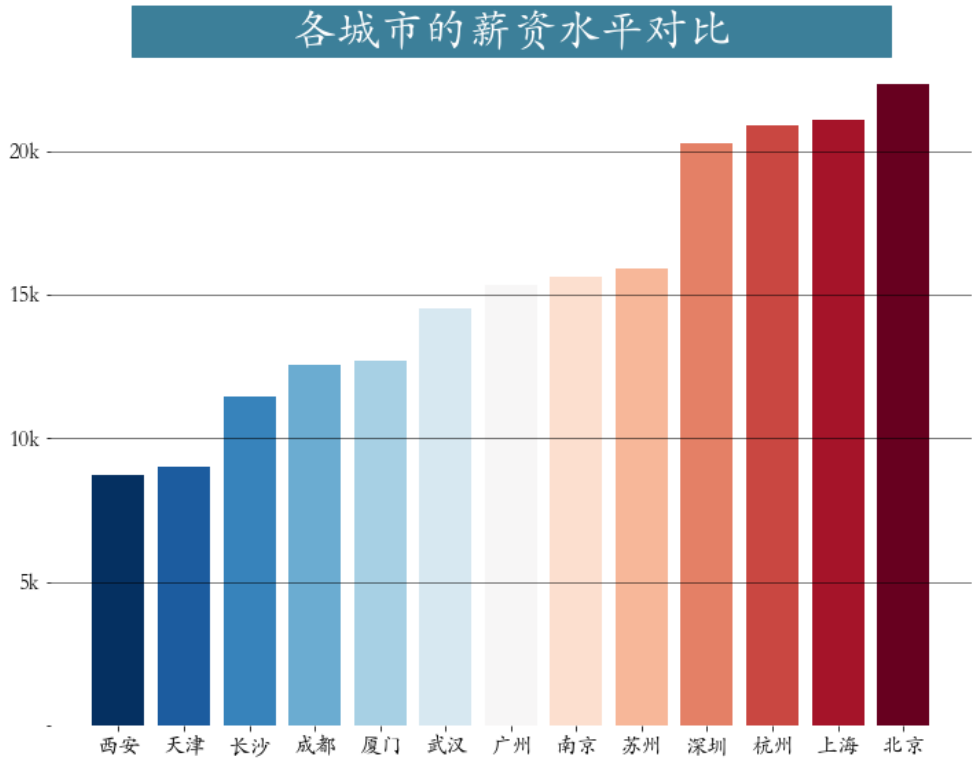

```
plt.figure(figsize=(12,9))
cities = job['city'].value_counts() # 统计城市工作数量
plt.barh(y = cities.index[::-1],
        width = cities.values[::-1],
        color = '#3c7f99')
plt.box(False) # 不显示边框
plt.title(label='            各城市数据分析岗位的需求量            ',
          fontsize=32, weight='bold', color='white',
          backgroundcolor='#c5b783',pad = 30 )
plt.tick_params(labelsize = 16)
plt.grid(axis = 'x',linewidth = 0.5,color = '#3c7f99')
```

第二节 不同领域对数据分析岗的需求量



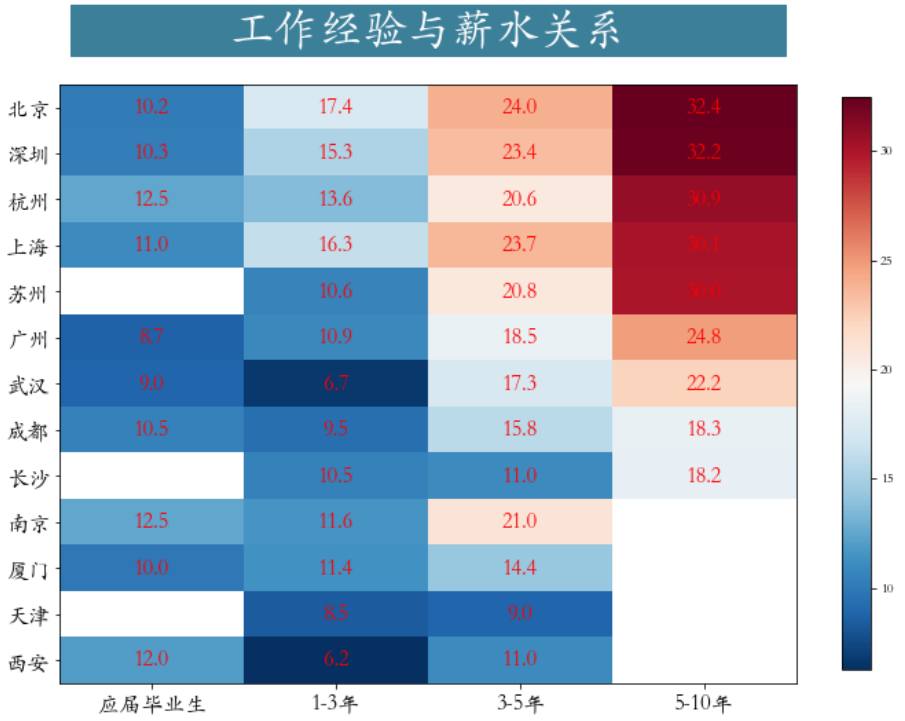

```
# 获取需求量前10多的领域
industry_index = job["industryField"].value_counts()[:10].index
industry =job.loc[job["industryField"].isin(industry_index),"industryField"]
plt.figure(figsize=(12,9))
plt.barh(y = industry_index[::-1],
         width=pd.Series.value_counts(industry.values).values[::-1],
         color = '#3c7f99')
plt.title(label='      细分领域数据分析岗位的需求量（取前十）      ',
          fontsize=32, weight='bold', color='white',
          backgroundcolor='#c5b783',ha = 'center',pad = 30)
plt.tick_params(labelsize=16)
plt.grid(lw = 0.5,color = '#3c7f99',ls = '--')
```

第三节 各城市薪资状况



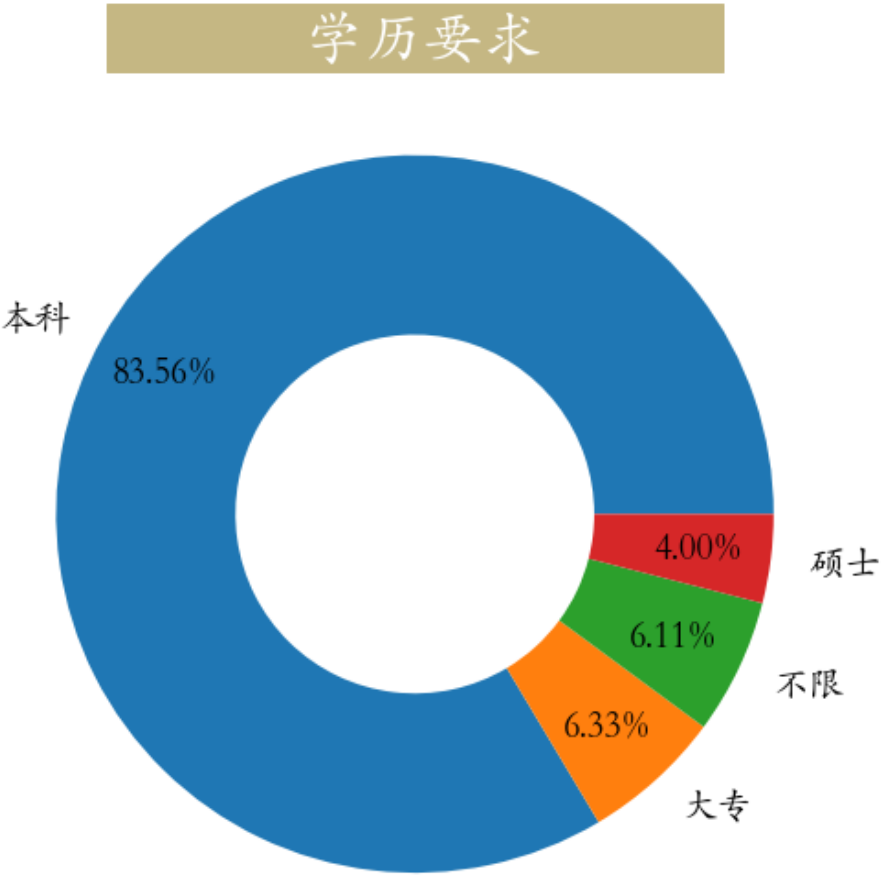

```
plt.figure(figsize=(12,9))
city_salary = job.groupby("city")["salary"].mean().sort_values() # 分组聚合运算
plt.bar(x = city_salary.index,height = city_salary.values,
       color = plt.cm.RdBu_r(np.linspace(0,1,len(city_salary))))
plt.title(label='                各城市的薪资水平对比                ',
         fontsize=32, weight='bold', color='white', backgroundcolor='#3c7f99')
plt.tick_params(labelsize=16)
plt.grid(axis = 'y',linewidth = 0.5,color = 'black')
plt.yticks(ticks = np.arange(0,25,step = 5,),labels =
['','5k','10k','15k','20k'])
plt.box(False) # 去掉边框
plt.savefig('./各城市薪资状况.png')
```

第四节 工作经验与薪水关系



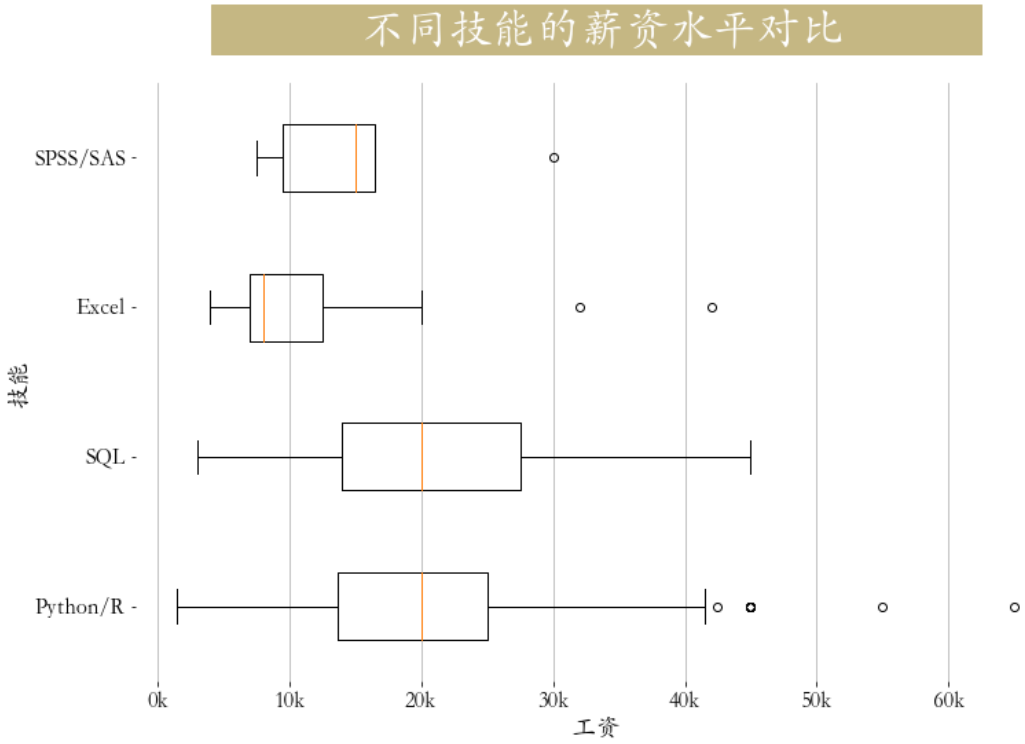

```
work_salary = job.pivot_table(index="city",columns="workYear",values="salary") #
透视表
work_salary = work_salary[["应届毕业生","1-3年","3-5年","5-10年"]]\
              .sort_values(by = '5-10年',ascending = False) # 筛选一部分工作经验
data = work_salary.values
data = np.repeat(data,4,axis = 1) # 重复4次，目的画图，美观，图片宽度拉大
plt.figure(figsize=(12,9))
plt.imshow(data,cmap='RdBu_r')
plt.yticks(np.arange(13),work_salary.index)
plt.xticks(np.array([1.5,5.5,9.5,13.5]),work_salary.columns)
# 绘制文本
h,w = data.shape
for x in range(w):
    for y in range(h):
        if (x%4 == 0) and (~np.isnan(data[y,x])):
            text = plt.text(x + 1.5, y, round(data[y,x],1),
                            ha="center", va="center", color='r',fontsize = 16)
plt.colorbar(shrink = 0.85)
plt.tick_params(labelsize = 16)
plt.savefig('./工作经验与薪水关系.png')
```

第五节 学历要求




```
education = job["education"].value_counts(normalize=True)
plt.figure(figsize=(9,9))
_ = plt.pie(education,labels=education.index,autopct='%0.2f%%',
            wedgeprops=dict(linewidth=3,width = 0.5),pctdistance=0.8,
            textprops = dict(fontsize = 20))
_ = plt.title(label='              学历要求              ',
          fontsize=32, weight='bold',
          color='white', backgroundcolor='#c5b783')
plt.savefig('./学历要求.png')
```

第六节 技能要求

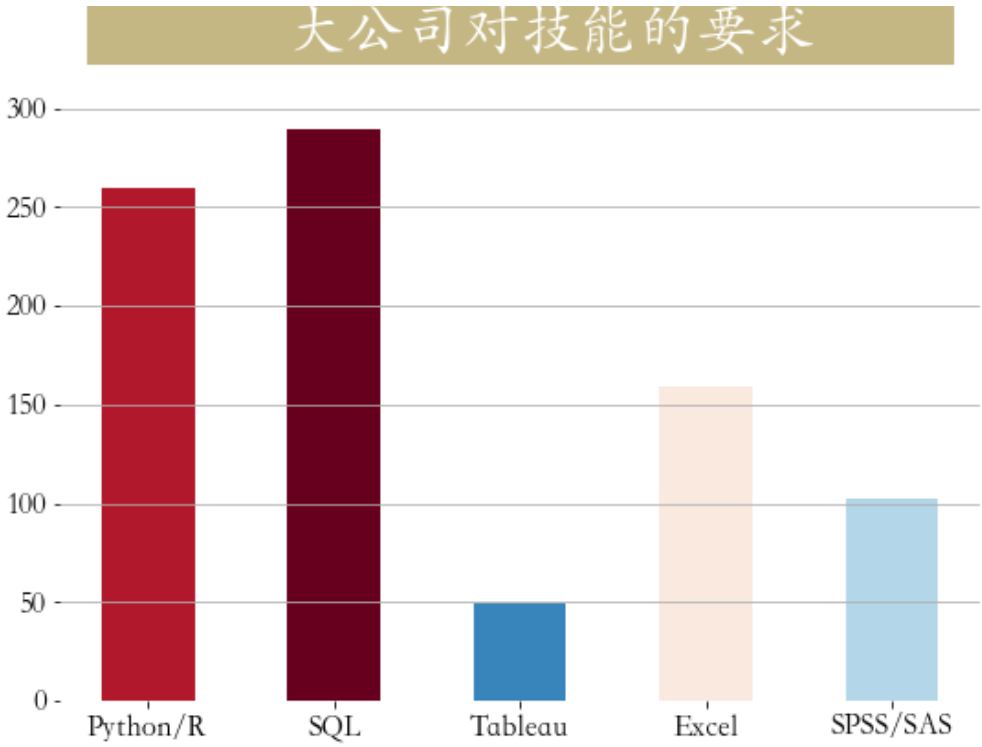



```
def get_level(x):
    if x["Python/R"] == 1:
        x["skill"] = "Python/R"
    elif x["SQL"] == 1:
        x["skill"] = "SQL"
    elif x["Excel"] == 1:
        x["skill"] = "Excel"
    elif x['SPSS/SAS'] == 1:
        x['skill'] = 'SPSS/SAS'
    else:
        x["skill"] = "其他"
    return x
job = job.apply(get_level,axis=1) # 数据转换

# 获取主要技能
x = job.loc[job.skill!='其他'][['salary','skill']]
cond1 = x['skill'] == 'Python/R'
cond2 = x['skill'] =='SQL'
cond3 = x['skill'] == 'Excel'
cond4 = x['skill'] == 'SPSS/SAS'

plt.figure(figsize=(12,8))
plt.title(label='              不同技能的薪资水平对比              ',
          fontsize=32, weight='bold', color='white',
          backgroundcolor='#c5b783',pad = 30)
plt.boxplot(x = [job.loc[job.skill!='其他']['salary'][cond1],
                 job.loc[job.skill!='其他']['salary'][cond2],
                 job.loc[job.skill!='其他']['salary'][cond3],
                 job.loc[job.skill!='其他']['salary'][cond4]],
            vert = False,labels = ["Python/R","SQL","Excel",'SPSS/SAS'])
plt.tick_params(axis="both",labelsize=16)
plt.grid(axis = 'x',linewidth = 0.75)
plt.xticks(np.arange(0,61,10), [str(i)+"k" for i in range(0,61,10)])
plt.box(False)
```

```
plt.xlabel('工资', fontsize=18)
plt.ylabel('技能', fontsize=18)
plt.savefig('./技能要求.png')
```

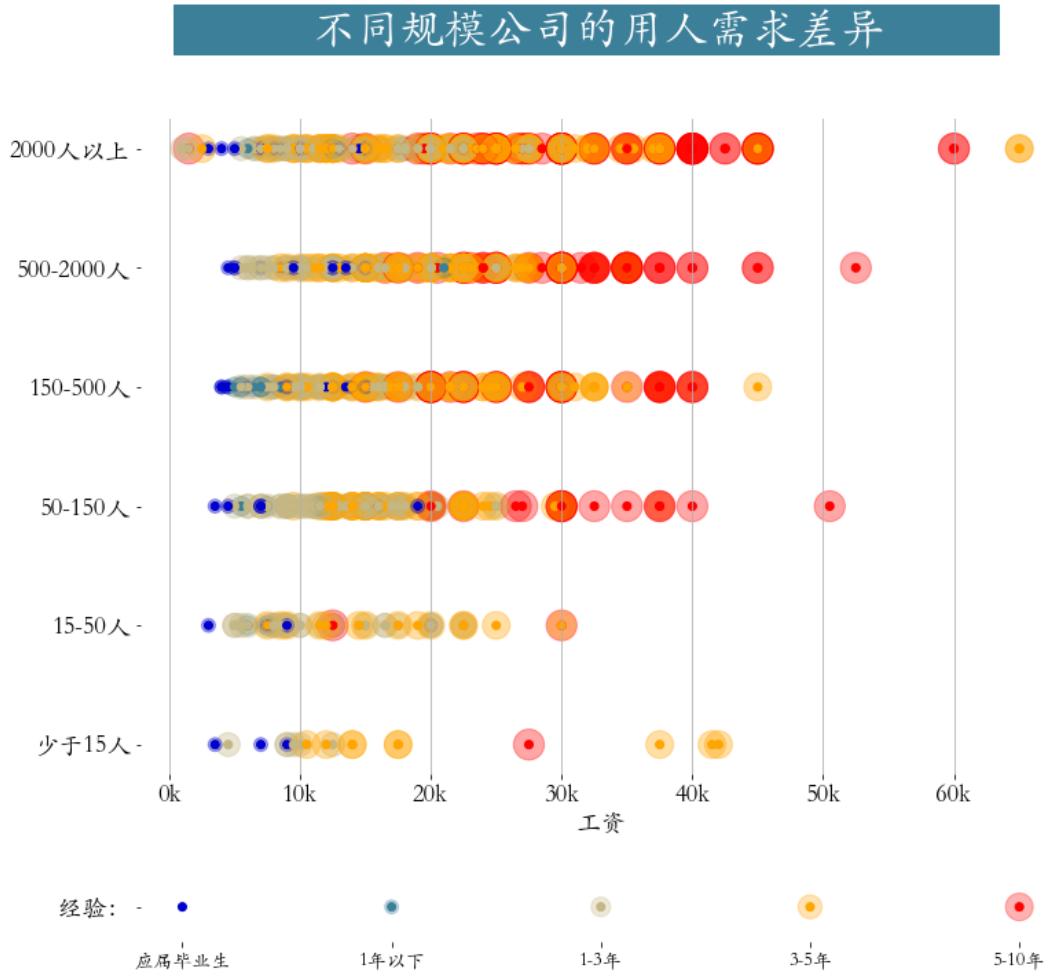
第七节 大公司对技能要求

colors = ['#ff0000', '#ffa500', '#c5b783', '#3c7f99', '#0000cd']




```
skill_count = job[job['companySize'] == '2000人以上']
[['Python','SQL','Tableau','Excel','SPSS/SAS']].sum()
plt.figure(figsize=(9,6))
plt.bar(np.arange(5),skill_count,
        tick_label = ['Python/R','SQL','Tableau','Excel','SPSS/SAS'],
        width = 0.5,
        color = plt.cm.RdBu_r(skill_count/skill_count.max()))
_ = plt.title(label='              大公司对技能的要求          ',
          fontsize=32, weight='bold', color='white',
          backgroundcolor='#c5b783',pad = 30)
plt.tick_params(labelsize=16,)
plt.grid(axis = 'y')
plt.box(False)
plt.savefig('./大公司技能要求.png')
```

第八节 不同规模的公司在招人要求上的差异




```
from matplotlib import gridspec
workYear_map = {
    "5-10年": 5,
    "3-5年": 4,
    "1-3年": 3,
    "1年以下": 2,
    "应届毕业生": 1}
color_map = {
    5:"#ff0000",
    4:"#ffa500",
    3:"#c5b783",
    2:"#3c7f99",
    1:"#0000cd"}
cond = job.workYear.isin(workYear_map)
job = job[cond]
job['workYear'] = job.workYear.map(workYear_map)
# 根据companySize进行排序，人数从多到少
job['companySize'] = job['companySize'].astype('category')
list_custom = ['2000人以上', '500-2000人','150-500人','50-150人','15-50人','少于15
人']
job['companySize'].cat.reorder_categories(list_custom, inplace=True)
job.sort_values(by = 'companySize',inplace = True,ascending = False)

plt.figure(figsize=(12,11))
gs = gridspec.GridSpec(10,1)
plt.subplot(gs[:8])
```

```
plt.suptitle(t='                不同规模公司的用人需求差异                ',
         fontsize=32,
         weight='bold', color='white', backgroundcolor='#3c7f99')
plt.scatter(job.salary,job.companySize,
            c = job.workYear.map(color_map),
            s = (job.workYear*100),alpha = 0.35)
plt.scatter(job.salary,job.companySize,
            c = job.workYear.map(color_map))
plt.grid(axis = 'x')
plt.xticks(np.arange(0,161,10), [str(i)+"k" for i in range(0,161,10)])
plt.xlabel('工资', fontsize=18)
plt.box(False)
plt.tick_params(labelsize = 18)

# 绘制底部标记
plt.subplot(gs[9:])
x = np.arange(5)[::-1]
y = np.zeros(len(x))
s = x*100
plt.scatter(x,y,s=s,c=color_map.values(),alpha=0.3)
plt.scatter(x,y,c=color_map.values())
plt.box(False)
plt.xticks(ticks=x,labels=list(workYear_map.keys()),fontsize=14)
plt.yticks(np.arange(1),labels=['  经验：'],fontsize=18)
plt.savefig('./不同规模公司招聘薪资工作经验差异.png')
```