科学编程基础

6. 绘图模块

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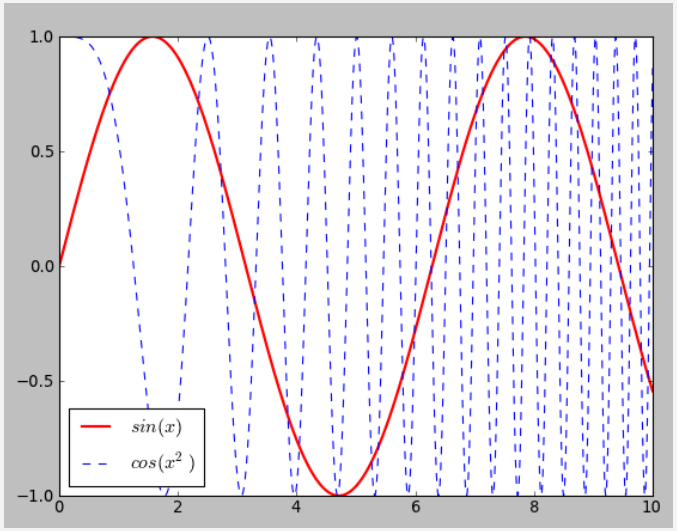
图形相关模块

- Matplotlib：基于数值计算模块 Numeric 及 Numarray，克隆了许多 Matlab 中的函数， 帮助用户轻松地获得高质量的二维图形。
- Mayavi：全称"The MayaVi Data Visualizer"。它可以绘制几 乎所有Matlab能绘制的3D数据图，并且有比Matlab更强大的交互性，甚至能录制下对数据图的操作。
- PIL(Python Imaging Library)：支持各种图片文件格式，能进行图形格式的转换、显示，以及图形的放大、缩小和旋转等处理。
- Visual 是Python的一个简单易用的3D图形库，使用它可以快速创建3D场景、动画。

范例1：绘制函数




```
import numpy as np
import pyplot as plt

x = np.linspace(0, 10, 1000)
y = np.sin(x) ; z = np.cos(x**2)
plt.figure()
plt.plot(x,y,label="$sin(x)$",color="red",
    linewidth=2)
plt.plot(x,z,"b--",label="$cos(x^2)$")
plt.legend(loc=3)
plt.show() #保存图像可用 plt.savefig('fig.jpg')
plt.close()
```

Plot 参数

- alpha : float
- color or c : any matplotlib color
- label : any string ，图注名称
- linestyle or ls : ['-' | '--' | '-.' | ':' | 'steps' | ...]
- linewidth or lw: float value (*points, 0.3527mm*)
- marker ['+' | ',' | '.' | '1' | '2' | '3' | '4']
- markersize or ms : float
- zorder: any number 叠放顺序

颜色

- 蓝色： 'b' (blue)
- 绿色： 'g' (green)
- 红色： 'r' (red)
- 青色： 'c' (cyan)
- 洋红： 'm' (magenta)
- 黄色： 'y' (yellow)
- 黑色： 'k' (black)
- 白色： 'w' (white)

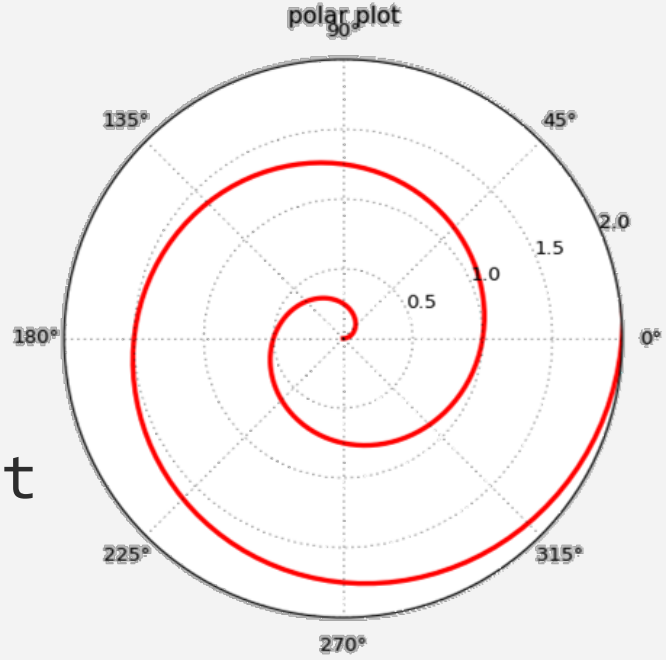
Color Name	Color Code
Red	#FF0000
Cyan	#00FFFF
Blue	#0000FF
DarkBlue	#0000A0
LightBlue	#ADD8E6
Purple	#800080
Yellow	#FFFF00
Lime	#00FF00
Magenta	#FF00FF

- 灰度表示： e.g. 0.75 ([0,1]内任意浮点数)
- RGB表示法：由红色、绿色和蓝色的值组成的十六进制符号来定义 e.g. '#2F4F4F' 或 (0.18, 0.31, 0.31)

坐标轴定制

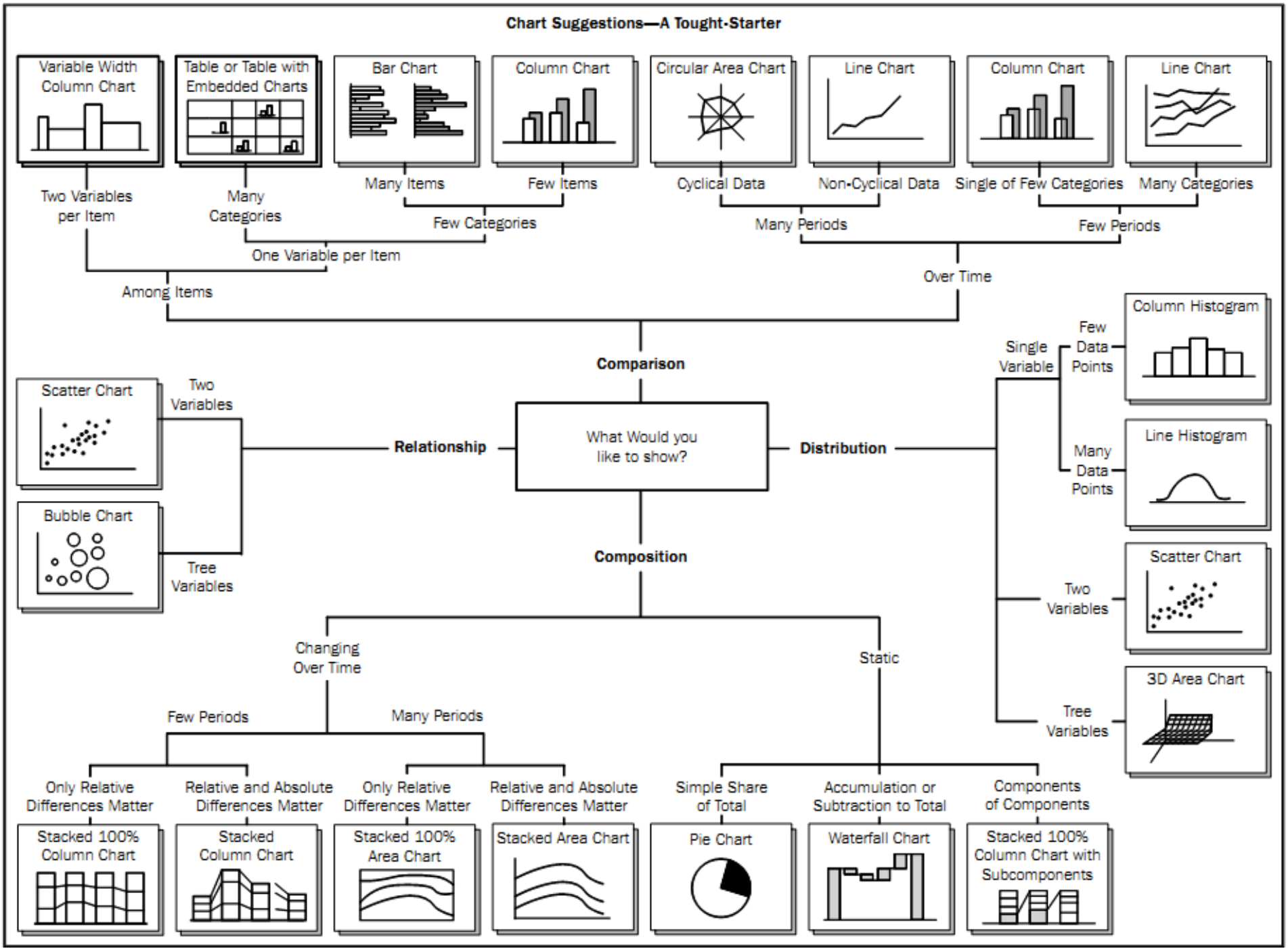
- plt.title('sine function demo')
- plt.xlabel('time(s)')
- plt.ylabel('votage(mV)')
- plt.xlim([0.0,5.0])
- plt.ylim([-1.2,1.2])
- plt.hold('on') # 保持之前plot的结果
- plt.grid('on') # 添加网格
- plt.text(4,0,'$\mu=100$') # 文本
- plt.axis('equal') # 等比例坐标轴
- plt.ylim(plt.ylim()[::-1]) # 翻转Y轴
- plt.gca().invert_yaxis() # 翻转Y轴

极坐标

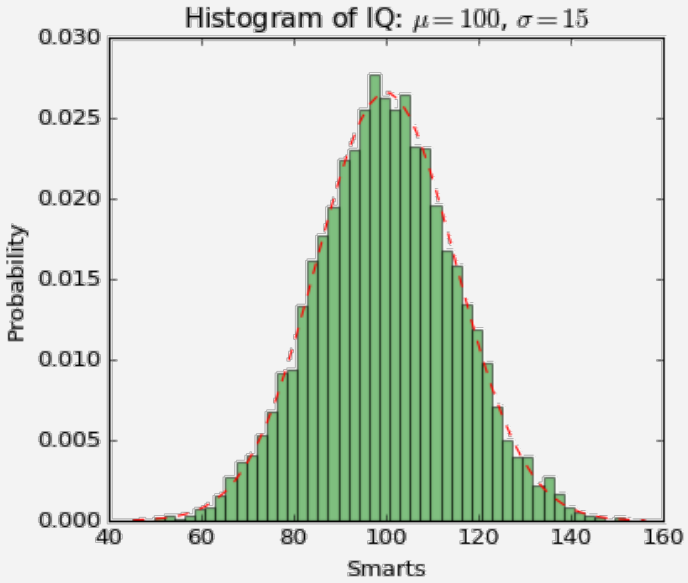



```
import numpy as np
import matplotlib.pyplot as plt
r = np.arange(0, 3.0, 0.01)
theta = 2 * np.pi * r
ax = plt.subplot(111, polar=True)
ax.plot(theta, r, color='r', linewidth=3)
ax.set_rmax(2.0)
ax.grid(True)
ax.set_title("polar plot")
plt.show()
```

Chart Suggestions—A Tought-Starter



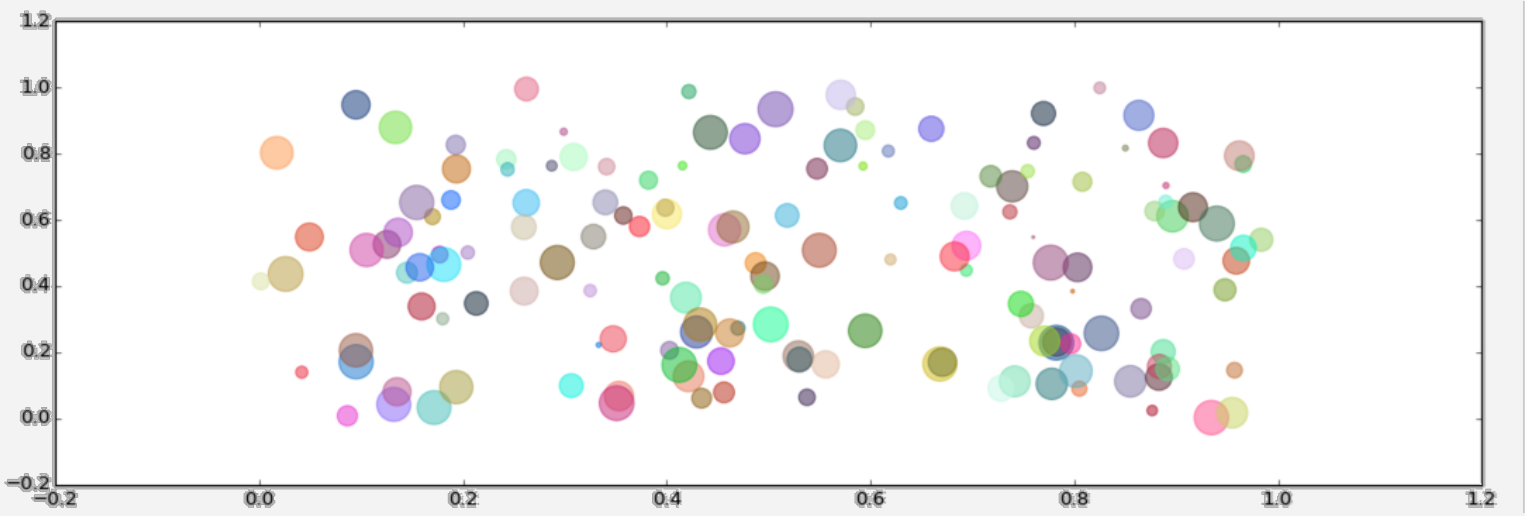
直方图




```
import numpy as np
import matplotlib.mlab as mlab
import matplotlib.pyplot as plt
mu = 100  # mean of distribution
sigma = 15  # standard deviation of distribution
x = mu + sigma * np.random.randn(10000)
num_bins = 50
# the histogram of the data
n, bins, patches = plt.hist(x, num_bins, normed=1,
facecolor='green', alpha=0.5)
y = mlab.normpdf(bins, mu, sigma) # add a 'best fit' line
plt.plot(bins, y, 'r--')
plt.show()
```

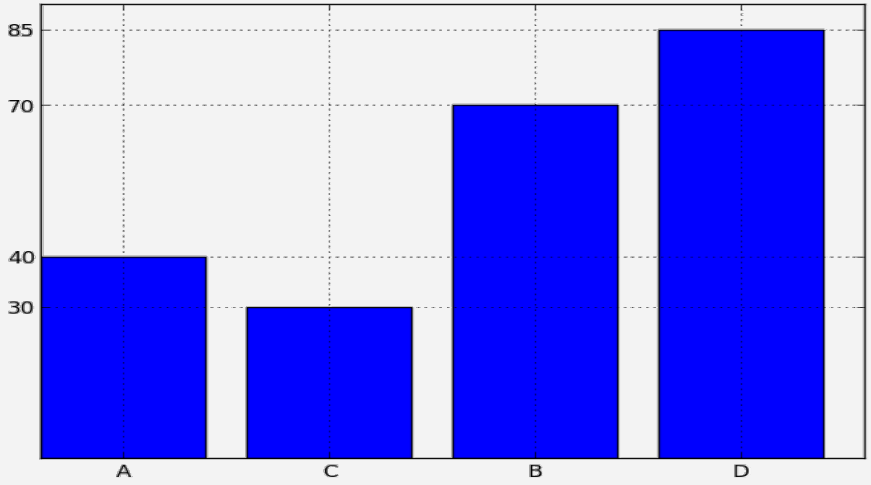
散点图

- `import matplotlib.pyplot as plt`
- `import numpy as np`
- `n = 150`
- `x = np.random.rand(n,3)`
- `c = np.random.rand(n,3)`
- `plt.scatter(x[:,0], x[:,1], s=x[:,2]*500, alpha=0.5, color=c)`
- `plt.show()`



柱状图

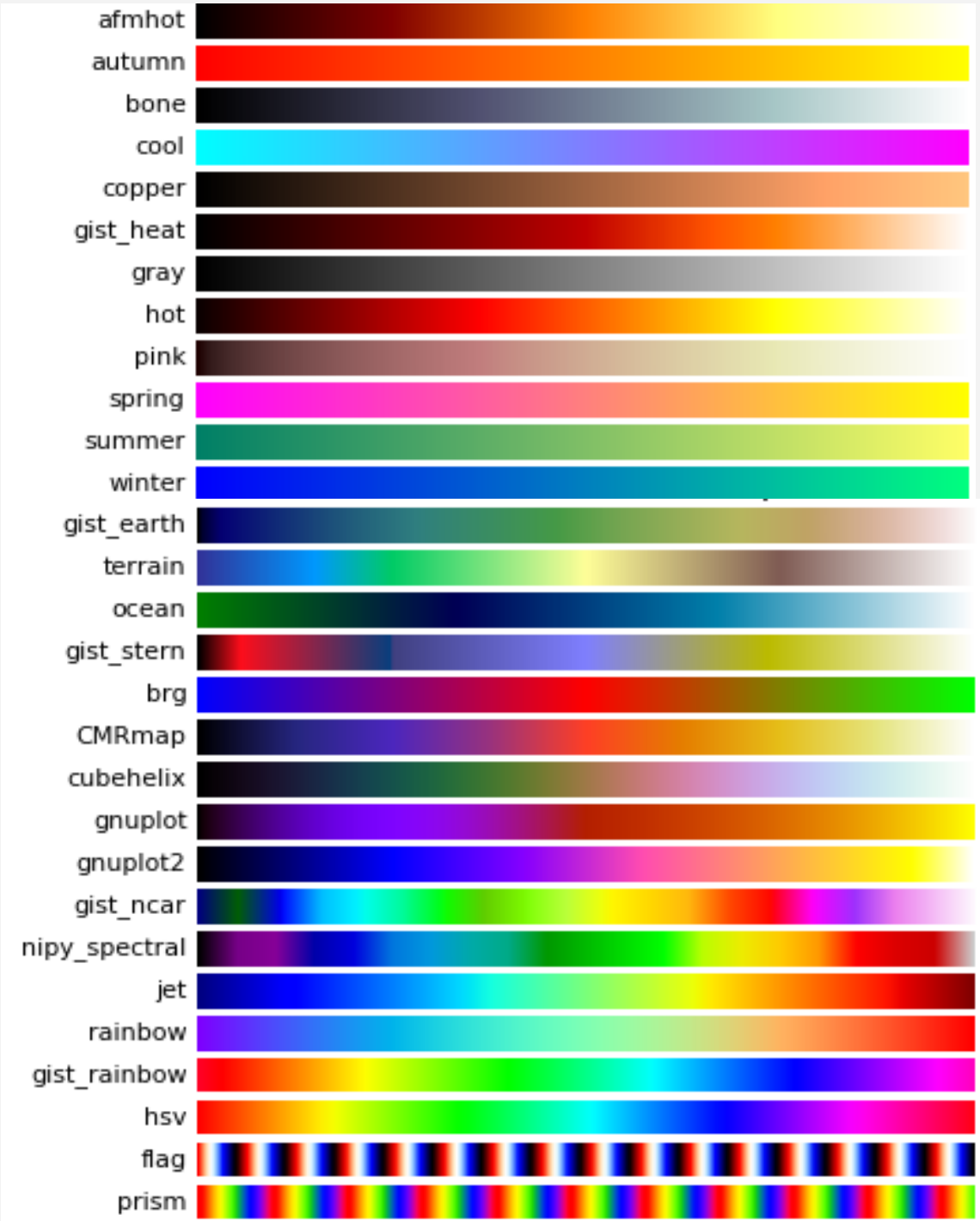
```
import matplotlib.pyplot as plt
import numpy as np
dict = {'A': 40, 'B': 70, 'C': 30, 'D': 85}
i = 0
for key in dict.keys():
    plt.bar(i, dict[key]);
    i=i+1
plt.xticks(np.arange(len(dict))+0.4, dict.keys());
plt.yticks(dict.values());
plt.grid(True)
plt.show()
```



多子图

- subplot(numRows, numCols, plotNum)
  - plt.subplot(221) # 第一行的左图
  - plt.subplot(222) # 第一行的右图
  - plt.subplot(212) # 第二整行
  - plt.show()

  - ax1 = plt.subplot(211) # 创建子图1
  - ax1.plot(x,y)
  - ax2 = plt.subplot(212) # 创建子图2
  - ax2.plot(x,y)



colormap

- 查看可用色表

```
import pylab as pl
pl.colormaps()
```

- 查看色表内容

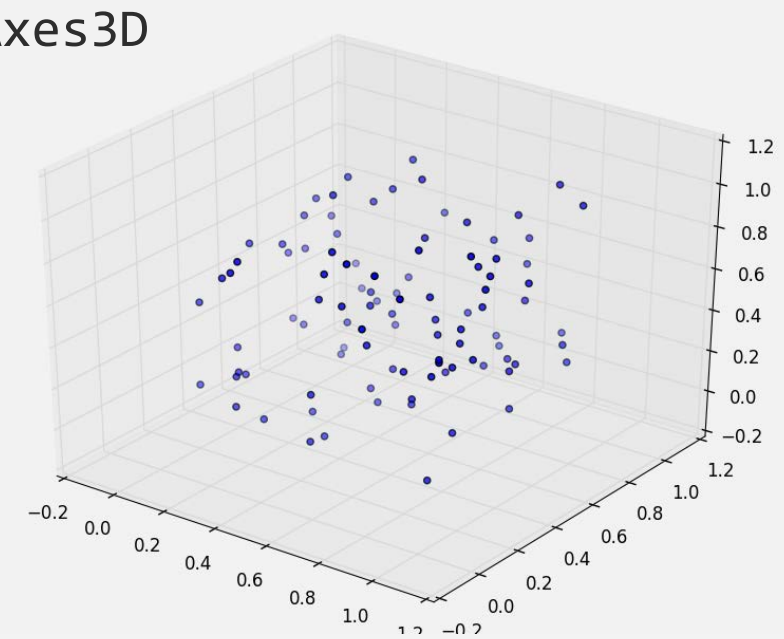
```
pl.cm.hot(0.001)
pl.cm.hot(0.999)
pl.cm.hot(0.5)
pl.cm.hot(0.5, 0.5)
```

三维作图

- `from matplotlib import pyplot as plt`
- `from mpl_toolkits.mplot3d import Axes3D`
- `import numpy as np`

- `fig = plt.figure()`
- `ax = Axes3D(fig)`

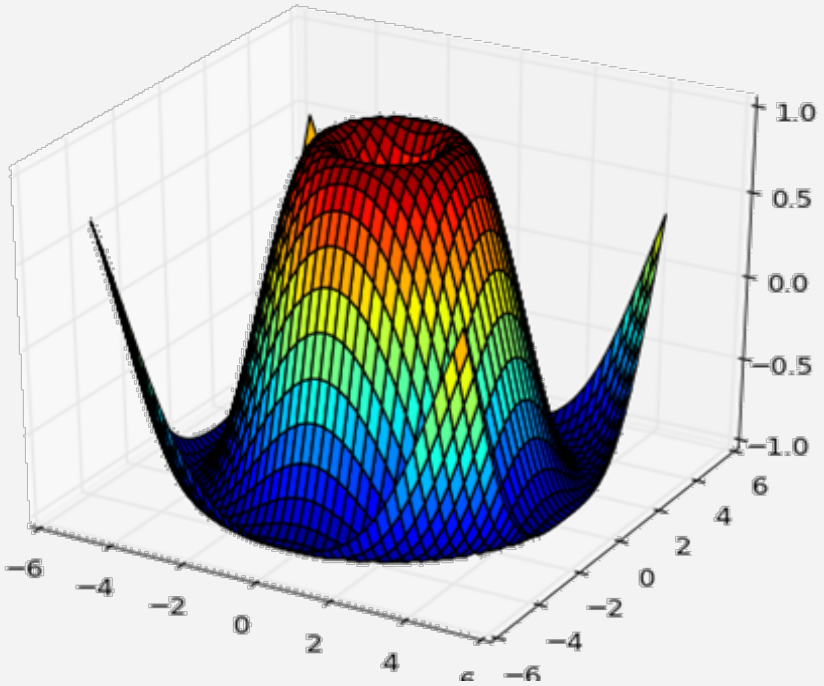
- `data = np.random.random([100,3])`
- `np.random.shuffle(data)`



- `ax.scatter(data[:,0],data[:,1],data[:,2], marker='o')`
- `plt.show()`

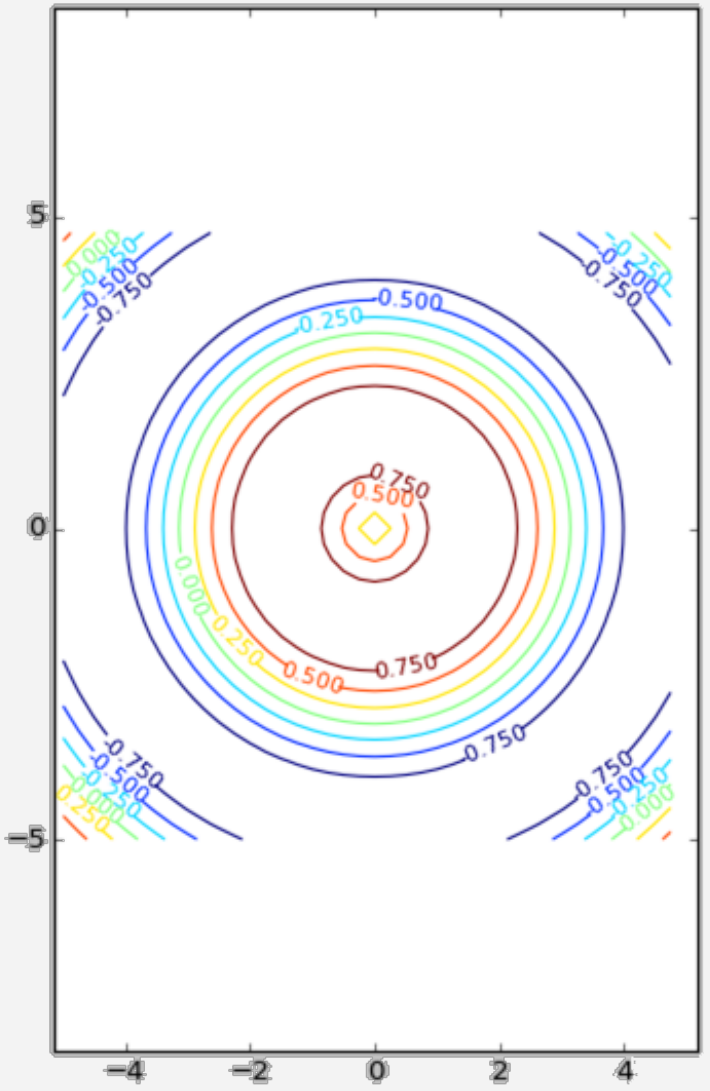
三维曲面

```
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt
import numpy as np
cmap = plt.cm.jet
fig = plt.figure()
ax = fig.gca(projection='3d')
X = np.arange(-5, 5, 0.25)
Y = np.arange(-5, 5, 0.25)
X, Y = np.meshgrid(X, Y)
Z = np.sin(np.sqrt(X**2 + Y**2))
ax.plot_surface(X, Y, Z, rstride=1, cstride=1, cmap=cmap )
ax.set_zlim(-1.01, 1.01)
plt.show()
```



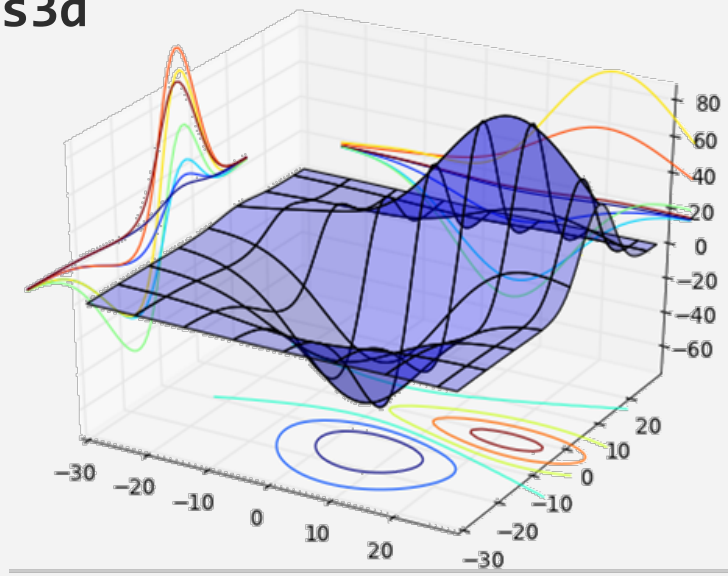
等高线图

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

plt.figure()
X = np.arange(-5, 5, 0.25)
Y = np.arange(-5, 5, 0.25)
X, Y = np.meshgrid(X, Y)
Z = np.sin(np.sqrt(X**2 + Y**2))
levels = np.arange(-1,1,0.25)
cs = plt.contour(X, Y, Z, levels)
plt.clabel(cs,inline=1,fontsize=8)
plt.axis('equal')
plt.show()
```



三维投影

```
from mpl_toolkits.mplot3d import axes3d
import matplotlib.pyplot as plt
from matplotlib import cm

fig = plt.figure()
ax = fig.gca(projection='3d')
X, Y, Z = axes3d.get_test_data(0.1)
ax.plot_surface(X, Y, Z, rstride=8,
    cstride=8, alpha=0.3)
cset = ax.contour(X, Y, Z, zdir='z', offset=-100)
cset = ax.contour(X, Y, Z, zdir='x', offset=-40)
cset = ax.contour(X, Y, Z, zdir='y', offset=40)
plt.show()
```



mplot3d 函数

- plot3D：三维控件绘图
- plot_surface： 三维网格曲面
- plot_trisurf： 三维三角曲面
- plot_wireframe：三维线图
- quiver： 矢量图
- quiver3D： 三维矢量图
- scatter: 散点图

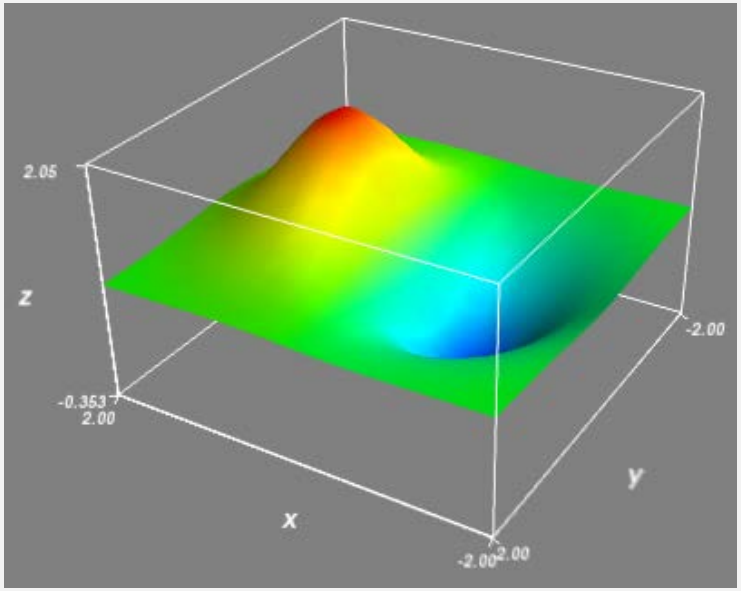
三维球面

```
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt
import numpy as np

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
u = np.linspace(0, 2 * np.pi, 100)
v = np.linspace(0, np.pi, 100)
x = 10 * np.outer(np.cos(u), np.sin(v))
y = 10 * np.outer(np.sin(u), np.sin(v))
z = 10 * np.outer(np.ones(np.size(u)), np.cos(v))
ax.plot_surface(x, y, z, rstride=4, cstride=4, color='b')
plt.show()
```

方法二

```
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt
import numpy as np

fig = plt.figure()
ax = fig.gca(projection='3d')
u, v = np.ogrid[0:2*np.pi:20j, 0:np.pi:20j]
x=np.cos(u)*np.sin(v)
y=np.sin(u)*np.sin(v)
z=np.cos(v)
ax.plot_surface(x, y, z, rstride=1, cstride=1, alpha=0.3)
plt.show()
```

mayavi三维曲面

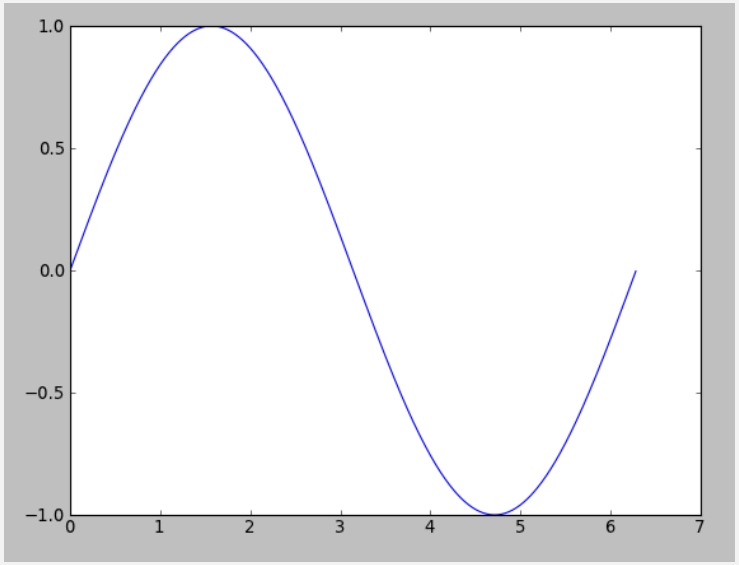


- `import numpy as np`
- `from mayavi import mlab`

- `x, y = np.ogrid[-2:2:20j, -2:2:20j]`
- `z = x * np.exp( - x**2 - y**2)`

- `pl = mlab.surf(x, y, z, warp_scale="auto")`
- `mlab.axes(xlabel='x', ylabel='y', zlabel='z')`
- `mlab.show()`

实时动画




```
import pylab as pl
import numpy as np
pl.ion() #实时绘图
pl.show()
x = np.arange(0,2*np.pi,0.01)
line, = pl.plot(x,np.sin(x))
for i in np.arange(1,200):
    line.set_ydata(np.sin(x+i/10.0))
    pl.pause(0.05)
pl.ioff() #关闭实时绘图
```

动画模块 animation

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.animation as ani
fig = plt.figure()
x = np.arange(0, 2*np.pi, 0.01)         # x-array
line, = plt.plot(x, np.sin(x))

def animate(i):
    line.set_ydata(np.sin(x+i/10.0))    # update the data
    return line,

ani.FuncAnimation(fig, animate, np.arange(1, 200),
    interval=25, blit=True)
plt.show()
```