Assignment 4, Exercise 7-1
Principal Component Analysis

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Consider the two-dimensional data sets pca3.csv and pca4.csv (the last data set has as a third column also a label, which should be used for coloring the plots). Perform PCA and visualize the principal components together with the data and determine the proportion of variance for each of the components.

First step is to read the data from the csv file:

```
In [6]: import pandas as pd

        df = pd.read_csv(
            filepath_or_buffer='pca3.csv',
            header=None,
            sep=',')
```

Next, we need to center the data. For this, for each attribute, the mean of that attribute over all observations is subtracted.

```
In [7]: import numpy as np

        data = np.array(df.ix[:,:].values)  # transform to numpy array
        data = data - np.mean(data, axis=0)
```

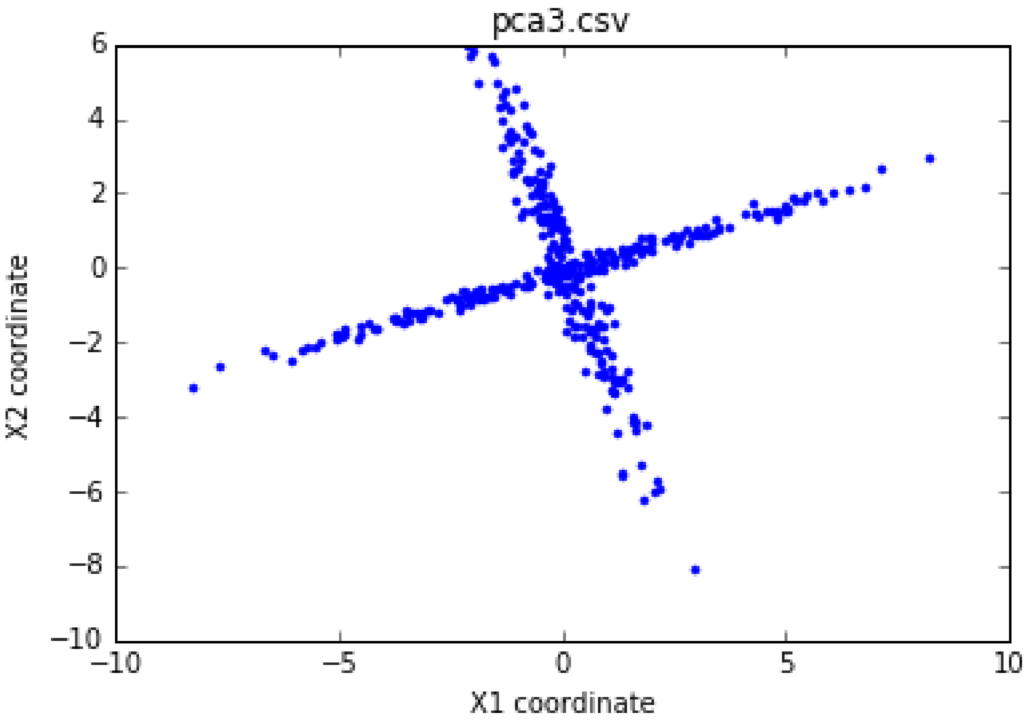
The first part of the requirement is to visualize the data. We make a 2D plot.

```
In [8]: %matplotlib inline
        import matplotlib.pyplot as plt
        from IPython.display import set_matplotlib_formats
        set_matplotlib_formats('png', 'pdf')

        plt.xlabel("X1 coordinate")
        plt.ylabel("X2 coordinate")
        plt.title("pca3.csv")

        plt.plot(data[:,0], data[:,1], 'b.')

Out[8]: [<matplotlib.lines.Line2D at 0x275ef444cc0>]
```



Then, apply PCA and display the amount of variance each of the principal components accounts for.

```
In [9]: # apply pca to get the first 2 components for first dataset
        from sklearn.decomposition import PCA
        pca_for_ds1 = PCA(n_components=2).fit(data)

        # print the ratio of the variance explained by each component
        print(pca_for_ds1.explained_variance_ratio_)
```

```
[ 0.593217  0.406783]
```

Now, display the principal components, each with a proportional length to the amount of variance they capture. The lw argument in the plot stands for line weight.

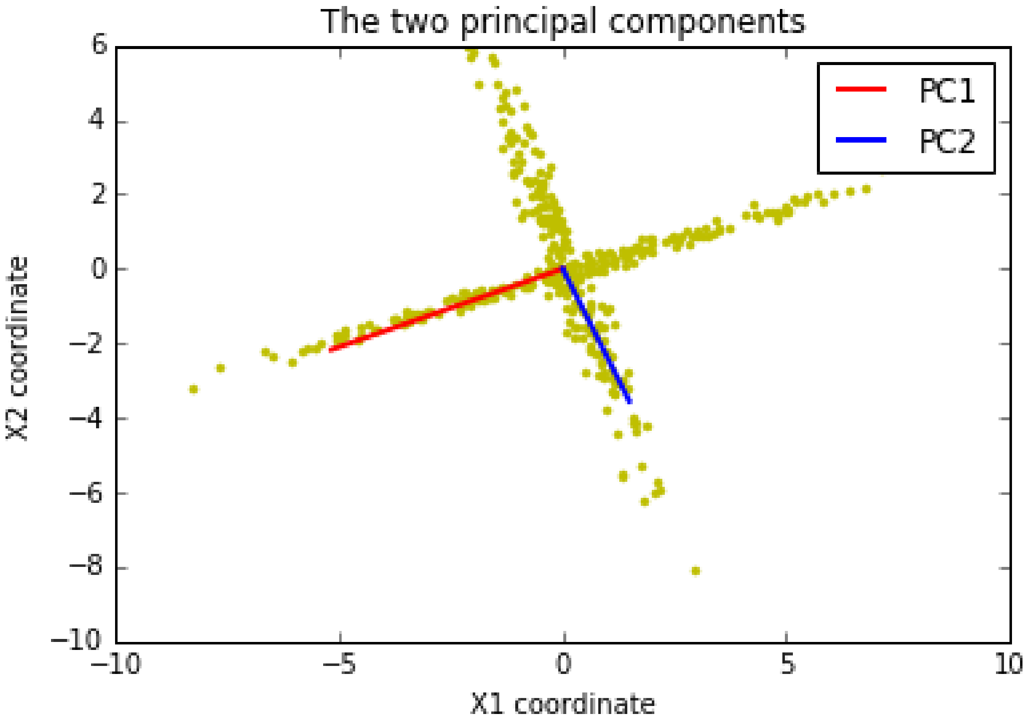
```
In [10]: # display the principal components (=eigenvectors)

         length_v1 = pca_for_ds1.explained_variance_[0]
         length_v2 = pca_for_ds1.explained_variance_[1]

         vector1 = pca_for_ds1.components_[0]*length_v1
         vector2 = pca_for_ds1.components_[1]*length_v2

         plt.plot(data[:,0], data[:,1], 'y.')
         pc1, = plt.plot([0, vector1[0]],[0, vector1[1]],'-r',lw=2, label = "PC1")
         pc2, = plt.plot([0, vector2[0]],[0, vector2[1]],'-b',lw=2, label = "PC2")
         plt.legend(handles=[pc1, pc2])
         plt.title("The two principal components")
         plt.xlabel("X1 coordinate")
         plt.ylabel("X2 coordinate")
```

```
Out[10]: <matplotlib.text.Text at 0x275f41a5e10>
```


The two principal components
PC1
PC2
X2 coordinate
X1 coordinate
6
4
2
0
−2
−4
−6
−8
−10
−10
−5
0
5
10