assignment_31.1

January 19, 2019

```
In [1]: import numpy as np
        import matplotlib.pyplot as plt
        from mpl_toolkits.mplot3d import Axes3D
        from sklearn.decomposition import PCA
        from sklearn import datasets
```

0.1 Load iris dataset

```
In [2]: iris = datasets.load_iris()

In [3]: ## Print iris data and target

In [34]: print(iris.data)

[[5.1 3.5 1.4 0.2]
 [4.9 3.  1.4 0.2]
 [4.7 3.2 1.3 0.2]
 [4.6 3.1 1.5 0.2]
 [5.  3.6 1.4 0.2]
 [5.4 3.9 1.7 0.4]
 [4.6 3.4 1.4 0.3]
 [5.  3.4 1.5 0.2]
 [4.4 2.9 1.4 0.2]
 [4.9 3.1 1.5 0.1]
 [5.4 3.7 1.5 0.2]
 [4.8 3.4 1.6 0.2]
 [4.8 3.  1.4 0.1]
 [4.3 3.  1.1 0.1]
 [5.8 4.  1.2 0.2]
 [5.7 4.4 1.5 0.4]
 [5.4 3.9 1.3 0.4]
 [5.1 3.5 1.4 0.3]
 [5.7 3.8 1.7 0.3]
 [5.1 3.8 1.5 0.3]
 [5.4 3.4 1.7 0.2]
 [5.1 3.7 1.5 0.4]
 [4.6 3.6 1.  0.2]
 [5.1 3.3 1.7 0.5]
```

```
[4.8 3.4 1.9 0.2]
[5.  3.  1.6 0.2]
[5.  3.4 1.6 0.4]
[5.2 3.5 1.5 0.2]
[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]
[5.2 4.1 1.5 0.1]
[5.5 4.2 1.4 0.2]
[4.9 3.1 1.5 0.1]
[5.  3.2 1.2 0.2]
[5.5 3.5 1.3 0.2]
[4.9 3.1 1.5 0.1]
[4.4 3.  1.3 0.2]
[5.1 3.4 1.5 0.2]
[5.  3.5 1.3 0.3]
[4.5 2.3 1.3 0.3]
[4.4 3.2 1.3 0.2]
[5.  3.5 1.6 0.6]
[5.1 3.8 1.9 0.4]
[4.8 3.  1.4 0.3]
[5.1 3.8 1.6 0.2]
[4.6 3.2 1.4 0.2]
[5.3 3.7 1.5 0.2]
[5.  3.3 1.4 0.2]
[7.  3.2 4.7 1.4]
[6.4 3.2 4.5 1.5]
[6.9 3.1 4.9 1.5]
[5.5 2.3 4.  1.3]
[6.5 2.8 4.6 1.5]
[5.7 2.8 4.5 1.3]
[6.3 3.3 4.7 1.6]
[4.9 2.4 3.3 1. ]
[6.6 2.9 4.6 1.3]
[5.2 2.7 3.9 1.4]
[5.  2.  3.5 1. ]
[5.9 3.  4.2 1.5]
[6.  2.2 4.  1. ]
[6.1 2.9 4.7 1.4]
[5.6 2.9 3.6 1.3]
[6.7 3.1 4.4 1.4]
[5.6 3.  4.5 1.5]
[5.8 2.7 4.1 1. ]
[6.2 2.2 4.5 1.5]
[5.6 2.5 3.9 1.1]
[5.9 3.2 4.8 1.8]
[6.1 2.8 4.  1.3]
```

```
[6.3 2.5 4.9 1.5]
[6.1 2.8 4.7 1.2]
[6.4 2.9 4.3 1.3]
[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. ]
[5.5 2.4 3.8 1.1]
[5.5 2.4 3.7 1. ]
[5.8 2.7 3.9 1.2]
[6.  2.7 5.1 1.6]
[5.4 3.  4.5 1.5]
[6.  3.4 4.5 1.6]
[6.7 3.1 4.7 1.5]
[6.3 2.3 4.4 1.3]
[5.6 3.  4.1 1.3]
[5.5 2.5 4.  1.3]
[5.5 2.6 4.4 1.2]
[6.1 3.  4.6 1.4]
[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]
[5.7 2.9 4.2 1.3]
[6.2 2.9 4.3 1.3]
[5.1 2.5 3.  1.1]
[5.7 2.8 4.1 1.3]
[6.3 3.3 6.  2.5]
[5.8 2.7 5.1 1.9]
[7.1 3.  5.9 2.1]
[6.3 2.9 5.6 1.8]
[6.5 3.  5.8 2.2]
[7.6 3.  6.6 2.1]
[4.9 2.5 4.5 1.7]
[7.3 2.9 6.3 1.8]
[6.7 2.5 5.8 1.8]
[7.2 3.6 6.1 2.5]
[6.5 3.2 5.1 2. ]
[6.4 2.7 5.3 1.9]
[6.8 3.  5.5 2.1]
[5.7 2.5 5.  2. ]
[5.8 2.8 5.1 2.4]
[6.4 3.2 5.3 2.3]
[6.5 3.  5.5 1.8]
[7.7 3.8 6.7 2.2]
[7.7 2.6 6.9 2.3]
[6.  2.2 5.  1.5]
```

```
[6.9 3.2 5.7 2.3]
[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]
[6.4 2.8 5.6 2.1]
[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]
[6.4 3.1 5.5 1.8]
[6.  3.  4.8 1.8]
[6.9 3.1 5.4 2.1]
[6.7 3.1 5.6 2.4]
[6.9 3.1 5.1 2.3]
[5.8 2.7 5.1 1.9]
[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]]
```

In [4]: print(iris.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]
```

0.2 Apply PCA to reduce dimension of IRIS data to 3

iris data has 4 dimensions. Using PCA reducing dimesion to 3

In [5]: pca = PCA(n_components=3, whiten=True).fit(iris.data)
        reduced_iris = pca.transform(iris.data)
        print(reduced_iris)

```
[[-1.3059028    0.66358991 -0.07676735]
 [-1.32107398 -0.34449998 -0.72628852]
 [-1.405936   -0.27905426  0.08817764]
 [-1.33617856 -0.63213207  0.13443657]
 [-1.32749711  0.67845686  0.34340624]
 [-1.10920067  1.51932013  0.62210009]
 [-1.37240118 -0.16681722  0.94300898]
 [-1.27781875  0.34622394 -0.05638942]
 [-1.40503061 -1.15972851  0.09754939]
 [-1.30086133 -0.21677267 -0.68350758]
 [-1.21945893  1.32457995 -0.24721542]
 [-1.27132901  0.04372491  0.38416209]
 [-1.35612405 -0.46271497 -0.71489168]
 [-1.56910331 -1.02254743  0.24414154]
 [-1.28611926  2.41007147 -0.51568445]
 [-1.15978443  2.73222729  1.01252399]
 [-1.2758942   1.66216748  0.51857604]
 [-1.28844456  0.6484113   0.11917106]
 [-1.06988095  1.78641899 -0.40868241]
 [-1.25877865  1.05748108  0.78356707]
 [-1.12410469  0.80837465 -0.8339684 ]
 [-1.23731792  0.89404193  0.76666715]
 [-1.56455794  0.28772982  1.06922319]
 [-1.12050295  0.21439748  0.16301424]
 [-1.14630886 -0.06341061  0.46180513]
 [-1.2201354  -0.28253006 -0.88186175]
 [-1.20122889  0.28015487  0.3613684 ]
 [-1.24663759  0.76127167 -0.25822159]
 [-1.28430848  0.64872297 -0.49694094]
 [-1.28091585 -0.38618977  0.16582067]
 [-1.25932153 -0.40105671 -0.25435291]
 [-1.17253498  0.8494411  -0.49385361]
 [-1.28811078  1.66601353  0.82287002]
 [-1.26355295  2.23498808  0.58375999]
 [-1.30086133 -0.21677267 -0.68350758]
 [-1.39483391  0.15683837 -0.55970913]
 [-1.27720889  1.23287614 -0.93198936]
 [-1.30086133 -0.21677267 -0.68350758]
 [-1.45070648 -0.97575613  0.28450672]
 [-1.26022692  0.47961754 -0.26372467]
 [-1.34770976  0.55072954  0.3006253 ]
 [-1.38763898 -1.89536493 -1.21675847]
 [-1.45871147 -0.67923505  0.71018339]
 [-1.1703149   0.39805819  0.96608355]
 [-1.07462688  0.89945512  1.08302953]
 [-1.32120757 -0.49307219 -0.32301487]
 [-1.23456351  1.03694786  0.61350968]
 [-1.38185444 -0.44815969  0.3213939 ]
```

5

```
[-1.23705075  1.19118635 -0.03988017]
[-1.31548964  0.23367524 -0.29510877]
[ 0.62506981  1.39265261 -1.44931785]
[ 0.45363035  0.6485361  -0.06112996]
[ 0.71228549  1.02439619 -1.2071205 ]
[ 0.08804298 -1.67743472 -0.63193959]
[ 0.52890552  0.15317569 -1.09393754]
[ 0.31158108 -0.84790402  0.14698664]
[ 0.53284104  0.57680075  0.60674406]
[-0.36559885 -2.03401705  0.05592794]
[ 0.50757837  0.46518706 -1.48031127]
[-0.00495761 -1.46404012  1.0114769 ]
[-0.24865029 -2.5650893  -0.95099862]
[ 0.24865607 -0.20781745  0.47222659]
[ 0.12762987 -1.11319144 -2.4692694 ]
[ 0.47875088 -0.25267138 -0.2218156 ]
[-0.08507368 -0.51163053  0.33423112]
[ 0.45127669  0.9513468  -1.11779347]
[ 0.32090075 -0.71513376  1.17187538]
[ 0.11410714 -0.67438777 -0.96452621]
[ 0.45847162 -1.1008565  -1.77484281]
[ 0.02103995 -1.18145098 -0.831356  ]
[ 0.5430661  -0.17110324  1.64100455]
[ 0.17358145 -0.13577044 -0.81175942]
[ 0.6307495  -0.66552864 -1.24013901]
[ 0.44783689 -0.37057469 -0.82653075]
[ 0.34737458  0.30553538 -1.1432838 ]
[ 0.43768736  0.66969266 -1.12329655]
[ 0.64756952  0.49711142 -1.86011967]
[ 0.75769419  0.54327939 -0.58753051]
[ 0.39527053 -0.32981991  0.12969604]
[-0.14952248 -0.74177088 -1.12531537]
[-0.03422276 -1.42739328 -0.86274009]
[-0.09335438 -1.37650283 -1.08455951]
[ 0.06567686 -0.63332132 -0.62441142]
[ 0.67077405 -0.85579064  0.05524384]
[ 0.2857171  -0.98192095  1.58654588]
[ 0.39271631  0.39630418  1.38982612]
[ 0.59375507  0.82903267 -0.84421202]
[ 0.39547109 -0.7531333  -2.18709755]
[ 0.11929074 -0.54192918  0.67647451]
[ 0.08003799 -1.38091364 -0.20626292]
[ 0.22527079 -1.36032184 -0.08583895]
[ 0.43307501 -0.068699   -0.03485827]
[ 0.11135273 -0.8172937  -0.81136875]
[-0.34400454 -2.048884   -0.36424564]
[ 0.1729716  -1.02242264  0.06384052]
[ 0.1610977  -0.42906881  0.29908187]
```

```
[ 0.18255844 -0.59250796  0.28218194]
[ 0.31219093  0.03874818 -0.7286133 ]
[-0.44197961 -1.52701242 -0.02760885]
[ 0.14488754 -0.70505666  0.04346259]
[ 1.23171916 -0.02406066  2.70664287]
[ 0.68796512 -1.16811367  1.05772957]
[ 1.27295488  0.69473278 -0.40018878]
[ 0.95882793 -0.36800518  0.38019664]
[ 1.1431888  -0.08509558  1.01388012]
[ 1.65262768  1.1117179  -1.25569795]
[ 0.25268692 -2.42054886  1.95090727]
[ 1.42645984  0.71594792 -1.51198879]
[ 1.12855195 -0.49889663 -1.24873568]
[ 1.41971148  1.58555149  1.50502163]
[ 0.80855366  0.4917656   0.8665129 ]
[ 0.87686282 -0.43917576 -0.13451991]
[ 1.05348588  0.43739934  0.11829293]
[ 0.65416314 -1.57749512  1.00944554]
[ 0.77125382 -1.09574619  2.25025994]
[ 0.92668332  0.24141249  1.71342539]
[ 0.9483357   0.08275439  0.15248346]
[ 1.69733119  2.38030536  0.4614929 ]
[ 1.8461661   0.51457659 -1.84486669]
[ 0.63165489 -1.54620289 -1.23076725]
[ 1.18133597  0.76553312  0.78027318]
[ 0.58289045 -1.23039526  1.82941479]
[ 1.70243963  0.92805719 -2.05876727]
[ 0.67511923 -0.41454339 -0.22664712]
[ 1.10723335  0.67736369  1.01590521]
[ 1.27184039  1.13447146 -0.74378157]
[ 0.61185153 -0.36396461  0.16764546]
[ 0.62792811 -0.23654897  0.82653839]
[ 1.03279696 -0.42840796  0.54783827]
[ 1.16158213  0.93973128 -1.61309708]
[ 1.38216563  0.75732604 -1.78798599]
[ 1.57257821  2.7845853  -0.42269745]
[ 1.0502552  -0.44358658  0.74377668]
[ 0.70208879 -0.29217069 -0.54986198]
[ 0.8658188  -1.01885954 -0.6274015 ]
[ 1.49676907  1.39331346 -1.20056144]
[ 1.0435649   0.28222584  2.62001875]
[ 0.92674138  0.09762133  0.57265704]
[ 0.5686629  -0.33423073  1.00799263]
[ 1.02540183  0.75476532  0.097915  ]
[ 1.12593967  0.37101861  1.15216275]
[ 0.93529816  0.83154361  0.41214878]
[ 0.68796512 -1.16811367  1.05772957]
[ 1.24709091  0.56071584  1.03937046]
```

```
[ 1.1770663    0.61664924   1.79965883]
[ 0.94579039   0.38078403   0.63986196]
[ 0.74225584  -0.76195493  -0.43050437]
[ 0.85823203   0.15953268   0.46671724]
[ 0.92516807   0.23543454   2.57965357]
[ 0.67609123  -0.57475984   1.29297091]]
```

0.3   Display reduced iris data in 3 dimensions

```python
In [6]: fig = plt.figure()
        ax = fig.add_subplot(111, projection='3d')

        y = np.choose(iris.target, [1, 2, 0]).astype(np.float)

        ax.scatter(reduced_iris[:, 0], reduced_iris[:, 1], reduced_iris[:, 2], c=y, cmap=plt.c
                   edgecolor='k')


        ax.set_xlabel('Setosa')
        ax.set_ylabel('Versicolour')
        ax.set_zlabel('Virginica')

        plt.show()
```