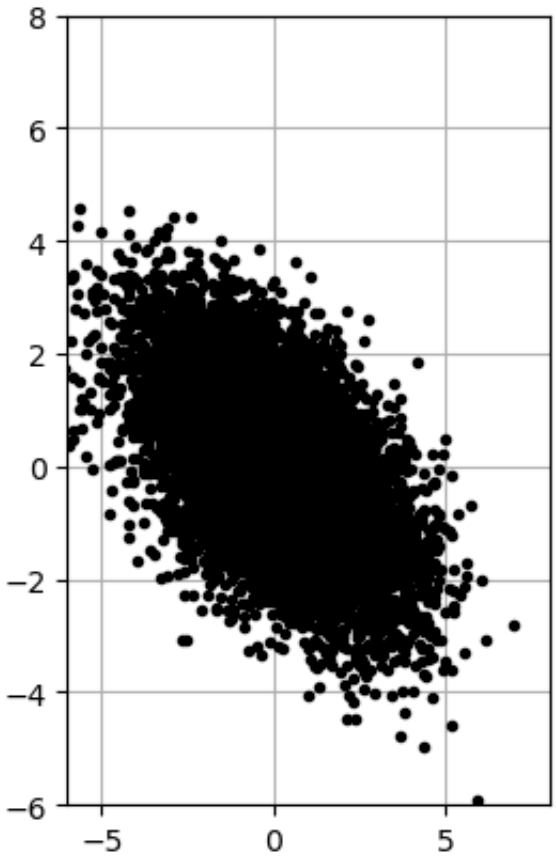
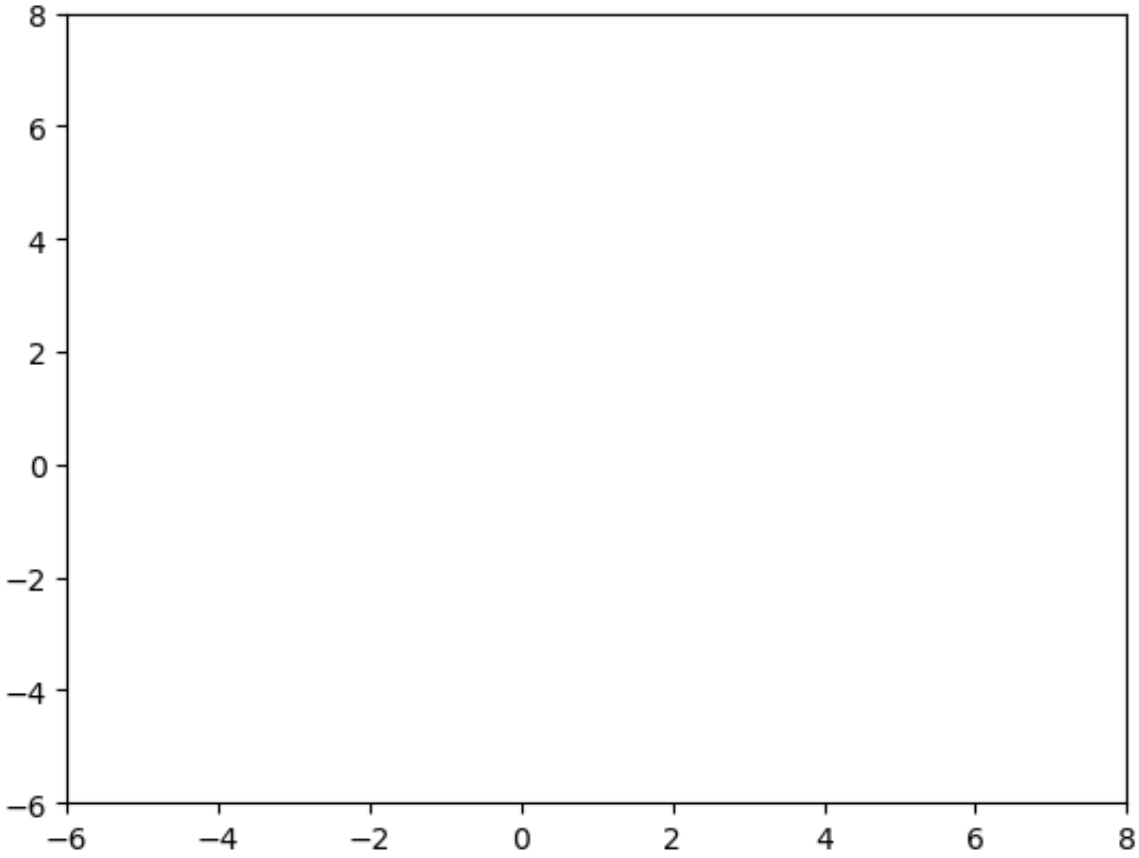
In [1]:
```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
```

In [2]:
```
data = pd.read_csv('11.csv', sep=',')
center_and_axes = data.values.flatten()
center = center_and_axes[:1000]
axes = center_and_axes[1000:]
theta = np.pi / 3
R = np.array([[np.cos(theta), -np.sin(theta)],
[np.sin(theta), np.cos(theta)]])
nPoints = 10000
sig = np.array([1.0, 2.0])
xC = np.array([0.0, 0.0])
X = R @ np.diag(sig) @ np.random.randn(2, nPoints) + np.diag(xC) @ np.one
fig = plt.figure()
ax1 = fig.add_subplot(121)
ax1.plot(X[0, :], X[1, :], '.', color='k')
ax1.grid()
plt.xlim((-6, 8))
plt.ylim((-6, 8))
Xavg = np.mean(X, axis=1)
B = X - np.tile(Xavg, (nPoints, 1)).T
```



In [3]:
```
U, S, VT = np.linalg.svd(B / np.sqrt(nPoints), full_matrices=0)
ax2 = fig.add_subplot(122)
ax2.plot(X[0, :], X[1, :], '.', color='k')
ax2.grid()
plt.xlim((-6, 8))
plt.ylim((-6, 8))
```

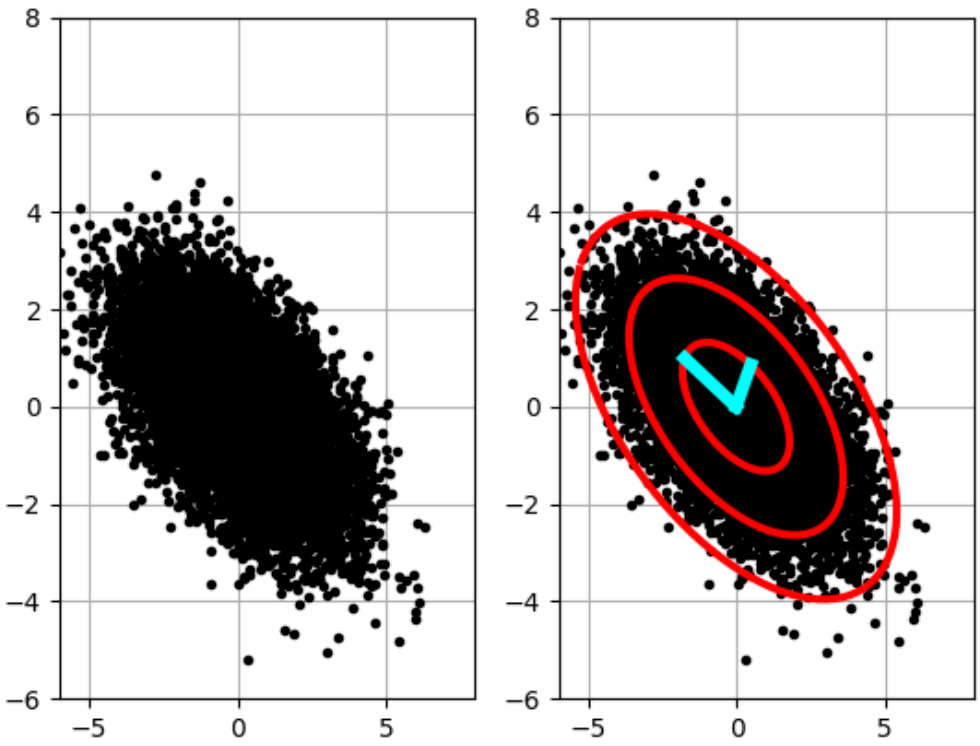
```
theta = 2 * np.pi * np.arange(0, 1, 0.01)
```



In [4]:
```
Xstd = U @ np.diag(S) @ np.array([np.cos(theta), np.sin(theta)])
ax2.plot(Xavg[0] + Xstd[0, :], Xavg[1] + Xstd[1, :], '-', color='r',
linewidth=3)
ax2.plot(Xavg[0] + 2 * Xstd[0, :], Xavg[1] + 2 * Xstd[1, :], '-',
color='r', linewidth=3)
ax2.plot(Xavg[0] + 3 * Xstd[0, :], Xavg[1] + 3 * Xstd[1, :], '-',
color='r', linewidth=3)
```

Out[4]:
```
[<matplotlib.lines.Line2D at 0xffff38313ed0>]
```

In [5]:
```
ax2.plot(np.array([Xavg[0], Xavg[0] + U[0, 0] * S[0]]),
np.array([Xavg[1], Xavg[1] + U[1, 0] * S[0]]), '-',
color='cyan', linewidth=5)
ax2.plot(np.array([Xavg[0], Xavg[0] + U[0, 1] * S[1]]),
np.array([Xavg[1], Xavg[1] + U[1, 1] * S[1]]), '-',
color='cyan', linewidth=5)
plt.show()
```



In [ ]: