In [1]:

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

```
C:\Users\user\anaconda3\lib\site-packages\scipy\__init__.py:146: UserWarning: A NumPy version >=1.16.5 and <1.23.0 is required for this version of SciPy (detected version 1.23.2
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
```

In [2]:

```
df = pd.read_csv(r'C:\Users\user\Downloads\archive (4)\Churn_Modelling.csv')
df.head()
```

Out[2]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15634602	Hargrave	619	France	Female	42	2	0.00	1	1	1	101348.88	1
1	2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	0
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	0	113931.57	1
3	4	15701354	Boni	699	France	Female	39	1	0.00	2	0	0	93826.63	0
4	5	15737888	Mitchell	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	0

In [3]:

```
df.columns
```

Out[3]:

```
Index(['RowNumber', 'CustomerId', 'Surname', 'CreditScore', 'Geography',
       'Gender', 'Age', 'Tenure', 'Balance', 'NumOfProducts', 'HasCrCard',
       'IsActiveMember', 'EstimatedSalary', 'Exited'],
      dtype='object')
```

In [4]:

```
df.shape
```

Out[4]:

```
(10000, 14)
```

In [5]:

```
df.describe()
```

Out[5]:

	RowNumber	CustomerId	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
count	10000.00000	1.000000e+04	10000.000000	10000.000000	10000.000000	10000.000000	10000.000000	10000.00000	10000.000000	10000.000000	10000.000000
mean	5000.50000	1.569094e+07	650.528800	38.921800	5.012800	76485.889288	1.530200	0.70550	0.515100	100090.239881	0.203700
std	2886.89568	7.193619e+04	96.653299	10.487806	2.892174	62397.405202	0.581654	0.45584	0.499797	57510.492818	0.402769
min	1.00000	1.556570e+07	350.000000	18.000000	0.000000	0.000000	1.000000	0.00000	0.000000	11.580000	0.000000
25%	2500.75000	1.562853e+07	584.000000	32.000000	3.000000	0.000000	1.000000	0.00000	0.000000	51002.110000	0.000000
50%	5000.50000	1.569074e+07	652.000000	37.000000	5.000000	97198.540000	1.000000	1.00000	1.000000	100193.915000	0.000000
75%	7500.25000	1.575323e+07	718.000000	44.000000	7.000000	127644.240000	2.000000	1.00000	1.000000	149388.247500	0.000000
max	10000.00000	1.581569e+07	850.000000	92.000000	10.000000	250898.090000	4.000000	1.00000	1.000000	199992.480000	1.000000

In [6]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 14 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   RowNumber        10000 non-null  int64  
 1   CustomerId       10000 non-null  int64  
 2   Surname          10000 non-null  object 
 3   CreditScore      10000 non-null  int64  
 4   Geography        10000 non-null  object 
 5   Gender           10000 non-null  object 
 6   Age              10000 non-null  int64  
 7   Tenure           10000 non-null  int64  
 8   Balance          10000 non-null  float64
 9   NumOfProducts    10000 non-null  int64  
 10  HasCrCard        10000 non-null  int64  
 11  IsActiveMember   10000 non-null  int64  
 12  EstimatedSalary  10000 non-null  float64
 13  Exited           10000 non-null  int64  
dtypes: float64(2), int64(9), object(3)
memory usage: 1.1+ MB
```

In [7]:

```
print(df['Geography'].unique())
print(df['Gender'].unique())
print(df['NumOfProducts'].unique())
print(df['HasCrCard'].unique())
print(df['IsActiveMember'].unique())
```

```
['France' 'Spain' 'Germany']
['Female' 'Male']
[1 3 2 4]
[1 0]
[1 0]
```

In [8]:

```
df.isnull().sum()/100*len(df)
```

Out[8]:

```
RowNumber          0.0
CustomerId         0.0
Surname            0.0
CreditScore        0.0
Geography          0.0
Gender             0.0
Age                0.0
Tenure             0.0
Balance            0.0
NumOfProducts      0.0
HasCrCard          0.0
IsActiveMember     0.0
EstimatedSalary    0.0
Exited             0.0
dtype: float64
```

In [9]:

```
df.head()
```

Out[9]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15634602	Hargrave	619	France	Female	42	2	0.00	1	1	1	101348.88	1
1	2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	0
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	0	113931.57	1
3	4	15701354	Boni	699	France	Female	39	1	0.00	2	0	0	93826.63	0
4	5	15737888	Mitchell	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	0

In [10]:

```
final_df=df[['CreditScore','Geography','Gender','Age','Tenure','Balance','NumOfProducts','HasCrCard','IsActiveMember','EstimatedSalary','Exited']]
final_df.head()
```

Out[10]:

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	619	France	Female	42	2	0.00	1	1	1	101348.88	1
1	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	0
2	502	France	Female	42	8	159660.80	3	1	0	113931.57	1
3	699	France	Female	39	1	0.00	2	0	0	93826.63	0
4	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	0

In [11]:

```
final_df = pd.get_dummies(final_df, drop_first=True)
final_df.head()
```

Out[11]:

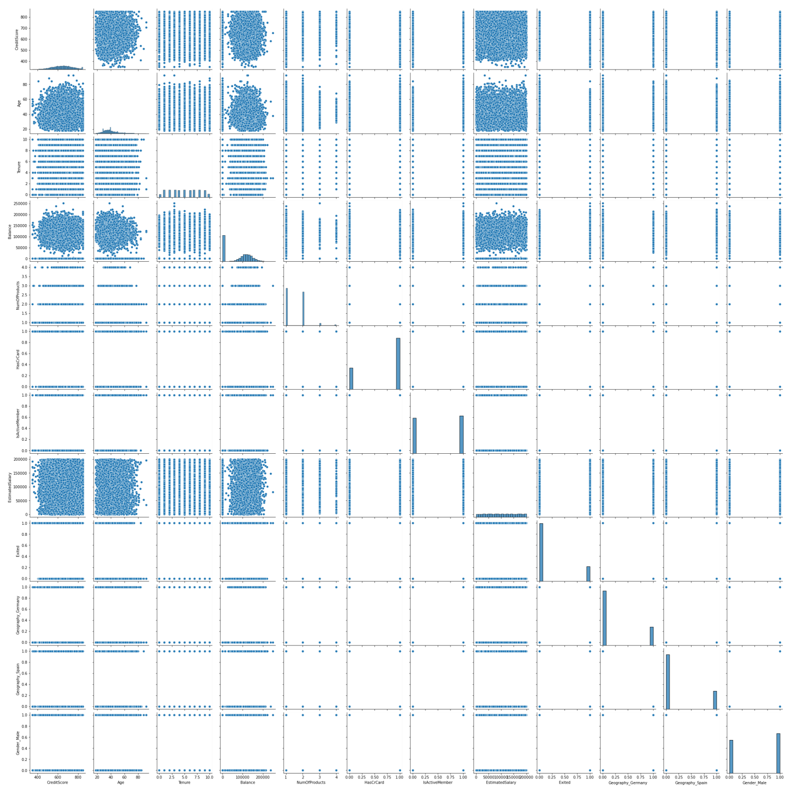
	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited	Geography_Germany	Geography_Spain	Gender_Male
0	619	42	2	0.00	1	1	1	101348.88	1	0	0	0
1	608	41	1	83807.86	1	0	1	112542.58	0	0	1	0
2	502	42	8	159660.80	3	1	0	113931.57	1	0	0	0
3	699	39	1	0.00	2	0	0	93826.63	0	0	0	0
4	850	43	2	125510.82	1	1	1	79084.10	0	0	1	0

In [12]:

```
sns.pairplot(final_df)
```

Out[12]:

```
<seaborn.axisgrid.PairGrid at 0x24af37c7580>
```

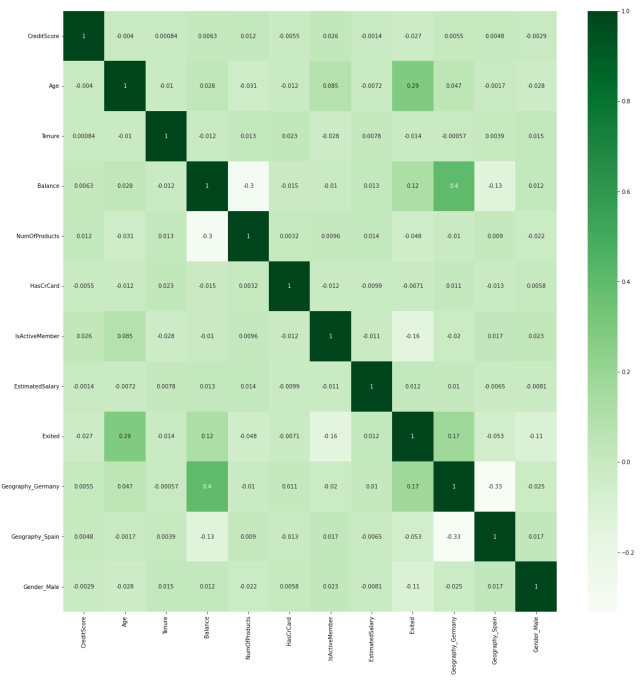


In [13]:

```
corr = final_df.corr()
top_corr_features = corr.index
plt.figure(figsize=(20,20))
sns.heatmap(final_df[top_corr_features].corr(), annot=True, cmap='Greens')
```

Out[13]:

```
<AxesSubplot:>
```



In [14]:

```
final_df.head()
```

Out[14]:

	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited	Geography_Germany	Geography_Spain	Gender_Male
0	619	42	2	0.00	1	1	1	101348.88	1	0	0	0
1	608	41	1	83807.86	1	0	1	112542.58	0	0	1	0
2	502	42	8	159660.80	3	1	0	113931.57	1	0	0	0
3	699	39	1	0.00	2	0	0	93826.63	0	0	0	0
4	850	43	2	125510.82	1	1	1	79084.10	0	0	1	0

In [15]:

```
X = final_df.iloc[:, [0,1,2,3,4,5,6,7,9,10,11]]
y = final_df.iloc[:, 8].values
```

In [16]:

```
X.head()
```

Out[16]:

	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Geography_Germany	Geography_Spain	Gender_Male
0	619	42	2	0.00	1	1	1	101348.88	0	0	0
1	608	41	1	83807.86	1	0	1	112542.58	0	1	0
2	502	42	8	159660.80	3	1	0	113931.57	0	0	0
3	699	39	1	0.00	2	0	0	93826.63	0	0	0
4	850	43	2	125510.82	1	1	1	79084.10	0	1	0

In [17]:

```
y
```

Out[17]:

```
array([1, 0, 1, ..., 1, 1, 0], dtype=int64)
```

In [18]:

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2, random_state = 42)
```

In [19]:

```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

In [20]:

```
print(X_train)
```

```
[[ 0.35649971 -0.6557859   0.34567966 ... -0.57946723 -0.57638802
   0.91324755]
 [-0.20389777  0.29493847 -0.3483691  ...  1.72572313 -0.57638802
   0.91324755]
 [-0.96147213 -1.41636539 -0.69539349 ... -0.57946723  1.73494238
   0.91324755]
 ...
 [ 0.86500853 -0.08535128 -1.38944225 ... -0.57946723 -0.57638802
  -1.09499335]
 [ 0.15932282  0.3900109   1.03972843 ... -0.57946723 -0.57638802
   0.91324755]
 [ 0.47065475  1.15059039 -1.38944225 ...  1.72572313 -0.57638802
   0.91324755]]
```

In [21]:

```
from sklearn.ensemble import ExtraTreesRegressor
model = ExtraTreesRegressor()
model.fit(X,y)
```

Out[21]:

```
ExtraTreesRegressor()
```

In [22]:

```
print(model.feature_importances_)
```

```
[0.11942737 0.23685857 0.10349055 0.12882935 0.14359871 0.03140217
 0.04397227 0.11848181 0.02929549 0.02165771 0.022986  ]
```

In [23]:

```
from sklearn.ensemble import RandomForestClassifier
rf = RandomForestClassifier()
rf.fit(X_train,y_train)
```

Out[23]:

```
RandomForestClassifier()
```

In [24]:

```
y_pred = rf.predict(X_test)
```

In [25]:

```
from sklearn.metrics import accuracy_score, confusion_matrix
cm = confusion_matrix(y_test,y_pred)
print(cm)
print(accuracy_score(y_test,y_pred))
```

```
[[1546   61]
 [ 201  192]]
0.869
```

In [26]:

```
plt.figure(figsize=(16,8))
plt.plot(y_test,label='actual value')
plt.plot(y_pred,label='predicted value',color='yellow')
plt.title('actual value vs predicted value')
plt.legend()
plt.show()
```

In [ ]:

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