Performing blind source separation

Blind source separation refers to the process of separating signals from a mixture. Let's say a bunch of different signal generators generate signals and a common receiver receives all of these signals. Now, our job is to separate these signals from this mixture using the properties of these signals. We will use **Independent Components Analysis** (**ICA**) to achieve this. You can learn more about it at http://www.mit.edu/~gari/teaching/6.555/LECTURE_NOTES/ch15_bss.pdf. Let's see how to do it.

How to do it...

1. Create a new Python file, and import the following packages:

```
import numpy as np
import matplotlib.pyplot as plt
from scipy import signal

from sklearn.decomposition import PCA, FastICA
```

2. We will use data from the `mixture_of_signals.txt` file that's already provided to you. Let's load the data:

```
# Load data
input_file = 'mixture_of_signals.txt'
X = np.loadtxt(input_file)
```

3. Create the ICA object:

```
# Compute ICA
ica = FastICA(n_components=4)
```

4. Reconstruct the signals, based on ICA:

```
# Reconstruct the signals
signals_ica = ica.fit_transform(X)
```

5. Extract the mixing matrix:

```
# Get estimated mixing matrix
mixing_mat = ica.mixing_
```

6. Perform PCA for comparison:

```
# Perform PCA
pca = PCA(n_components=4)
signals_pca = pca.fit_transform(X)  # Reconstruct signals based on orthogonal c
```

7. Define the list of signals to plot them:

```
# Specify parameters for output plots
models = [X, signals_ica, signals_pca]
```

8. Specify the colors of the plots:

```
colors = ['blue', 'red', 'black', 'green']
```

9. Plot the input signal:

```
# Plotting input signal
plt.figure()
plt.title('Input signal (mixture)')
for i, (sig, color) in enumerate(zip(X.T, colors), 1):
    plt.plot(sig, color=color)
```

10. Plot the ICA-separated signals:

```
# Plotting ICA signals
plt.figure()
plt.title('ICA separated signals')
plt.subplots_adjust(left=0.1, bottom=0.05, right=0.94,
        top=0.94, wspace=0.25, hspace=0.45)
```

11. Plot the subplots with different colors:

```
for i, (sig, color) in enumerate(zip(signals_ica.T, colors), 1):
    plt.subplot(4, 1, i)
    plt.title('Signal ' + str(i))
    plt.plot(sig, color=color)
```

12. Plot the PCA-separated signals:

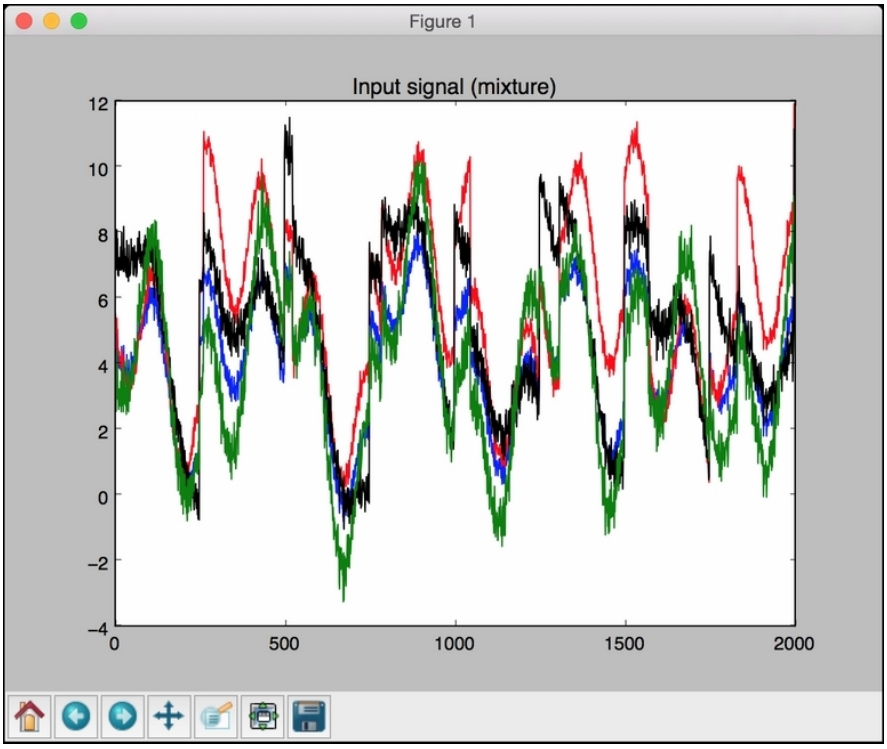
```
# Plotting PCA signals
plt.figure()
plt.title('PCA separated signals')
plt.subplots_adjust(left=0.1, bottom=0.05, right=0.94,
        top=0.94, wspace=0.25, hspace=0.45)
```

13. Use a different color in each subplot:

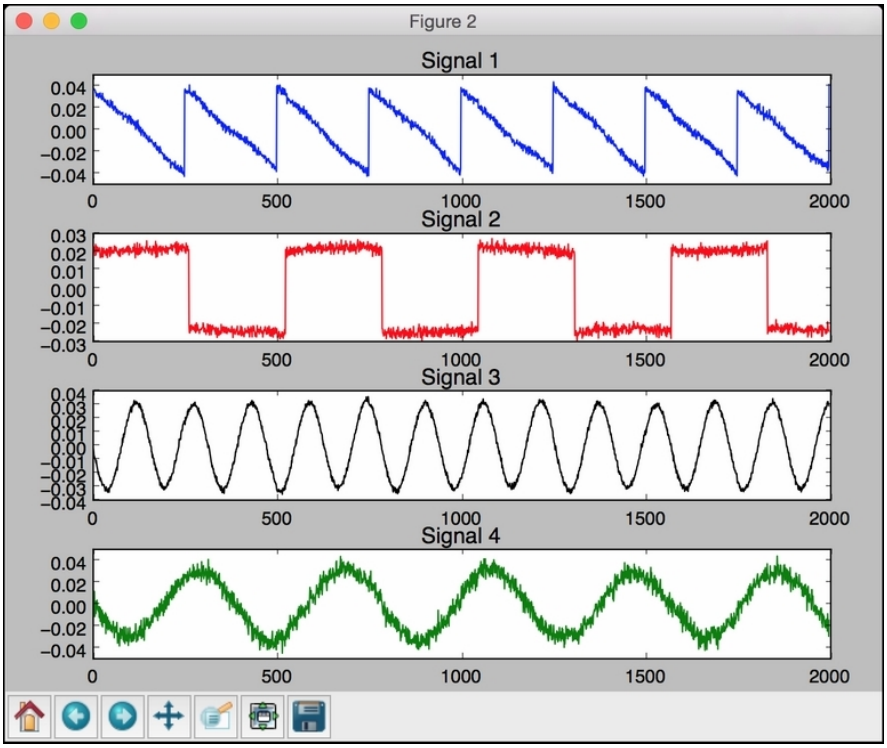
```
for i, (sig, color) in enumerate(zip(signals_pca.T, colors), 1):
    plt.subplot(4, 1, i)
    plt.title('Signal ' + str(i))
    plt.plot(sig, color=color)

plt.show()
```

14. The full code is given in the `blind_source_separation.py` file that's already provided to you for reference. If you run this code, you will see three figures. The first figure depicts the input, which is a mixture of signals:



The second figure depicts the signals, separated using ICA:



The third figure depicts the signals, separated using PCA: