

# FIFA 22 Player Clustering

## Description

This is notebook to build clustering model for FIFA players. The intention is use this clustering as classification for players position. Our aim is get classification model with the most accuracy possible.

## What is FIFA 22 ?

FIFA 22 in this context is the football (soccer) video game which have teams and players based on the real world.

Football is my favorite sport and the most famous sport in the world. I think player's attributes from FIFA reflect real world attributes of each player in number properly. It's not perfect representation. But, I think this is good enough data. Since this is my first unsupervised learning project, I might not get a good model compared to supervised model.

P.S. I chose FIFA 22 because it's the latest version of FIFA games which I am able to find data.

## Data Overview

source : <https://www.kaggle.com/datasets/stefanoleone992/fifa-22-complete-player-dataset>

data type : CSV (110 columns)

data size : 19,239 rows (13.6 MB)

data include

- player's attributes like age, height, etc.
- URL of the scraped players
- URL of the uploaded player faces, club and nation logos
- Player positions, with the role in the club and in the national team
- Player attributes with statistics as Attacking, Skills, Defense, Mentality, GK Skills, etc.
- Player personal data like Nationality, Club, DateOfBirth, Wage, Salary, etc.

```
In [2]: import pandas as pd
import numpy as np

data = pd.read_csv('players_22.csv')
```

```
/var/folders/ww/wcmtx4s5569768p2bvygj_b40000gn/T/ipykernel_6355/1344860873.py:4: DtypeWarning: Columns (25,108) have mixed types. Specify dtype option on import or set low_memory=False.  
data = pd.read_csv('players_22.csv')
```

In [3]: `data.info()`

```
<class 'pandas.core.frame.DataFrame'>  
RangeIndex: 19239 entries, 0 to 19238  
Columns: 110 entries, sofifa_id to nation_flag_url  
dtypes: float64(16), int64(44), object(50)  
memory usage: 16.1+ MB
```

In [4]: `data.head()`

Out[4]:

	sofifa_id	player_url	short_name	long_name	player_position
0	158023	<a href="https://sofifa.com/player/158023/lionel-messi/...">https://sofifa.com/player/158023/lionel-messi/...</a>	L. Messi	Lionel Andrés Messi Cuccittini	RW, ST, C
1	188545	<a href="https://sofifa.com/player/188545/robert-lewand...">https://sofifa.com/player/188545/robert-lewand...</a>	R. Lewandowski	Robert Lewandowski	S
2	20801	<a href="https://sofifa.com/player/20801/c-ronaldo-dos-...">https://sofifa.com/player/20801/c-ronaldo-dos-...</a>	Cristiano Ronaldo	Cristiano Ronaldo dos Santos Aveiro	ST, L
3	190871	<a href="https://sofifa.com/player/190871/neymar-da-sil...">https://sofifa.com/player/190871/neymar-da-sil...</a>	Neymar Jr	Neymar da Silva Santos Júnior	LW, CA
4	192985	<a href="https://sofifa.com/player/192985/kevin-de-bruy...">https://sofifa.com/player/192985/kevin-de-bruy...</a>	K. De Bruyne	Kevin De Bruyne	CM, CA

5 rows x 110 columns

First, I want see all columns we have.

In [5]: `for c in data.columns:  
print(c)`

sofifa\_id  
player\_url  
short\_name  
long\_name  
player\_positions  
overall  
potential  
value\_eur  
wage\_eur  
age  
dob  
height\_cm  
weight\_kg  
club\_team\_id  
club\_name  
league\_name  
league\_level  
club\_position  
club\_jersey\_number  
club\_loaned\_from  
club\_joined  
club\_contract\_valid\_until  
nationality\_id  
nationality\_name  
nation\_team\_id  
nation\_position  
nation\_jersey\_number  
preferred\_foot  
weak\_foot  
skill\_moves  
international\_reputation  
work\_rate  
body\_type  
real\_face  
release\_clause\_eur  
player\_tags  
player\_traits  
pace  
shooting  
passing  
dribbling  
defending  
physic  
attacking\_crossing  
attacking\_finishing  
attacking\_heading\_accuracy  
attacking\_short\_passing  
attacking\_volleys  
skill\_dribbling  
skill\_curve  
skill\_fk\_accuracy  
skill\_long\_passing  
skill\_ball\_control  
movement\_acceleration  
movement\_sprint\_speed  
movement\_agility  
movement\_reactions  
movement\_balance  
power\_shot\_power  
power\_jumping  
power\_stamina  
power\_strength  
power\_long\_shots  
mentality\_aggression

```
mentality_interceptions
mentality_positioning
mentality_vision
mentality_penalties
mentality_composure
defending_marking_awareness
defending_standing_tackle
defending_sliding_tackle
goalkeeping_diving
goalkeeping_handling
goalkeeping_kicking
goalkeeping_positioning
goalkeeping_reflexes
goalkeeping_speed
ls
st
rs
lw
lf
cf
rf
rw
lam
cam
ram
lm
lcm
cm
rcm
rm
lwb
ldm
cdm
rdm
rwb
lb
lcb
cb
rcb
rb
gk
player_face_url
club_logo_url
club_flag_url
nation_logo_url
nation_flag_url
```

This is official data <https://www.ea.com/games/fifa/fifa-22/ratings/ratings-database>. So, I want to check if it match our source (kaggle) or not.

```
In [6]: pd.concat([data.iloc[:,2:6], data.loc[:, 'pace':'physic']], axis=1).head()
```

Out[6]:	short_name	long_name	player_positions	overall	pace	shooting	passing	dribbling
0	L. Messi	Lionel Andrés Messi Cuccittini	RW, ST, CF	93	85.0	92.0	91.0	95.0
1	R. Lewandowski	Robert Lewandowski	ST	92	78.0	92.0	79.0	86.0
2	Cristiano Ronaldo	Cristiano Ronaldo dos Santos Aveiro	ST, LW	91	87.0	94.0	80.0	88.0
3	Neymar Jr	Neymar da Silva Santos Júnior	LW, CAM	91	91.0	83.0	86.0	94.0
4	K. De Bruyne	Kevin De Bruyne	CM, CAM	91	76.0	86.0	93.0	88.0

I manually check and it matches. So, I assumed this source data is accurate.

```
In [7]: data.iloc[:,2:6].describe()
```

Out[7]:	overall
count	19239.000000
mean	65.772182
std	6.880232
min	47.000000
25%	61.000000
50%	66.000000
75%	70.000000
max	93.000000

```
In [8]: data.loc[:,['overall','age','height_cm','weight_kg','weak_foot','skill_moves']]
```

Out[8]:	overall	age	height_cm	weight_kg	weak_foot	skill_mov
count	19239.000000	19239.000000	19239.000000	19239.000000	19239.000000	19239.0000
mean	65.772182	25.210822	181.299704	74.943032	2.946151	2.3524
std	6.880232	4.748235	6.863179	7.069434	0.671560	0.7676
min	47.000000	16.000000	155.000000	49.000000	1.000000	1.0000
25%	61.000000	21.000000	176.000000	70.000000	3.000000	2.0000
50%	66.000000	25.000000	181.000000	75.000000	3.000000	2.0000
75%	70.000000	29.000000	186.000000	80.000000	3.000000	3.0000
max	93.000000	54.000000	206.000000	110.000000	5.000000	5.0000

```
In [9]: data.loc[:,['attacking_crossing':'defending_sliding_tackle']].describe()
```

Out[9]:

	attacking_crossing	attacking_finishing	attacking_heading_accuracy	attacking_short_
<b>count</b>	19239.000000	19239.000000	19239.000000	19239
<b>mean</b>	49.577421	45.894433	51.783877	58
<b>std</b>	18.034661	19.721023	17.294183	14
<b>min</b>	6.000000	2.000000	5.000000	7
<b>25%</b>	38.000000	30.000000	44.000000	54
<b>50%</b>	54.000000	50.000000	55.000000	62
<b>75%</b>	63.000000	62.000000	64.000000	68
<b>max</b>	94.000000	95.000000	93.000000	94

8 rows × 29 columns

From tables above, data looks fine as well (player's attributes are between 0 and 100). But, there are some data missing (count less than rows) on pace, shooting, passing, dribbling, defending and physic. Therefore, we are checking it.

In [10]:

```
nandf = data.loc[:,['short_name', 'player_positions', 'pace', 'shooting', 'passing', 'dribbling', 'defending', 'physic']]
nandf = nandf[nandf.isnull().any(axis=1)]
nandf.head()
```

Out[10]:

	short_name	player_positions	pace	shooting	passing	dribbling	defending	physic
<b>5</b>	J. Oblak	GK	NaN	NaN	NaN	NaN	NaN	NaN
<b>7</b>	M. Neuer	GK	NaN	NaN	NaN	NaN	NaN	NaN
<b>8</b>	M. ter Stegen	GK	NaN	NaN	NaN	NaN	NaN	NaN
<b>12</b>	T. Courtois	GK	NaN	NaN	NaN	NaN	NaN	NaN
<b>18</b>	Ederson	GK	NaN	NaN	NaN	NaN	NaN	NaN

In [11]:

```
nandf['player_positions'].unique()
```

Out[11]:

```
array(['GK'], dtype=object)
```

As expected, players which have missing data are all GK (in FIFA they replace those attributes with goal keeper attributes).

## Clean Up

Remove column that we are not going to use and fill null data. And create new column which is most preferred position (pos). we will use it as responses.

First, add most preferred position column. (checked on official website, this first position on player\_positions column is most preferred position)

In [12]:

```
data['pos'] = data['player_positions'].str.split(', ').apply(lambda x: x[0])
all_pos = data['pos'].unique()
```

```
print(len(all_pos))
print(' '.join(data['pos'].unique()))
```

```
15
RW ST LW CM GK CDM CF LM CB CAM LB RB RM LWB RWB
```

I think 15 classes is too much. Therefore, I will merge into 4 classes FW for forward (RW ST LW CF), MF for midfield (CM CDM LM CAM RM), DE for defense (CB LB RB LWB RWB) and GK.

```
In [13]: data['pos'] = data['pos'].replace(['RW', 'ST', 'LW', 'CF'], 'FW')
data['pos'] = data['pos'].replace(['CM', 'CDM', 'LM', 'CAM', 'RM'], 'MF')
data['pos'] = data['pos'].replace(['CB', 'LB', 'RB', 'LWB', 'RWB'], 'DE')

data['pos'].unique()
```

```
Out[13]: array(['FW', 'MF', 'GK', 'DE'], dtype=object)
```

Then, we remove useless columns.

```
In [14]: data = pd.concat([data.loc[:, ['pos', 'overall', 'age', 'height_cm', 'weight_kg',
data.head()
```

```
Out[14]:
```

	pos	overall	age	height_cm	weight_kg	weak_foot	skill_moves	pace	shooting	passir
0	FW	93	34	170	72	4	4	85.0	92.0	91
1	FW	92	32	185	81	4	4	78.0	92.0	79
2	FW	91	36	187	83	4	5	87.0	94.0	80
3	FW	91	29	175	68	5	5	91.0	83.0	86
4	MF	91	30	181	70	5	4	76.0	86.0	93

5 rows × 42 columns

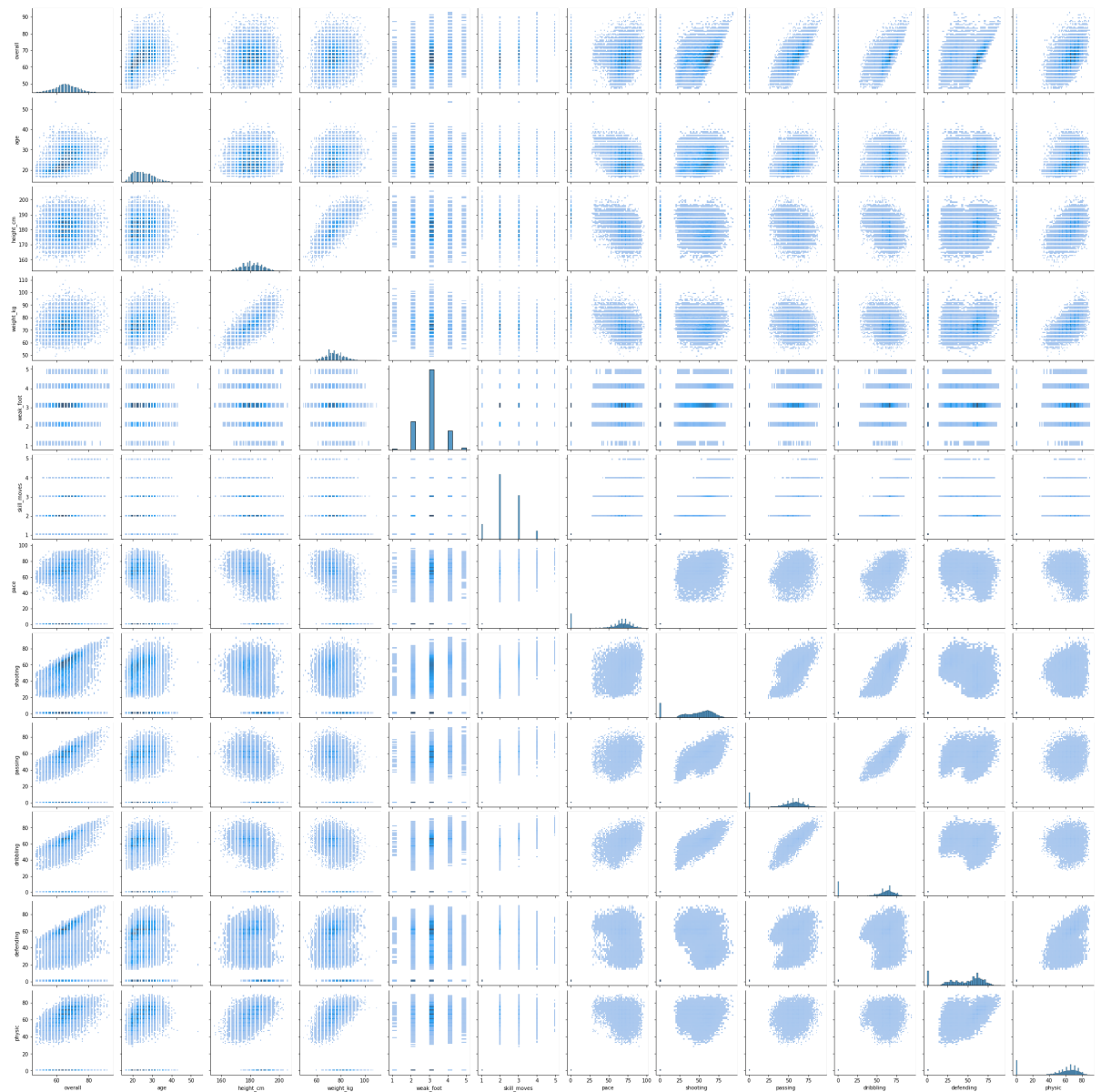
Impute data, set missing player's attributes as 0

```
In [15]: data = data.fillna(0)
```

## Visual Display

```
In [16]: import seaborn as sns
import matplotlib.pyplot as plt

for_plot = data.loc[:, ['overall', 'age', 'height_cm', 'weight_kg', 'weak_foot', '
sns.pairplot(for_plot, kind="hist")
plt.savefig('pair_plot1.png')
```



I use histogram because we get more info than normal scatter.

I filter out 0 because before compute correlation because data I impute will cause bias.

```
In [53]: for_corr = for_plot.replace(0, np.nan)
```

```
In [54]: corr_data = for_corr.corr()
corr_data
```

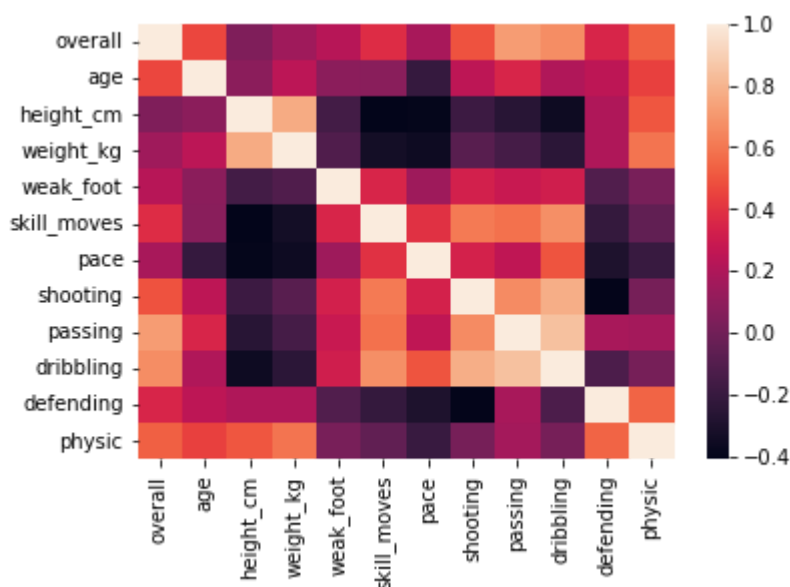


Out[54]:

	overall	age	height_cm	weight_kg	weak_foot	skill_moves	pace
overall	1.000000	0.459451	0.042787	0.150324	0.223762	0.376226	0.174695
age	0.459451	1.000000	0.083009	0.239444	0.082149	0.074076	-0.209383
height_cm	0.042787	0.083009	1.000000	0.765465	-0.158167	-0.411341	-0.399614
weight_kg	0.150324	0.239444	0.765465	1.000000	-0.115391	-0.336606	-0.360537
weak_foot	0.223762	0.082149	-0.158167	-0.115391	1.000000	0.344650	0.144947
skill_moves	0.376226	0.074076	-0.411341	-0.336606	0.344650	1.000000	0.389891
pace	0.174695	-0.209383	-0.399614	-0.360537	0.144947	0.389891	1.000000
shooting	0.489623	0.249207	-0.190318	-0.087062	0.323203	0.606717	0.327717
passing	0.715001	0.346893	-0.259754	-0.154743	0.283897	0.577815	0.254596
dribbling	0.666402	0.202410	-0.358324	-0.250922	0.314096	0.672223	0.496839
defending	0.346760	0.247524	0.199484	0.197474	-0.110634	-0.214747	-0.300617
physic	0.529234	0.443169	0.501150	0.586895	0.020740	-0.055771	-0.197067

In [55]: `sns.heatmap(corr_data)`

Out[55]: `<AxesSubplot:>`



```
In [56]: # listing feature pair that has strong correlation
for i in corr_data.columns:
    for j in corr_data.columns:
        if i < j and corr_data[i][j] > 0.7:
            print(i, ' ', j, corr_data[i][j])
```

```
overall    passing 0.7150010326789458
height_cm  weight_kg 0.7654649723878713
dribbling  shooting 0.7774137418397219
dribbling  passing 0.8454130913141136
```

## Analysis

From information above, we see 4 strong correlation between features (more than 0.7).

- overall and passing is indeed correlate

- height\_cm and weight\_kg is indeed correlate
- dribbling and shooting is new knowledge
- dribbling and passing is new knowledge

I expected weight\_kg and physic, shooting and passing, skill\_moves and dribbling have strong correlation (from my football knowledge). But, it doesn't. Also, I did not expected dribbling to have strong correlation with shooting and passing.

Since, those are features of football player and in reality lot of them able to play more than one position. I think we can cluster same position into same cluster. But, we would missing some.

## Clustering

for compare between model, we will use accuracy on test data to compare which model is better. I want to use k-means first as based line.

First, split data in to train and test (test for 20%).

```
In [20]: from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(data.drop('pos', axis=1)
```

```
In [21]: X1_train = X_train.loc[:, ['overall', 'age', 'height_cm', 'weight_kg', 'weak_foot',
X1_test = X_test.loc[:, ['overall', 'age', 'height_cm', 'weight_kg', 'weak_foot',
```

```
In [22]: X1_train.head()
```

```
Out[22]:
```

	overall	age	height_cm	weight_kg	weak_foot	skill_moves	pace	shooting	passing
3482	72	26	185	71	3	3	75.0	72.0	71.0
4694	70	31	180	77	3	3	61.0	67.0	69.0
9981	65	29	196	92	3	2	44.0	69.0	47.0
3770	72	24	172	67	3	4	79.0	65.0	70.0
227	82	28	179	70	3	4	68.0	74.0	83.0

```
In [23]: from sklearn.cluster import KMeans

kmeans = KMeans(n_clusters=4, random_state=1992).fit(X1_train)
```

```
In [24]: import itertools
from sklearn.metrics import accuracy_score

ppos = ['FW', 'MF', 'DE', 'GK']

def label_permute_compare(ytdf, yp, n=4):
    perms = list(itertools.permutations(list(range(n))))
    acc=[]
    for i in range(len(perms)):
        mapdict = dict(zip(list(ppos), list(perms[i])))
        yt = ytdf.apply(lambda x: mapdict[x])
        acc.append(accuracy_score(yt, yp))
```

```
idx = np.argmax(acc)
return perms[idx], acc[idx]
```

```
In [25]: # first model acc on training data
labelorder, acc = label_permute_compare(y_train, kmeans.labels_)
print(labelorder, acc)
```

```
(3, 2, 0, 1) 0.6757845494119941
```

```
In [26]: ld = dict(zip(ppos, labelorder))
```

```
In [27]: # first model acc on test data
y_pred1 = kmeans.predict(X1_test)

accuracy_score(y_test.apply(lambda x: ld[x]), y_pred1)
```

```
Out[27]: 0.6798336798336798
```

```
In [28]: # confusion matrix for test data
from sklearn.metrics import confusion_matrix

confusion_matrix(y_test.apply(lambda x: ld[x]), y_pred1, labels=labelorder)
```

```
Out[28]: array([[650,  91,   4,   0],
                [524, 693, 217,   0],
                [  9, 387, 871,   0],
                [  0,   0,   0, 402]])
```

Now, we have first classification model with K-Means using 13 features. As result, we got 0.6758 accuracy on training data and 0.6798 on test data. This will be our base line. I think this is already good base line. Becuase from confusion matrix above, we get all GK position corret.

For second model, I will use K-Means clustering with all features we have.

```
In [29]: # 2nd model acc on training data
kmeans2 = KMeans(n_clusters=4, random_state=1992).fit(X_train)

labelorder, acc = label_permute_compare(y_train, kmeans2.labels_)
print(labelorder, acc)
```

```
(3, 0, 1, 2) 0.7040478201546359
```

```
In [30]: # 2nd model acc on test data
ld = dict(zip(ppos, labelorder))

y_pred2 = kmeans2.predict(X_test)

accuracy_score(y_test.apply(lambda x: ld[x]), y_pred2)
```

```
Out[30]: 0.7042619542619543
```

```
In [31]: # confusion matrix for test data
confusion_matrix(y_test.apply(lambda x: ld[x]), y_pred2, labels=labelorder)
```

```
Out[31]: array([[689,  51,   5,   0],
                [492, 736, 206,   0],
                [  2, 382, 883,   0],
                [  0,   0,   0, 402]])
```

As expected, our model get a bit more accuracy.

Since we have models from clustering technique which looks good for me. I will create new model using supervise technique which is k-nearest neighbors to compare with our model to see which one is better.

```
In [32]: # knn acc on tarin data
from sklearn.neighbors import KNeighborsClassifier

neigh = KNeighborsClassifier(n_neighbors=3)
neigh.fit(X_train, y_train)

neigh.score(X_train, y_train)
```

Out[32]: 0.927749983756741

```
In [33]: # knn acc on test data
neigh.score(X_test, y_test)
```

Out[33]: 0.8700623700623701

KNN with all features has more accuracy than our k-means model (0.9277 on training data and 0.8701 on test data). So, I will try another model to see if I can create better model with clustering technique.

I think Non-Negative Matrix Factorization would give us a better model. Let's find out.

```
In [34]: def get_prediction(w_matrix):
          sortedMatrix = np.argsort(w_matrix)
          n_predictions, maxValue = sortedMatrix.shape
          re = sortedMatrix[:,3:].ravel()
          return re
```

```
In [35]: # first NMF acc on training data
from sklearn.decomposition import NMF

nmfm1 = NMF(n_components=4, init='random', random_state=1992, max_iter=20000)
W1 = nmfm1.fit_transform(X_train)
H1 = nmfm1.components_

yhat1 = get_prediction(W1)

labelorder, acc = label_permute_compare(y_train, yhat1)
print(labelorder, acc)

(3, 2, 1, 0) 0.4867779871353388
```

```
In [36]: # 2nd NMF acc on training data
nmfm2 = NMF(n_components=4, init='random', random_state=1992, max_iter=20000)
W2 = nmfm2.fit_transform(X_train)
H2 = nmfm2.components_

yhat2 = get_prediction(W2)

labelorder, acc = label_permute_compare(y_train, yhat2)
print(labelorder, acc)

(0, 1, 3, 2) 0.7328958482229875
```

```
In [37]: def nmfx(a):
          nmfm = NMF(n_components=4, init='random', random_state=1992, max_iter=20000)
          W = nmfm.fit_transform(X_train)
```

```

yhat = get_prediction(W)

return label_permute_compare(y_train, yhat)

```

```

In [38]: bi = 0
bacc = 0
labelorder = []
for i in range(10):
    labelorder, acc = nmfx(i*0.01)
    if acc > bacc:
        bacc = acc
        labelorder = labelorder
        bi = i*0.01
print(bi, bacc, labelorder)

0.02 0.7513481905009421 (0, 1, 3, 2)

```

```

In [39]: # NMF with best alpha_W acc on training data
nmfmb = NMF(n_components=4, init='random', random_state=1992, max_iter=20000)
Wb = nmfmb.fit_transform(X_train)

yhatb = get_prediction(Wb)

labelorder, acc = label_permute_compare(y_train, yhatb)
print(labelorder, acc)

(0, 1, 3, 2) 0.7513481905009421

```

```

In [40]: # NMF with best alpha_W acc on test data
test_yhat = get_prediction(nmfmb.transform(X_test))
labelorder, acc = label_permute_compare(y_test, test_yhat)
print(labelorder, acc)

(0, 1, 3, 2) 0.7492203742203742

```

```

In [41]: # NMF with tol=0.00005 acc on train data
nmfm4 = NMF(n_components=4, init='random', random_state=1992, max_iter=20000)
W4 = nmfm4.fit_transform(X_train)

yhat4 = get_prediction(W4)

labelorder, acc = label_permute_compare(y_train, yhat4)
print(labelorder, acc)

(0, 1, 3, 2) 0.7523877590799818

```

```

In [42]: # NMF with tol=0.00005 NMF acc on test data
test_yhat4 = get_prediction(nmfm4.transform(X_test))
labelorder, acc = label_permute_compare(y_test, test_yhat4)
print(labelorder, acc)

(0, 1, 3, 2) 0.7481808731808732

```

So, best NMF model after tuning hyperparameter has accuracy 0.7513 on training data and 0.7482 on test data. You can see that actually NMF with tol=0.00005 have more accuracy on training data but it over-fitted. I think this is the best model with NMF I can build.

Next, I will try to tune hyperparameter for k-means.

```

In [43]: # 3rd model acc on training data
kmeans3 = KMeans(n_clusters=4, random_state=1992, init='random', max_iter=40

```

```
labelorder, acc = label_permute_compare(y_train, kmeans3.labels_)
print(labelorder, acc)
```

```
(2, 0, 3, 1) 0.7040478201546359
```

From what I tried, tuning hyperparameter for k-means not gain any accuracy.

Last, I will try hierarchical clustering

```
In [57]: from sklearn.cluster import AgglomerativeClustering

# 1st model acc on training data
hi1 = AgglomerativeClustering(n_clusters=4, affinity='manhattan' , linkage='

labelorder, acc = label_permute_compare(y_train, hi1.labels_)
print(labelorder, acc)

(2, 0, 3, 1) 0.4761873822363719
```

```
In [45]: # 2nd model acc on training data
hi2 = AgglomerativeClustering(n_clusters=4, affinity='manhattan' , linkage='

labelorder, acc = label_permute_compare(y_train, hi2.labels_)
print(labelorder, acc)

(3, 0, 2, 1) 0.47631732830875184
```

First hierarchical clustering not perform well. So, hyperparameter tuning would help.

```
In [46]: metrics = ["euclidean", "l1", "l2", "manhattan", "cosine"]
linkages = ["complete", "average", "single"]
maxx = 0
mm = ""
ll = ""

for m in metrics:
    for l in linkages:
        nmodel = AgglomerativeClustering(n_clusters=5, affinity=m , linkage=
        nlabelorder, acc = label_permute_compare(y_train, nmodel.labels_)
        print('matric =',m,' and linkage =',l,'acc =', acc)
        if acc>maxx:
            maxx=acc
            mm=m
            ll=l
print('best parameter :',mm,ll, 'acc =',maxx)

# for affinity='euclidean' linkage='ward'
model2 = AgglomerativeClustering(n_clusters=5, affinity='euclidean' , linkag
labelorder, acc = label_permute_compare(y_train, model2.labels_)
print('labelorder =',labelorder)
print('accuracy =', acc)
```

```
matric = euclidean and linkage = complete acc = 0.48274965889156
matric = euclidean and linkage = average acc = 0.6270547722695081
matric = euclidean and linkage = single acc = 0.4761873822363719
matric = l1 and linkage = complete acc = 0.5110129296342018
matric = l1 and linkage = average acc = 0.6527840946007407
matric = l1 and linkage = single acc = 0.47631732830875184
matric = l2 and linkage = complete acc = 0.48274965889156
matric = l2 and linkage = average acc = 0.6270547722695081
matric = l2 and linkage = single acc = 0.4761873822363719
matric = manhattan and linkage = complete acc = 0.5110129296342018
matric = manhattan and linkage = average acc = 0.6527840946007407
matric = manhattan and linkage = single acc = 0.47631732830875184
matric = cosine and linkage = complete acc = 0.5572737314014684
matric = cosine and linkage = average acc = 0.6265999610161783
matric = cosine and linkage = single acc = 0.47599246312780197
best parameter : l1 average acc = 0.6527840946007407
labelorder = (1, 2, 0, 3)
accuracy = 0.5882008966278994
```

The best accuracy we can get from hierarchical clustering on training data is 0.6528 which is worst than NMF.

As result, the best model with unsupervise approach by Non-Negative Matrix Factorization is 0.7482.

## Conclusion

For this problem first we look at overview of data we have. Then, we verify it with official site. After that we clean up data and run analysis. Since we have every thing ready, we build models with unsupervise and supervise techniques. So, we get best unsupervise model wich is using NMF which 0.7482 on test data and KNN wih 0.8701 on test data as supervise model. As result, for this problem KNN wihch is supervise have better accuracy than NMF wich is best unsupervise model about 0.12. In my opinion NMF is doing a good job because the model does not use label of the data on trainig. I think if I have more experience I might build better model. I think this can be improve. But this is the best for me currently.

github : <https://github.com/Satjarporn/FIFA>