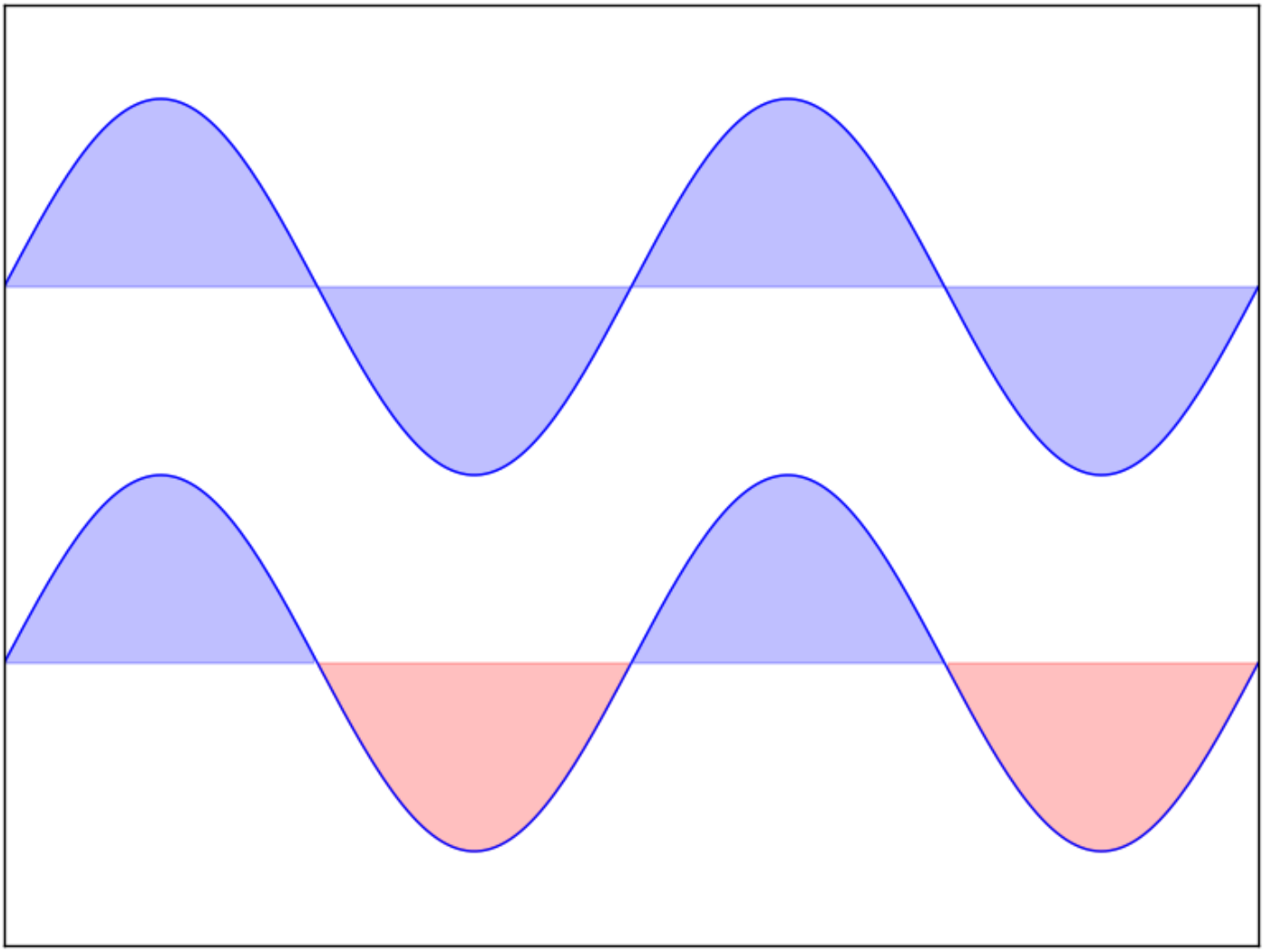
python matplotlib plotting examples and exercises

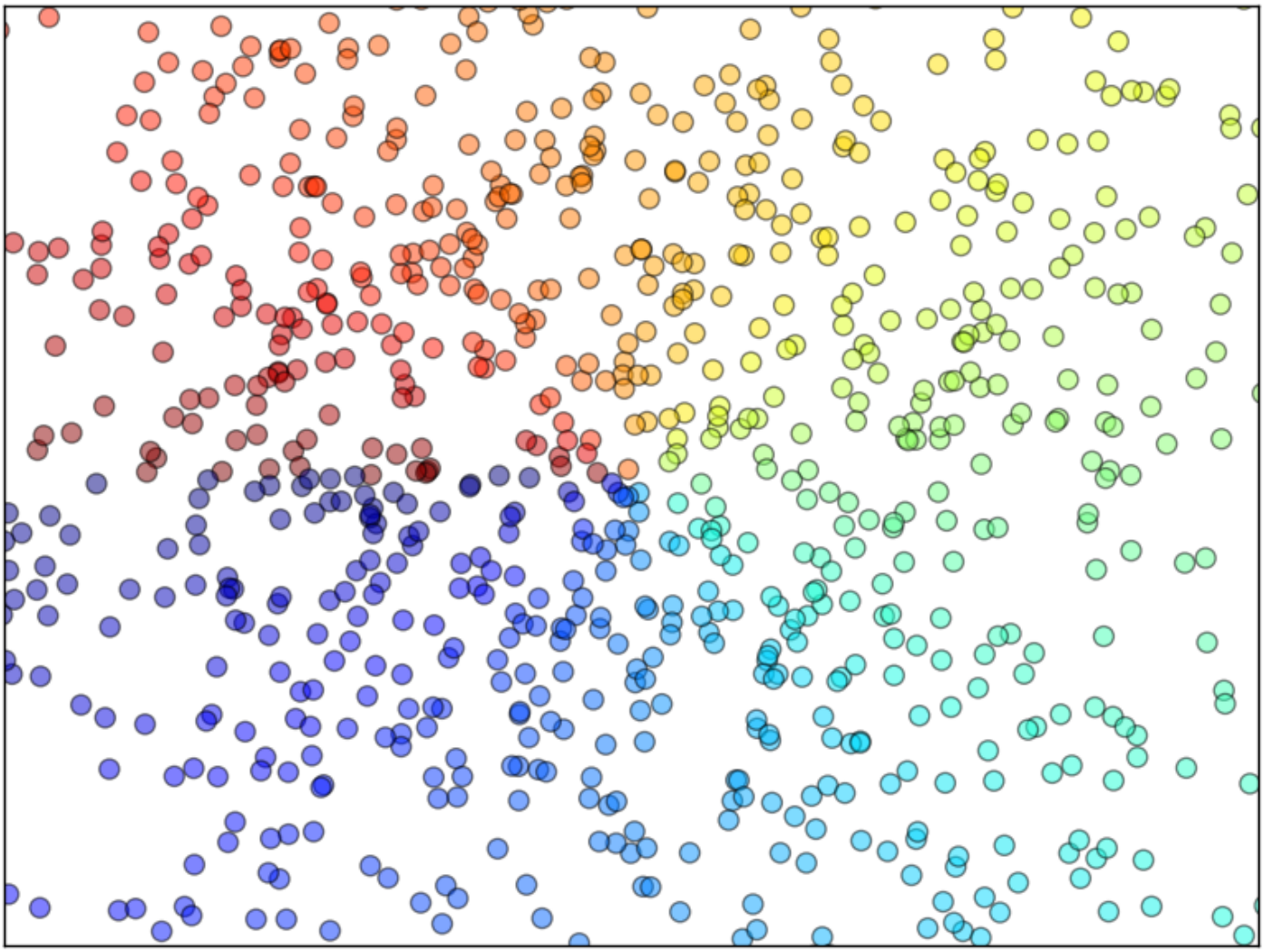
10 April 2015

1. regular plots



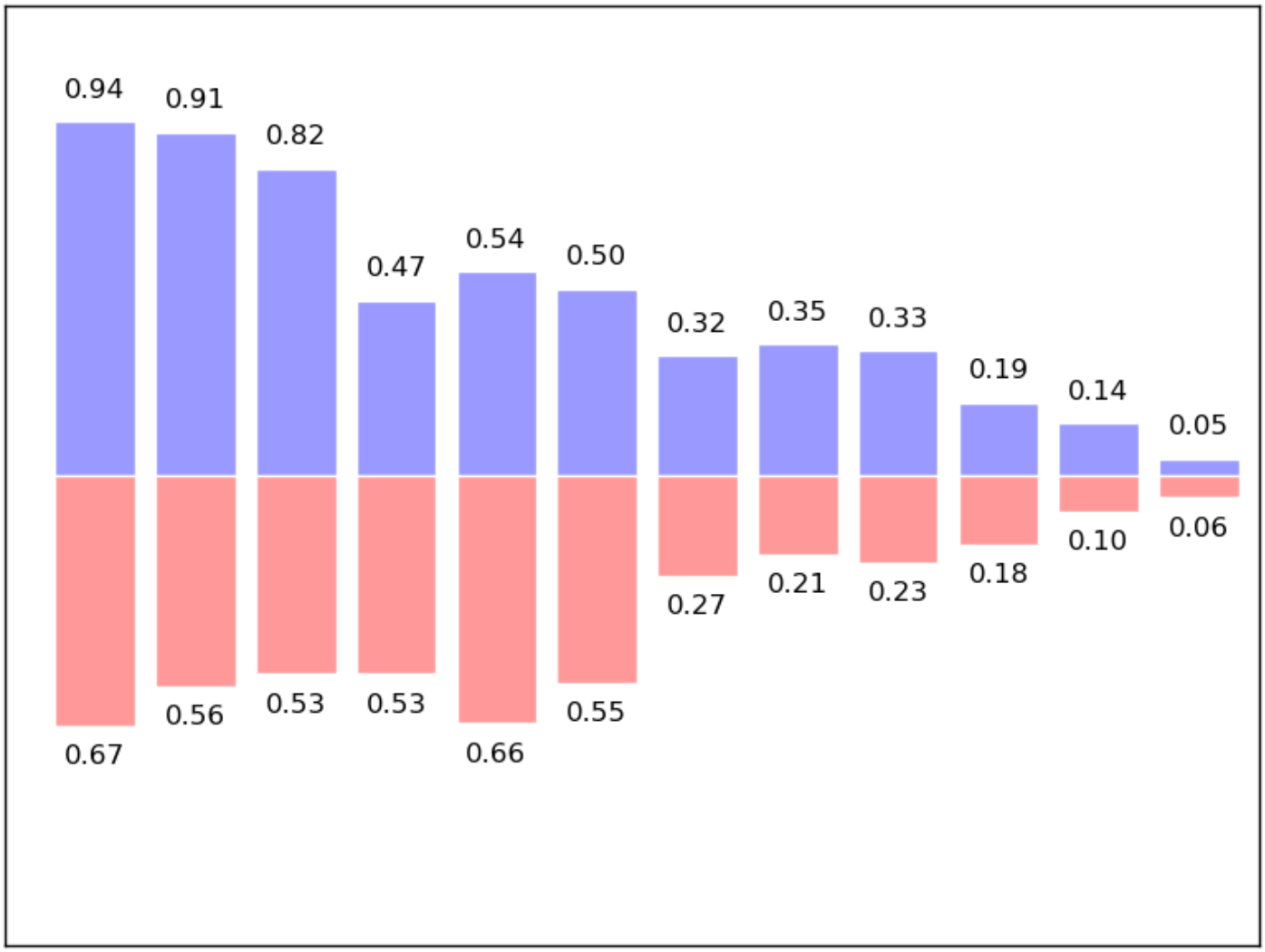
```
import numpy as np
import pylab as pl

n = 256
X = np.linspace(-np.pi, np.pi, n, endpoint=True)
Y = np.sin(2 * X)

pl.axes([0.025, 0.025, 0.95, 0.95])

pl.plot(X, Y + 1, color='blue', alpha=1.00)
pl.fill_between(X, 1, Y + 1, color='blue', alpha=.25)

pl.plot(X, Y - 1, color='blue', alpha=1.00)
pl.fill_between(X, -1, Y - 1, (Y - 1) > -1, color='blue', alpha=.25)
pl.fill_between(X, -1, Y - 1, (Y - 1) < -1, color='red',  alpha=.25)

pl.xlim(-np.pi, np.pi)
pl.xticks(())
pl.ylim(-2.5, 2.5)
pl.yticks(())

pl.show()
```

2. scatter plots



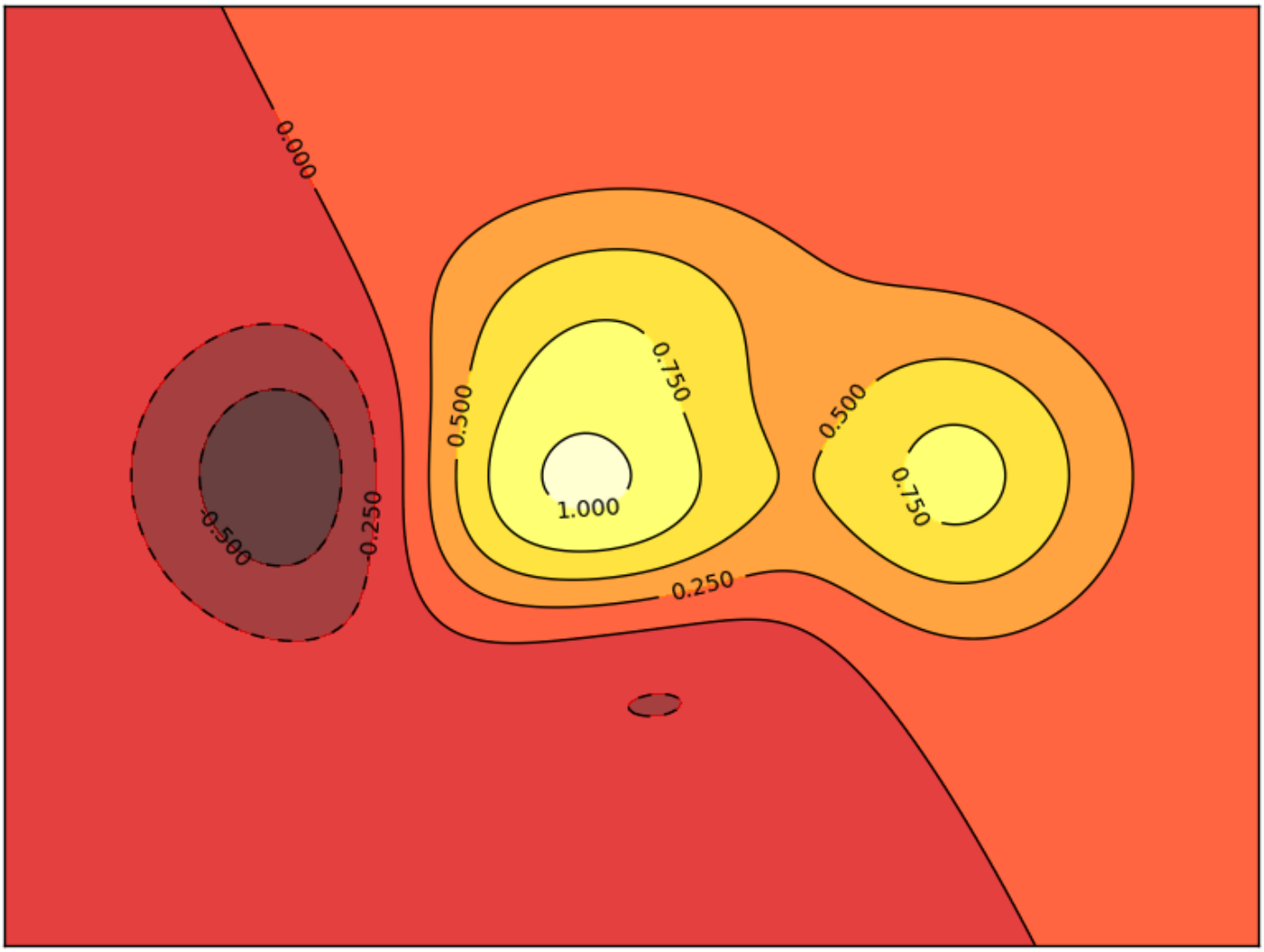
```
import numpy as np
import pylab as pl

n = 1024
X = np.random.normal(0, 1, n)
Y = np.random.normal(0, 1, n)
T = np.arctan2(Y, X)

pl.axes([0.025, 0.025, 0.95, 0.95])
pl.scatter(X, Y, s=75, c=T, alpha=.5)

pl.xlim(-1.5, 1.5)
pl.xticks(())
pl.ylim(-1.5, 1.5)
pl.yticks(())

pl.show()
```

3. bar plots


0.94
0.91
0.82
0.47
0.54
0.50
0.32
0.35
0.33
0.19
0.14
0.05
0.67
0.56
0.53
0.53
0.66
0.55
0.27
0.21
0.23
0.18
0.10
0.06

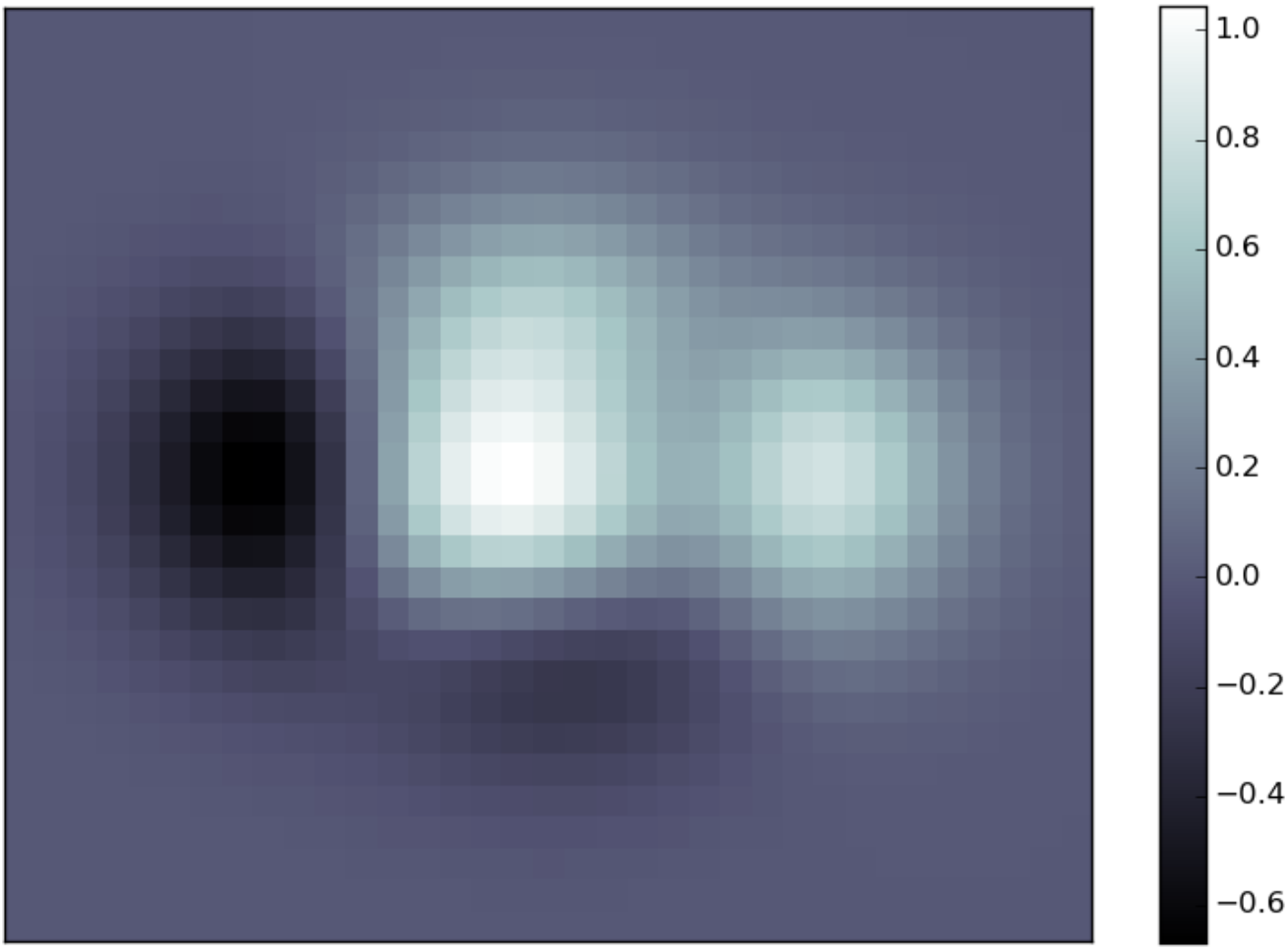
```
import numpy as np
import pylab as pl

n = 12
X = np.arange(n)
Y1 = (1 - X / float(n)) * np.random.uniform(0.5, 1.0, n)
Y2 = (1 - X / float(n)) * np.random.uniform(0.5, 1.0, n)

pl.axes([0.025, 0.025, 0.95, 0.95])
pl.bar(X, +Y1, facecolor='#9999ff', edgecolor='white')
pl.bar(X, -Y2, facecolor='#ff9999', edgecolor='white')

for x, y in zip(X, Y1):
    pl.text(x + 0.4, y + 0.05, '%.2f' % y, ha='center', va= 'bottom')

for x, y in zip(X, Y2):
    pl.text(x + 0.4, -y - 0.05, '%.2f' % y, ha='center', va= 'top')

pl.xlim(-.5, n)
pl.xticks(())
pl.ylim(-1.25, 1.25)
pl.yticks(())

pl.show()
```

4. Contour plots



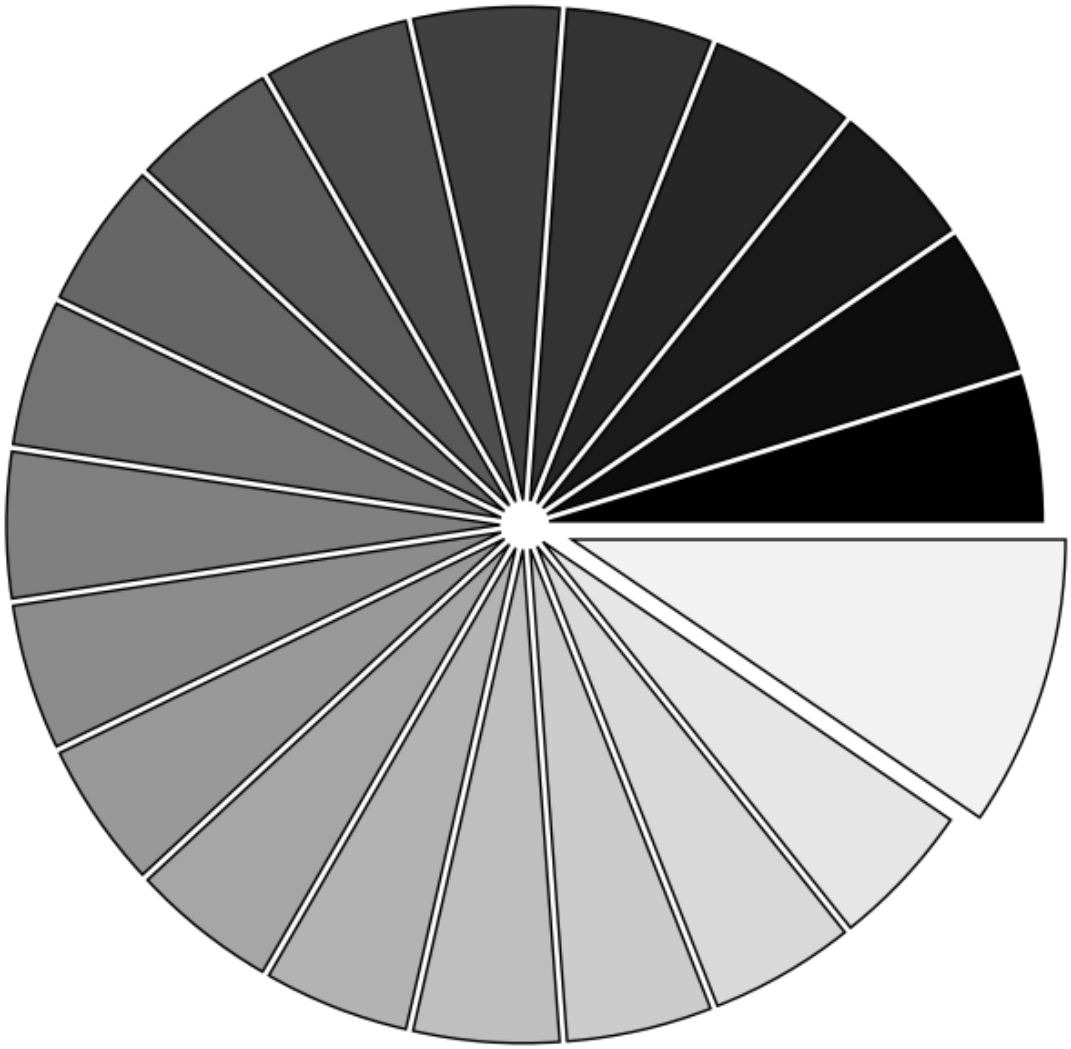

```
import numpy as np
import pylab as pl

def f(x,y):
    return (1 - x / 2 + x**5 + y**3) * np.exp(-x**2 -y**2)

n = 256
x = np.linspace(-3, 3, n)
y = np.linspace(-3, 3, n)
X,Y = np.meshgrid(x, y)

pl.axes([0.025, 0.025, 0.95, 0.95])

pl.contourf(X, Y, f(X, Y), 8, alpha=.75, cmap=pl.cm.hot)
C = pl.contour(X, Y, f(X, Y), 8, colors='black', linewidth=.5)
pl.clabel(C, inline=1, fontsize=10)

pl.xticks(())
pl.yticks(())
pl.show()
```

5. imshow



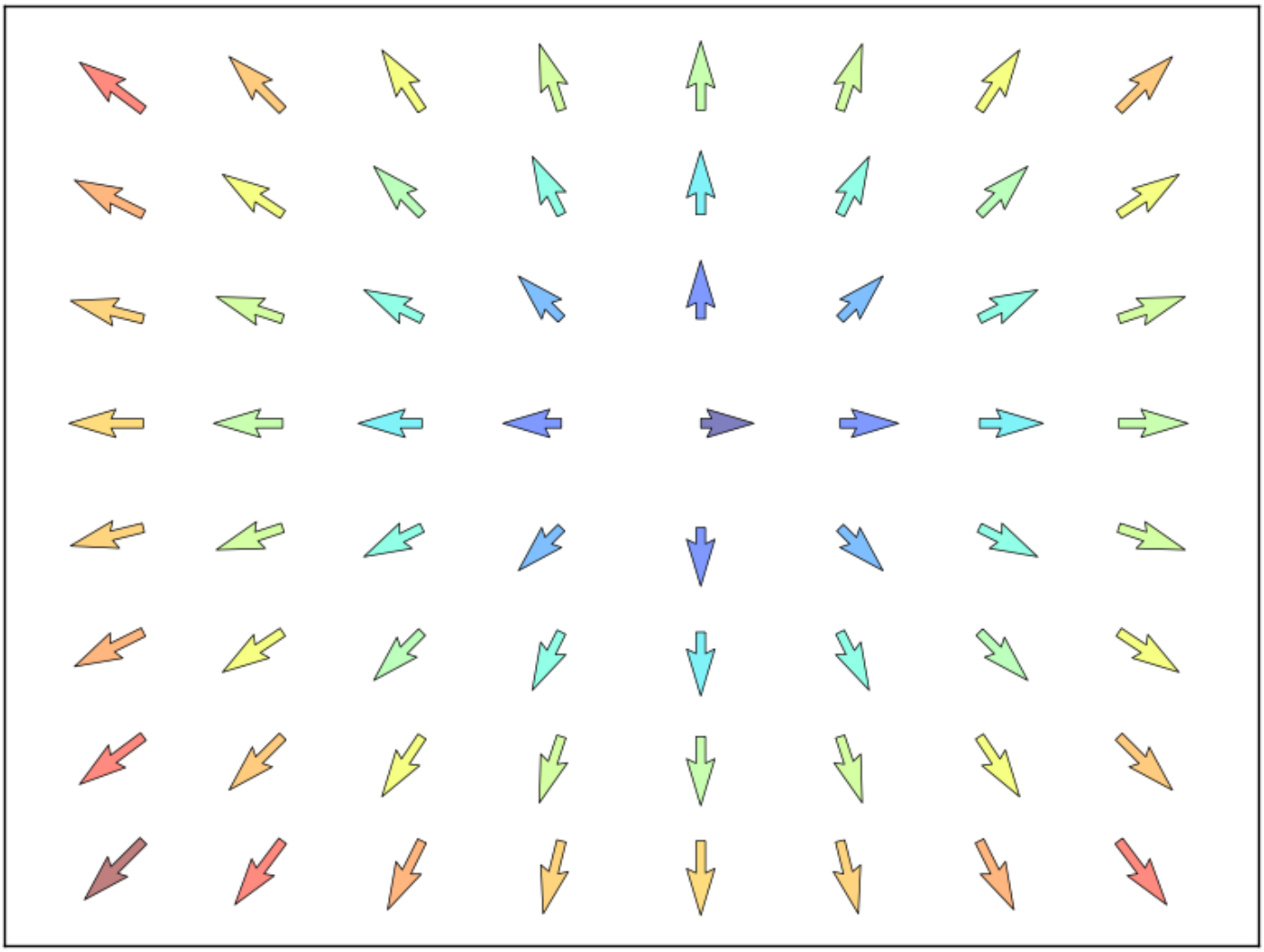

```
import numpy as np
import pylab as pl

def f(x, y):
    return (1 - x / 2 + x ** 5 + y ** 3 ) * np.exp(-x ** 2 - y ** 2)

n = 10
x = np.linspace(-3, 3, 3.5 * n)
y = np.linspace(-3, 3, 3.0 * n)
X, Y = np.meshgrid(x, y)
Z = f(X, Y)

pl.axes([0.025, 0.025, 0.95, 0.95])
pl.imshow(Z, interpolation='nearest', cmap='bone', origin='lower')
pl.colorbar(shrink=.92)

pl.xticks(())
pl.yticks(())
pl.show()
```

6. pie charts



```
import numpy as np
import pylab as pl

n = 20
Z = np.ones(n)
Z[-1] *= 2

pl.axes([0.025, 0.025, 0.95, 0.95])

pl.pie(Z, explode=Z*.05, colors = ['%f' % (i/float(n)) for i in range(n)])
pl.axis('equal')
pl.xticks(())
pl.yticks()

pl.show()
```

7. quiver plots

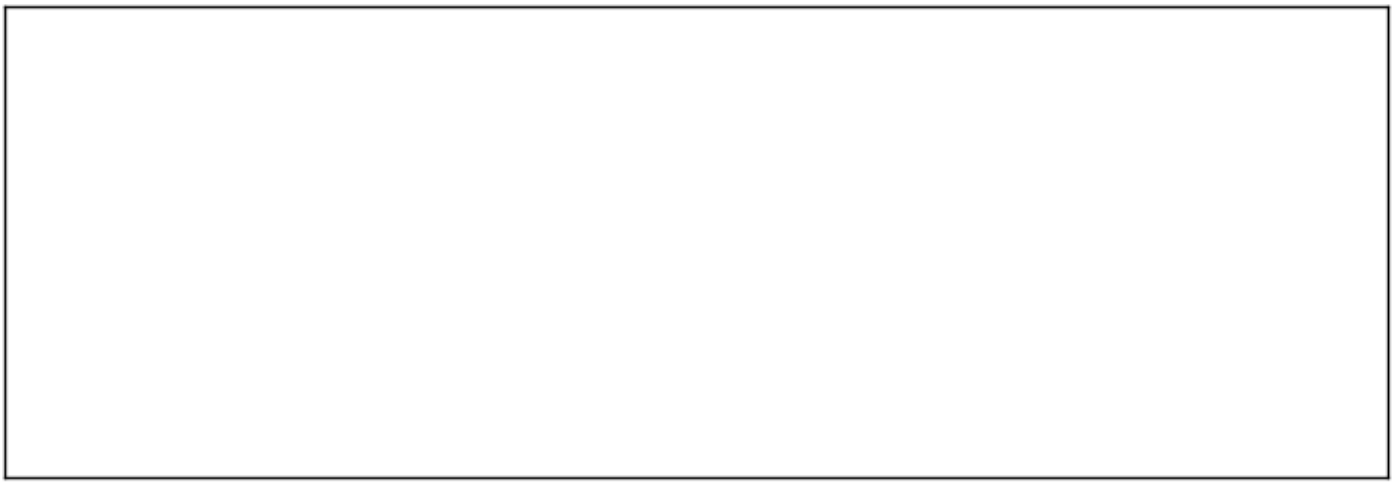


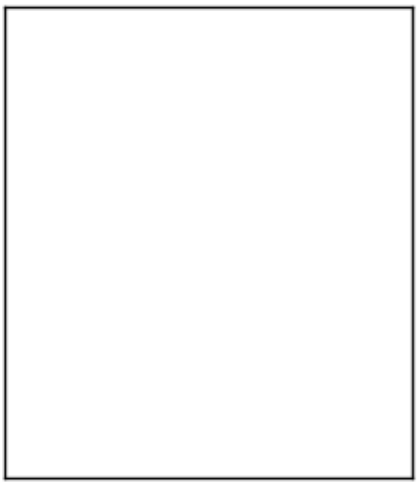
```
import numpy as np
import pylab as pl

n = 8
X, Y = np.mgrid[0:n, 0:n]
T = np.arctan2(Y - n / 2., X - n/2.)
R = 10 + np.sqrt((Y - n / 2.0) ** 2 + (X - n / 2.0) ** 2)
U, V = R * np.cos(T), R * np.sin(T)

pl.axes([0.025, 0.025, 0.95, 0.95])
pl.quiver(X, Y, U, V, R, alpha=.5)
pl.quiver(X, Y, U, V, edgecolor='k', facecolor='None', linewidth=.5)

pl.xlim(-1, n)
pl.xticks(())
pl.ylim(-1, n)
pl.yticks(())

pl.show()
```

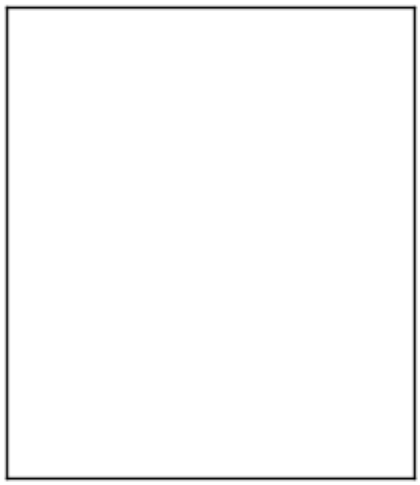
8. grids

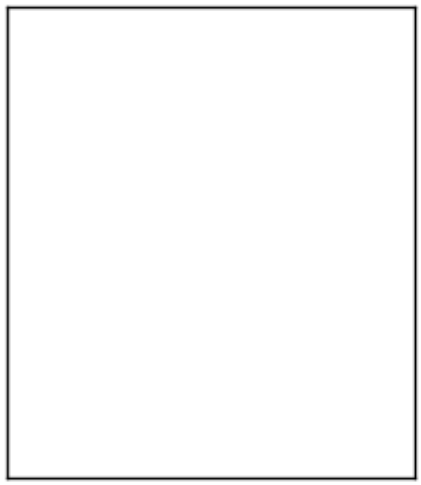
```
import pylab as pl

ax = pl.axes([0.025, 0.025, 0.95, 0.95])

ax.set_xlim(0,4)
ax.set_ylim(0,3)
ax.xaxis.set_major_locator(pl.MultipleLocator(1.0))
ax.xaxis.set_minor_locator(pl.MultipleLocator(0.1))
ax.yaxis.set_major_locator(pl.MultipleLocator(1.0))
ax.yaxis.set_minor_locator(pl.MultipleLocator(0.1))
ax.grid(which='major', axis='x', linewidth=0.75, linestyle='-', color='0.75')
ax.grid(which='minor', axis='x', linewidth=0.25, linestyle='-', color='0.75')
ax.grid(which='major', axis='y', linewidth=0.75, linestyle='-', color='0.75')
ax.grid(which='minor', axis='y', linewidth=0.25, linestyle='-', color='0.75')
ax.set_xticklabels([])
ax.set_yticklabels([])

pl.show()
```

9. multi plots



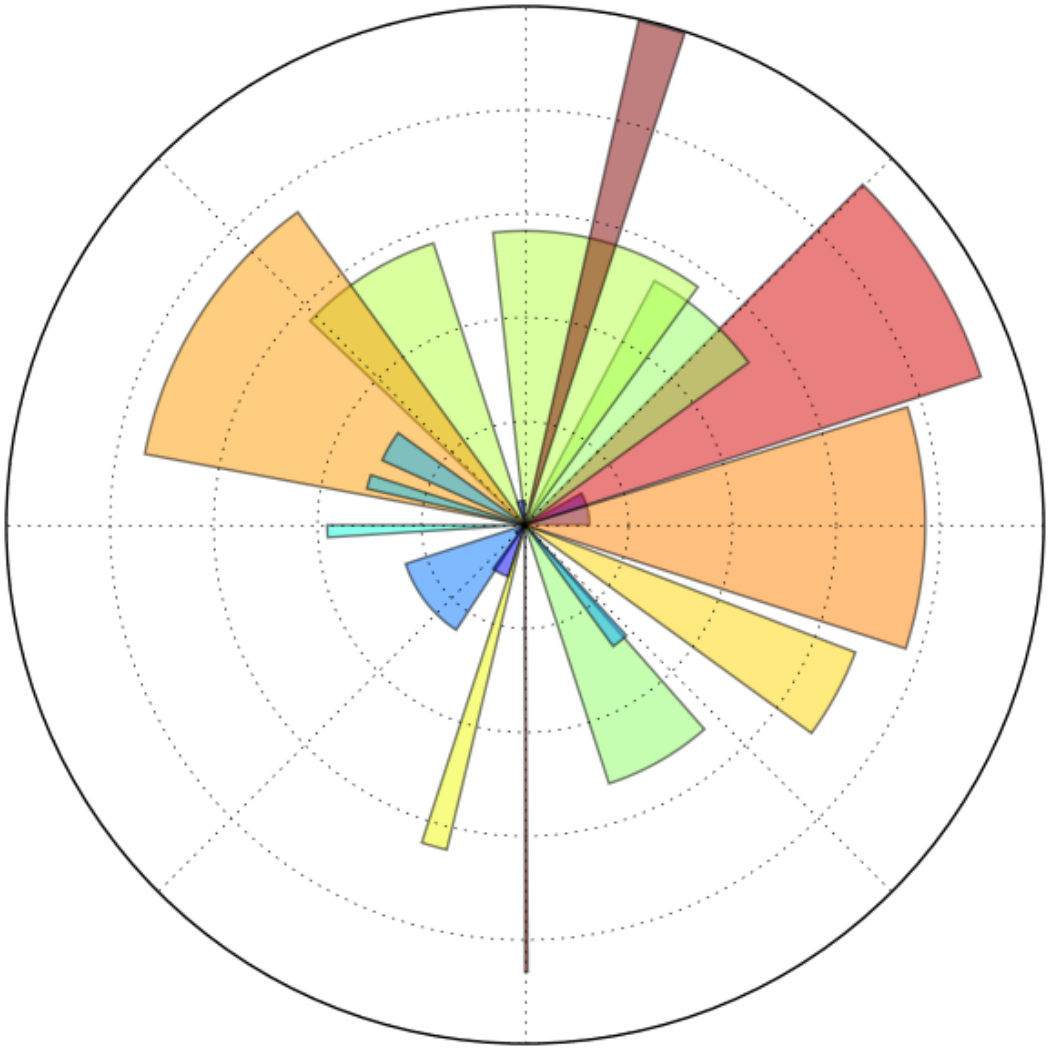






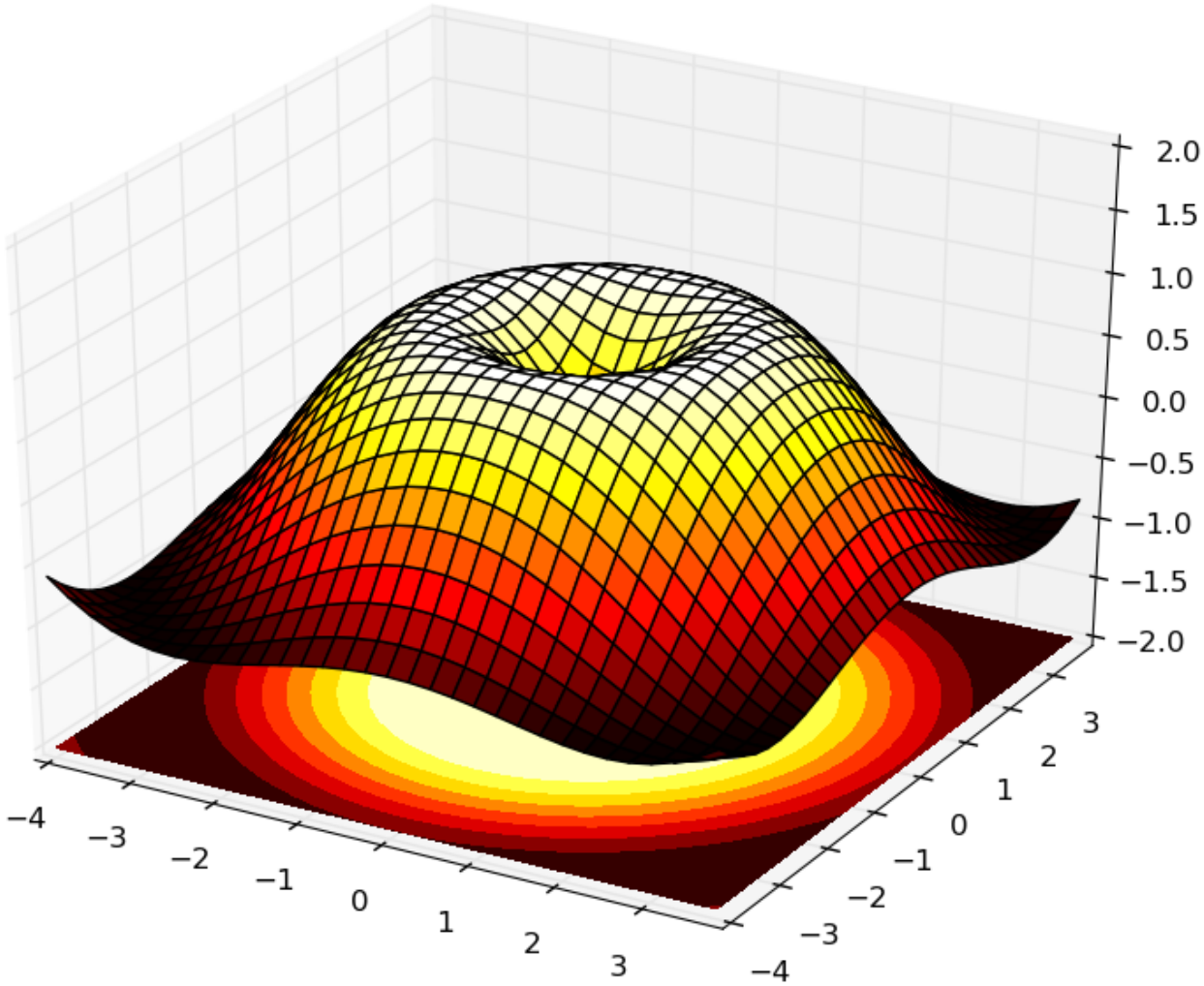
```
import pylab as pl

fig = pl.figure()
fig.subplots_adjust(bottom=0.025, left=0.025, top = 0.975, right=0.975)

pl.subplot(2, 1, 1)
pl.xticks(()), pl.yticks(())

pl.subplot(2, 3, 4)
pl.xticks(())
pl.yticks(())

pl.subplot(2, 3, 5)
pl.xticks(())
pl.yticks(())

pl.subplot(2, 3, 6)
pl.xticks(())
pl.yticks(())

pl.show()
```

10. polar axis



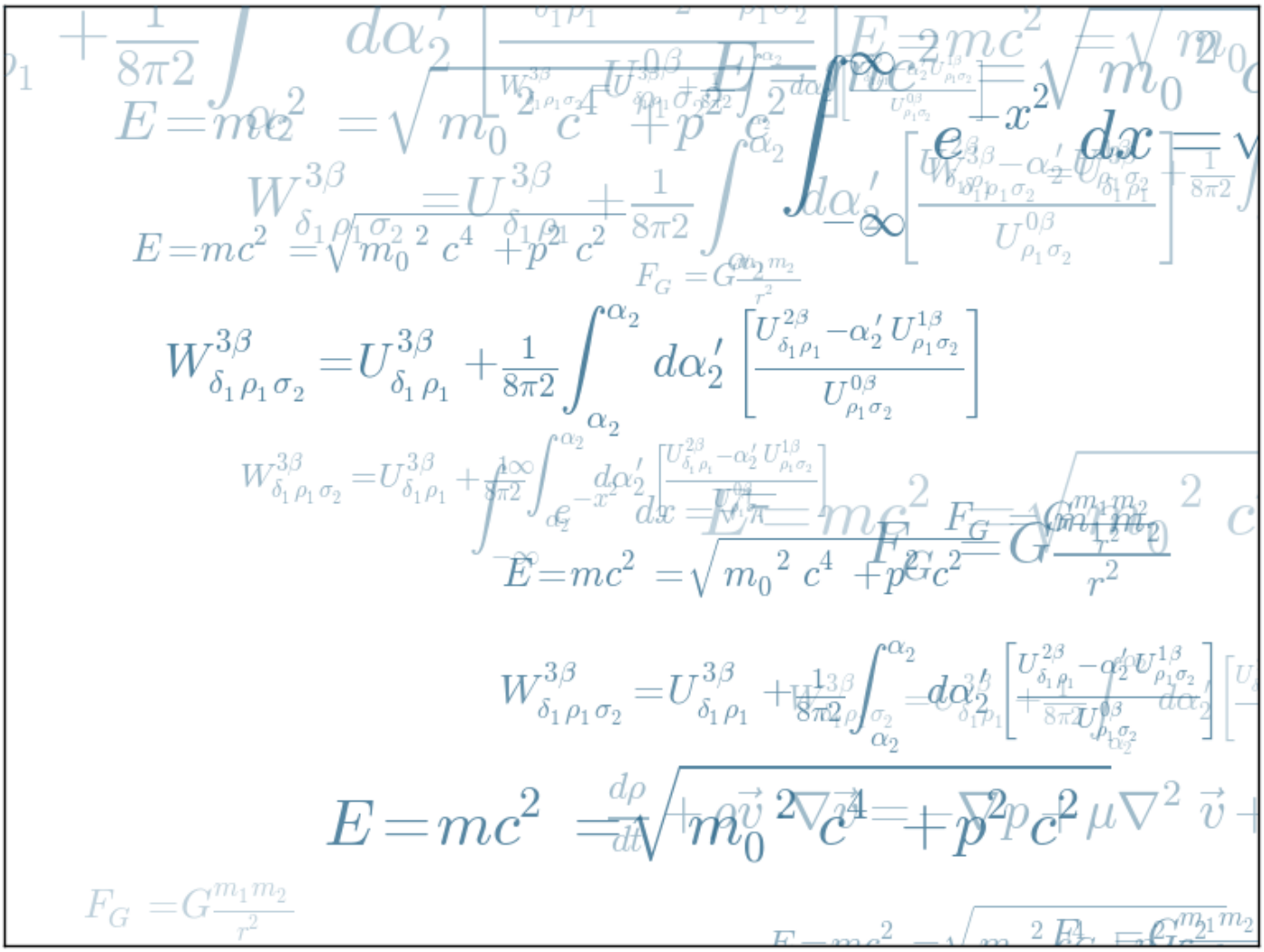
```
import numpy as np
import pylab as pl

ax = pl.axes([0.025, 0.025, 0.95, 0.95], polar=True)

N = 20
theta = np.arange(0.0, 2 * np.pi, 2 * np.pi / N)
radii = 10 * np.random.rand(N)
width = np.pi / 4 * np.random.rand(N)
bars = pl.bar(theta, radii, width=width, bottom=0.0)

for r,bar in zip(radii, bars):
    bar.set_facecolor(pl.cm.jet(r/10.))
    bar.set_alpha(0.5)

ax.set_xticklabels([])
ax.set_yticklabels([])
pl.show()
```

11. 3d plots




```
import numpy as np
import pylab as pl
from mpl_toolkits.mplot3d import Axes3D

fig = pl.figure()
ax = Axes3D(fig)
X = np.arange(-4, 4, 0.25)
Y = np.arange(-4, 4, 0.25)
X, Y = np.meshgrid(X, Y)
R = np.sqrt(X ** 2 + Y ** 2)
Z = np.sin(R)

ax.plot_surface(X, Y, Z, rstride=1, cstride=1, cmap=pl.cm.hot)
ax.contourf(X, Y, Z, zdir='z', offset=-2, cmap=pl.cm.hot)
ax.set_zlim(-2, 2)

pl.show()
```

12. text


$$E = mc^2 = \sqrt{m_0^2 c^4 + p^2 c^2}$$
$$W^{3\beta}_{\delta_1 \rho_1 \sigma_2} = U^{3\beta}_{\delta_1 \rho_1} + \frac{1}{8\pi 2} \int_{\alpha_2}^{\alpha_2} d\alpha_2' \left[\frac{U^{2\beta}_{\delta_1 \rho_1} - \alpha_2' U^{1\beta}_{\rho_1 \sigma_2}}{U^{0\beta}_{\rho_1 \sigma_2}} \right]$$
$$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi}$$
$$F_G = G\frac{m_1 m_2}{r^2}$$
$$\frac{d\rho}{dt} = -\rho \vec{v} \cdot \nabla \vec{v} - \nabla p + \mu \nabla^2 \vec{v} +$$

```
    import numpy as np
    import pylab as pl

    eqs = []
    eqs.append((r"$W^{3\beta}_{\delta_1 \rho_1 \sigma_2} = U^{3\beta}_{\delta_1 \rho_1} +
 \frac{1}{8 \pi 2} \int^{\alpha_2}_{\alpha_2} d \alpha^\prime_2 \left[\frac{ U^{2\beta}_
{\delta_1 \rho_1} - \alpha^\prime_2U^{1\beta}_{\rho_1 \sigma_2} }{U^{0\beta}_{\rho_1 \sigm
a_2}}\right]$"))
    eqs.append((r"$\frac{d\rho}{d t} + \rho \vec{v}\cdot\nabla\vec{v} = -\nabla p + \mu\na
bla^2 \vec{v} + \rho \vec{g}$"))
    eqs.append((r"$\int_{-\infty}^\infty e^{-x^2}dx=\sqrt{\pi}$"))
    eqs.append((r"$E = mc^2 = \sqrt{{m_0}^2c^4 + p^2c^2}$"))
    eqs.append((r"$F_G = G\frac{m_1m_2}{r^2}$"))

    pl.axes([0.025, 0.025, 0.95, 0.95])

    for i in range(24):
        index = np.random.randint(0, len(eqs))
        eq = eqs[index]
        size = np.random.uniform(12, 32)
        x,y = np.random.uniform(0, 1, 2)
        alpha = np.random.uniform(0.25, .75)
        pl.text(x, y, eq, ha='center', va='center', color="#11557c", alpha=alpha,
             transform=pl.gca().transAxes, fontsize=size, clip_on=True)
    pl.xticks(())
    pl.yticks(())

    pl.show()
```

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