CSE 4020 Machine Learning
Lab Assessment - 4

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https://github.com/sujaykumarmag/CSE4020

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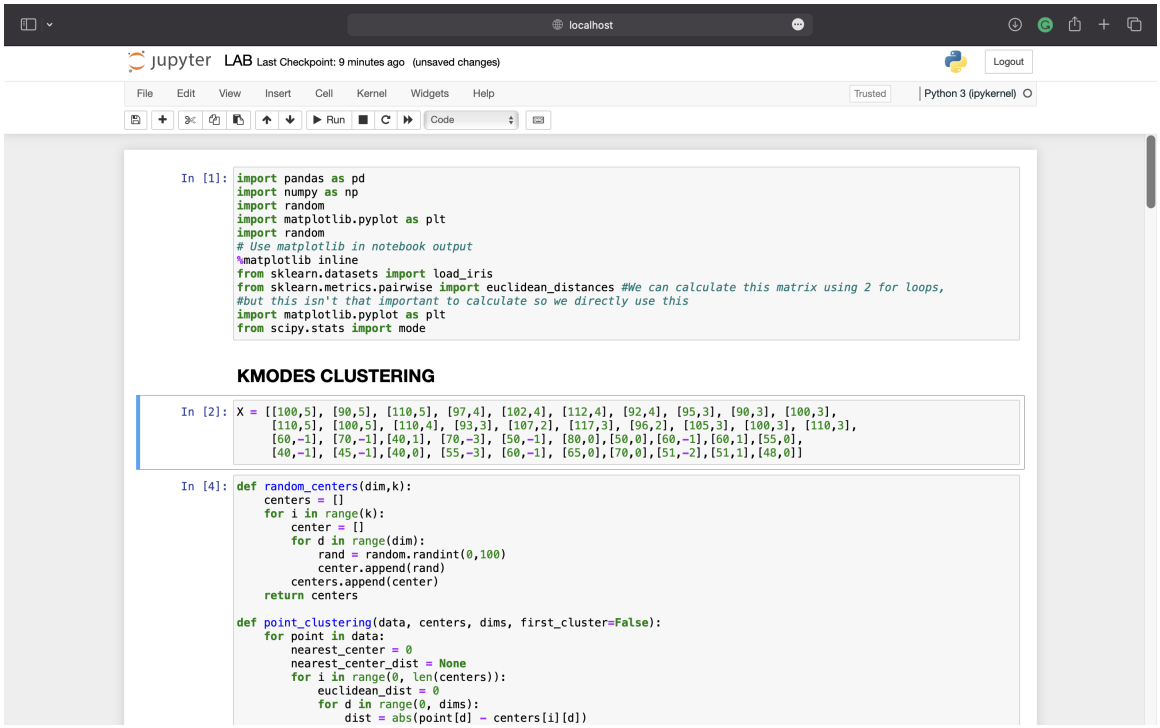
1 Imports

```
import pandas as pd
import numpy as np
import random
import matplotlib.pyplot as plt
import random
# Use matplotlib in notebook output
%matplotlib inline
from sklearn.datasets import load_iris
from sklearn.metrics.pairwise import euclidean_distances #We can calculate this matrix
  using 2 for loops,
#but this isn't that important to calculate so we directly use this
import matplotlib.pyplot as plt
from scipy.stats import mode
```

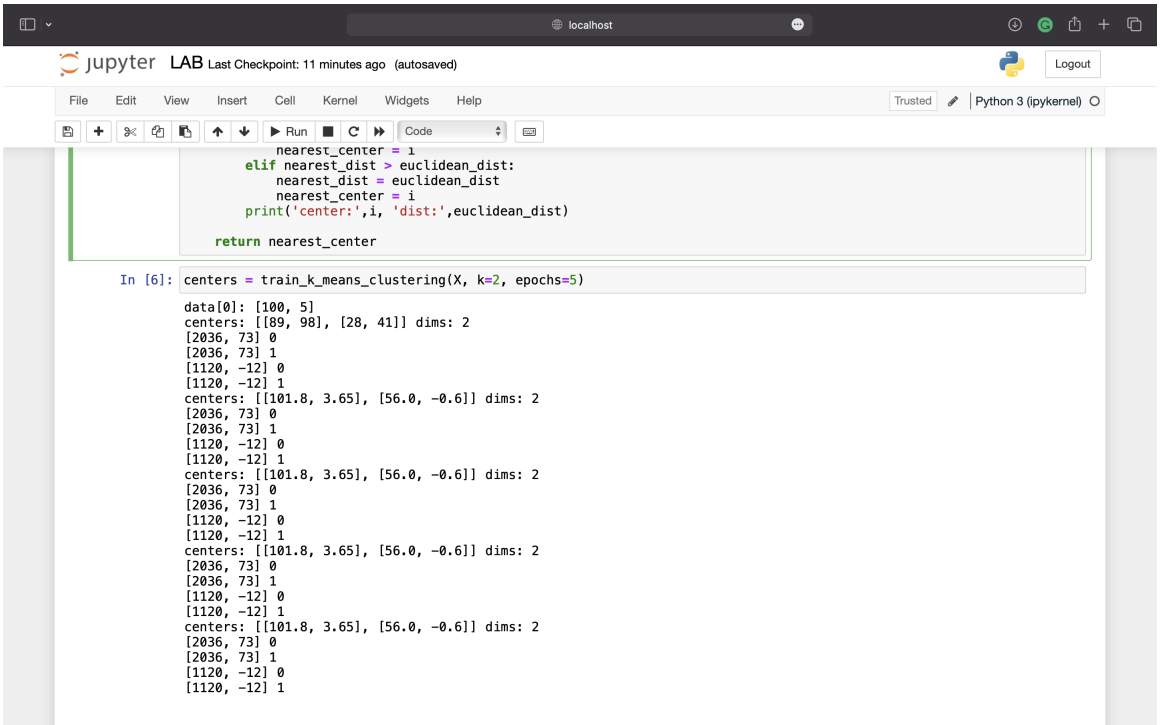


2 KModes Clustering

2.1 Input - a 2D array

```
def random_centers(dim,k):
centers = []
for i in range(k):
center = []
for d in range(dim):
rand = random.randint(0,100)
center.append(rand)
centers.append(center)
return centers

def point_clustering(data, centers, dims, first_cluster=False):
for point in data:
nearest_center = 0
nearest_center_dist = None
for i in range(0, len(centers)):
euclidean_dist = 0
for d in range(0, dims):
dist = abs(point[d] - centers[i][d])
euclidean_dist += dist
euclidean_dist = np.sqrt(euclidean_dist)
if nearest_center_dist == None:
nearest_center_dist = euclidean_dist
nearest_center = i
elif nearest_center_dist > euclidean_dist:
nearest_center_dist = euclidean_dist
nearest_center = i
if first_cluster:
point.append(nearest_center)
else:
point[-1] = nearest_center
return data

def mean_center(data, centers, dims):
print('centers:', centers, 'dims:', dims)
new_centers = []
for i in range(len(centers)):
new_center = []
n_of_points = 0
total_of_points = []
for point in data:
if point[-1] == i:
n_of_points += 1
for dim in range(0,dims):
if dim < len(total_of_points):
total_of_points[dim] += point[dim]
else:
total_of_points.append(point[dim])
if len(total_of_points) != 0:
for dim in range(0,dims):
print(total_of_points, dim)
new_center.append(total_of_points[dim]/n_of_points)
new_centers.append(new_center)
else:
new_centers.append(centers[i])


return new_centers

# Gets data and k, returns a list of center points.
def train_k_means_clustering(data, k=2, epochs=5):
dims = len(data[0])
print('data[0]:',data[0])
centers = random_centers(dims,k)

clustered_data = point_clustering(data, centers, dims, first_cluster=True)

for i in range(epochs):
centers = mean_center(clustered_data, centers, dims)
clustered_data = point_clustering(data, centers, dims, first_cluster=False)

return centers

def predict_k_means_clustering(point, centers):
```

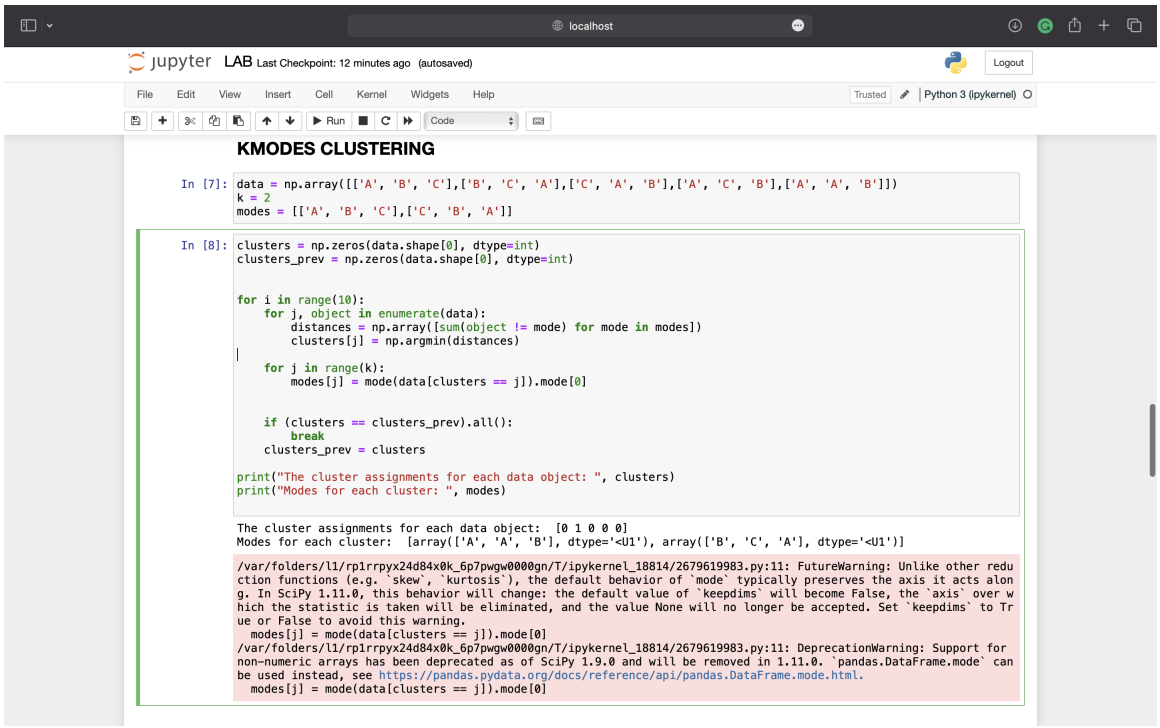
```
dims = len(point)
center_dims = len(centers[0])

if dims != center_dims:
raise ValueError('Point given for prediction have', dims, 'dimensions but centers have'
  , center_dims, 'dimensions')

nearest_center = None
nearest_dist = None

for i in range(len(centers)):
euclidean_dist = 0
for dim in range(1, dims):
dist = point[dim] - centers[i][dim]
euclidean_dist += dist**2
euclidean_dist = np.sqrt(euclidean_dist)
if nearest_dist == None:
nearest_dist = euclidean_dist
nearest_center = i
elif nearest_dist > euclidean_dist:
nearest_dist = euclidean_dist
nearest_center = i
print('center:',i, 'dist:',euclidean_dist)

return nearest_center
```



3 KModes Clustering

```
clusters = np.zeros(data.shape[0], dtype=int)
clusters_prev = np.zeros(data.shape[0], dtype=int)


for i in range(10):
for j, object in enumerate(data):
distances = np.array([sum(object != mode) for mode in modes])
clusters[j] = np.argmin(distances)

for j in range(k):
modes[j] = mode(data[clusters == j]).mode[0]


if (clusters == clusters_prev).all():
```

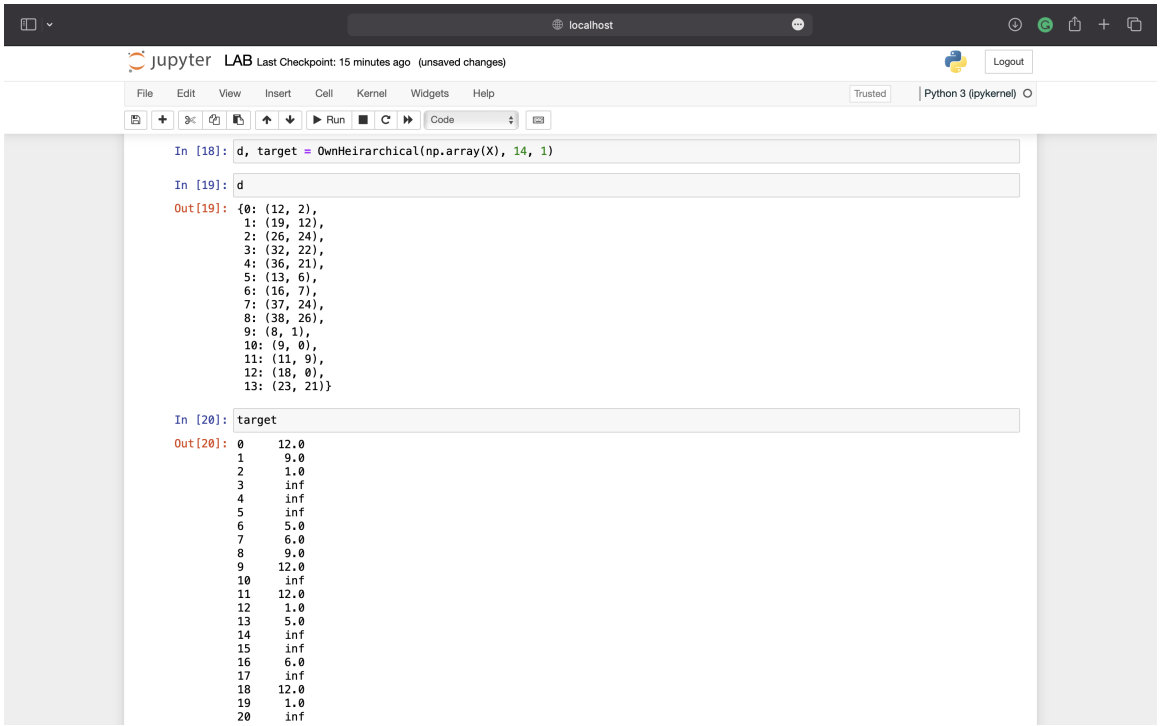
```
    break
    clusters_prev = clusters

    print("The cluster assignments for each data object: ", clusters)
    print("Modes for each cluster: ", modes)

```

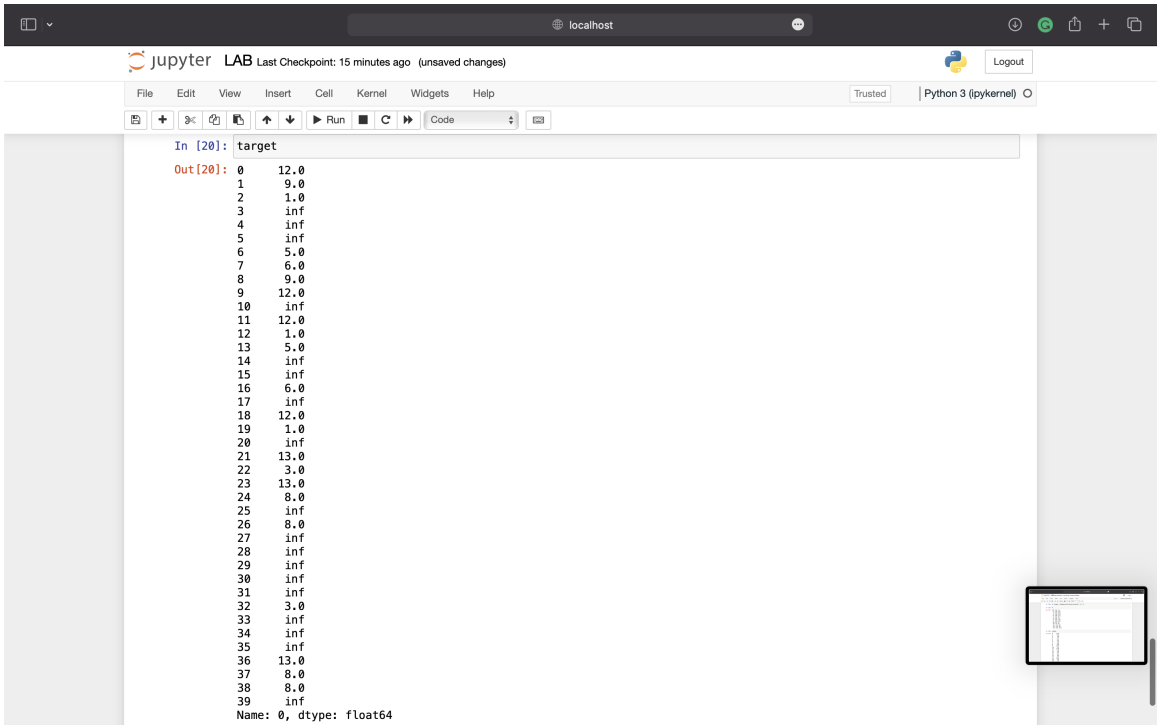


4 Heirarchial Clustering

```
def OwnHeirarchical(data, cutoff, linkage):
#This is done using dynamic programming approach
# if 1, it is single linkage else 2 is complete linkage, 3 is average linkage
distance_matrix = euclidean_distances(data, data)
distance_matrix = np.tril(distance_matrix)
distance_matrix[distance_matrix == 0] = np.inf #Step 3 - Replace 0 by inf, it makes it easy for us to extract minimum using min function
df = pd.DataFrame(data=np.ones(data.shape[0])*np.inf) #Initialized a dataframe which will store which point is in which cluster
if cutoff > distance_matrix.shape[0]: #If user provides impractical cut-off, cluster everthing into one cluster and not listen to user
cutoff = distance_matrix.shape[0]
if linkage == 1: #This 1 means formula of single linkage will be used, it is explained ahead
d = {} #This dictionary keeps record of which data points or cluster are merging, hence can be used to make a dendogram
for i in range(0,cutoff):
ij_min = np.unravel_index(distance_matrix.argmin(), distance_matrix.shape) #from the distance matrix, get the minimum distance
#np.unravel_index gives us the position of minimum distance. e.g. (0,4) is where minimum value is present in matrix.
#This is what we need as in Hierarchical clustering, we merge the two pairs with minimum distance
if i == 0:
df.iloc[ij_min[0]] = 0
df.iloc[ij_min[1]] = 0
else:
try:
a = int(df.iloc[ij_min[0]])
except:
df.iloc[ij_min[0]] = i
a = i
try:
```

```
    b = int(df.iloc[ij_min[1]])
    except:
    df.iloc[ij_min[1]] = i
    b = i
    df[(df[0]==a) | (df[0]==b)] = i
    d[i] = ij_min

    for j in range(0, ij_min[0]):

    if np.isfinite(distance_matrix[ij_min[0]][j]) and np.isfinite(distance_matrix[ij_min
      [1]][j]):

    distance_matrix[ij_min[1]][j] = min(distance_matrix[ij_min[0]][j], distance_matrix[
      ij_min[1]][j])

    distance_matrix[ij_min[0]] = np.inf
    return d, df[0]
    elif linkage == 2:
    d_complete = {}
    for i in range(0,cutoff):
    ij_min = np.unravel_index(distance_matrix.argmin(), distance_matrix.shape)
    if i == 0:
    df.iloc[ij_min[0]] = 0
    df.iloc[ij_min[1]] = 0
    else:
    try:
    a = int(df.iloc[ij_min[0]])
    except:
    df.iloc[ij_min[0]] = i
    a = i
    try:
    b = int(df.iloc[ij_min[1]])
    except:
    df.iloc[ij_min[1]] = i
    b = i
    df[(df[0]==a) | (df[0]==b)] = i
    d_complete[i] = ij_min
    for j in range(0, ij_min[0]):
    if np.isfinite(distance_matrix[ij_min[0]][j]) and np.isfinite(distance_matrix[ij_min
      [1]][j]):

    distance_matrix[ij_min[1]][j] = max(distance_matrix[ij_min[0]][j], distance_matrix[
      ij_min[1]][j])
    distance_matrix[ij_min[0]] = np.inf
    return d_complete, df[0]
    elif linkage == 3:
    d_average = {}
    for i in range(0,cutoff):
    ij_min = np.unravel_index(distance_matrix.argmin(), distance_matrix.shape)
    if i == 0:
    df.iloc[ij_min[0]] = 0
    df.iloc[ij_min[1]] = 0
    else:
    try:
    a = int(df.iloc[ij_min[0]])
    except:
    df.iloc[ij_min[0]] = i
    a = i
    try:
    b = int(df.iloc[ij_min[1]])
    except:
    df.iloc[ij_min[1]] = i
    b = i
    df[(df[0]==a) | (df[0]==b)] = i
    d_average[i] = ij_min
    for j in range(0, ij_min[0]):
    if np.isfinite(distance_matrix[ij_min[0]][j]) and np.isfinite(distance_matrix[ij_min
      [1]][j]):

    distance_matrix[ij_min[1]][j] = (distance_matrix[ij_min[0]][j] + distance_matrix[ij_min
      [1]][j])/2.0
    distance_matrix[ij_min[0]] = np.inf
    return d_average, df[0]
```


localhost
jupyter LAB Last Checkpoint: 15 minutes ago (unsaved changes)
Logout
File Edit View Insert Cell Kernel Widgets Help
Trusted
Python 3 (ipykernel)
Run
Code
In [18]: d, target = OwnHeirarchical(np.array(X), 14, 1)
In [19]: d
Out[19]: {0: (12, 2),
1: (19, 12),
2: (26, 24),
3: (32, 22),
4: (36, 21),
5: (13, 6),
6: (16, 7),
7: (37, 24),
8: (38, 26),
9: (8, 1),
10: (9, 0),
11: (11, 9),
12: (18, 0),
13: (23, 21)}
In [20]: target
Out[20]: 0 12.0
1 9.0
2 1.0
3 inf
4 inf
5 inf
6 5.0
7 6.0
8 9.0
9 12.0
10 inf
11 12.0
12 1.0
13 5.0
14 inf
15 inf
16 6.0
17 inf
18 12.0
19 1.0
20 inf


localhost
jupyter LAB Last Checkpoint: 15 minutes ago (unsaved changes)
Logout
File Edit View Insert Cell Kernel Widgets Help
Trusted
Python 3 (ipykernel)
Run
Code
In [20]: target
Out[20]: 0 12.0
1 9.0
2 1.0
3 inf
4 inf
5 inf
6 5.0
7 6.0
8 9.0
9 12.0
10 inf
11 12.0
12 1.0
13 5.0
14 inf
15 inf
16 6.0
17 inf
18 12.0
19 1.0
20 inf
21 13.0
22 3.0
23 13.0
24 8.0
25 inf
26 8.0
27 inf
28 inf
29 inf
30 inf
31 inf
32 3.0
33 inf
34 inf
35 inf
36 13.0
37 8.0
38 8.0
39 inf
Name: 0, dtype: float64