HW5-KAI YE

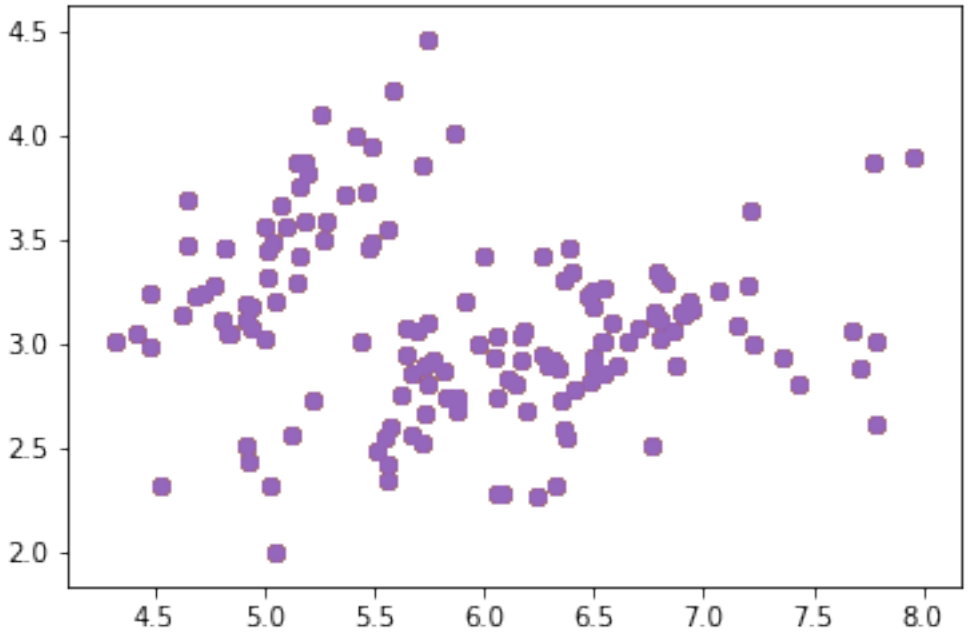
December 3, 2017

1 Problem1

1.1

```
In [6]: import numpy as np
        import matplotlib.pyplot as plt
        import mltools as ml
        iris = np.genfromtxt("data/iris.txt",delimiter=None) # load the text file
        X= iris[:,0:2] # target value is the last column
        print(X.shape)
        plt.scatter(X[:,0],X[:,1])
        plt.show()
```

```
(148, 2)
```



I think there are 4 clusters.

1.2

```
In [65]: from sklearn.cluster import KMeans
         from sklearn import metrics

         import numpy as np
         import matplotlib.pyplot as plt
         import mltools as ml
         iris = np.genfromtxt("data/iris.txt",delimiter=None) # load the text file
         X= iris[:,0:2] # target value is the last column
         kcollec=[2,5,20]
         for i in kcollec:
             s=[]
             for j in range(5):
                 kmeans = KMeans(n_clusters=i)
                 kmeans = kmeans.fit(X)
                 labels = kmeans.predict(X)
                 print(metrics.calinski_harabaz_score(X, labels))
                 centroids = kmeans.cluster_centers_
                 plt.scatter(centroids[:, 0], centroids[:, 1], marker='*', s=300)
                 ml.plotClassify2D(kmeans, X, labels)
                 plt.show()
```

```
184.37150919


C:\Users\admin\Desktop\mltools\plot.py:42: MatplotlibDeprecationWarning: pyplot.hold is deprec
    Future behavior will be consistent with the long-time default:
    plot commands add elements without first clearing the
    Axes and/or Figure.
  hld = axis.ishold();
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  axis.hold(True);
E:\Anaconda3\lib\site-packages\matplotlib\__init__.py:917: UserWarning: axes.hold is deprecate
  warnings.warn(self.msg_depr_set % key)
E:\Anaconda3\lib\site-packages\matplotlib\rcsetup.py:152: UserWarning: axes.hold is deprecated
  warnings.warn("axes.hold is deprecated, will be removed in 3.0")
C:\Users\admin\Desktop\mltools\plot.py:64: MatplotlibDeprecationWarning: pyplot.hold is deprec
    Future behavior will be consistent with the long-time default:
    plot commands add elements without first clearing the
    Axes and/or Figure.
  axis.axis(ax); axis.hold(hld)
```
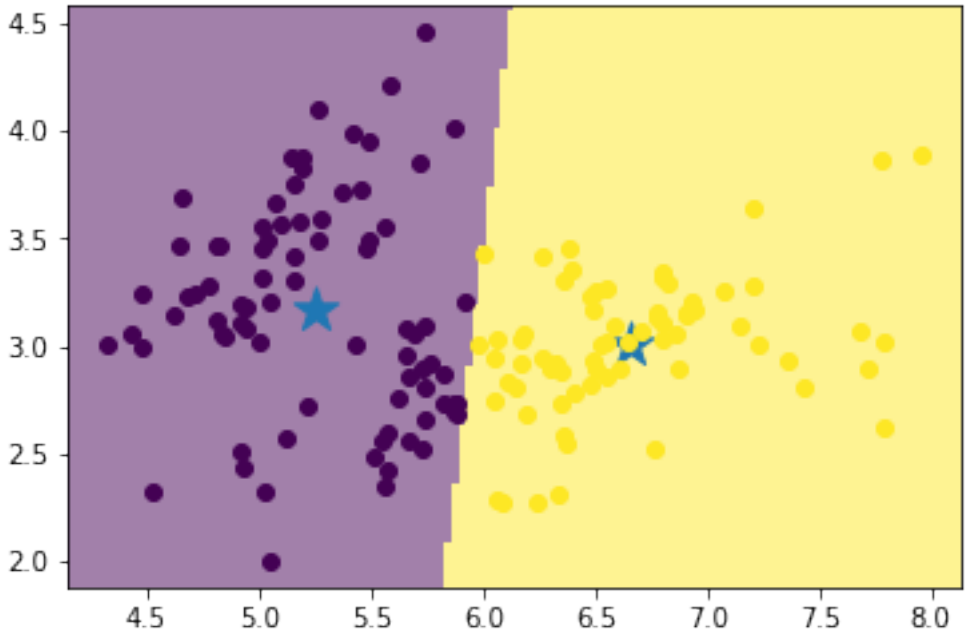
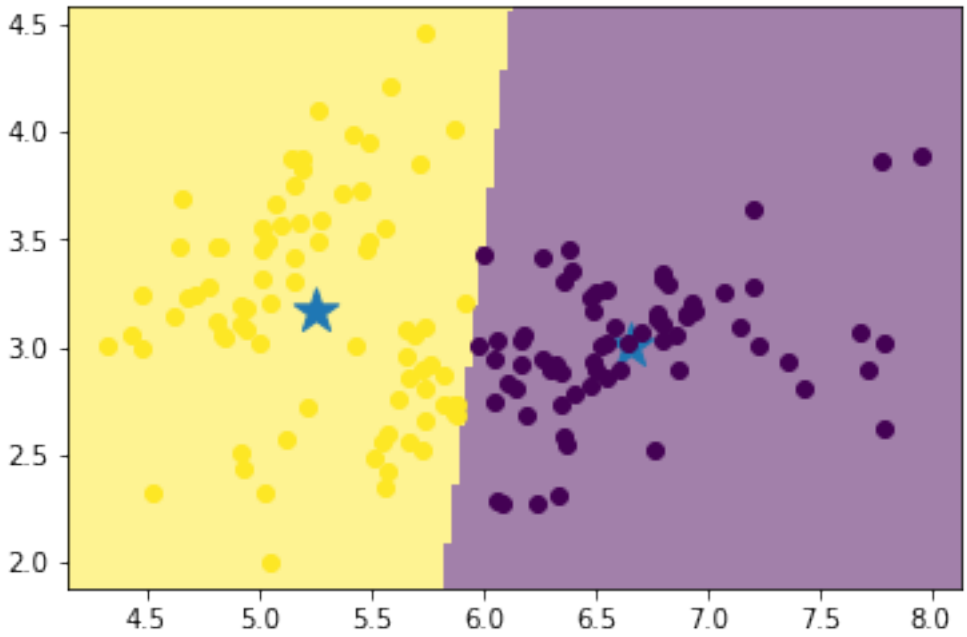



184.37150919



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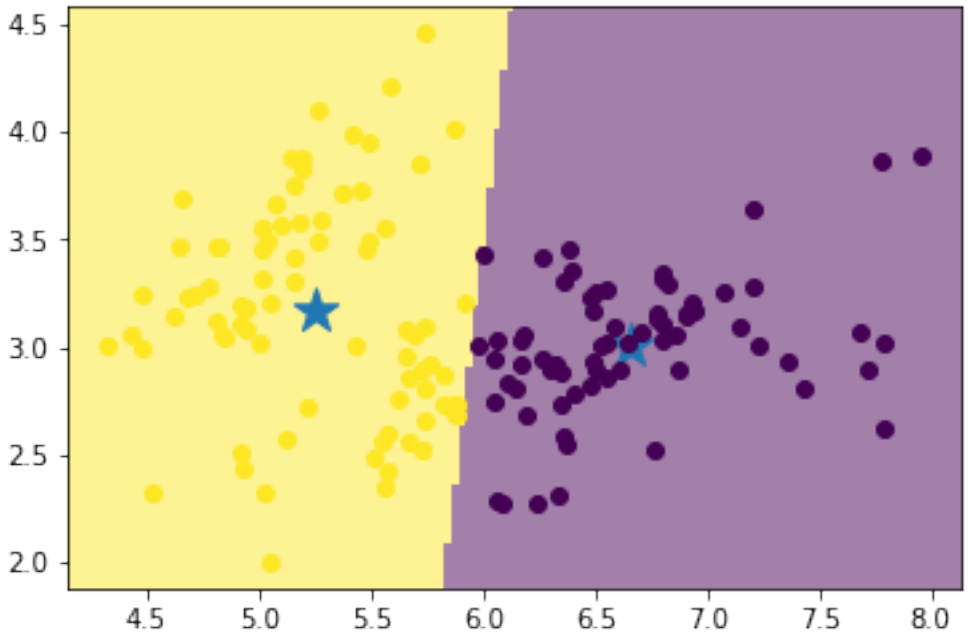

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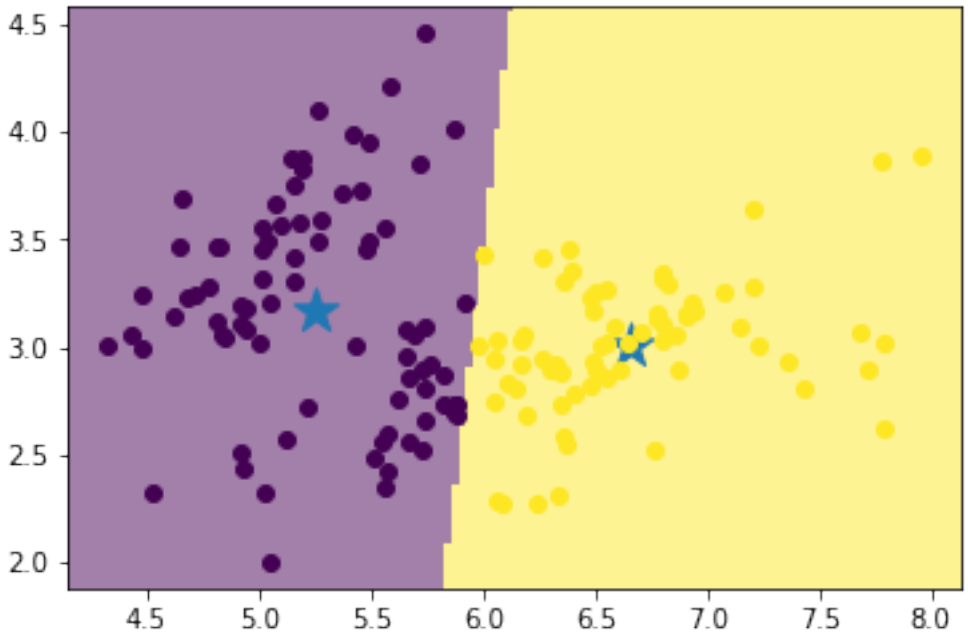

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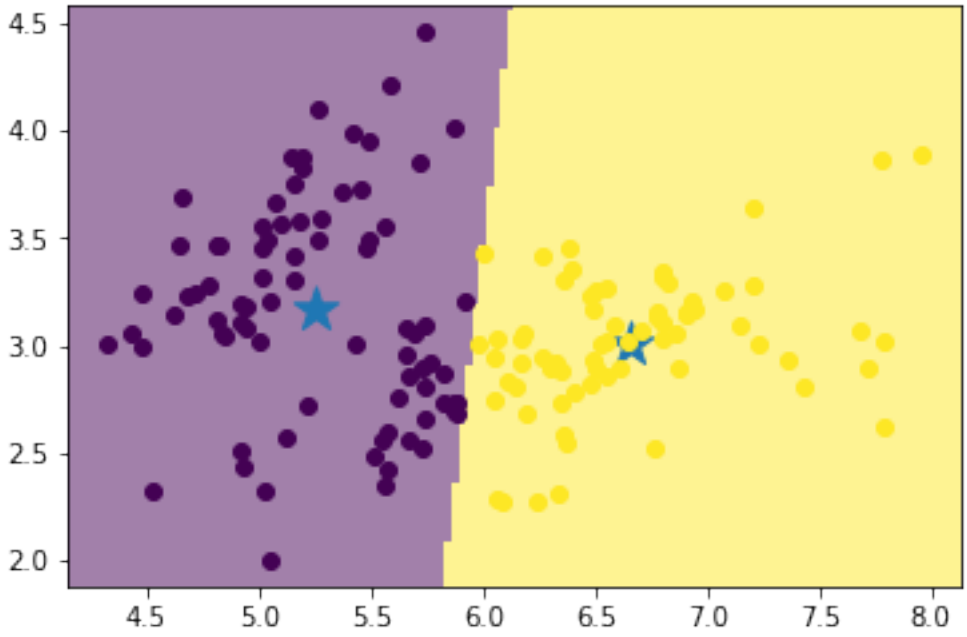
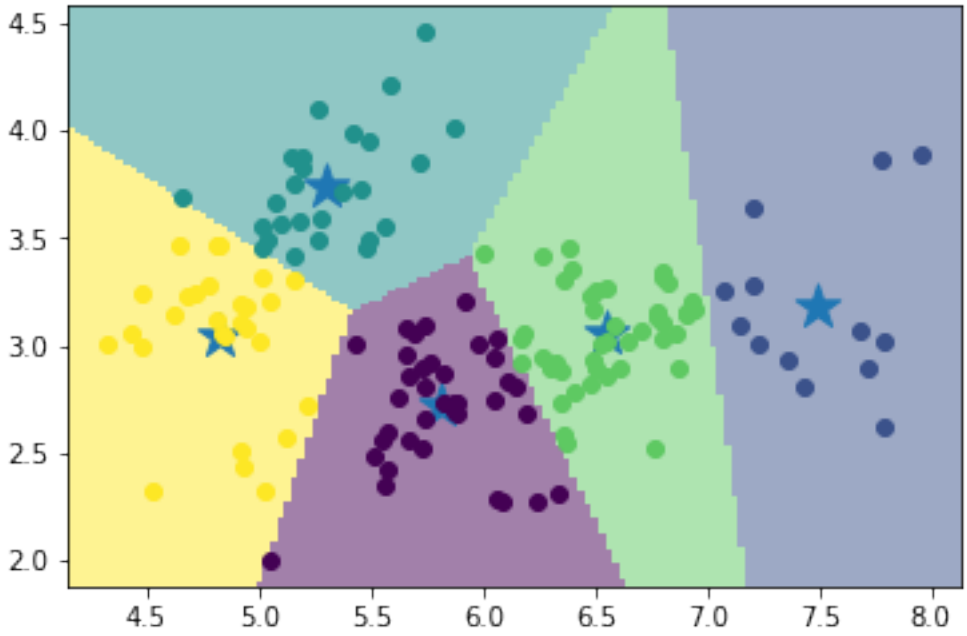
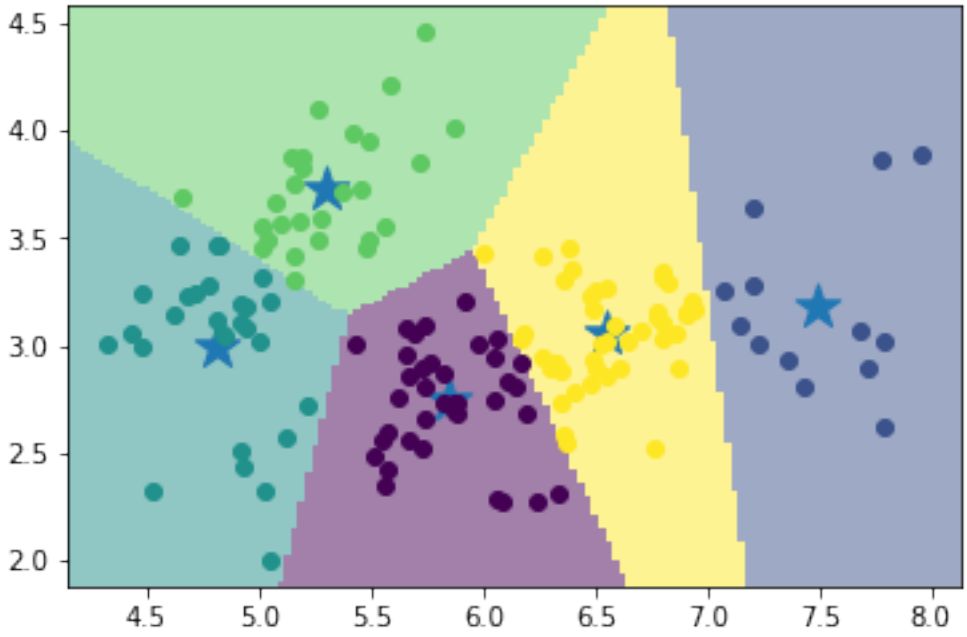


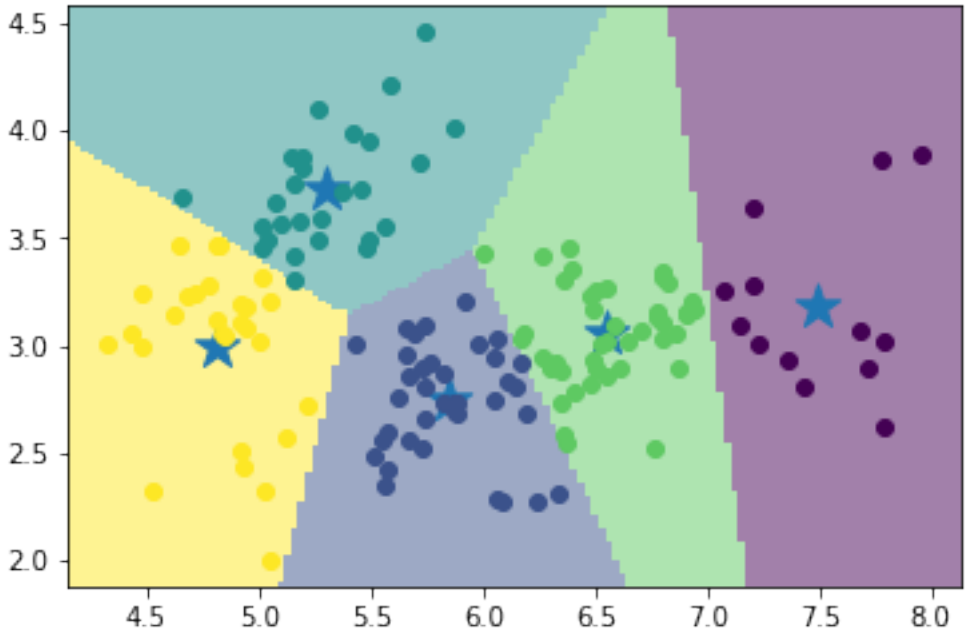
188.243347226



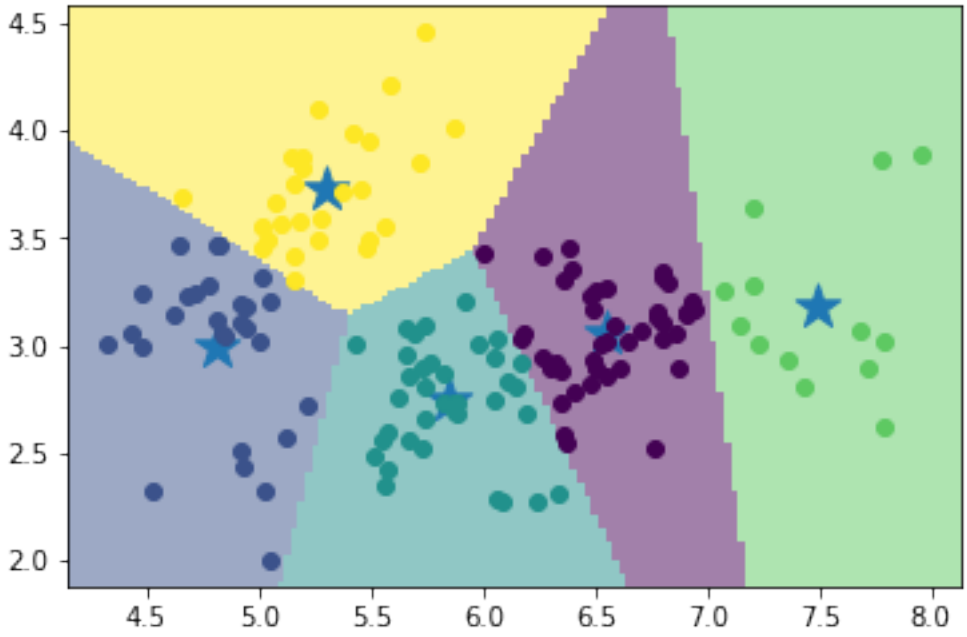
188.623784448



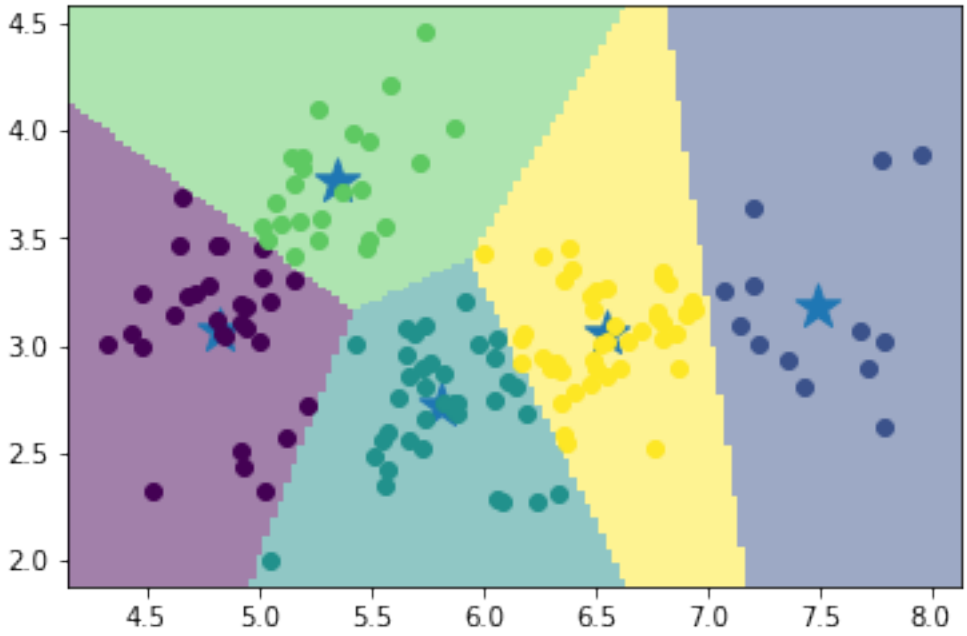
188.623784448



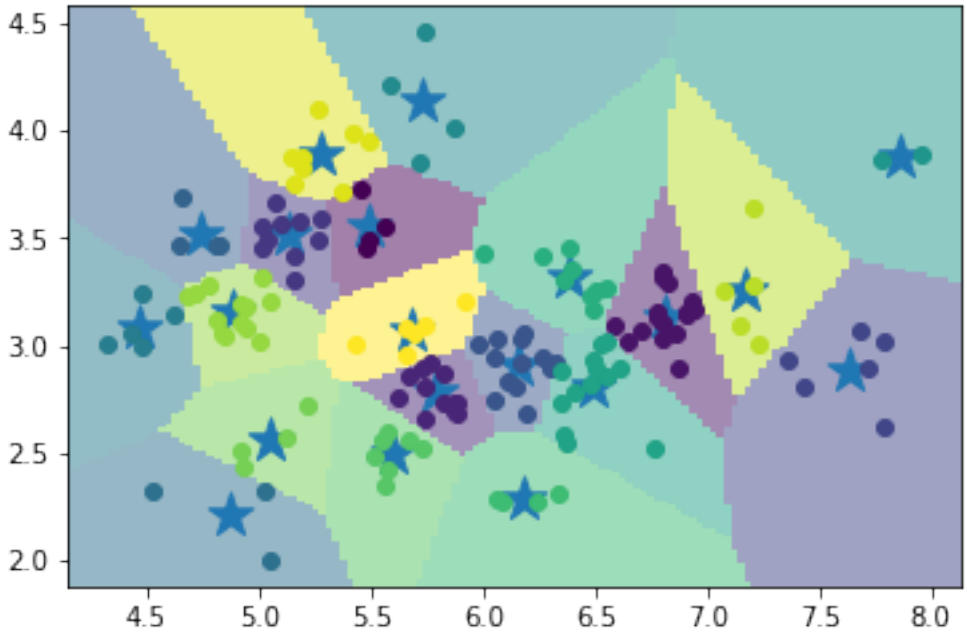
```
188.623784448
```



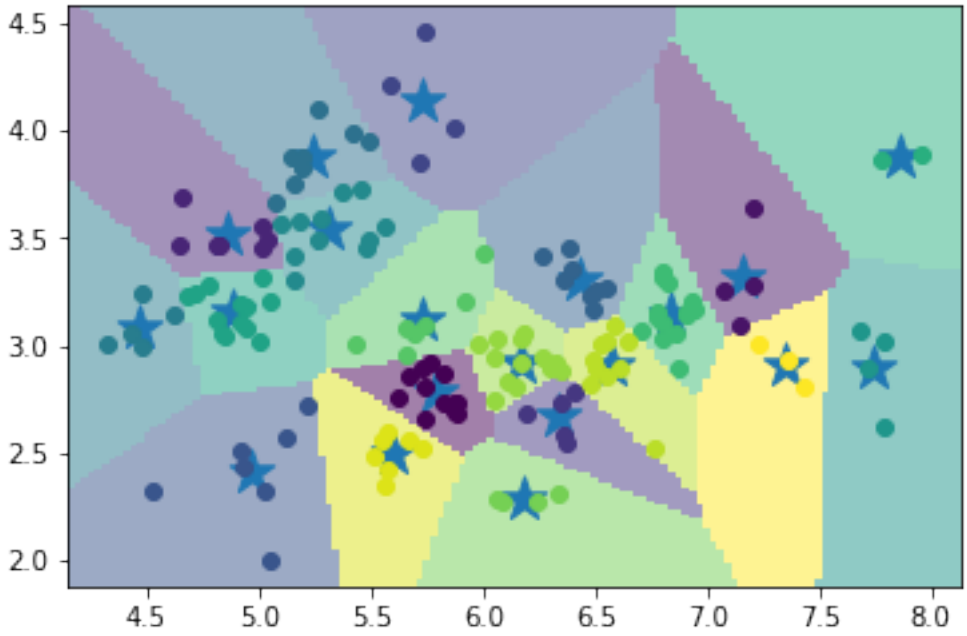

```
188.414685651
```



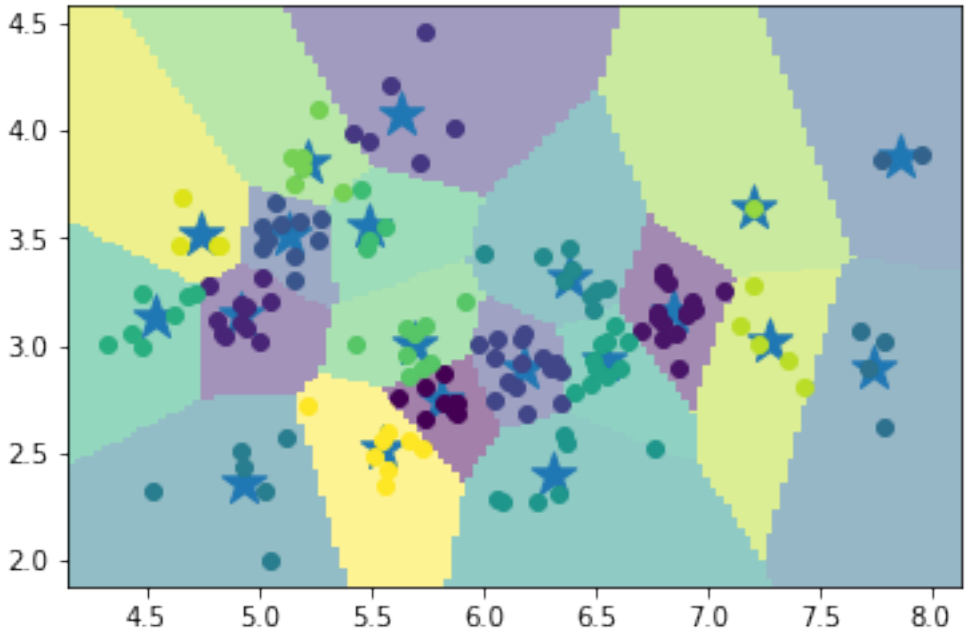
215.827104205



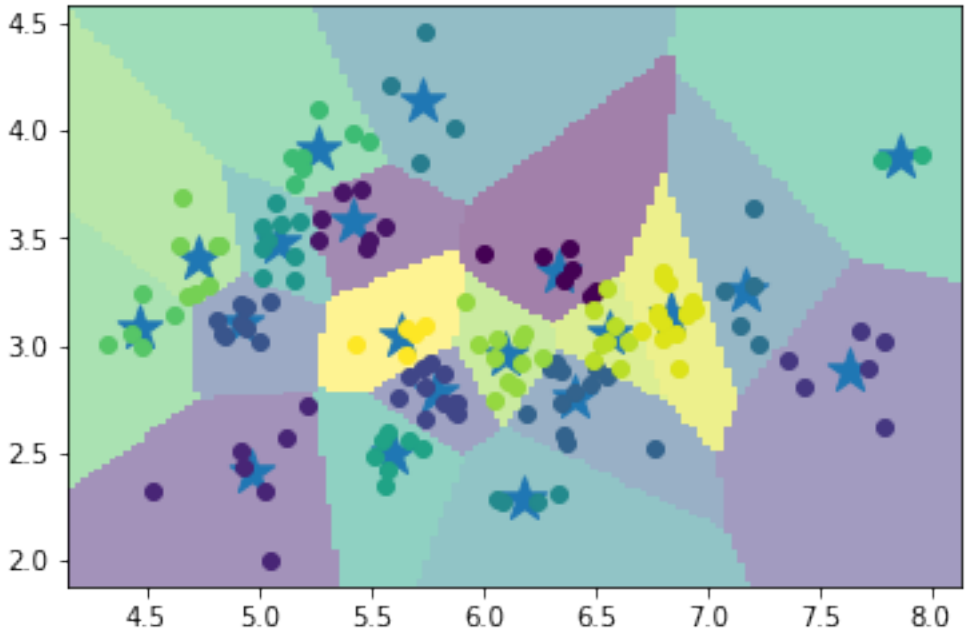
206.717885089



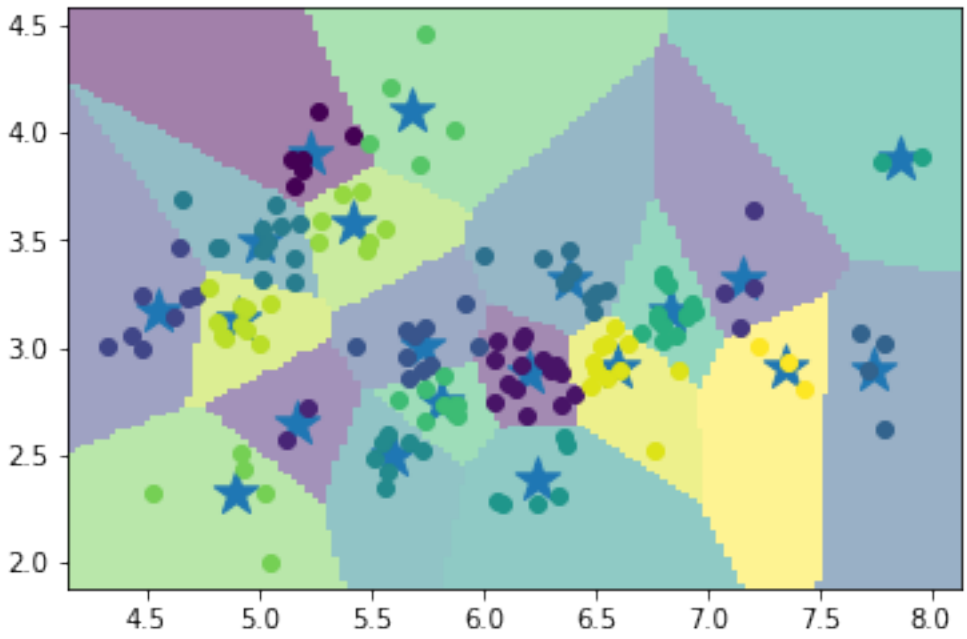
```
208.735690755
```




```
213.968664205
```



```
207.900593379
```



From the graphs and scores above we can see that when K=2, all scores are the same, but when K=5 and K=20, the performance depends on the initialization.

When K=5, graphs with score=188.623784448 is the best. When K=20, the one with score=215.827104205 is the best.

1.3

```
In [11]: from sklearn.cluster import KMeans
         import numpy as np
         import matplotlib.pyplot as plt
         import mltools as ml
         iris = np.genfromtxt("data/iris.txt",delimiter=None) # load the text file
         X= iris[:,0:2] # target value is the last column
         kcollec=[2,5,20]
         for i in kcollec:
             z,_=ml.cluster.agglomerative(X,i,method='min')
             ml.plotClassify2D(None, X, z)
             print("single linkage k=",i)
             plt.show()
         for i in kcollec:
             z,_=ml.cluster.agglomerative(X,i,method='max')
```

```
            ml.plotClassify2D(None, X, z)
            print("complete linkage k=",i)
            plt.show()
```

```
single linkage k= 2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    Future behavior will be consistent with the long-time default:
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    Axes and/or Figure.
  axis.axis(ax); axis.hold(hld)
```
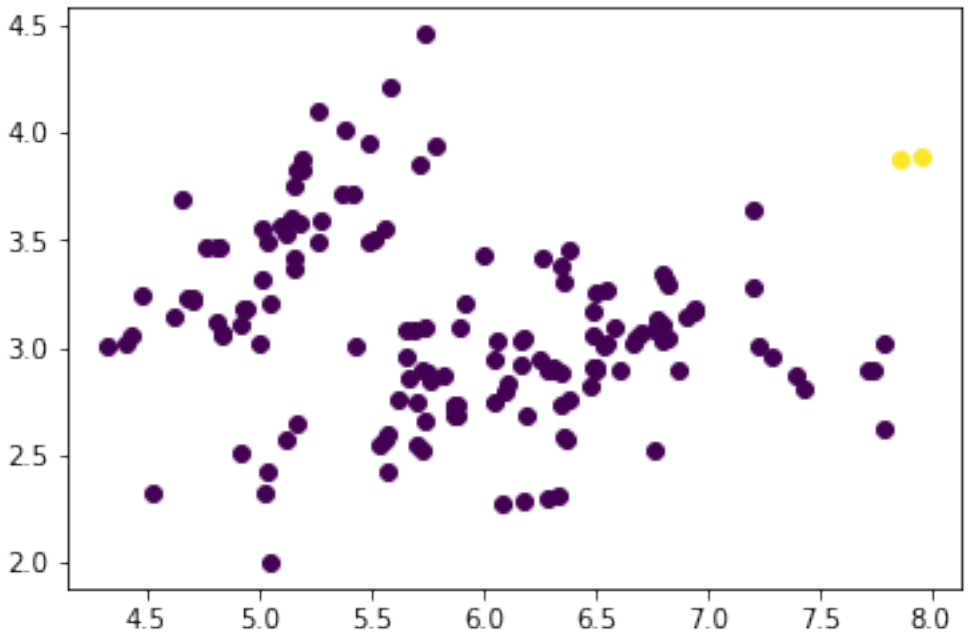
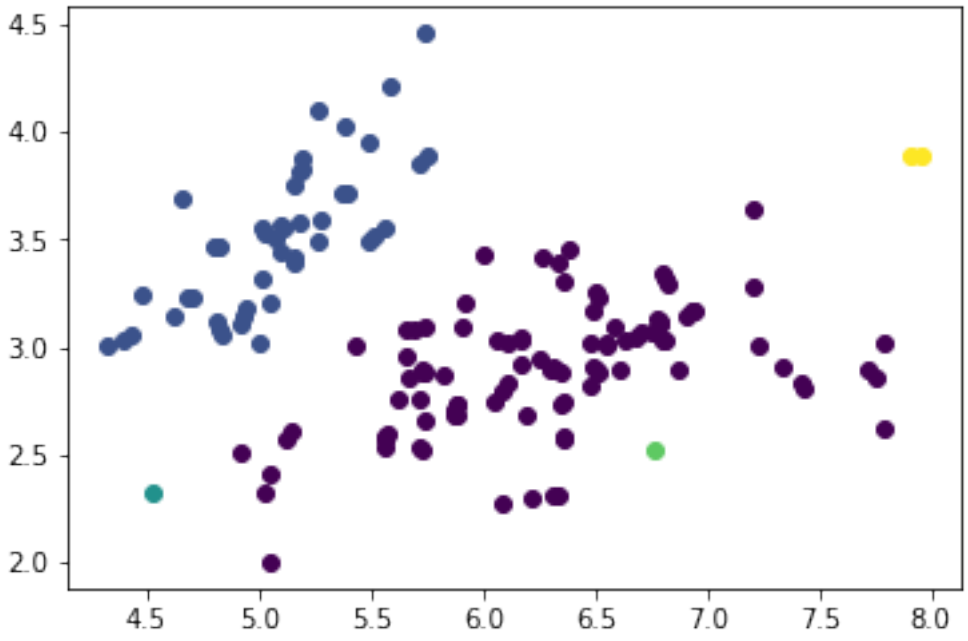
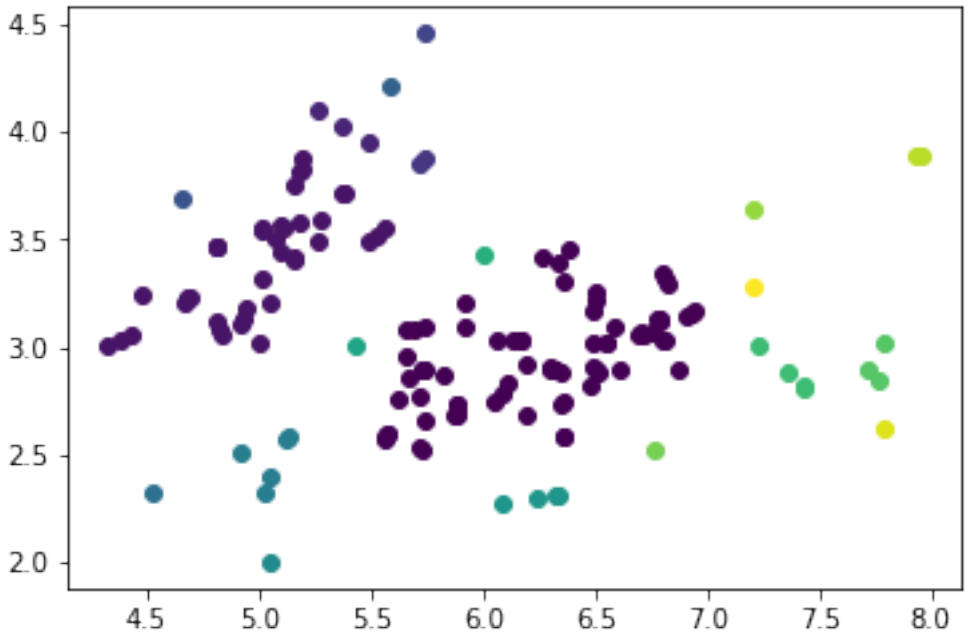



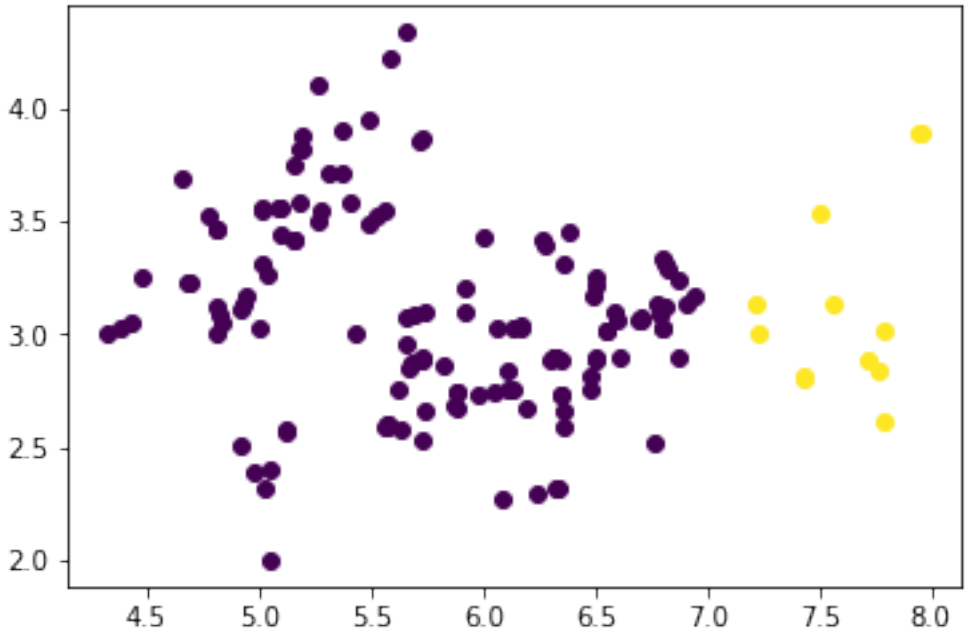
single linkage k= 5



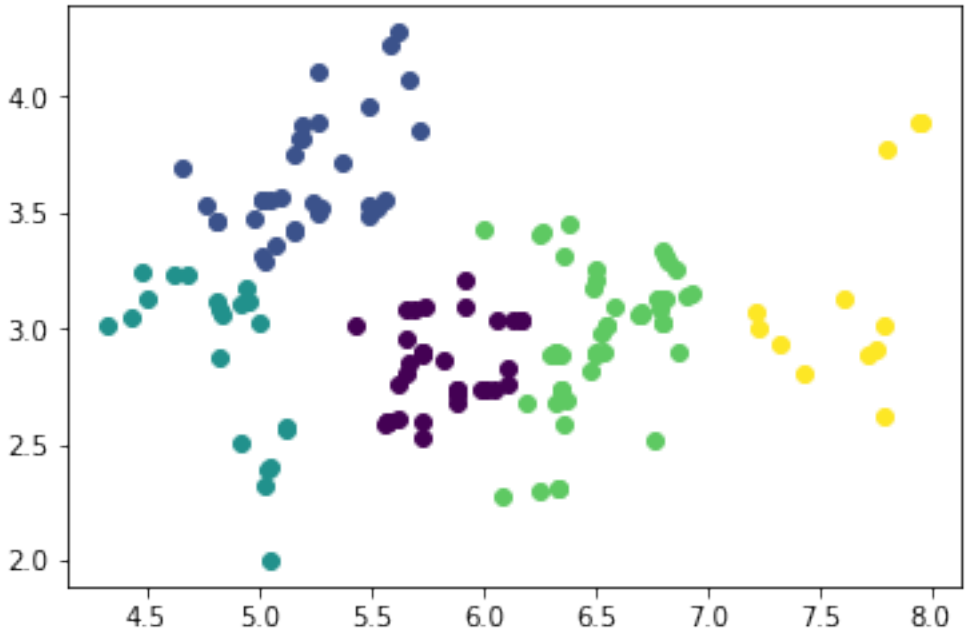
single linkage k= 20



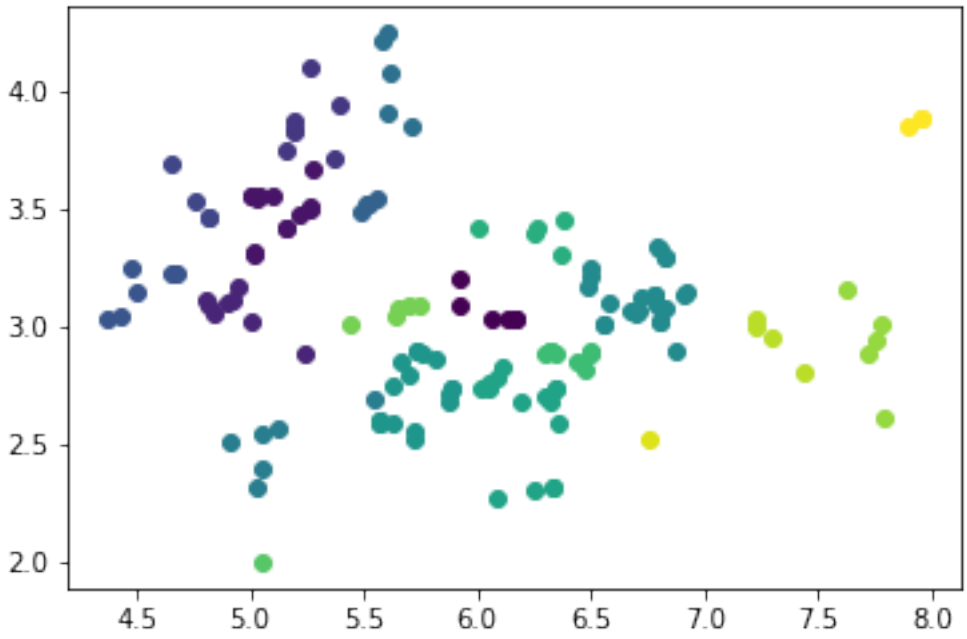
complete linkage k= 2



complete linkage k= 5



```
complete linkage k= 20
```



1.4

Both Kmeans and agglomerative clustering use the calculation of distance as a measure for clustering.

But Kmeans depends on the initialization, different initializations may have different scores, so if you

only use one initialization, it may not be the best. While agglomerative does not have initialization issue.

Also agglomerative clustering has complete linkage which considers all the data in the clustering, this makes

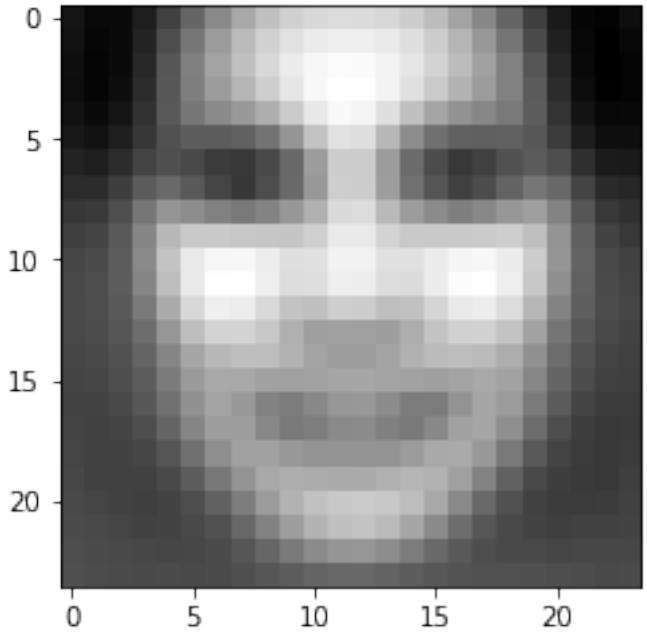
it more precise(At least from the result above).

2 Problem 2

2.1

```
In [2]: from sklearn.cluster import KMeans
        import numpy as np
        import matplotlib.pyplot as plt
        import mltools as ml
```

```
X = np.genfromtxt("data/faces.txt", delimiter=None) # load face dataset
plt.figure()
# pick a data point i for display
u=[]
for i in range(576):
    u.append(np.mean(X[:,i]))
X0=X-u
img = np.reshape(u,(24,24)) # convert vectorized data to 24x24 image patches
plt.imshow( img.T , cmap="gray")
plt.show()
```



2.2

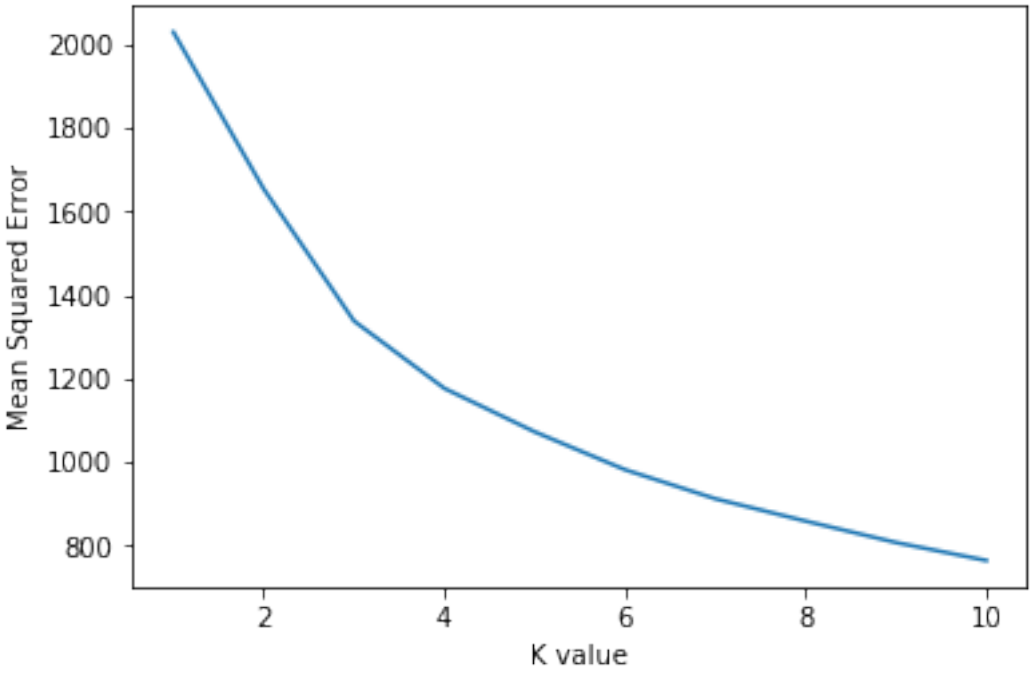
```
In [3]: from scipy.linalg import svd
        U, s, V = svd(X0, full_matrices=False)
        W = np.dot(U, np.diag(s))
        print(W.shape)
        print(V.shape)
```

```
(4916, 576)
(576, 576)
```

2.3

```
In [10]: kcollect=[1,2,3,4,5,6,7,8,9,10]
         result=[]
```

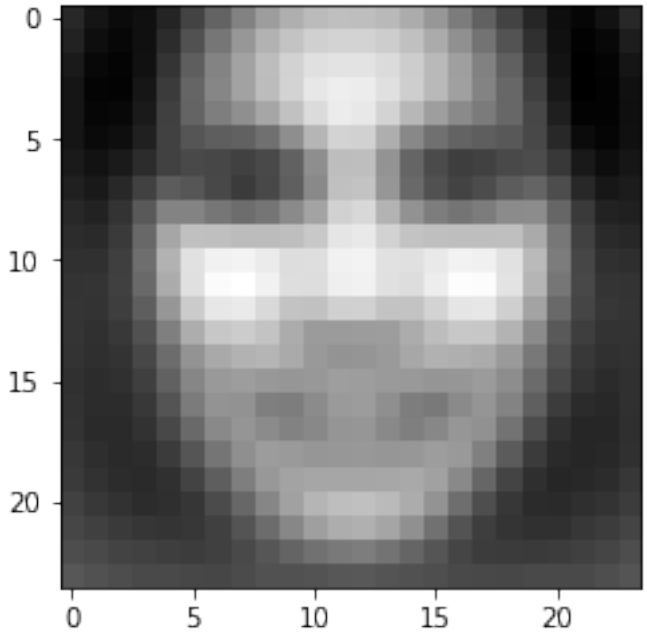
```
for k in kcollect:
    Xp=(np.dot(W[:,:k],V[:k,:]))
    result.append(np.mean( (X0-Xp)**2 ))
plt.plot(kcollect,result)
plt.xlabel('K value')
plt.ylabel('Mean Squared Error')
plt.show()
```

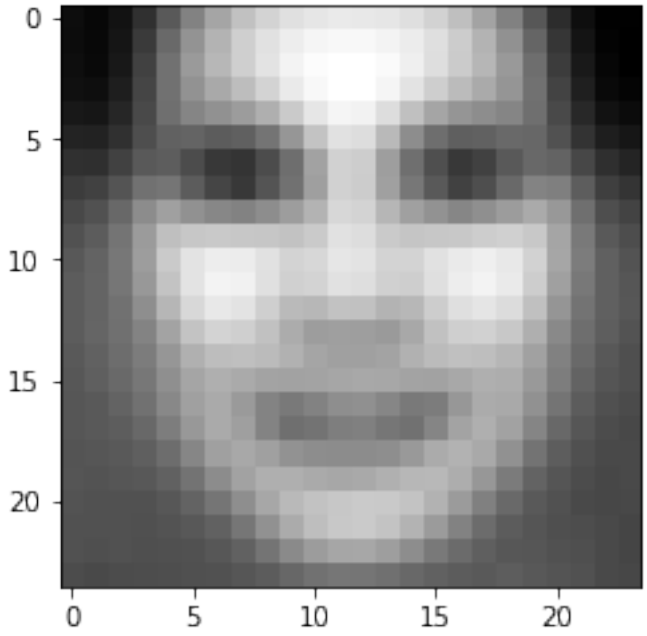


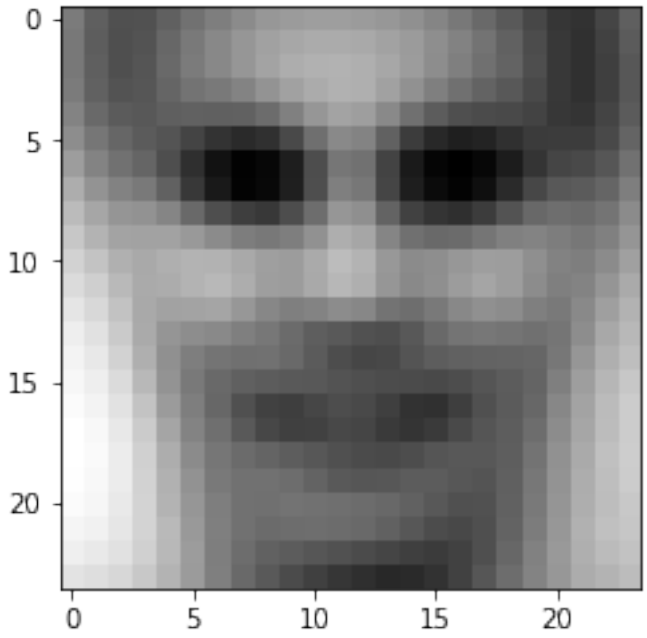
2.4

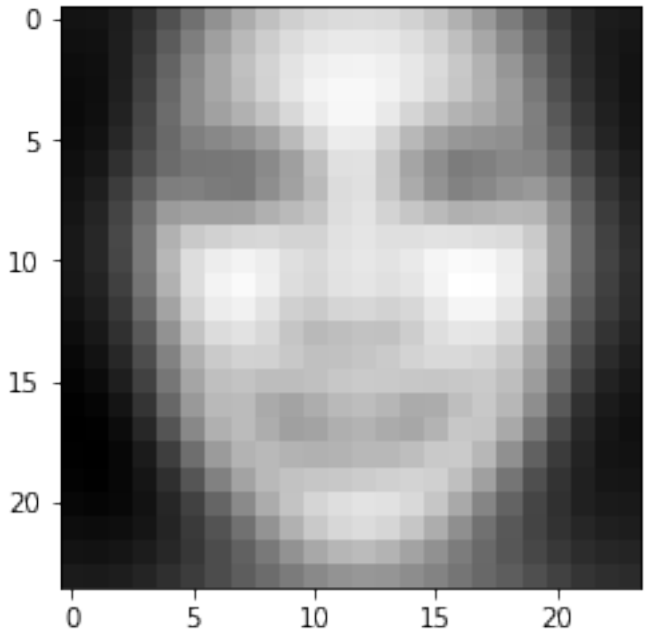
```
In [8]: from sklearn.cluster import KMeans
        import numpy as np
        import matplotlib.pyplot as plt
        import mltools as ml
        from scipy.linalg import svd
        X = np.genfromtxt("data/faces.txt", delimiter=None)
        u=[]
        for i in range(576):
            u.append(np.mean(X[:,i]))
        X0=X-u
        U, s, V = svd(X0, full_matrices=False)
        W = np.dot(U, np.diag(s))
        for j in range(3):
            alpha=2* np.median(np.abs(W[:,j]))
```

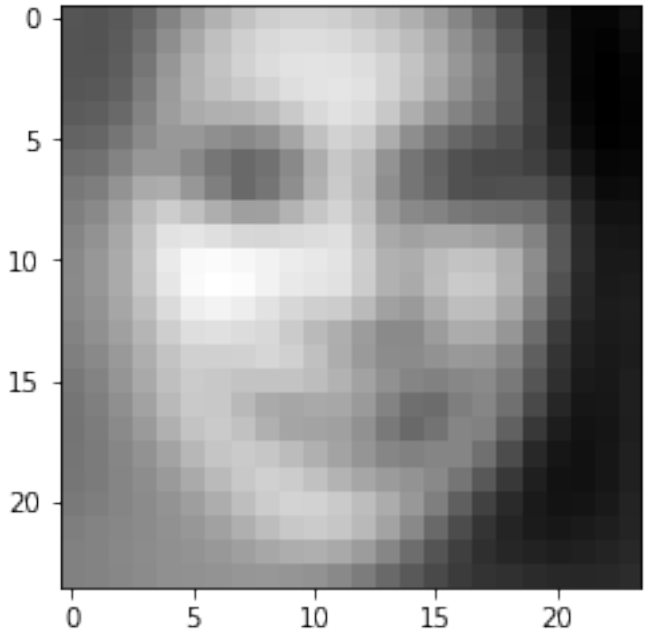
```
img = np.reshape(u+np.dot(alpha,V[j,:]),(24,24)) # convert vectorized data to 24x2
plt.imshow( img.T , cmap="gray")
plt.show()
img = np.reshape(u-np.dot(alpha,V[j,:]),(24,24)) # convert vectorized data to 24x2
plt.imshow( img.T , cmap="gray")
plt.show()
```

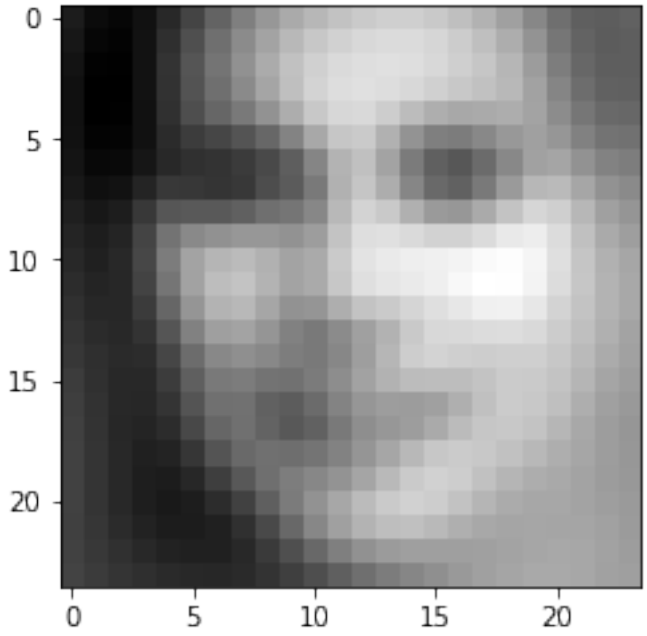





0
5
10
15
20
0
5
10
15
20


0
5
10
15
20
0
5
10
15
20

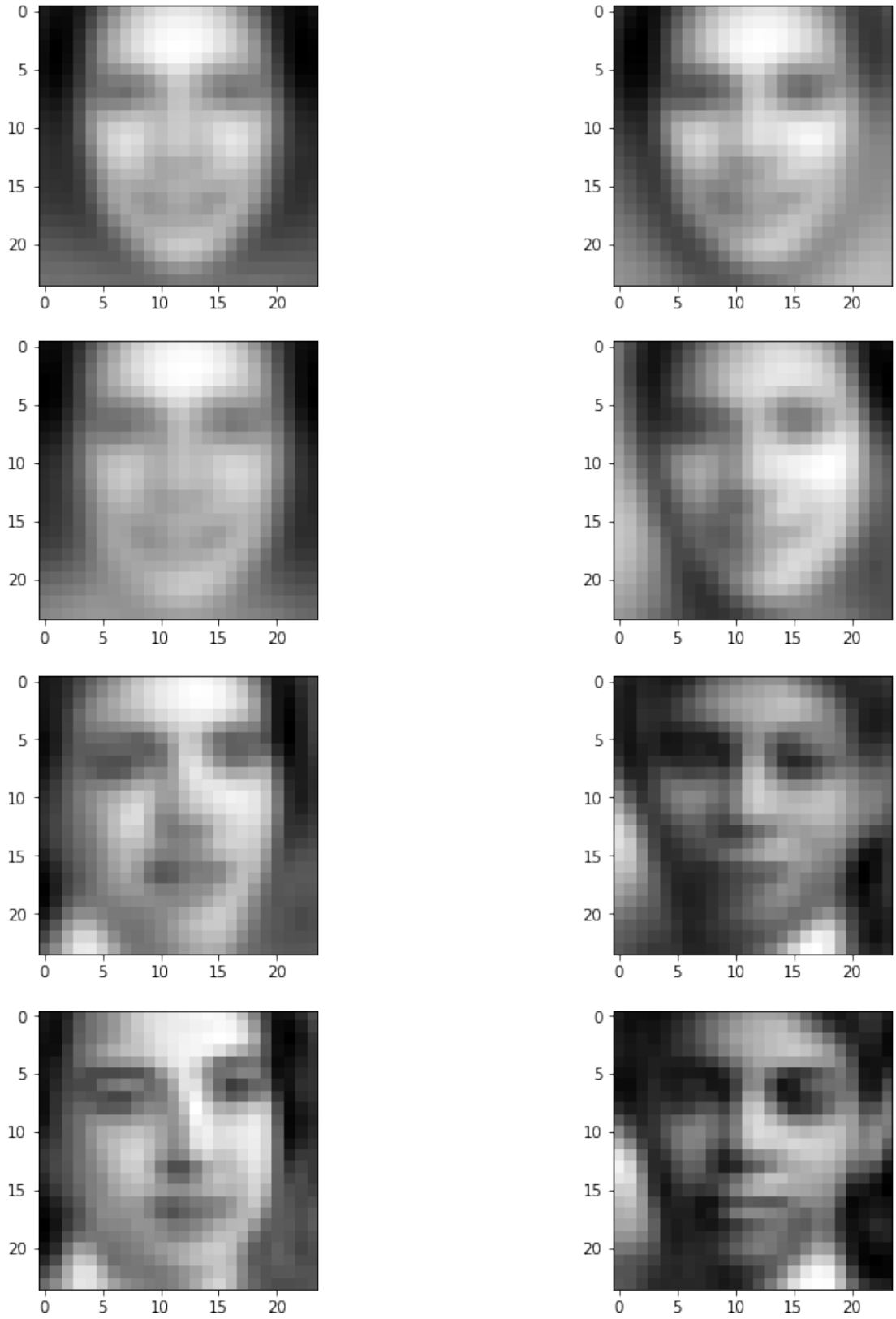




2.5

```
In [34]: from sklearn.cluster import KMeans
         import numpy as np
```

```
import matplotlib.pyplot as plt
import mltools as ml
from scipy.linalg import svd
X = np.genfromtxt("data/faces.txt", delimiter=None)
u=[]
kcollection=[5,10,50,100]
for i in range(576):
    u.append(np.mean(X[:,i]))
X0=X-u
U, s, V = svd(X0, full_matrices=False)
W = np.dot(U, np.diag(s))

f, ax = plt.subplots(4, 2, figsize=(12, 15))
idx=[2,5]
count=0
for p in range(len(kcollection)):
    for j in range(len(idx)):
        k=kcollection[p]
        i = idx[j]
        img = np.dot(W[i,:k], V[:k]) + u  # DON'T FORGET TO ADD THE MU
        img = np.reshape(img,(24,24))  # reshape flattened data into a 24*24 patch
    # We've seen the imshow method in the previous discussion :)
        ax[p][j].imshow( img.T , cmap="gray")
plt.show()
```


0
5
10
15
20

2.6

```
In [1]: import mltools.transforms
        from sklearn.cluster import KMeans
        import numpy as np
        import matplotlib.pyplot as plt
        import mltools as ml
        from scipy.linalg import svd
        X = np.genfromtxt("data/faces.txt", delimiter=None)
        u=[]
        for i in range(576):
            u.append(np.mean(X[:,i]))
        X0=X-u
        U, s, V = svd(X0, full_matrices=False)
        W = np.dot(U, np.diag(s))
        idx = [1,2,3,4,5,7,9,11,20,25,30]# pick some data (randomly or otherwise); an array of

        coord,params = ml.transforms.rescale( W[:,0:2] ) # normalize scale of "W" locations
        plt.figure(); plt.hold(True); # you may need this for pyplot
        for i in idx:
        # compute where to place image (scaled W values) & size
            loc = (coord[i,0],coord[i,0]+0.5, coord[i,1],coord[i,1]+0.5)
            img = np.reshape( X[i,:], (24,24) ) # reshape to square
            plt.imshow( img.T , cmap="gray", extent=loc ) # draw each image
            plt.axis( (-2,2,-2,2) ) # set axis to a reasonable scale
        plt.show()
```

```
E:\Anaconda3\lib\site-packages\ipykernel_launcher.py:17: MatplotlibDeprecationWarning: pyplot.h
    Future behavior will be consistent with the long-time default:
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E:\Anaconda3\lib\site-packages\matplotlib\__init__.py:917: UserWarning: axes.hold is deprecated
  warnings.warn(self.msg_depr_set % key)
E:\Anaconda3\lib\site-packages\matplotlib\rcsetup.py:152: UserWarning: axes.hold is deprecated
  warnings.warn("axes.hold is deprecated, will be removed in 3.0")
```

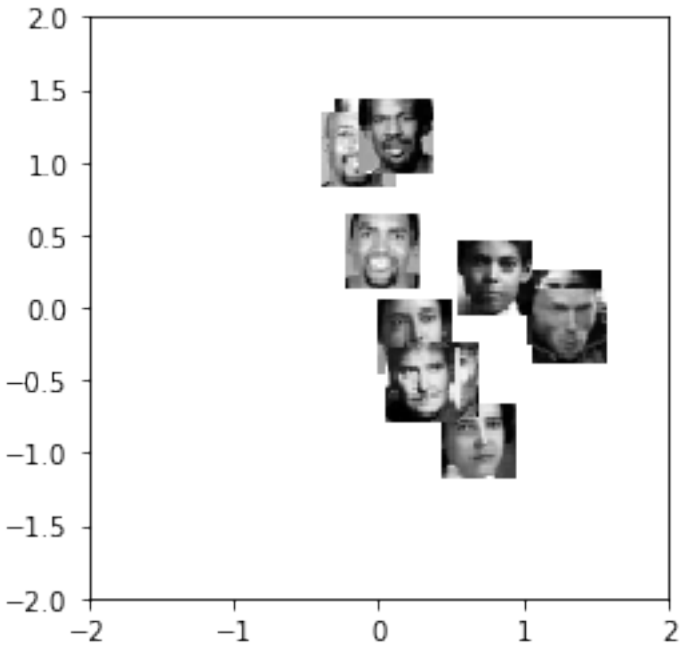

3 Statement of Collaboration

```
In [ ]: No disscussion with others.
```