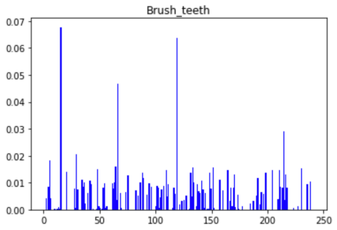
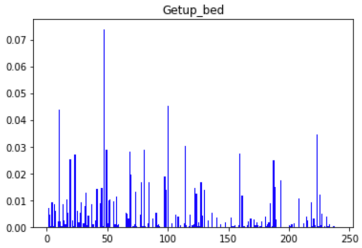
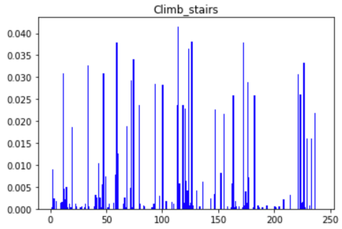
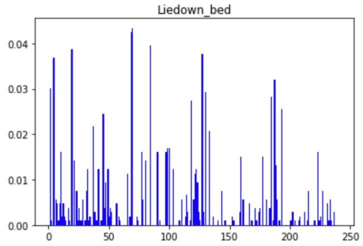
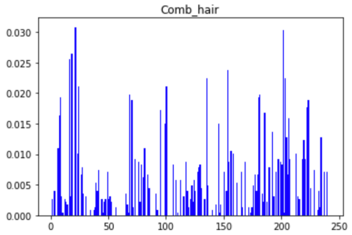
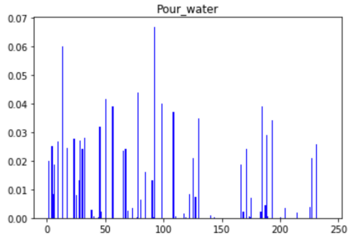
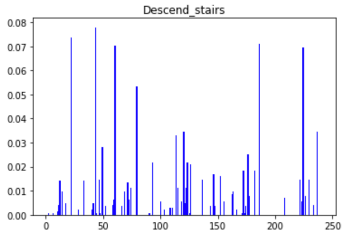
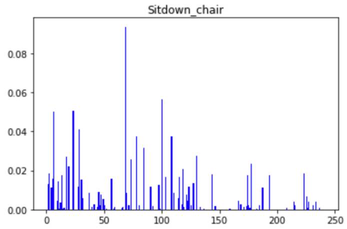
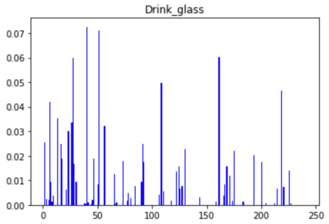
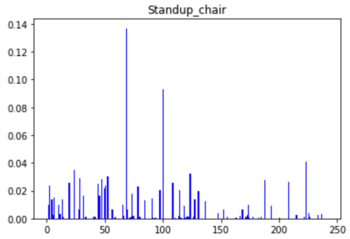
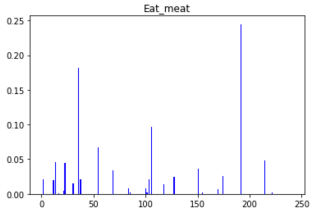
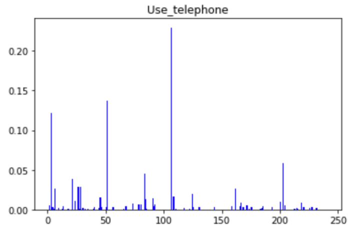
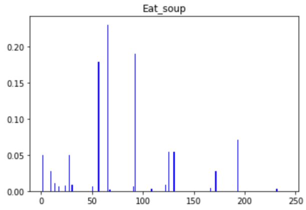
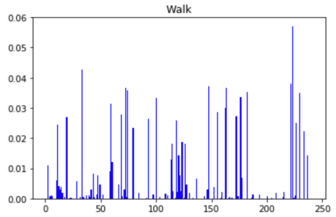
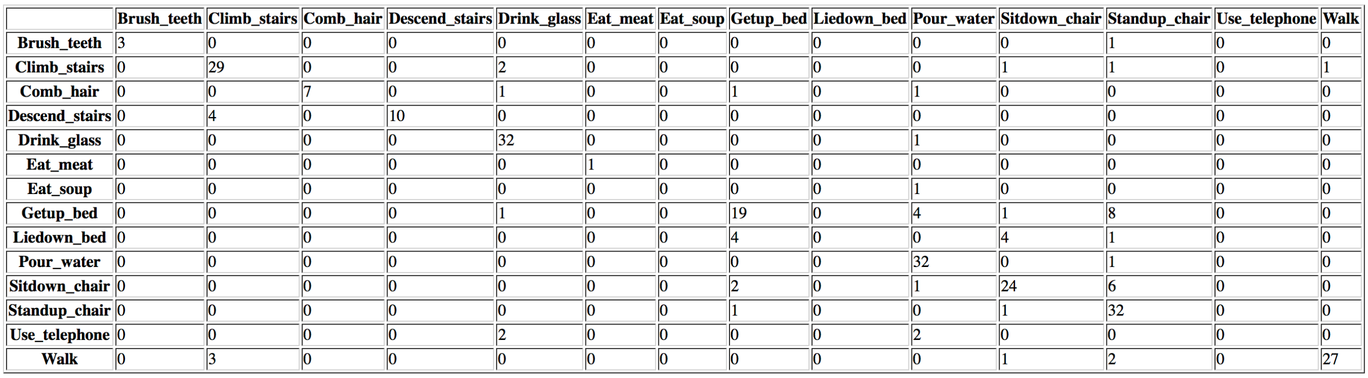
1 Experiment Table

Fixed Sample Length	Overlap %	K-Value (Number of Cluster Centres)	Classifier Accuracy
16	0%	240	72.68
16	50%	240	78.55
16	70%	240	79.96
16	0%	480	73.79
16	50%	480	77.22
16	70%	480	79.75
16	0%	780	69.16
16	50%	780	77.37
16	70%	780	77.23
32	0%	240	71.06
32	50%	240	74.97
32	70%	240	**80.81**
32	0%	480	66.86
32	50%	480	74.15
32	70%	480	78.42
32	0%	780	65.20
32	50%	780	72.94
32	70%	780	76.39
64	0%	240	66.76
64	50%	240	75.34
64	70%	240	76.40
64	0%	480	62.92
64	50%	480	71.29
64	70%	480	77.71
64	0%	780	62.45
64	50%	780	68.42
64	70%	780	75.21

2 Histogram

Brush Teeth		Get Up Bed	
Climb Stairs		Lie Down Bed	
Comb Hair		Pour Water	
Descend Stairs		Sit down Chair	
Drink Glass		Stand Up Chair	
Eat Meat		Use Telephone	
Eat Soup		Walk	

3 Confusion Matrix



	Brush_teeth	Climb_stairs	Comb_hair	Descend_stairs	Drink_glass	Eat_meat	Eat_soup	Getup_bed	Liedown_bed	Pour_water	Sitdown_chair	Standup_chair	Use_telephone	Walk
Brush_teeth	3	0	0	0	0	0	0	0	0	0	0	1	0	0
Climb_stairs	0	29	0	0	2	0	0	0	0	0	1	1	0	1
Comb_hair	0	0	7	0	1	0	0	1	0	1	0	0	0	0
Descend_stairs	0	4	0	10	0	0	0	0	0	0	0	0	0	0
Drink_glass	0	0	0	0	32	0	0	0	0	1	0	0	0	0
Eat_meat	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Eat_soup	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Getup_bed	0	0	0	0	1	0	0	19	0	4	1	8	0	0
Liedown_bed	0	0	0	0	0	0	0	4	0	0	4	1	0	0
Pour_water	0	0	0	0	0	0	0	0	0	32	0	1	0	0
Sitdown_chair	0	0	0	0	0	0	0	2	0	1	24	6	0	0
Standup_chair	0	0	0	0	0	0	0	1	0	0	1	32	0	0
Use_telephone	0	0	0	0	2	0	0	0	0	2	0	0	0	0
Walk	0	3	0	0	0	0	0	0	0	0	1	2	0	27

