CHESS TITLE ANALYSIS

In this project I will analyze some chess ELO data, and try to predict which Title a player holds based on their ELO. For this the plan is to use a Unsupervised learning approach. In this case KMeans Clustering.

We have 3 Ratings (1500-3000 and a Title [FM, GM, IM]), based on the 3 Ratings we want to predict the Title.

EDA

Inital Code to load the Data

In [37]:

```
import matplotlib.pyplot as plt
import pandas as pd
import sqlite3 as sql
import numpy as np
import warnings
from sklearn.cluster import KMeans
from sklearn.metrics import accuracy_score
import seaborn as sns
from mpl_toolkits.mplot3d import Axes3D
```

In [38]:

```
db2 = "fide_ranking.sqlite"
db = "fideDB.sqlite"
```

In [39]:

```
def connect(db):
    return sql.connect(db)

def close(con):
    con.close()

query1 = """
    SELECT *
    FROM fide;
    """


query2 = """
    SELECT *
    FROM Fide_1600;
    """
query3 = """
    SELECT *
    FROM Fide_1700;
    """
query4 = """
    SELECT *
    FROM Fide_bundes;
    """
query5 = """
    SELECT *
    FROM Fide_ranking;
    """
```

In [40]:

```
con = connect(db)
data1 = pd.read_sql(query1, con)
con2 = connect(db2)
data2 = pd.read_sql(query2, con2)
data3 = pd.read_sql(query3, con2)
data4 = pd.read_sql(query4, con2)
data5 = pd.read_sql(query5, con2)
close(con)
close(con2)
data1
```

Out[40]:

	level_0	index	title	name	FIDE	bullet	blitz	Chess960	Rapid	UltraBullet	...	King
0	0	0	FM	Umut Erdem Gündüz	2340	2738	2472	None	None	None	...	Non
1	1	1	FM	Abubaker Tagelsir 12200875	2219	2245	2468	1876	None	None	...	Non
2	2	2	IM	Matvey Galchenko	2453	2968	2819	None	2643	2395	...	Non
3	3	3	FM	Nikhil Dixit	2331	2581	2516	1933	None	None	...	Non
4	4	4	FM	Mohamed Elsayed	2212	2198	2326	None	2115	None	...	Non
...	...	...	...	...	...	...	...	...	...	...	...	.
5287	995	995	None	None	None	1837.0	1976.0	None	None	None	...	Non
5288	996	996	None	None	None	1668.0	1913.0	None	None	None	...	Non
5289	997	997	None	None	None	1751.0	2069.0	None	None	None	...	Non
5290	998	998	None	None	None	1910.0	1881.0	None	None	None	...	Non
5291	999	999	None	None	None	1862.0	1637.0	None	None	None	...	Non

5292 rows × 22 columns

As we only care about title, FIDE, bullet and blitz lets filter it out.

In [41]:

```
def trans(data):
    try:
        df = data[["title", "FIDE", "blitz", "bullet"]]
    except:
        df = data[["FIDE", "blitz", "bullet"]]
    df2 = pd.DataFrame({"FIDE": 0, "blitz": 0, "bullet": 0}, index=[0])
    df = pd.concat([df,df2])
    df2 = pd.DataFrame({"FIDE": 3500, "blitz": 3500, "bullet": 3500}, index=[0])
    df = pd.concat([df,df2]).reset_index()
    return df
```

In [42]:

```
data11 = trans(data1)
data22 = trans(data2)
data33 = trans(data3)
```

```
data44 = trans(data4)
data55 = trans(data5)
data11
```

Out[42]:

	index	title	FIDE	blitz	bullet
0	0	FM	2340	2472	2738
1	1	FM	2219	2468	2245
2	2	IM	2453	2819	2968
3	3	FM	2331	2516	2581
4	4	FM	2212	2326	2198
...	...	...	...	...	...
5289	5289	None	None	2069.0	1751.0
5290	5290	None	None	1881.0	1910.0
5291	5291	None	None	1637.0	1862.0
5292	0	NaN	0	0	0
5293	0	NaN	3500	3500	3500

5294 rows × 5 columns

Let's remove all the NaNs and more.

In [43]:

```
df   = pd.concat([data11,data22,data33,data44,data55])
df = df[["title","FIDE","blitz","bullet"]]
df = df.drop_duplicates()
df = df.dropna()
```

In [44]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1426 entries, 0 to 394
Data columns (total 4 columns):
 #   Column  Non-Null Count  Dtype 
---  ------  --------------  ----- 
 0   title   1426 non-null   object
 1   FIDE    1426 non-null   object
 2   blitz   1426 non-null   object
 3   bullet  1426 non-null   object
dtypes: object(4)
memory usage: 55.7+ KB
```

We need to convert all the data into a uniform format.

In [45]:

```
warnings.simplefilter('ignore')

df_filtered = df[df['title'].isin(['NM', 'IM', 'GM'])]

df_filtered['FIDE'] = pd.to_numeric(df_filtered['FIDE'])
df_filtered['blitz'] = pd.to_numeric(df_filtered['blitz'])
df_filtered['bullet'] = pd.to_numeric(df_filtered['bullet'])


df_filtered['FIDE'] = df_filtered['FIDE'].round().astype(int)
```

```
df_filtered['blitz'] = df_filtered['blitz'].round().astype(int)
df_filtered['bullet'] = df_filtered['bullet'].round().astype(int)
```

In [46]:

```
df_filtered.title.value_counts()
```

Out[46]:

```
IM    338
GM    234
NM    104
Name: title, dtype: int64
```

In [47]:

```
df_filtered = df_filtered[df_filtered['FIDE'] >= 1800]
```

In [48]:

```
df_filtered = df_filtered.reset_index(drop=True)
```

So let's see how the data actually looks.

In [49]:

```
df_filtered
```

Out[49]:

	title	FIDE	blitz	bullet
0	IM	2453	2819	2968
1	NM	2375	2659	2662
2	IM	2376	2595	2431
3	GM	2680	2728	2512
4	IM	2443	2563	2640
...	...	...	...	...
667	NM	2100	2344	2431
668	NM	2106	2216	1913
669	NM	2126	2276	2259
670	NM	2119	2310	2203
671	NM	1988	2205	2064

672 rows × 4 columns

Initial Plots

Let's take a look how the Data actual looks. This will include the labels we already know (these won't be used for the training later), but it gives us an idea of what Clusters we need to build.

In [50]:

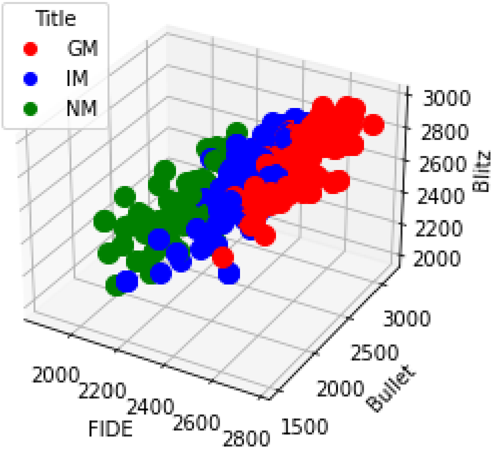
```
colors = {'GM': 'red', 'IM': 'blue', 'NM': 'green'}

fig = plt.figure()
ax = fig.add_subplot(projection='3d')
for i in range(len(df_filtered)):
    row = df_filtered.iloc[i]
    ax.scatter(row['FIDE'], row['bullet'], row['blitz'], c=colors[row['title']], s=1
ax.set_xlabel('FIDE')
ax.set_ylabel('Bullet')
ax.set_zlabel('Blitz')
```

```
handles = [plt.plot([], [], marker='o', ls="", color=color, label=title)[0] for titl
ax.legend(handles=handles, title='Title', loc='upper left')

# https://stackoverflow.com/questions/31303912/matplotlib-pyplot-scatterplot-legend-
# How to get the legend with the colors

plt.show()
```



We can see 3 distinct sections, so let's try and build a KMeans and see where we are at. We will just do 5 clusters to start.

In [51]:

```
kmeans = KMeans(n_clusters=5)

kmeans.fit(df_filtered[["FIDE", "blitz", "bullet"]])

df_filtered['pred_title'] = kmeans.labels_
df_filtered['pred_title'] = df_filtered['pred_title']
```

In [52]:

```
df_filtered
```

Out[52]:

	title	FIDE	blitz	bullet	pred_title
0	IM	2453	2819	2968	1
1	NM	2375	2659	2662	3
2	IM	2376	2595	2431	0
3	GM	2680	2728	2512	3
4	IM	2443	2563	2640	3
...	...	...	...	...	...
667	NM	2100	2344	2431	2
668	NM	2106	2216	1913	2
669	NM	2126	2276	2259	2
670	NM	2119	2310	2203	2
671	NM	1988	2205	2064	2

672 rows × 5 columns

We can see we now have a pred_title column which gives a label for the title. These are not mapped yet. To find out the mapping we are using cross tab and some logic.

In [53]:

```
df_test = df_filtered.copy()
```

In [54]:

```
cross_tab = pd.crosstab(df_test['pred_title'], df_test['title'])
cross_tab
```

Out[54]:

title	GM	IM	NM
pred_title			
0	22	101	20
1	119	68	0
2	0	11	62
3	92	150	18
4	1	8	0

In [55]:

```
test = cross_tab.divide(cross_tab.sum(axis=1), axis=0)
test
```

Out[55]:

title	GM	IM	NM
pred_title			
0	0.153846	0.706294	0.139860
1	0.636364	0.363636	0.000000
2	0.000000	0.150685	0.849315
3	0.353846	0.576923	0.069231
4	0.111111	0.888889	0.000000

If GM,IM or NM are more than 60% then I assign the label as mapped.

In [56]:

```
result = test.idxmax(axis=1)
result[test.max(axis=1) < 0.6] = None
result = result.dropna()
mapping = result.to_dict()
mapping
```

Out[56]:

```
{0: 'IM', 1: 'GM', 2: 'NM', 4: 'IM'}
```

Now we can apply our mapping and get our accuracy.

In [57]:

```
df_test['pred_title'] = df_test['pred_title'].map(mapping)
df_test = df_test.dropna()
df_test
```

Out[57]:

	title	FIDE	blitz	bullet	pred_title
0	IM	2453	2819	2968	GM

	title	FIDE	blitz	bullet	pred_title
2	IM	2376	2595	2431	IM
5	GM	2536	2848	2713	GM
7	NM	2001	2273	2331	NM
9	GM	2602	2814	2801	GM
...	...	...	...	...	...
667	NM	2100	2344	2431	NM
668	NM	2106	2216	1913	NM
669	NM	2126	2276	2259	NM
670	NM	2119	2310	2203	NM
671	NM	1988	2205	2064	NM

412 rows × 5 columns

In [58]:

```
accuracy = accuracy_score(df_test['pred_title'], df_test['title'])
accuracy
```

Out[58]:

```
0.7038834951456311
```

An accuracy of 70% is not great and we would want to improve this significantly. To do this we will adjust our Hyperparameters.

Automating Hyperparameter finding

To find the best Hyperparameters I will create a function which tests various combinations to find a good balance. The following function just does what we done above, but makes it into a function where we control the parameters.

In [59]:

```
def train(df, n=3, i=300, init="k-means++"):
    data = df.copy()
    kmeans = KMeans(n_clusters=n, max_iter=i, init=init)

    kmeans.fit(data[["FIDE", "blitz", "bullet"]])

    data['pred_title'] = kmeans.labels_
    data['pred_title'] = data['pred_title']
    cross_tab = pd.crosstab(data['pred_title'], data['title'])

    test = cross_tab.divide(cross_tab.sum(axis=1), axis=0)
    result = test.idxmax(axis=1)
    result[test.max(axis=1) < 0.6] = None
    result = result.dropna()
    mapping = result.to_dict()
    data['pred_title'] = data['pred_title'].map(mapping)
    data = data.dropna()
    accuracy = accuracy_score(data['pred_title'], data['title'])
    return accuracy, data, kmeans
```

Here is the output of our function if we have n=3 (Cluster Size) and i=100 (max_iterations). These are in my opinion the two most important parameters for k means clustering in scikitlearn.

In [60]:

```
a, d, m = train(df_filtered, n=3, i=100)
a,d,m
```

Out[60]:

```
(0.7142857142857143,
      title  FIDE  blitz  bullet pred_title
 1       NM  2375   2659    2662         IM
 2       IM  2376   2595    2431         IM
 4       IM  2443   2563    2640         IM
 6       IM  2410   2629    2626         IM
 7       NM  2001   2273    2331         NM
 ..     ...   ...    ...     ...        ...
 667     NM  2100   2344    2431         NM
 668     NM  2106   2216    1913         NM
 669     NM  2126   2276    2259         NM
 670     NM  2119   2310    2203         NM
 671     NM  1988   2205    2064         NM

 [371 rows x 5 columns],
 KMeans(max_iter=100, n_clusters=3))
```

Let's visualize this one

In [61]:

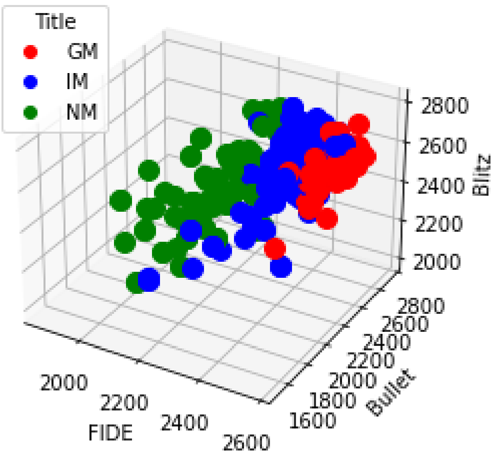
```
colors = {'GM': 'red', 'IM': 'blue', 'NM': 'green'}

fig = plt.figure()
ax = fig.add_subplot(projection='3d')
for i in range(len(d)):
    row = d.iloc[i]
    ax.scatter(row['FIDE'], row['bullet'], row['blitz'], c=colors[row['title']], s=1
ax.set_xlabel('FIDE')
ax.set_ylabel('Bullet')
ax.set_zlabel('Blitz')


handles = [plt.plot([], [], marker='o', ls="", color=color, label=title)[0] for titl
ax.legend(handles=handles, title='Title', loc='upper left')

# https://stackoverflow.com/questions/31303912/matplotlib-pyplot-scatterplot-legend-
# How to get the legend with the colors

plt.show()
```



with 3 clusters we can see it goes in the right direction, but we don't we see a lof mixing here. We should try more clusters and see how it progresses, but lets automate this search.

So, onto automation.

In [62]:

```
results = []
```

In [63]:

```
list_n = list(range(3,15))
list_i = list(range(200,1500,100))

beste = None
top_score = 0
results = []
for n in list_n:
    for i in list_i:
        best = train(df_filtered, n=n, i=i)
        score = best[0]
        if score > top_score:
            top_score = score
            beste = best
        results.append((n, i, score))

df = pd.DataFrame(results, columns=['n', 'i', 'score'])
pivot_table = df.pivot(index='n', columns='i', values='score')
pivot_table.head()
```

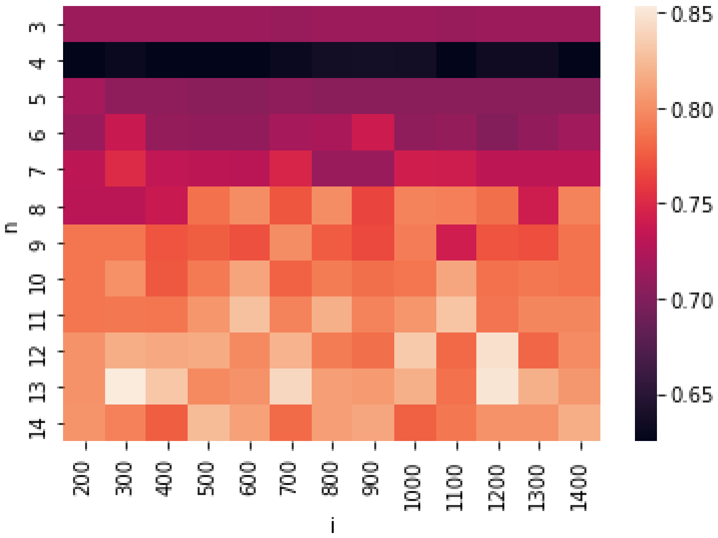
Out[63]:

i	200	300	400	500	600	700	800	900	1000	1100
n										
3	0.714286	0.714286	0.714286	0.714286	0.714286	0.712366	0.714286	0.714286	0.714286	0.712366
4	0.625000	0.631707	0.625000	0.625000	0.625000	0.631707	0.636139	0.637037	0.636364	0.625000
5	0.719626	0.707317	0.707317	0.703883	0.703883	0.707317	0.703883	0.703883	0.703883	0.703883
6	0.713427	0.738041	0.710472	0.708758	0.708758	0.719409	0.721174	0.739857	0.707566	0.710472
7	0.731898	0.751566	0.733333	0.731898	0.729941	0.747934	0.712798	0.712798	0.742138	0.740594

In [64]:

```
sns.heatmap(pivot_table)

plt.show()
```



The lighter the square the better the accuracy. beste variable has stored our best model and accuracy.

In [65]:

```
beste
```

Out[65]:

```
(0.8537037037037037,
     title  FIDE  blitz  bullet pred_title
0       IM  2453   2819    2968         IM
1       NM  2375   2659    2662         IM
2       IM  2376   2595    2431         IM
3       GM  2680   2728    2512         GM
4       IM  2443   2563    2640         IM
..     ...   ...    ...     ...        ...
667     NM  2100   2344    2431         NM
668     NM  2106   2216    1913         NM
669     NM  2126   2276    2259         NM
670     NM  2119   2310    2203         NM
671     NM  1988   2205    2064         NM

[540 rows x 5 columns],
KMeans(n_clusters=13))
```

We have a high amount of clusters at a decent amount iterations as our best result. This is a sensible result.

In [66]:

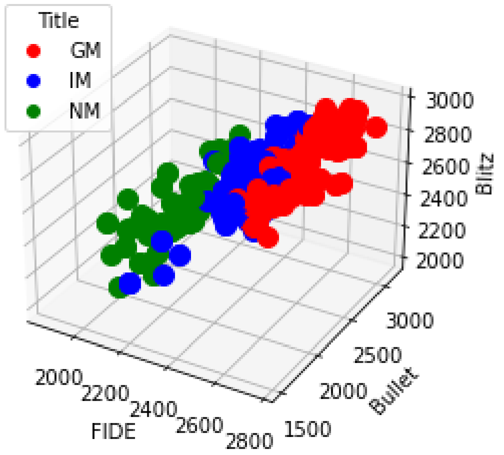
```
colors = {'GM': 'red', 'IM': 'blue', 'NM': 'green'}

fig = plt.figure()
ax = fig.add_subplot(projection='3d')
for i in range(len(beste[1])):
    row = beste[1].iloc[i]
    ax.scatter(row['FIDE'], row['bullet'], row['blitz'], c=colors[row['title']], s=1
ax.set_xlabel('FIDE')
ax.set_ylabel('Bullet')
ax.set_zlabel('Blitz')


handles = [plt.plot([], [], marker='o', ls="", color=color, label=title)[0] for titl
ax.legend(handles=handles, title='Title', loc='upper left')

# https://stackoverflow.com/questions/31303912/matplotlib-pyplot-scatterplot-legend-
# How to get the legend with the colors

plt.show()
```



We can see we have a much better Seperation now, aswell as a good accuracy. For the future one could look into a different approach of classification, as this problem presents a very hard problem for unsupervised learning. An SVM could be good here, I wanted to test KMeans though as I was interested in how it would fair here.

In [ ]: