labset-3

March 19, 2025

Develop a program to implement Principal Component Analysis (PCA) for reducing the dimensionality of Iris dataset from 4 features to 2

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
from sklearn.datasets import load_iris
```

[2]:
```
data = load_iris()
print(data)
```

```
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```

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       0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
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       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]), 'frame': None,
'target_names': array(['setosa', 'versicolor', 'virginica'], dtype='<U10'),
'DESCR': '.. _iris_dataset:\n\nIris plants
dataset\n--------------------\n\n**Data Set Characteristics:**\n\n:Number of
Instances: 150 (50 in each of three classes)\n:Number of Attributes: 4 numeric,
predictive attributes and the class\n:Attribute Information:\n    - sepal length
in cm\n    - sepal width in cm\n    - petal length in cm\n    - petal width in
cm\n    - class:\n            - Iris-Setosa\n            - Iris-Versicolour\n
- Iris-Virginica\n\n:Summary Statistics:\n\n============== ==== ==== =======
===== ====================\n                Min  Max   Mean    SD   Class
Correlation\n============== ==== ==== ======= ===== ====================\nsepal
length:   4.3  7.9   5.84   0.83    0.7826\nsepal width:    2.0  4.4   3.05
0.43   -0.4194\npetal length:   1.0  6.9   3.76   1.76    0.9490  (high!)\npetal
```

```
width:    0.1  2.5   1.20   0.76    0.9565  (high!)\n============== ==== ====
======= ===== ====================\n\n:Missing Attribute Values: None\n:Class
Distribution: 33.3% for each of 3 classes.\n:Creator: R.A. Fisher\n:Donor:
Michael Marshall (MARSHALL%PLU@io.arc.nasa.gov)\n:Date: July, 1988\n\nThe famous
Iris database, first used by Sir R.A. Fisher. The dataset is taken\nfrom
Fisher\'s paper. Note that it\'s the same as in R, but not as in the
UCI\nMachine Learning Repository, which has two wrong data points.\n\nThis is
perhaps the best known database to be found in the\npattern recognition
literature.  Fisher\'s paper is a classic in the field and\nis referenced
frequently to this day.  (See Duda & Hart, for example.)  The\ndata set contains
3 classes of 50 instances each, where each class refers to a\ntype of iris
plant.  One class is linearly separable from the other 2; the\nlatter are NOT
linearly separable from each other.\n\n|details-
start|\n**References**\n|details-split|\n\n- Fisher, R.A. "The use of multiple
measurements in taxonomic problems"\n  Annual Eugenics, 7, Part II, 179-188
(1936); also in "Contributions to\n  Mathematical Statistics" (John Wiley, NY,
1950).\n- Duda, R.O., & Hart, P.E. (1973) Pattern Classification and Scene
Analysis.\n  (Q327.D83) John Wiley & Sons.  ISBN 0-471-22361-1.  See page
218.\n- Dasarathy, B.V. (1980) "Nosing Around the Neighborhood: A New System\n
Structure and Classification Rule for Recognition in Partially Exposed\n
Environments".  IEEE Transactions on Pattern Analysis and Machine\n
Intelligence, Vol. PAMI-2, No. 1, 67-71.\n- Gates, G.W. (1972) "The Reduced
Nearest Neighbor Rule".  IEEE Transactions\n  on Information Theory, May 1972,
431-433.\n- See also: 1988 MLC Proceedings, 54-64.  Cheeseman et al"s AUTOCLASS
II\n  conceptual clustering system finds 3 classes in the data.\n- Many, many
more …\n\n|details-end|\n', 'feature_names': ['sepal length (cm)', 'sepal
width (cm)', 'petal length (cm)', 'petal width (cm)'], 'filename': 'iris.csv',
'data_module': 'sklearn.datasets.data'}
```

[3]:
```
data.keys()
```

[3]:
```
dict_keys(['data', 'target', 'frame', 'target_names', 'DESCR', 'feature_names',
 'filename', 'data_module'])
```

[4]:
```
data.data
```

[4]:
```
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       [5. , 3.6, 1.4, 0.2],
       [5.4, 3.9, 1.7, 0.4],
       [4.6, 3.4, 1.4, 0.3],
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       [6.1, 3. , 4.9, 1.8],
       [6.4, 2.8, 5.6, 2.1],
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       [7.4, 2.8, 6.1, 1.9],
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       [6.7, 3. , 5.2, 2.3],
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       [6.5, 3. , 5.2, 2. ],
       [6.2, 3.4, 5.4, 2.3],
       [5.9, 3. , 5.1, 1.8]])
```

[5]:

```
data.target
```

```
[5]: array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
        0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
        0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
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        2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2])
```

```
[6]: data.target_names
```

```
[6]: array(['setosa', 'versicolor', 'virginica'], dtype='<U10')
```

```
[7]: feature = data.data
     print(feature)
```

```
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 [4.7 3.2 1.3 0.2]
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 [5.4 3.9 1.7 0.4]
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 [5.2 3.4 1.4 0.2]
 [4.7 3.2 1.6 0.2]
 [4.8 3.1 1.6 0.2]
 [5.4 3.4 1.5 0.4]
```

```
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[4.9 3.6 1.4 0.1]
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[6.5 2.8 4.6 1.5]
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[5.9 3.  4.2 1.5]
[6.  2.2 4.  1. ]
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[6.7 3.1 4.4 1.4]
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[6.6 3.  4.4 1.4]
[6.8 2.8 4.8 1.4]
[6.7 3.  5.  1.7]
[6.  2.9 4.5 1.5]
[5.7 2.6 3.5 1. ]
```

```
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[5.5 2.4 3.7 1. ]
[5.8 2.7 3.9 1.2]
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[5.4 3.  4.5 1.5]
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[5.8 2.6 4.  1.2]
[5.  2.3 3.3 1. ]
[5.6 2.7 4.2 1.3]
[5.7 3.  4.2 1.2]
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[6.5 3.2 5.1 2. ]
[6.4 2.7 5.3 1.9]
[6.8 3.  5.5 2.1]
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[5.6 2.8 4.9 2. ]
[7.7 2.8 6.7 2. ]
[6.3 2.7 4.9 1.8]
[6.7 3.3 5.7 2.1]
[7.2 3.2 6.  1.8]
[6.2 2.8 4.8 1.8]
[6.1 3.  4.9 1.8]
```

```
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 [7.2 3.  5.8 1.6]
 [7.4 2.8 6.1 1.9]
 [7.9 3.8 6.4 2. ]
 [6.4 2.8 5.6 2.2]
 [6.3 2.8 5.1 1.5]
 [6.1 2.6 5.6 1.4]
 [7.7 3.  6.1 2.3]
 [6.3 3.4 5.6 2.4]
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 [6.  3.  4.8 1.8]
 [6.9 3.1 5.4 2.1]
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 [6.8 3.2 5.9 2.3]
 [6.7 3.3 5.7 2.5]
 [6.7 3.  5.2 2.3]
 [6.3 2.5 5.  1.9]
 [6.5 3.  5.2 2. ]
 [6.2 3.4 5.4 2.3]
 [5.9 3.  5.1 1.8]]
```

[8]:
```
target = data.target
print(target)
```

```
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2]
```

[9]:
```
std = StandardScaler()
stand_ard = std.fit_transform(feature)
print(stand_ard)
```

```
[[-9.00681170e-01  1.01900435e+00 -1.34022653e+00 -1.31544430e+00]
 [-1.14301691e+00 -1.31979479e-01 -1.34022653e+00 -1.31544430e+00]
 [-1.38535265e+00  3.28414053e-01 -1.39706395e+00 -1.31544430e+00]
 [-1.50652052e+00  9.82172869e-02 -1.28338910e+00 -1.31544430e+00]
 [-1.02184904e+00  1.24920112e+00 -1.34022653e+00 -1.31544430e+00]
 [-5.37177559e-01  1.93979142e+00 -1.16971425e+00 -1.05217993e+00]
 [-1.50652052e+00  7.88807586e-01 -1.34022653e+00 -1.18381211e+00]
 [-1.02184904e+00  7.88807586e-01 -1.28338910e+00 -1.31544430e+00]
 [-1.74885626e+00 -3.62176246e-01 -1.34022653e+00 -1.31544430e+00]
 [-1.14301691e+00  9.82172869e-02 -1.28338910e+00 -1.44707648e+00]
 [-5.37177559e-01  1.47939788e+00 -1.28338910e+00 -1.31544430e+00]
 [-1.26418478e+00  7.88807586e-01 -1.22655167e+00 -1.31544430e+00]
```

```
[-1.26418478e+00 -1.31979479e-01 -1.34022653e+00 -1.44707648e+00]
[-1.87002413e+00 -1.31979479e-01 -1.51073881e+00 -1.44707648e+00]
[-5.25060772e-02  2.16998818e+00 -1.45390138e+00 -1.31544430e+00]
[-1.73673948e-01  3.09077525e+00 -1.28338910e+00 -1.05217993e+00]
[-5.37177559e-01  1.93979142e+00 -1.39706395e+00 -1.05217993e+00]
[-9.00681170e-01  1.01900435e+00 -1.34022653e+00 -1.18381211e+00]
[-1.73673948e-01  1.70959465e+00 -1.16971425e+00 -1.18381211e+00]
[-9.00681170e-01  1.70959465e+00 -1.28338910e+00 -1.18381211e+00]
[-5.37177559e-01  7.88807586e-01 -1.16971425e+00 -1.31544430e+00]
[-9.00681170e-01  1.47939788e+00 -1.28338910e+00 -1.05217993e+00]
[-1.50652052e+00  1.24920112e+00 -1.56757623e+00 -1.31544430e+00]
[-9.00681170e-01  5.58610819e-01 -1.16971425e+00 -9.20547742e-01]
[-1.26418478e+00  7.88807586e-01 -1.05603939e+00 -1.31544430e+00]
[-1.02184904e+00 -1.31979479e-01 -1.22655167e+00 -1.31544430e+00]
[-1.02184904e+00  7.88807586e-01 -1.22655167e+00 -1.05217993e+00]
[-7.79513300e-01  1.01900435e+00 -1.28338910e+00 -1.31544430e+00]
[-7.79513300e-01  7.88807586e-01 -1.34022653e+00 -1.31544430e+00]
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[-1.14301691e+00  1.24920112e+00 -1.34022653e+00 -1.44707648e+00]
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[-9.00681170e-01  1.70959465e+00 -1.05603939e+00 -1.05217993e+00]
[-1.26418478e+00 -1.31979479e-01 -1.34022653e+00 -1.18381211e+00]
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[-6.58345429e-01  1.47939788e+00 -1.28338910e+00 -1.31544430e+00]
[-1.02184904e+00  5.58610819e-01 -1.34022653e+00 -1.31544430e+00]
[ 1.40150837e+00  3.28414053e-01  5.35408562e-01  2.64141916e-01]
[ 6.74501145e-01  3.28414053e-01  4.21733708e-01  3.95774101e-01]
[ 1.28034050e+00  9.82172869e-02  6.49083415e-01  3.95774101e-01]
[-4.16009689e-01 -1.74335684e+00  1.37546573e-01  1.32509732e-01]
[ 7.95669016e-01 -5.92373012e-01  4.78571135e-01  3.95774101e-01]
[-1.73673948e-01 -5.92373012e-01  4.21733708e-01  1.32509732e-01]
[ 5.53333275e-01  5.58610819e-01  5.35408562e-01  5.27406285e-01]
[-1.14301691e+00 -1.51316008e+00 -2.60315415e-01 -2.62386821e-01]
[ 9.16836886e-01 -3.62176246e-01  4.78571135e-01  1.32509732e-01]
[-7.79513300e-01 -8.22569778e-01  8.07091462e-02  2.64141916e-01]
```

```
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[ 3.10997534e-01 -3.62176246e-01  5.35408562e-01  2.64141916e-01]
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[ 7.95669016e-01 -1.31979479e-01  1.16062026e+00  1.31719939e+00]
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```

```
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 [ 1.64384411e+00  1.24920112e+00  1.33113254e+00  1.71209594e+00]
 [ 7.95669016e-01  3.28414053e-01  7.62758269e-01  1.05393502e+00]
 [ 6.74501145e-01 -8.22569778e-01  8.76433123e-01  9.22302838e-01]
 [ 1.15917263e+00 -1.31979479e-01  9.90107977e-01  1.18556721e+00]
 [-1.73673948e-01 -1.28296331e+00  7.05920842e-01  1.05393502e+00]
 [-5.25060772e-02 -5.92373012e-01  7.62758269e-01  1.58046376e+00]
 [ 6.74501145e-01  3.28414053e-01  8.76433123e-01  1.44883158e+00]
 [ 7.95669016e-01 -1.31979479e-01  9.90107977e-01  7.90670654e-01]
 [ 2.24968346e+00  1.70959465e+00  1.67215710e+00  1.31719939e+00]
 [ 2.24968346e+00 -1.05276654e+00  1.78583195e+00  1.44883158e+00]
 [ 1.89829664e-01 -1.97355361e+00  7.05920842e-01  3.95774101e-01]
 [ 1.28034050e+00  3.28414053e-01  1.10378283e+00  1.44883158e+00]
 [-2.94841818e-01 -5.92373012e-01  6.49083415e-01  1.05393502e+00]
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 [ 5.53333275e-01 -8.22569778e-01  6.49083415e-01  7.90670654e-01]
 [ 1.03800476e+00  5.58610819e-01  1.10378283e+00  1.18556721e+00]
 [ 1.64384411e+00  3.28414053e-01  1.27429511e+00  7.90670654e-01]
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 [ 5.53333275e-01 -5.92373012e-01  7.62758269e-01  3.95774101e-01]
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 [ 2.24968346e+00 -1.31979479e-01  1.33113254e+00  1.44883158e+00]
 [ 5.53333275e-01  7.88807586e-01  1.04694540e+00  1.58046376e+00]
 [ 6.74501145e-01  9.82172869e-02  9.90107977e-01  7.90670654e-01]
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 [ 1.03800476e+00  9.82172869e-02  1.04694540e+00  1.58046376e+00]
 [ 1.28034050e+00  9.82172869e-02  7.62758269e-01  1.44883158e+00]
 [-5.25060772e-02 -8.22569778e-01  7.62758269e-01  9.22302838e-01]
 [ 1.15917263e+00  3.28414053e-01  1.21745768e+00  1.44883158e+00]
 [ 1.03800476e+00  5.58610819e-01  1.10378283e+00  1.71209594e+00]
 [ 1.03800476e+00 -1.31979479e-01  8.19595696e-01  1.44883158e+00]
 [ 5.53333275e-01 -1.28296331e+00  7.05920842e-01  9.22302838e-01]
 [ 7.95669016e-01 -1.31979479e-01  8.19595696e-01  1.05393502e+00]
 [ 4.32165405e-01  7.88807586e-01  9.33270550e-01  1.44883158e+00]
 [ 6.86617933e-02 -1.31979479e-01  7.62758269e-01  7.90670654e-01]]
```

[10]:
```
pc = PCA(n_components=2)
Pca = pc.fit_transform(stand_ard)
print(Pca)
```

```
[[-2.26470281  0.4800266 ]
```

```
[-2.08096115 -0.67413356]
[-2.36422905 -0.34190802]
[-2.29938422 -0.59739451]
[-2.38984217  0.64683538]
[-2.07563095  1.48917752]
[-2.44402884  0.0476442 ]
[-2.23284716  0.22314807]
[-2.33464048 -1.11532768]
[-2.18432817 -0.46901356]
[-2.1663101   1.04369065]
[-2.32613087  0.13307834]
[-2.2184509  -0.72867617]
[-2.6331007  -0.96150673]
[-2.1987406   1.86005711]
[-2.26221453  2.68628449]
[-2.2075877   1.48360936]
[-2.19034951  0.48883832]
[-1.898572    1.40501879]
[-2.34336905  1.12784938]
[-1.914323    0.40885571]
[-2.20701284  0.92412143]
[-2.7743447   0.45834367]
[-1.81866953  0.08555853]
[-2.22716331  0.13725446]
[-1.95184633 -0.62561859]
[-2.05115137  0.24216355]
[-2.16857717  0.52714953]
[-2.13956345  0.31321781]
[-2.26526149 -0.3377319 ]
[-2.14012214 -0.50454069]
[-1.83159477  0.42369507]
[-2.61494794  1.79357586]
[-2.44617739  2.15072788]
[-2.10997488 -0.46020184]
[-2.2078089  -0.2061074 ]
[-2.04514621  0.66155811]
[-2.52733191  0.59229277]
[-2.42963258 -0.90418004]
[-2.16971071  0.26887896]
[-2.28647514  0.44171539]
[-1.85812246 -2.33741516]
[-2.5536384  -0.47910069]
[-1.96444768  0.47232667]
[-2.13705901  1.14222926]
[-2.0697443  -0.71105273]
[-2.38473317  1.1204297 ]
[-2.39437631 -0.38624687]
[-2.22944655  0.99795976]
```

```
[-2.20383344  0.00921636]
[ 1.10178118  0.86297242]
[ 0.73133743  0.59461473]
[ 1.24097932  0.61629765]
[ 0.40748306 -1.75440399]
[ 1.0754747  -0.20842105]
[ 0.38868734 -0.59328364]
[ 0.74652974  0.77301931]
[-0.48732274 -1.85242909]
[ 0.92790164  0.03222608]
[ 0.01142619 -1.03401828]
[-0.11019628 -2.65407282]
[ 0.44069345 -0.06329519]
[ 0.56210831 -1.76472438]
[ 0.71956189 -0.18622461]
[-0.0333547  -0.43900321]
[ 0.87540719  0.50906396]
[ 0.35025167 -0.19631173]
[ 0.15881005 -0.79209574]
[ 1.22509363 -1.6222438 ]
[ 0.1649179  -1.30260923]
[ 0.73768265  0.39657156]
[ 0.47628719 -0.41732028]
[ 1.2341781  -0.93332573]
[ 0.6328582  -0.41638772]
[ 0.70266118 -0.06341182]
[ 0.87427365  0.25079339]
[ 1.25650912 -0.07725602]
[ 1.35840512  0.33131168]
[ 0.66480037 -0.22592785]
[-0.04025861 -1.05871855]
[ 0.13079518 -1.56227183]
[ 0.02345269 -1.57247559]
[ 0.24153827 -0.77725638]
[ 1.06109461 -0.63384324]
[ 0.22397877 -0.28777351]
[ 0.42913912  0.84558224]
[ 1.04872805  0.5220518 ]
[ 1.04453138 -1.38298872]
[ 0.06958832 -0.21950333]
[ 0.28347724 -1.32932464]
[ 0.27907778 -1.12002852]
[ 0.62456979  0.02492303]
[ 0.33653037 -0.98840402]
[-0.36218338 -2.01923787]
[ 0.28858624 -0.85573032]
[ 0.09136066 -0.18119213]
[ 0.22771687 -0.38492008]
```

```
[ 0.57638829 -0.1548736 ]
[-0.44766702 -1.54379203]
[ 0.25673059 -0.5988518 ]
[ 1.84456887  0.87042131]
[ 1.15788161 -0.69886986]
[ 2.20526679  0.56201048]
[ 1.44015066 -0.04698759]
[ 1.86781222  0.29504482]
[ 2.75187334  0.8004092 ]
[ 0.36701769 -1.56150289]
[ 2.30243944  0.42006558]
[ 2.00668647 -0.71143865]
[ 2.25977735  1.92101038]
[ 1.36417549  0.69275645]
[ 1.60267867 -0.42170045]
[ 1.8839007   0.41924965]
[ 1.2601151  -1.16226042]
[ 1.4676452  -0.44227159]
[ 1.59007732  0.67624481]
[ 1.47143146  0.25562182]
[ 2.42632899  2.55666125]
[ 3.31069558  0.01778095]
[ 1.26376667 -1.70674538]
[ 2.0377163   0.91046741]
[ 0.97798073 -0.57176432]
[ 2.89765149  0.41364106]
[ 1.33323218 -0.48181122]
[ 1.7007339   1.01392187]
[ 1.95432671  1.0077776 ]
[ 1.17510363 -0.31639447]
[ 1.02095055  0.06434603]
[ 1.78834992 -0.18736121]
[ 1.86364755  0.56229073]
[ 2.43595373  0.25928443]
[ 2.30492772  2.62632347]
[ 1.86270322 -0.17854949]
[ 1.11414774 -0.29292262]
[ 1.2024733  -0.81131527]
[ 2.79877045  0.85680333]
[ 1.57625591  1.06858111]
[ 1.3462921   0.42243061]
[ 0.92482492  0.0172231 ]
[ 1.85204505  0.67612817]
[ 2.01481043  0.61388564]
[ 1.90178409  0.68957549]
[ 1.15788161 -0.69886986]
[ 2.04055823  0.8675206 ]
[ 1.9981471   1.04916875]
```

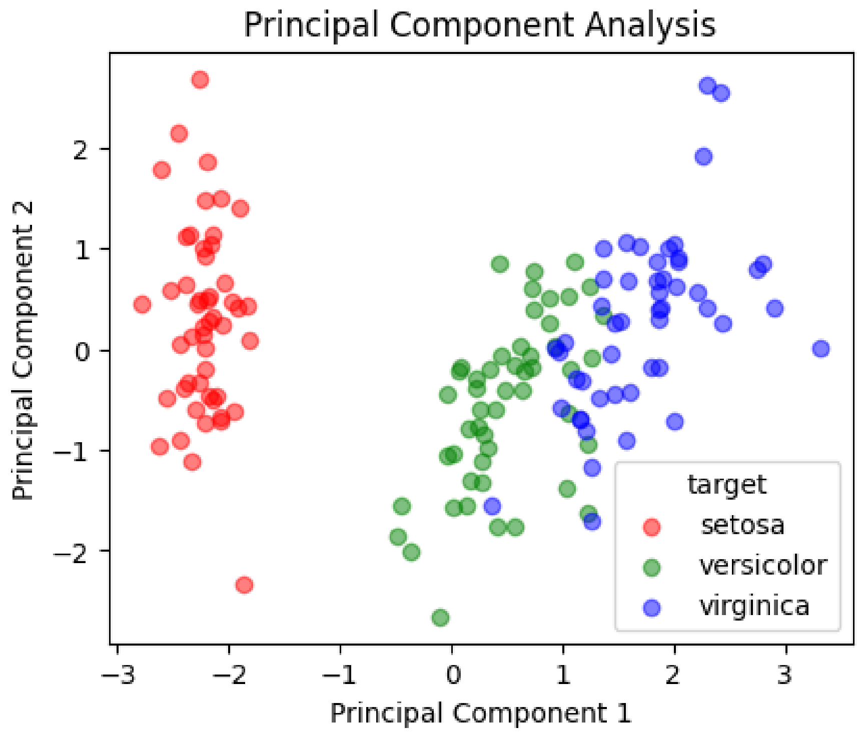
```
 [ 1.87050329  0.38696608]
 [ 1.56458048 -0.89668681]
 [ 1.5211705   0.26906914]
 [ 1.37278779  1.01125442]
 [ 0.96065603 -0.02433167]]
```

[11]:
```
df = pd.DataFrame(data=Pca,columns=['Principal Component 1','Principal␣
 ↪Component 2'])
df['target']=target
print(df)
```

```
     Principal Component 1  Principal Component 2  target
0                -2.264703               0.480027       0
1                -2.080961              -0.674134       0
2                -2.364229              -0.341908       0
3                -2.299384              -0.597395       0
4                -2.389842               0.646835       0
..                     …                     …      …
145               1.870503               0.386966       2
146               1.564580              -0.896687       2
147               1.521170               0.269069       2
148               1.372788               1.011254       2
149               0.960656              -0.024332       2

[150 rows x 3 columns]
```

[12]:
```
colors = ['red','green','blue']
plt.figure(figsize = (5,4))
for label,color in zip(data.target_names,colors):
    plt.scatter(
        df.loc[df['target'] == list(data.target_names).index(label),'Principal␣
 ↪Component 1'],
        df.loc[df['target'] == list(data.target_names).index(label),'Principal␣
 ↪Component 2'],
        label = label,
        color=color,
        alpha=0.5
    )
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.legend(title='target')
plt.title('Principal Component Analysis')
plt.show()
```




```
[13]: variance = pc.explained_variance_ratio_
      print('Variance of Principal Component 1:',variance[0])
      print('Variance of Principal Component 2:',variance[1])
      print('Total Variance:',sum(variance))
```

```
Variance of Principal Component 1: 0.7296244541329985
Variance of Principal Component 2: 0.22850761786701787
Total Variance: 0.9581320720000164
```

```
[ ]:
```