4 Code Screen Shot

Segmentation of the Vector

```
start_idx = 0
end_idx = start_idx+segment_length
run_ind=True

while(run_ind):
   data_extract=data[start_idx:end_idx,:].flatten().reshape(1,segment_lengt
h*3).astype(int)
   data_append=np.append(data_extract,folder_file_extract).reshape(1,(segme
nt_length*3)+3)
   if (final_data.shape[1] > 0):
      final_data=np.vstack((final_data,data_append))
   else:
      final_data=np.vstack(data_append)
      start_idx += int(np.round(segment_length - ((segment_length)*(overlap
/100))))
      end_idx = int(np.round(start_idx+segment_length))
      if (end_idx > data.shape[0]):
          run_ind = False
   num_elements_per_file+=1
   num_elements_per_folder+=1
```

K-Means

```
kmeans_predict_all = np.array([[]])
    kmeans = KMeans(n_clusters=n_cluster).fit(final_data[:,0:segment_length
*3].astype(int))
for file_name in range(len(dir_filename)):
            i+=1
            folder_file_extract = [folder_name,folder[folder_name],dir_file
name[file_name]]
            extract_final_data=final_data[(final_data[:,3*segment_length+1]
== folder[folder_name]) & (final_data[:,3*segment_length+2] == dir_filename
[file_name])][:,0:3*segment_length]
            kmeans_predict=kmeans.predict(extract_final_data)
            a,b=np.histogram(kmeans_predict,np.arange(n_cluster+1)+1)
            a=a.reshape(1,n_cluster)
            a_append=np.append(a,folder_file_extract).reshape(1,n_cluster+3
)

            if (kmeans_predict_all.shape[1] > 0):
                kmeans_predict_all=np.vstack((kmeans_predict_all,a_append))
            else:
                kmeans_predict_all=np.vstack(a_append)
```

Generating the Histogram

```
def plot_histogram(Category,data,cluster_centers=480):
    data_mean = np.mean(data,axis=0)
    bin_probability = data_mean/float(data_mean.sum())
    b = np.arange(cluster_centers+1)+1
    bin_middles = (b[1:]+b[:-1])/2
    bin_width = b[1]-b[0]
    #plt.subplots(figsize=(12,8))
    plt.bar(bin_middles, bin_probability, width=bin_width,color='blue')
    plt.title(Category)
    plt.show()
```

Classification

```
def predict(trn_fold,tst_fold,cluster=480,no_tree=1000,max_depth=10):
    clf = RandomForestClassifier(n_estimators=no_tree,max_depth=max_depth)
    X=trn_fold[:,0:cluster]
    y=trn_fold[:,cluster]
    X_test=tst_fold[:,0:cluster]
    y_true=tst_fold[:,cluster]
    clf.fit(X,y)
    y_pred=clf.predict(X_test)
    conf_mat=confusion_matrix(y_true=y_true, y_pred=y_pred)
    return (np.sum(y_true == y_pred)/y_pred.shape[0])*100,conf_mat
```

5 Source Code Screen Shot

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from os import listdir
from os.path import isfile,join
from sklearn.cluster import KMeans
from sklearn.model_selection import KFold
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import confusion_matrix
import warnings
warnings.filterwarnings('ignore')
import math
%matplotlib inline


def load_dataset(foldername,filename):
    file = "data/HMP_Dataset/"+foldername+"/"+filename
    data = np.array(pd.read_csv(file,sep=' ',header=None,names=['X','Y','Z']))
    return data


def resize_data_by_factor(segment_length=32,overlap=0,print_Ind=False):
    final_data=np.array([[]])
    folder = ['Brush_teeth','Climb_stairs','Comb_hair','Descend_stairs','Drink_glass','Eat_meat','Eat_soup',
              'Getup_bed','Liedown_bed','Pour_water','Sitdown_chair','Standup_chair','Use_telephone','Walk']
    for folder_name in range(len(folder)):
        #print ("Processing for :{} : {}".format(folder_name,folder[folder_name]))
        num_elements_per_folder=0
        file_folder_name = "data/HMP_Dataset/"+folder[folder_name]
        dir_filename = [f for f in listdir(file_folder_name) if isfile(join(file_folder_name, f))]
        for file_name in range(len(dir_filename)):
            num_elements_per_file=0
            folder_file_extract = [folder_name,folder[folder_name],dir_filename[file_name]]
            data=load_dataset(folder[folder_name],dir_filename[file_name])
            start_idx = 0
            end_idx = start_idx+segment_length
            run_ind=True

            while(run_ind):
                #print ("Folder:{} File:{} Total:{}. num:{} Start:{} End:{}".format(folder[folder_name],dir_filename[file_name],data.shape[0],num_elements,start_idx,end_idx))
                data_extract=data[start_idx:end_idx,:].flatten().reshape(1,segment_length*3).astype(int)
                data_append=np.append(data_extract,folder_file_extract).reshape(1,(segment_length*3)+3)
                if (final_data.shape[1] > 0):
                    final_data=np.vstack((final_data,data_append))
                else:
                    final_data=np.vstack(data_append)
                start_idx += int(np.round(segment_length - ((segment_length)*(overlap/100))))
                end_idx = int(np.round(start_idx+segment_length))
                if (end_idx > data.shape[0]):
                    run_ind = False
                num_elements_per_file+=1
                num_elements_per_folder+=1
            #if (print_Ind):
                #print ("Folder:{} File:{} Total:{}. num:{} Start:{} End:{}".format(folder[folder_name],dir_filename[file_name],data.shape[0],num_elements_per_file,start_idx,end_idx))
        if (print_Ind):
            print ("Category:{}:{}   File:{}  Segment:{}".format(folder[folder_name],folder_name,len(dir_filename),num_elements_per_folder))

    if (print_Ind):
        print ("Resize of Data Completed: {}".format(final_data.shape))
    return final_data



def kmeans_prediction(final_data,n_cluster=480,segment_length=32,print_Ind=False):
    i=0
    kmeans_predict_all = np.array([[]])
    kmeans = KMeans(n_clusters=n_cluster).fit(final_data[:,0:segment_length*3].astype(int))
    folder = ['Brush_teeth','Climb_stairs','Comb_hair','Descend_stairs','Drink_glass','Eat_meat','Eat_soup',
              'Getup_bed','Liedown_bed','Pour_water','Sitdown_chair','Standup_chair','Use_telephone','Walk']
    for folder_name in range(len(folder)):
        #print ("Processing for :{} : {}".format(folder_name,folder[folder_name]))
        file_folder_name = "data/HMP_Dataset/"+folder[folder_name]
        dir_filename = [f for f in listdir(file_folder_name) if isfile(join(file_folder_name, f))]
        for file_name in range(len(dir_filename)):
            i+=1
            folder_file_extract = [folder_name,folder[folder_name],dir_filename[file_name]]
            extract_final_data=final_data[(final_data[:,3*segment_length+1] == folder[folder_name]) & (final_data[:,3*segment_length+2] == dir_filename[file_name])][:,0:3*segment_length]
            if (print_Ind):
                print ("Processing Folder:{} File Name:{}  Records:{}".format(folder[folder_name],dir_filename[file_name],extract_final_data.shape))
            kmeans_predict=kmeans.predict(extract_final_data)
            a,b=np.histogram(kmeans_predict,np.arange(n_cluster+1)+1)
            a=a.reshape(1,n_cluster)
            a_append=np.append(a,folder_file_extract).reshape(1,n_cluster+3)

            if (kmeans_predict_all.shape[1] > 0):
                kmeans_predict_all=np.vstack((kmeans_predict_all,a_append))
            else:
                kmeans_predict_all=np.vstack(a_append)
    if (print_Ind):
        print ("KMeans Prediction Completed: {}".format(kmeans_predict_all.shape))
    return kmeans_predict_all



def plot_histogram(Category,data,cluster_centers=480):
    data_mean = np.mean(data,axis=0)
    bin_probability = data_mean/float(data_mean.sum())
    b = np.arange(cluster_centers+1)+1
    bin_middles = (b[1:]+b[:-1])/2
    bin_width = b[1]-b[0]
    #plt.subplots(figsize=(12,8))
    plt.bar(bin_middles, bin_probability, width=bin_width,color='blue')
    plt.title(Category)
    plt.show()



def kfold_data(kmeans_predict_all,n_cluster=480,print_Ind=False):
    folder = ['Brush_teeth','Climb_stairs','Comb_hair','Descend_stairs','Drink_glass','Eat_meat','Eat_soup',
                  'Getup_bed','Liedown_bed','Pour_water','Sitdown_chair','Standup_chair','Use_telephone','Walk']
    #folder = ['Brush_teeth']
    kmeans_predict_extract = kmeans_predict_all[:,0:n_cluster+1].astype(int)
    train_data_fold = np.array([[]])
    test_data_fold = np.array([[]])

    kf = KFold(n_splits=3)
    for f in range(len(folder)):
        fold=1
        kmeans_predict_extract_fold=kmeans_predict_extract[kmeans_predict_extract[:,n_cluster] == f]
        for trn_idx,test_idx in kf.split(kmeans_predict_extract_fold):
            if (print_Ind):
                print ("Category:{} Fold:{}  :: {}:{}  ::: ".format(f,fold,trn_idx.shape,test_idx.shape))
            category_trn_repeat = np.repeat(f,trn_idx.shape[0]).reshape(trn_idx.shape[0],1)
            category_test_repeat = np.repeat(f,test_idx.shape[0]).reshape(test_idx.shape[0],1)

            fold_trn_repeat = np.repeat(fold,trn_idx.shape[0]).reshape(trn_idx.shape[0],1)
            fold_test_repeat = np.repeat(fold,test_idx.shape[0]).reshape(test_idx.shape[0],1)

            if (train_data_fold.shape[1]>0):
                train_data_fold=np.vstack((train_data_fold,np.hstack((fold_trn_repeat,kmeans_predict_extract_fold[trn_idx]))))
            else:
                train_data_fold=np.vstack(np.hstack((fold_trn_repeat,kmeans_predict_extract_fold[trn_idx])))

            if (test_data_fold.shape[1]>0):
                test_data_fold=np.vstack((test_data_fold,np.hstack((fold_test_repeat,kmeans_predict_extract_fold[test_idx]))))
            else:
                test_data_fold=np.vstack(np.hstack((fold_test_repeat,kmeans_predict_extract_fold[test_idx])))

            fold+=1
    return train_data_fold,test_data_fold



def predict(trn_fold,tst_fold,cluster=480,no_tree=1000,max_depth=10):
    clf = RandomForestClassifier(n_estimators=no_tree,max_depth=max_depth) #n_estimators = no of tree, max_depth = depth of the tree
    X=trn_fold[:,0:cluster]
    y=trn_fold[:,cluster]
    X_test=tst_fold[:,0:cluster]
    y_true=tst_fold[:,cluster]
    clf.fit(X,y)
    y_pred=clf.predict(X_test)
    conf_mat=confusion_matrix(y_true=y_true, y_pred=y_pred)
    return (np.sum(y_true == y_pred)/y_pred.shape[0])*100,conf_mat



def predict_fold(train_data_fold,test_data_fold,cluster=480,print_Ind=False):
    avg_acc=0
    for fold in range(3):
        trn_fold=train_data_fold[train_data_fold[:,0] == fold+1][:,1:cluster+2]
        tst_fold=test_data_fold[test_data_fold[:,0] == fold+1][:,1:cluster+2]
        acc,conf_mat=predict(trn_fold,tst_fold,cluster=cluster)
        avg_acc+=acc
        if (print_Ind):
            print ("Fold:{} Trn:{}  Test:{}  Accuracy:{}".format(fold,trn_fold.shape,tst_fold.shape,acc))
    avg_acc=(avg_acc/3)
    if (print_Ind):
```

```python
        print ("Average Accuracy:{}".format(avg_acc/3))
    return avg_acc,conf_mat


def predict_segement_overlap_cluster():
    segment_list = [16,32,64]
    overlap_list = [0,50,70]
    cluster_list = [240,480,780]

    # segment_list = [16]
    # overlap_list = [0]
    # cluster_list = [240]

    labels=['Brush_teeth','Climb_stairs','Comb_hair','Descend_stairs','Drink_glass','Eat_meat','Eat_soup',
            'Getup_bed','Liedown_bed','Pour_water','Sitdown_chair','Standup_chair','Use_telephone','Walk']

    for s in (range(len(segment_list))):
        for o in (range(len(overlap_list))):
            final_data=resize_data_by_factor(segment_length=segment_list[s],overlap=overlap_list[o],print_Ind=True)
            df_final_data=pd.DataFrame(final_data)
            final_data_file_name = "submission/final_data/final_data_"+str(segment_list[s])+"_"+str(overlap_list[o])+".csv"
            df_final_data.to_csv(final_data_file_name,index=False)
            #final_data=np.array(pd.read_csv("final_data.csv")) Comment It out (Only Uncomment for Re-Run)
            for k in range(len(cluster_list)):
                kmeans_predict_all=kmeans_prediction(final_data,n_cluster=cluster_list[k],segment_length=segment_list[s],print_Ind=False)
                train_data_fold,test_data_fold=kfold_data(kmeans_predict_all,n_cluster=cluster_list[k],print_Ind=False)
                average_accuracy,confusion_mat=predict_fold(train_data_fold,test_data_fold,cluster=cluster_list[k],print_Ind=False)
                df_confusion_mat=pd.DataFrame(confusion_mat,columns=labels,index=labels)
                confusion_mat_file_name = "submission/confusion_matrix/confusion_matrix_"+str(overlap_list[k])+"_"+str(cluster_list[o])+"_"+str(segment_list[s]) +".html"
                df_confusion_mat.to_html(confusion_mat_file_name,index=True)
                print ("Segment:{}  Overlap%:{}  Cluster:{}  Accuracy:{}  Confusion Matrix:{}".format(segment_list[s],overlap_list[o],cluster_list[k],average_accuracy,confusion_mat_file_name))

def plot_histogram_all_category(file_name,no_cluster):
    labels=['Brush_teeth','Climb_stairs','Comb_hair','Descend_stairs','Drink_glass','Eat_meat','Eat_soup',
            'Getup_bed','Liedown_bed','Pour_water','Sitdown_chair','Standup_chair','Use_telephone','Walk']
    file_name="submission/final_data/"+str(file_name)+".csv"
    final_data=np.array(pd.read_csv(file_name))
    kmeans_predict_all=kmeans_prediction(final_data,n_cluster=no_cluster,segment_length=32,print_Ind=False)
    kmeans_predict_all_hist=kmeans_predict_all[:,0:no_cluster+1].astype(int)
    for i in range(14):
        print ("Processing for i:{}".format(i))
        x=kmeans_predict_all_hist[kmeans_predict_all_hist[:,no_cluster] == i][:,0:no_cluster]
        plot_histogram(Category=labels[i],data=x,cluster_centers=no_cluster)

predict_segement_overlap_cluster()
plot_histogram_all_category("submission/final_data/final_data_32_70.csv",240)
```