06-Solutions

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1 Solutions

In [2]:
```
import numpy as np
from pylab import *
from matplotlib import pyplot as plt
```

1.1 Solution 1.1 : Starting Matplotlib

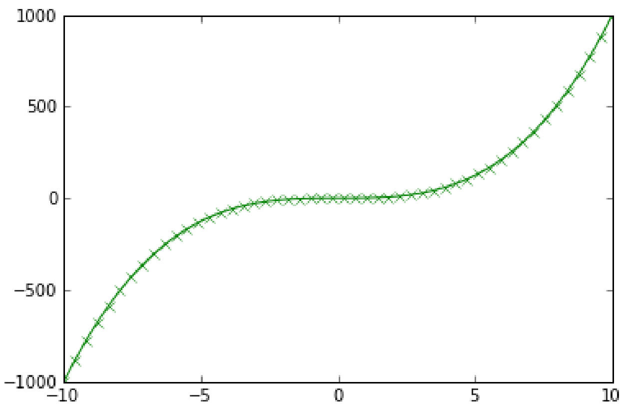
Part 1

See presented material.

Part 2

In [4]:
```
x = np.linspace(-10, 10)
y = x**3
plot(x, y, 'gx-')
```

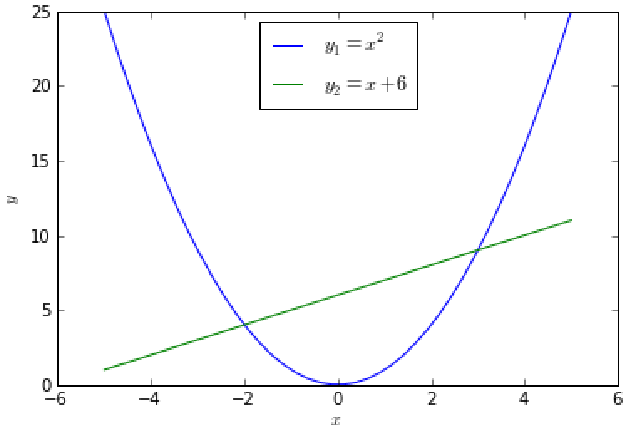
Out [4]: [<matplotlib.lines.Line2D at 0x10fd538d0>]



1.2 Solution 1.2 : Plot layout and saving

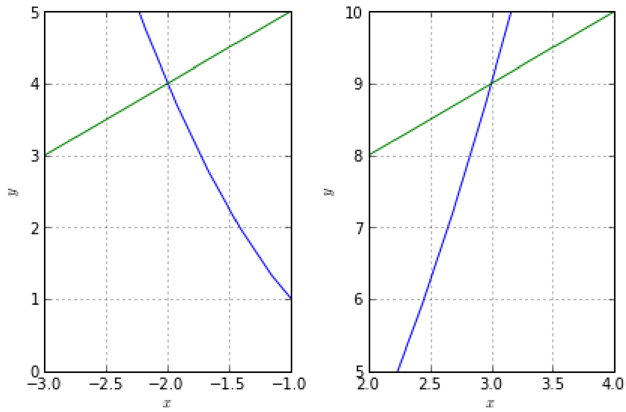
Part 1

In [5]:
```
from matplotlib import pyplot as plt

x = np.linspace(-5, 5, 40)
y = x**2
fig, axis = plt.subplots(1)
axis.plot(x, y, label='$y_1 = x^2$')
axis.plot(x, x + 6, label='$y_2 = x + 6$')
axis.legend(loc='upper center')
axis.set_xlabel('$x$')
axis.set_ylabel('$y$')
fig.savefig('data/ex_1.2.pdf')
```



Part 2

In [6]:
```
fig, axes = plt.subplots(1, 2)

# [(xlim, ylim), ...]
regions = [((-3, -1), (0, 5)),
           ((2, 4), (5, 10))]

for axis, (xlim, ylim) in zip(axes, regions):
    axis.plot(x, y)
    axis.plot(x, x + 6)
    axis.set_xlim(xlim)
    axis.set_ylim(ylim)
    axis.set_xlabel('$x$')
    axis.set_ylabel('$y$')
    axis.grid()

fig.tight_layout()
```



The plots indicate intersections at $x = -2$ and $x = 3$, consistent with $y = (x + 2)(x - 3) = x^2 - x - 6$.

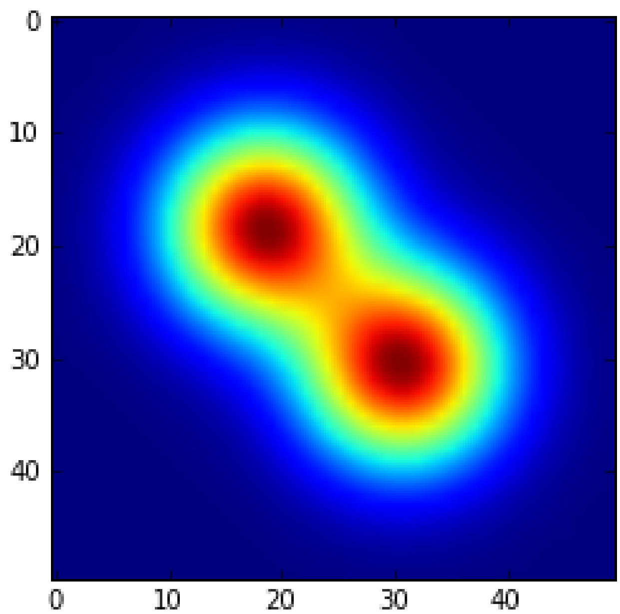
1.3 Solution 1.3 : Plotting 2D data

In [7]:
```
# From the Exercise
from scipy.stats import norm

def f(a, x):
    y = norm(loc=a).pdf(x)
    Y = np.reshape(y, (1, len(y)))
    return Y.T * Y

x = np.linspace(-4, 4, 50)
Z = f(-1, x) + f(1, x)
```

Part 1

In [8]:
```
plt.imshow(Z)
```

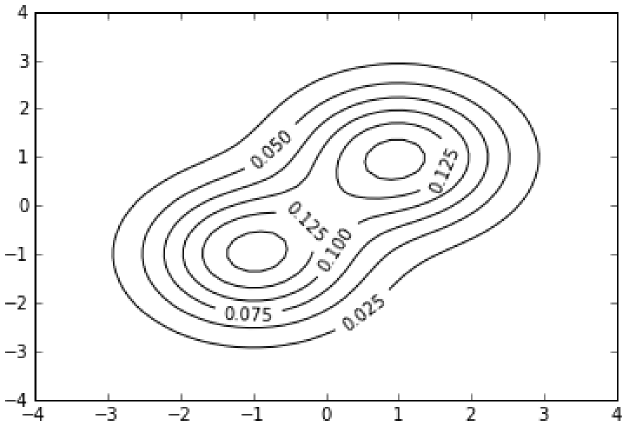
Out [8]: <matplotlib.image.AxesImage at 0x10fd236d0>



Part 2

In [9]:
```
fig, ax = plt.subplots()
X, Y = np.meshgrid(x, x)
p = ax.contour(X, Y, Z, colors='k')
ax.clabel(p)
```

Out [9]: <a list of 6 text.Text objects>

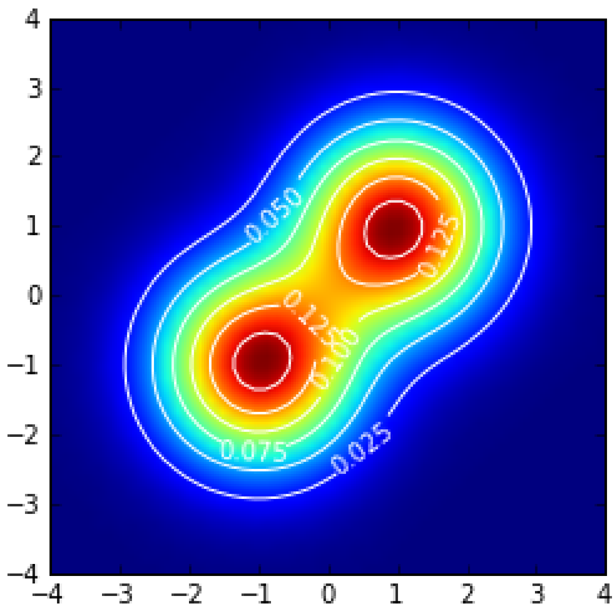


Part 3

In [10]:
```
imshow?
```

In [13]:
```
fig, ax = plt.subplots()

# Flip Z vertically
Z_vflip = Z[:,::-1]
ax.imshow(Z_vflip, extent=[x[0], x[-1], x[0], x[-1]])

# Alternatively this will use the lower-left corner as the image origin
# ax.imshow(Z, origin='lower', extent=[x[0], x[-1], x[0], x[-1]])

X, Y = np.meshgrid(x, x)
p = ax.contour(X, Y, Z, colors='w')
ax.clabel(p)
```

Out [13]: <a list of 6 text.Text objects>



1.4 Solution 2.1 : Numpy arrays

Part 1

In [14]:
```
print np.arange(20) + 1      # 1.
print np.arange(0, 30, 3)    # 2.
print np.linspace(0, 1, 8)   # 3.
n = np.arange(10) + 1        #
print 2*n + n**2             # 4.
```

```
[ 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20]
[ 0  3  6  9 12 15 18 21 24 27]
[ 0.          0.14285714  0.28571429  0.42857143  0.57142857
0.71428571
  0.85714286  1.        ]
[  3   8  15  24  35  48  63  80  99 120]
```

Part 2. Broadcasting

In [8]:
```
A = np.arange(1, 9)
A = A.reshape(2,4)
print A
```

```
[[1 2 3 4]
 [5 6 7 8]]
```

In [9]:
```
B = np.array([1,2])
print B
```

```
[1 2]
```

In [10]:
```
print A + B.reshape((2,1))
```

```
[[ 2  3  4  5]
 [ 7  8  9 10]]
```

1.5 Solution 2.2 : trapezoidal integration

Part 1

In [11]:
```
x = np.linspace(0, 3, 10)
y = x**2
```

Part 2

In [12]:
```
y[1:] + y[:-1]
```

Out [12]:
```
array([  0.11111111,   0.55555556,   1.44444444,   2.77777778,
         4.55555556,   6.77777778,   9.44444444,  12.55555556,
16.11111111])
```

Part 3

In [22]:
```
def trapz(x, y):
    dx = x[1:] - x[:-1]
    dy = y[1:] + y[:-1]
    return np.sum(dx * dy) / 2
```

Part 4

In [23]:
```
trapz(x, y)
```

Out [23]: 9.0555555555555554

Part 5 (extension)

In [15]:
```
# Solution 2.2.5
import scipy.integrate

scipy.integrate.trapz(y, x)
```

Out [15]: 9.0555555555555554

1.6 Solution 3 : Creating NetCDF

Part 1

In [16]:
```
from netcdftime import num2date, date2num
from datetime import datetime, timedelta

dates = []
units = 'seconds since 2013-03-19 00:00:00'
dt = datetime(2013, 3, 19, 0, 0, 0)
while dt < datetime(2013, 3, 19, 12, 0, 0):
    dt = dt + timedelta(minutes=5)
    dates.append(dt)

times = date2num(dates, units=units)
print num2date(times[:5], units)
print num2date(times[-5:], units)
```

```
[2013-03-19 00:05:00 2013-03-19 00:10:00 2013-03-19 00:15:00
 2013-03-19 00:20:00 2013-03-19 00:25:00]
[2013-03-19 11:40:00 2013-03-19 11:45:00 2013-03-19 11:50:00
 2013-03-19 11:55:00 2013-03-19 12:00:00]
```

Part 2

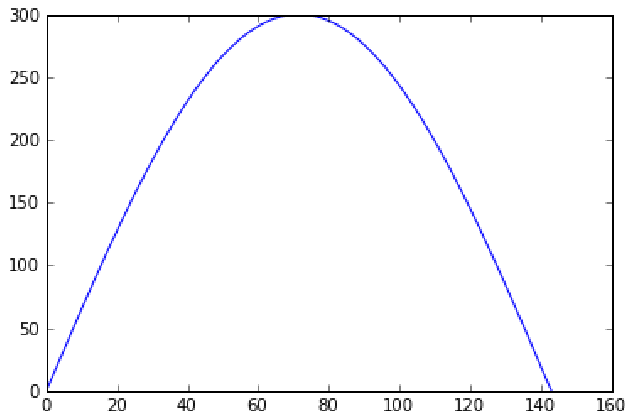
In [25]:
```
! rm data/ex5.nc
```

In [26]:
```
from netCDF4 import Dataset

# 1.
```

```
d = Dataset('data/ex5.nc', 'w', format='NETCDF4_CLASSIC')
time_d = d.createDimension('time', len(times))
time_v = d.createVariable('time', np.int32, ('time', ))
o3_v = d.createVariable('o3', np.float64, ('time', ))
```

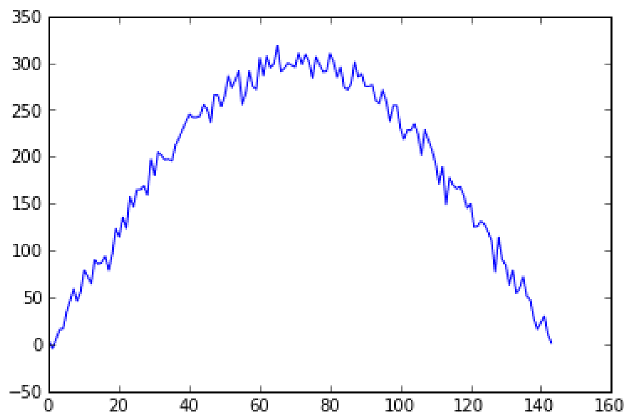
In [27]:
```
# 2.
o3_v[:] = sin(np.linspace(0, pi, len(times))) * 300
plot(o3_v)
```

Out [27]: [<matplotlib.lines.Line2D at 0x104a8d290>]



In [28]:
```
# 3.
o3_v[:] = o3_v + np.random.normal(size=len(times)) * 10
plot(o3_v)
```

Out [28]: [<matplotlib.lines.Line2D at 0x104b2a890>]



1.7 Solution 4.1 : Converting PP files to NetCDF

Part 1

In [89]:
```
import cf
from glob import glob

pp_files = glob('data/aatzja.pm90*.pp')
datasets = [cf.read(f) for f in pp_files]
fields = [d.select('cloud_area_fraction') for d in datasets]
```

Part 2

In [90]:
```
cloud_agg = cf.aggregate(fields)
print cloud_agg
```

```
cloud_area_fraction field summary
---------------------------------
Data            : cloud_area_fraction(time(12), latitude(73),
longitude(96)) 1
Cell methods    : time: mean
Dimensions      : time(12) = [1890-01-16 00:00:00, ..., 1890-12-16
00:00:00] 360_day
                : latitude(73) = [90.0, ..., -90.0] degrees_north
                : longitude(96) = [0.0, ..., 356.25] degrees_east
```

Part 3

In [91]:
```
cf.write(cloud_agg, 'data/ex_4.1.nc')
```

In [ ]:
```
%%sh
ncdump -h data/ex_4.1.nc
```

1.8 Solution 4.2 : Averaging and plotting gridded data

Part 1

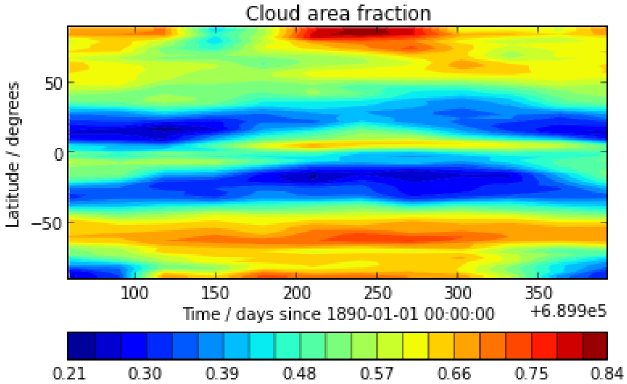
In [92]:
```
%%sh
cdo zonmean data/ex_4.1.nc data/ex_4.1_zmean.nc
```

```
cdo zonmean: Processed 84096 values from 1 variable over 12 timestep
( 0.00s )
```

Part 2

In [96]:
```
import iris
from iris import quickplot as qplt

cloud_zmean = iris.load_cube('data/ex_4.1_zmean.nc')
qplt.contourf(cloud_zmean[:,:,0], 20)
```

Out [96]: <matplotlib.contour.QuadContourSet instance at 0xb2bb3f8>



Cloud area fraction
Latitude / degrees
50
0
−50
100
150
200
250
300
350
Time / days since 1890-01-01 00:00:00
+6.899e5
0.21
0.30
0.39
0.48
0.57
0.66
0.75
0.84

In [ ]: