In [1]:

```
import pandas as pd
```

In [2]:

```
df = pd.read_csv('electronic_payment.csv')
```

In [3]:

```
df.head()
```

Out[3]:

	step	type	amount	nameOrig	oldbalanceOrg	newbalanceOrig	nameDest
0	1	PAYMENT	9839.64	C1231006815	170136.0	160296.36	M1979787155
1	1	PAYMENT	1864.28	C1666544295	21249.0	19384.72	M2044282225
2	1	TRANSFER	181.00	C1305486145	181.0	0.00	C553264065
3	1	CASH_OUT	181.00	C840083671	181.0	0.00	C38997010
4	1	PAYMENT	11668.14	C2048537720	41554.0	29885.86	M1230701703

In [4]:

```
df.tail()
```

Out[4]:

	step	type	amount	nameOrig	oldbalanceOrg	newbalanceOrig	nam
1048570	95	CASH_OUT	132557.35	C1179511630	479803.00	347245.65	C4356
1048571	95	PAYMENT	9917.36	C1956161225	90545.00	80627.64	M6683
1048572	95	PAYMENT	14140.05	C2037964975	20545.00	6404.95	M13551
1048573	95	PAYMENT	10020.05	C1633237354	90605.00	80584.95	M19649
1048574	95	PAYMENT	11450.03	C1264356443	80584.95	69134.92	M6775

In [5]:

```
df.shape
```

Out[5]:

```
(1048575, 11)
```

In [6]:

```
df.columns
```

Out[6]:

```
Index(['step', 'type', 'amount', 'nameOrig', 'oldbalanceOrg', 'newbalanceO
rig',
       'nameDest', 'oldbalanceDest', 'newbalanceDest', 'isFraud',
       'isFlaggedFraud'],
      dtype='object')
```

In [7]:

```
df.duplicated().sum()
```

Out[7]:

```
0
```

In [8]:

```
df.isnull().sum()
```

Out[8]:

```
step              0
type              0
amount            0
nameOrig          0
oldbalanceOrg     0
newbalanceOrig    0
nameDest          0
oldbalanceDest    0
newbalanceDest    0
isFraud           0
isFlaggedFraud    0
dtype: int64
```

In [9]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1048575 entries, 0 to 1048574
Data columns (total 11 columns):
 #   Column          Non-Null Count    Dtype  
---  ------          --------------    -----  
 0   step            1048575 non-null  int64  
 1   type            1048575 non-null  object 
 2   amount          1048575 non-null  float64
 3   nameOrig        1048575 non-null  object 
 4   oldbalanceOrg   1048575 non-null  float64
 5   newbalanceOrig  1048575 non-null  float64
 6   nameDest        1048575 non-null  object 
 7   oldbalanceDest  1048575 non-null  float64
 8   newbalanceDest  1048575 non-null  float64
 9   isFraud         1048575 non-null  int64  
 10  isFlaggedFraud  1048575 non-null  int64  
dtypes: float64(5), int64(3), object(3)
memory usage: 88.0+ MB
```

In [10]:

```
df.describe()
```

Out[10]:

	step	amount	oldbalanceOrg	newbalanceOrig	oldbalanceDest	newbala
count	1.048575e+06	1.048575e+06	1.048575e+06	1.048575e+06	1.048575e+06	1.048
mean	2.696617e+01	1.586670e+05	8.740095e+05	8.938089e+05	9.781600e+05	1.114
std	1.562325e+01	2.649409e+05	2.971751e+06	3.008271e+06	2.296780e+06	2.416
min	1.000000e+00	1.000000e-01	0.000000e+00	0.000000e+00	0.000000e+00	0.000
25%	1.500000e+01	1.214907e+04	0.000000e+00	0.000000e+00	0.000000e+00	0.000
50%	2.000000e+01	7.634333e+04	1.600200e+04	0.000000e+00	1.263772e+05	2.182
75%	3.900000e+01	2.137619e+05	1.366420e+05	1.746000e+05	9.159235e+05	1.149
max	9.500000e+01	1.000000e+07	3.890000e+07	3.890000e+07	4.210000e+07	4.220

In [11]:

```
df.nunique()
```

Out[11]:

```
step                   95
type                    5
amount            1009606
nameOrig          1048317
oldbalanceOrg      391033
newbalanceOrig     440792
nameDest           449635
oldbalanceDest     590110
newbalanceDest     437054
isFraud                 2
isFlaggedFraud          1
dtype: int64
```

In [12]:

```
object_columns = df.select_dtypes(include=['object']).columns
print("Object type columns:")
print(object_columns)

numerical_columns = df.select_dtypes(include=['int', 'float']).columns
print("\nNumerical type columns:")
print(numerical_columns)
```

```
Object type columns:
Index(['type', 'nameOrig', 'nameDest'], dtype='object')

Numerical type columns:
Index(['step', 'amount', 'oldbalanceOrg', 'newbalanceOrig', 'oldbalanceDes
t',
       'newbalanceDest', 'isFraud', 'isFlaggedFraud'],
      dtype='object')
```

In [13]:

```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [14]:

```
import numpy as np
```

In [15]:

```
import warnings
warnings.filterwarnings('ignore')
```

In [16]:

```
df['step'].unique()
```

Out[16]:

```
array([ 1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16, 17,
       18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34,
       35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51,
       52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68,
       69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85,
       86, 87, 88, 89, 90, 91, 92, 93, 94, 95], dtype=int64)
```

In [17]:

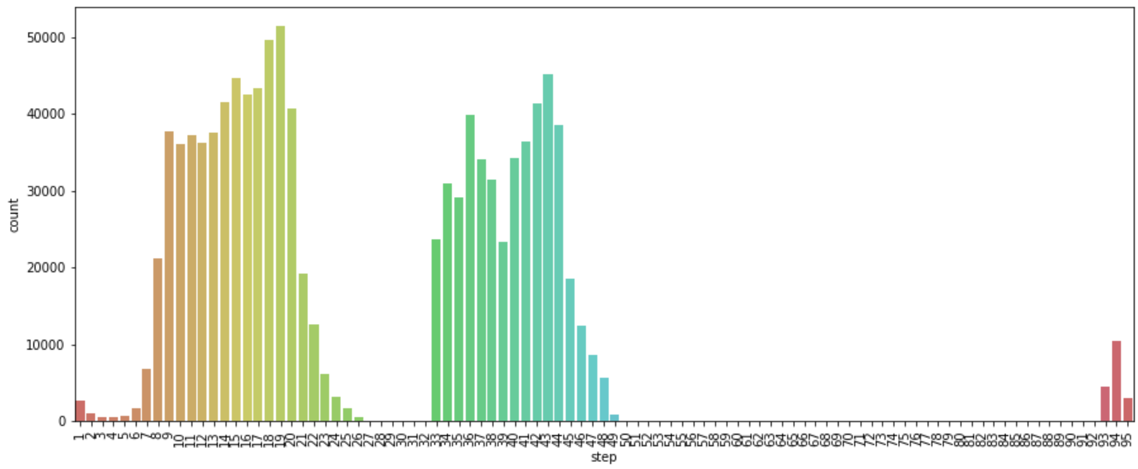
```
df['step'].value_counts()
```

Out[17]:

```
19    51352
18    49579
43    45060
15    44609
17    43361
      ...
67        6
54        4
76        4
28        4
29        4
Name: step, Length: 95, dtype: int64
```

In [18]:

```
plt.figure(figsize=(15,6))
sns.countplot(df['step'], data = df, palette = 'hls')
plt.xticks(rotation = 90)
plt.show()
```



In [19]:

```
df['type'].unique()
```

Out[19]:

```
array(['PAYMENT', 'TRANSFER', 'CASH_OUT', 'DEBIT', 'CASH_IN'],
      dtype=object)
```

In [20]:

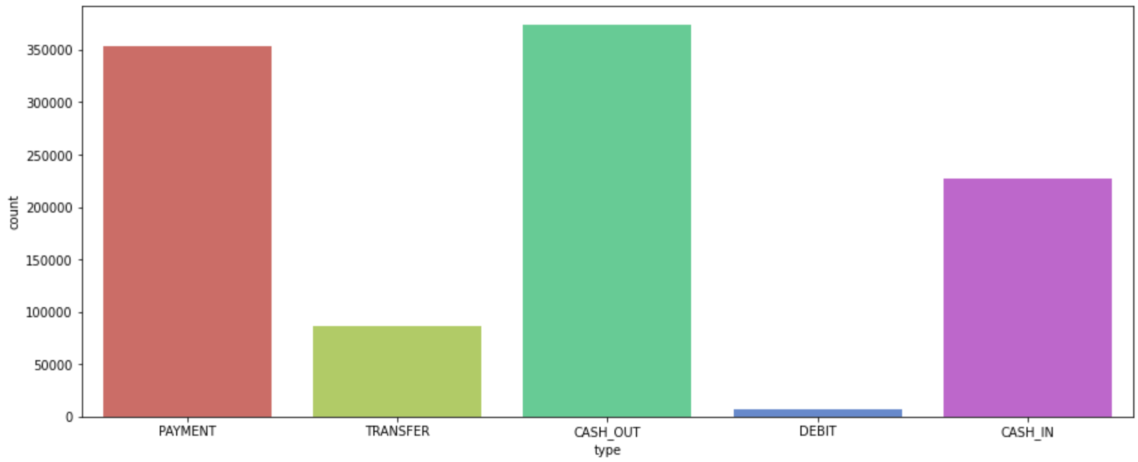
```
df['type'].value_counts()
```

Out[20]:

```
CASH_OUT    373641
PAYMENT     353873
CASH_IN     227130
TRANSFER     86753
DEBIT         7178
Name: type, dtype: int64
```

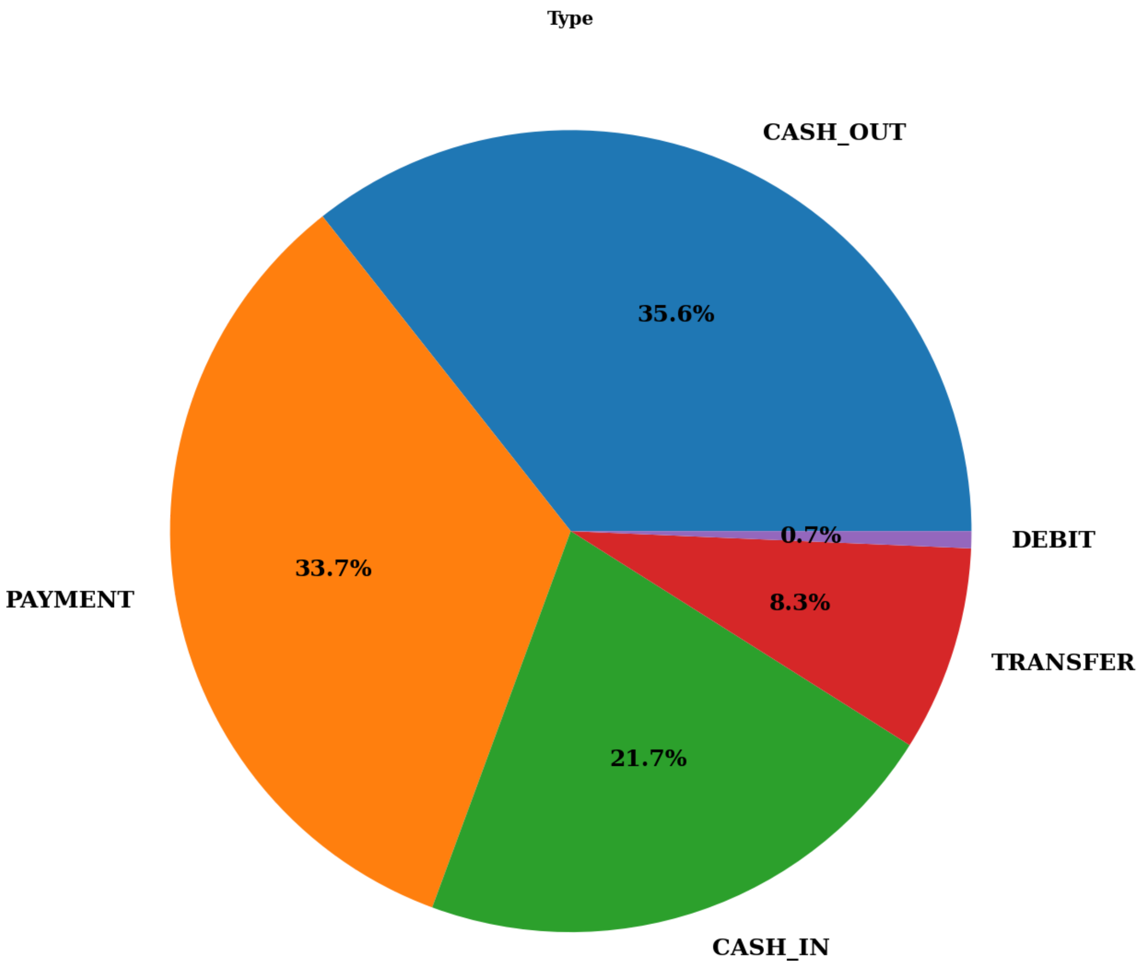
In [21]:

```
plt.figure(figsize=(15,6))
sns.countplot(df['type'], data = df, palette = 'hls')
plt.show()
```



In [22]:

```
plt.figure(figsize=(30,20))
plt.pie(df['type'].value_counts(), labels=df['type'].value_counts().index, autopct='%1.1
                                                     'color': 'black',
                                                     'weight': 'bold',
                                                     'family': 'serif' })
hfont = {'fontname':'serif', 'weight': 'bold'}
plt.title('Type', size=20, **hfont)
plt.show()
```



In [23]:

```
import plotly.express as px
import plotly.graph_objects as go
```

In [24]:

```
bar_chart_type = px.bar(df['type'].value_counts(), title='Frequency of Transaction Types
bar_chart_type.show()
```

In [25]:

```
pie_chart_type = go.Figure(data=[go.Pie(labels=df['type'].unique(), values=df['type'].va
pie_chart_type.update_layout(title='Proportion of Transaction Types')
pie_chart_type.show()
```

In [26]:

```
df['isFraud'].unique()
```

Out[26]:

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

In [27]:

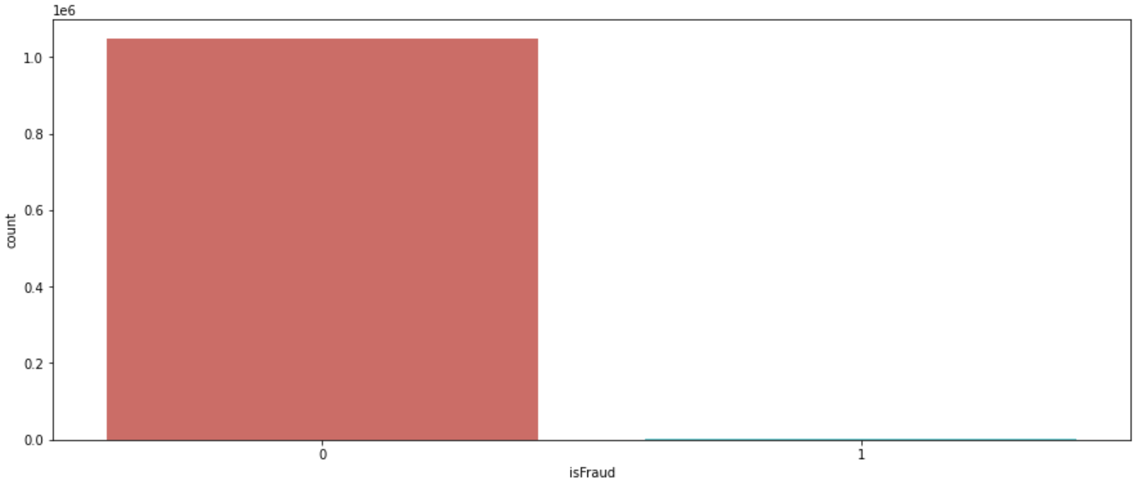
```
df['isFraud'].value_counts()
```

Out[27]:

```
0    1047433
1       1142
Name: isFraud, dtype: int64
```

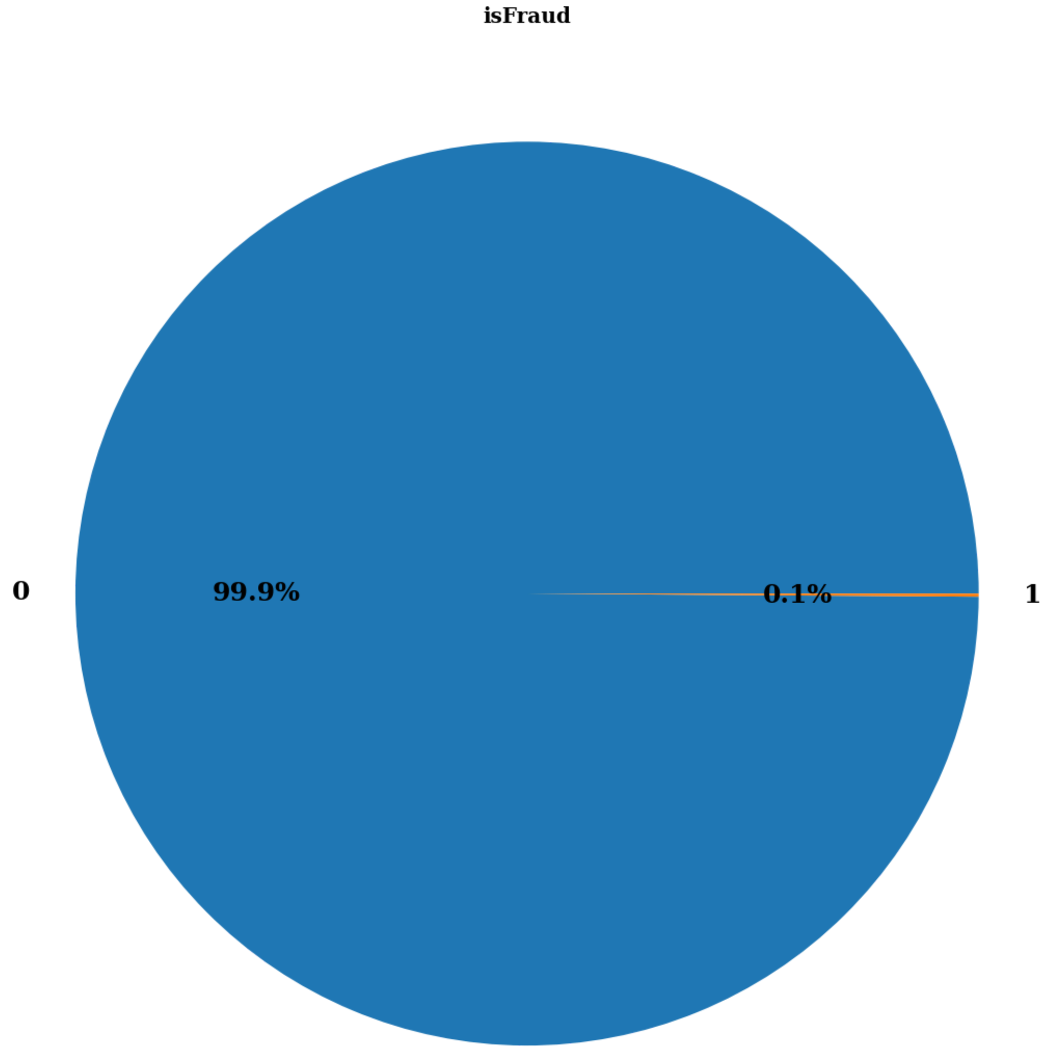
In [28]:

```
plt.figure(figsize=(15,6))
sns.countplot(df['isFraud'], data = df, palette = 'hls')
plt.show()
```



In [29]:

```
plt.figure(figsize=(30,20))
plt.pie(df['isFraud'].value_counts(), labels=df['isFraud'].value_counts().index, autopct
                                            'color': 'black',
                                            'weight': 'bold',
                                            'family': 'serif' })
hfont = {'fontname':'serif', 'weight': 'bold'}
plt.title('isFraud', size=20, **hfont)
plt.show()
```



In [30]:

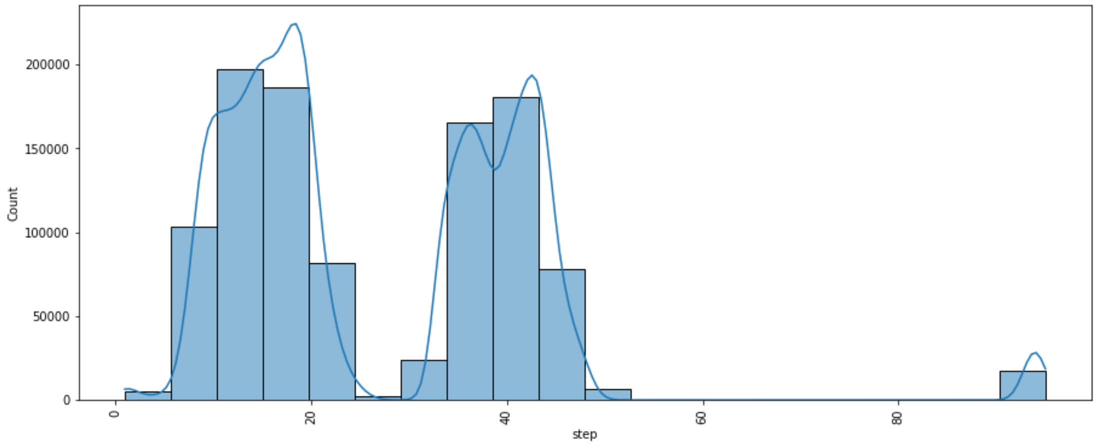
```
bar_chart_type = px.bar(df['isFraud'].value_counts(), title='Frequency of Fraudulent Tra
bar_chart_type.show()
```

In [31]:

```
pie_chart_fraud = go.Figure(data=[go.Pie(labels=df['isFraud'].unique(), values=df['isFra
pie_chart_fraud.update_layout(title='Proportion of Fraudulent Transactions')
pie_chart_fraud.show()
```

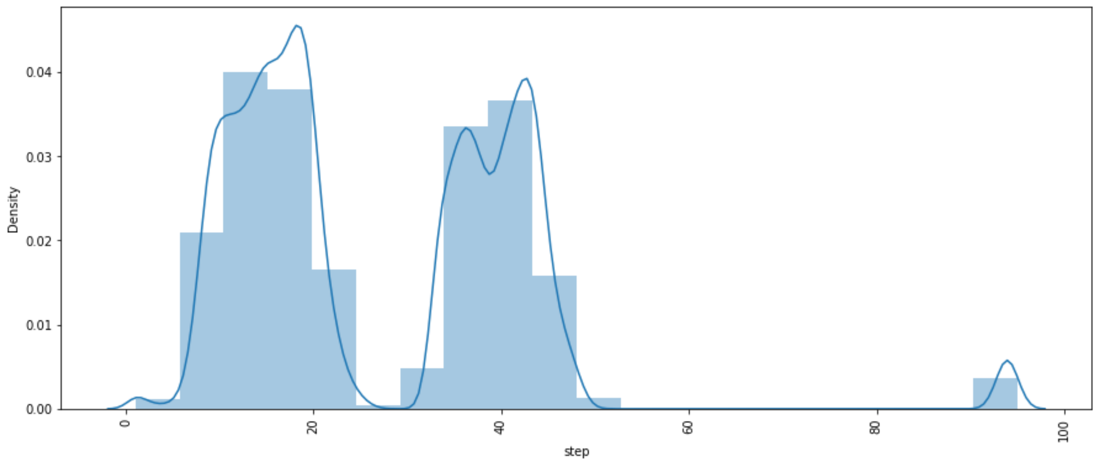
In [32]:

```python
for i in numerical_columns:
    if i != 'isFraud':
        if i != 'isFlaggedFraud':
            plt.figure(figsize=(15,6))
            sns.histplot(df[i], kde = True, bins = 20, palette = 'hls')
            plt.xticks(rotation = 90)
            plt.show()
```



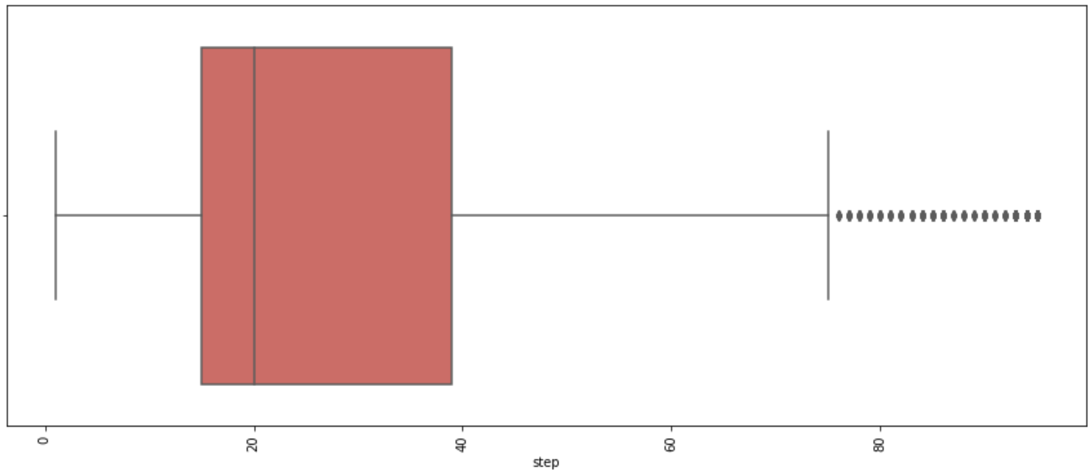
In [33]:

```python
for i in numerical_columns:
    if i != 'isFraud':
        if i != 'isFlaggedFraud':
            plt.figure(figsize=(15,6))
            sns.distplot(df[i], kde = True, bins = 20)
            plt.xticks(rotation = 90)
            plt.show()
```



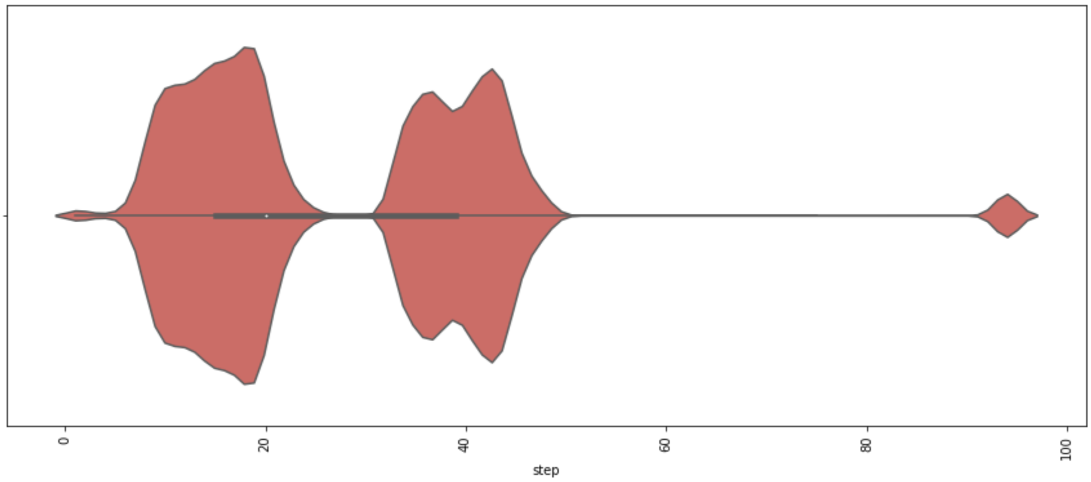
In [34]:

```
for i in numerical_columns:
    if i != 'isFraud':
        if i != 'isFlaggedFraud':
            plt.figure(figsize=(15,6))
            sns.boxplot(df[i], data = df, palette = 'hls')
            plt.xticks(rotation = 90)
            plt.show()
```



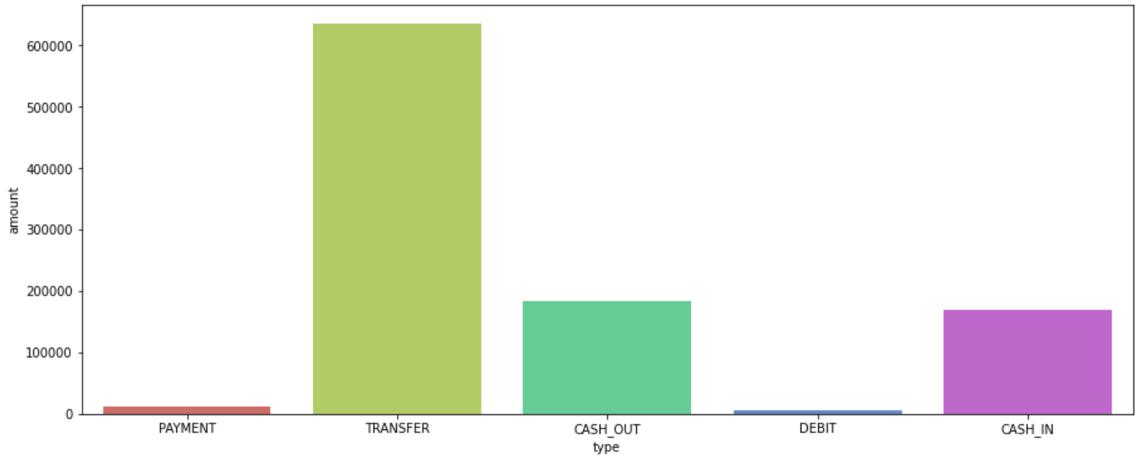
In [35]:

```
for i in numerical_columns:
    if i != 'isFraud':
        if i != 'isFlaggedFraud':
            plt.figure(figsize=(15,6))
            sns.violinplot(df[i], data = df, palette = 'hls')
            plt.xticks(rotation = 90)
            plt.show()
```



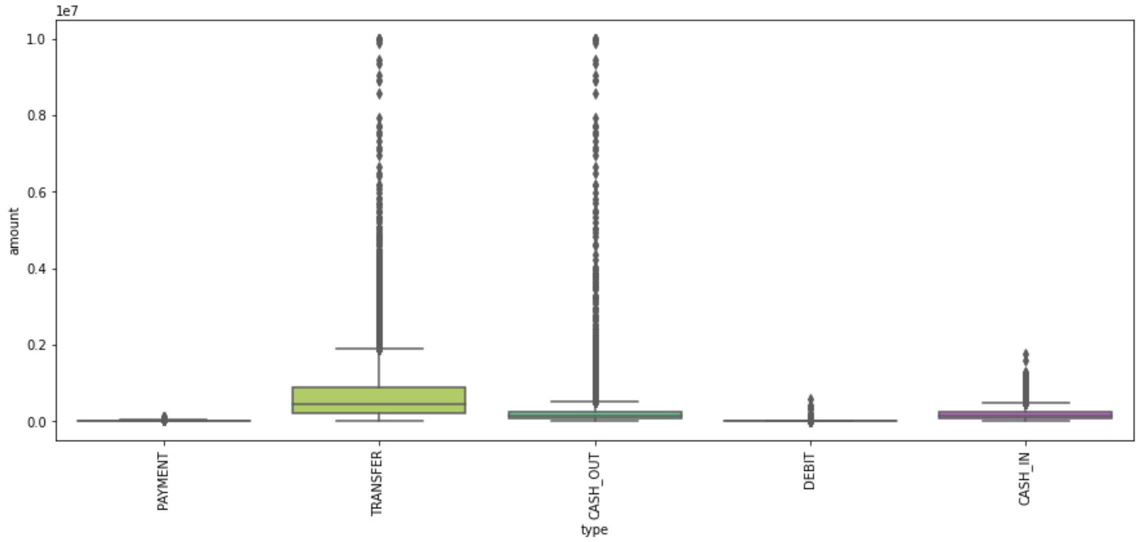
In [36]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['type'], y = df['amount'], data = df, ci = None, palette = 'hls')
plt.show()
```



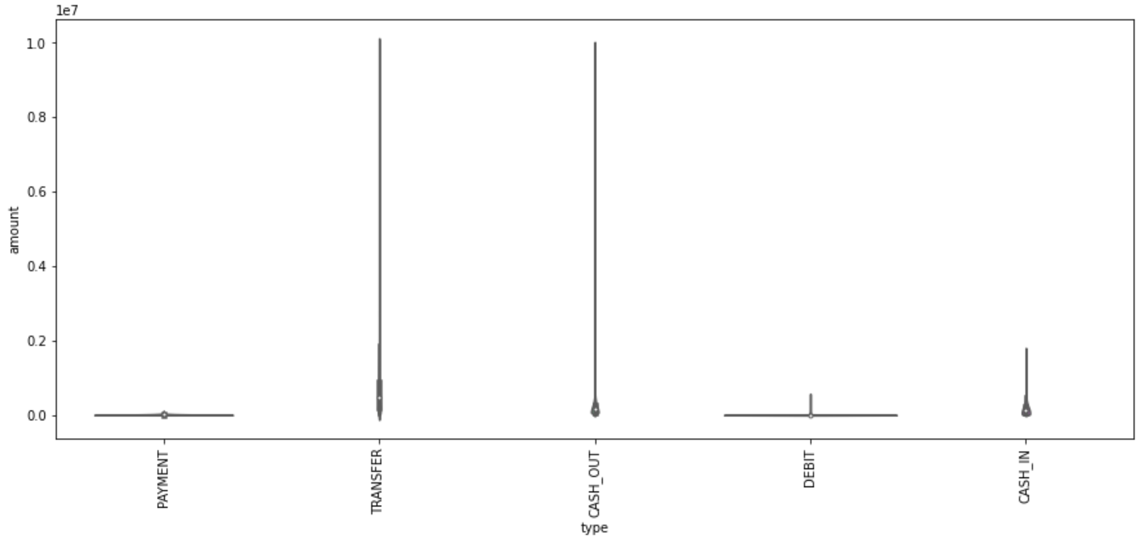
In [37]:

```
plt.figure(figsize=(15,6))
sns.boxplot(x = df['type'], y = df['amount'], data = df, palette = 'hls')
plt.xticks(rotation = 90)
plt.show()
```



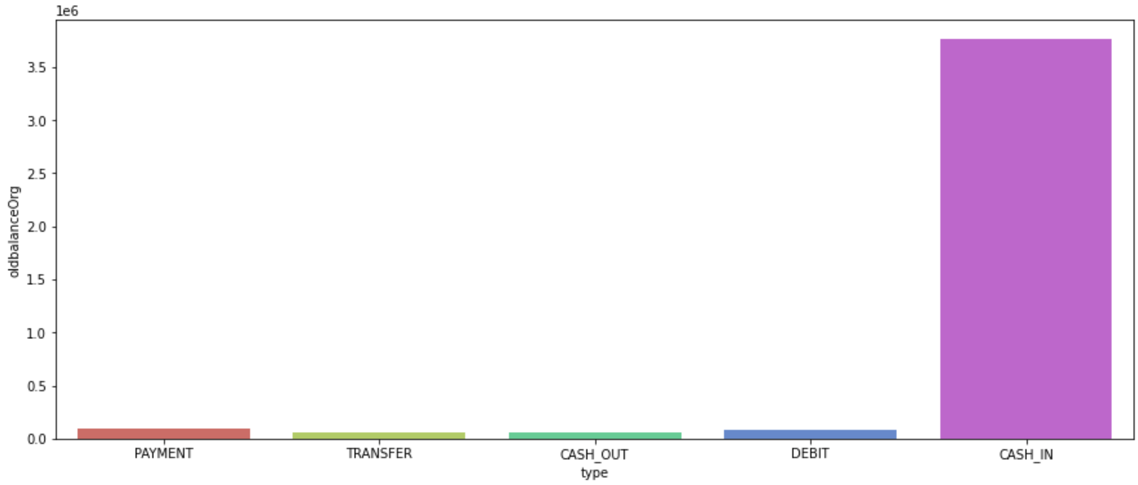
In [38]:

```
plt.figure(figsize=(15,6))
sns.violinplot(x = df['type'], y = df['amount'], data = df, palette = 'hls')
plt.xticks(rotation = 90)
plt.show()
```



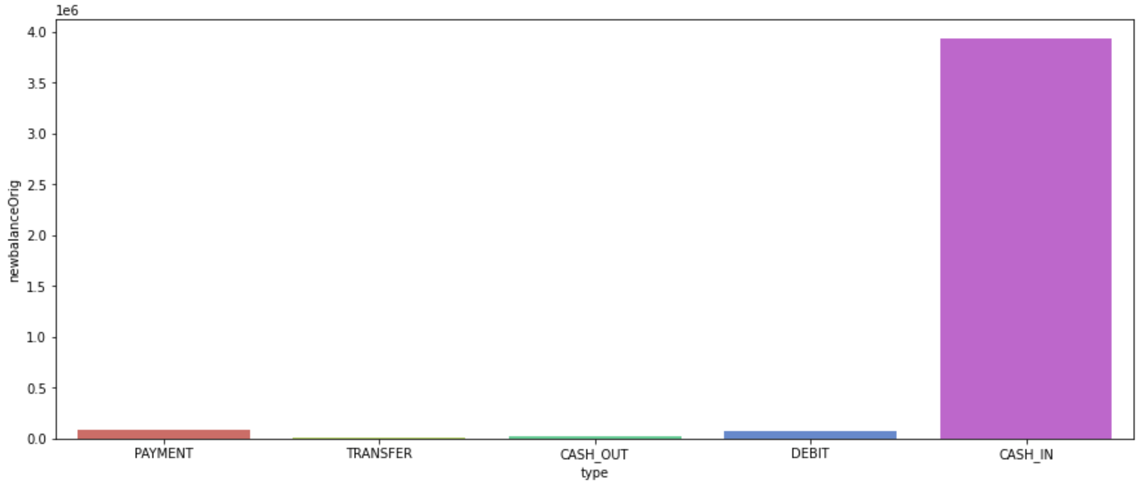
In [39]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['type'], y = df['oldbalanceOrg'], data = df, ci = None, palette = 'hl
plt.show()
```



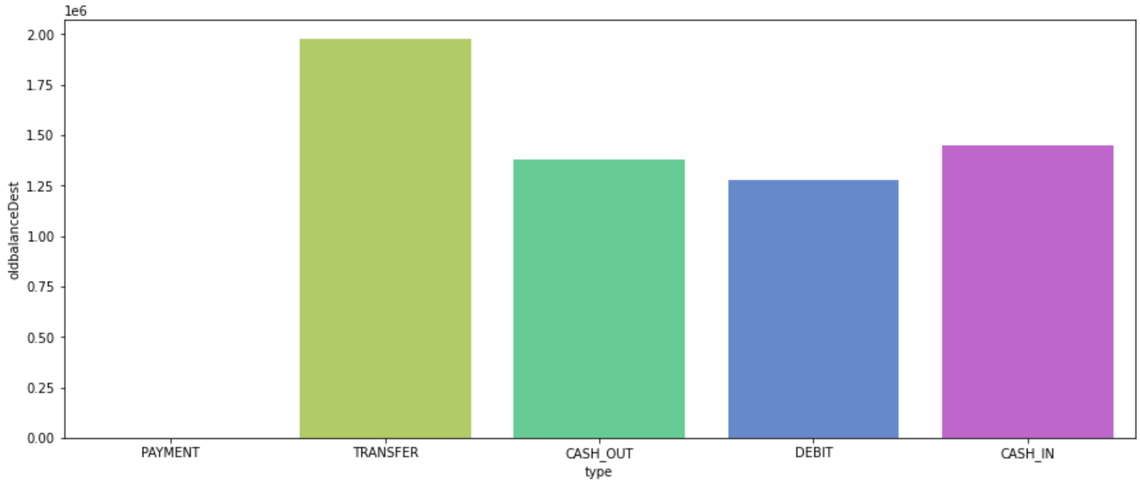
In [40]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['type'], y = df['newbalanceOrig'], data = df, ci = None, palette = 'h
plt.show()
```



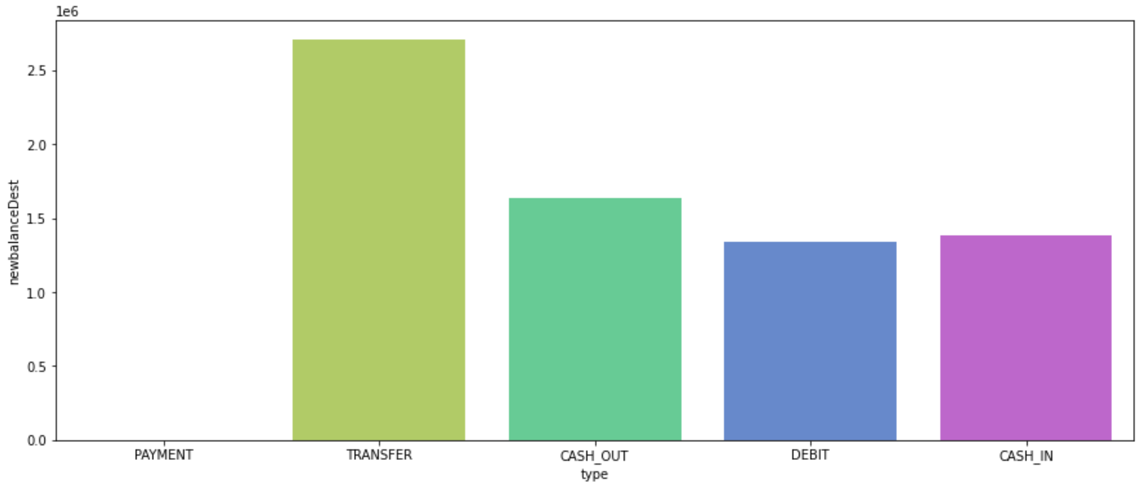
In [41]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['type'], y = df['oldbalanceDest'], data = df, ci = None, palette = 'h
plt.show()
```



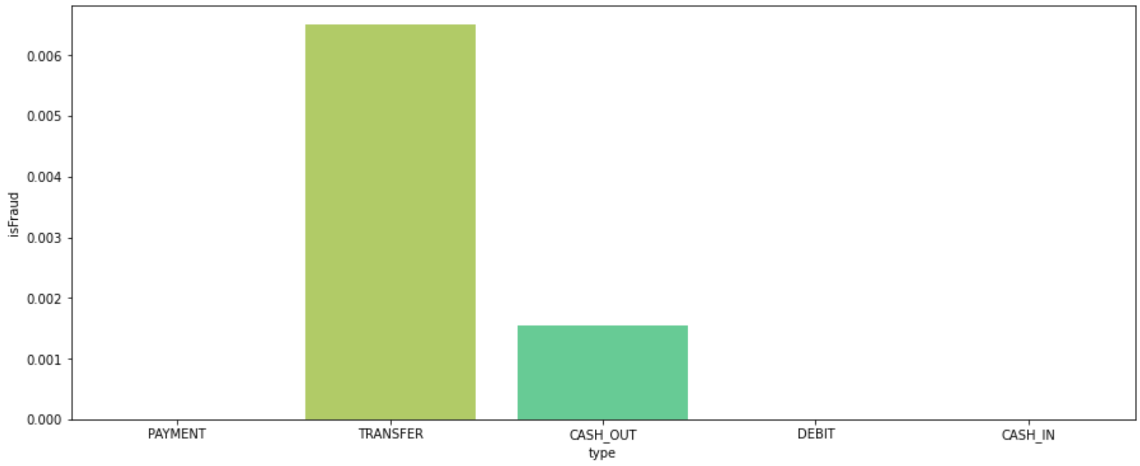
In [42]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['type'], y = df['newbalanceDest'], data = df, ci = None, palette = 'h
plt.show()
```



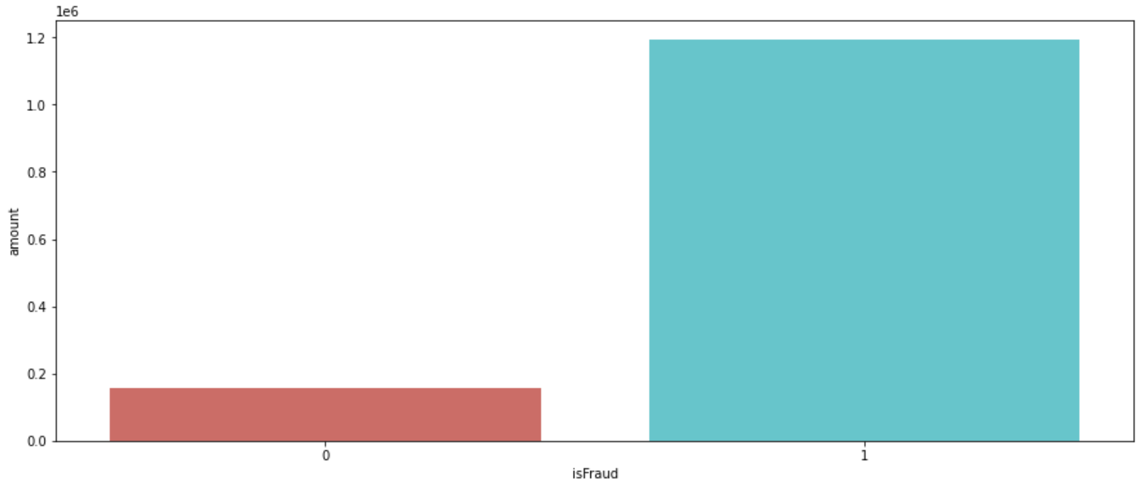
In [43]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['type'], y = df['isFraud'], data = df, ci = None, palette = 'hls')
plt.show()
```



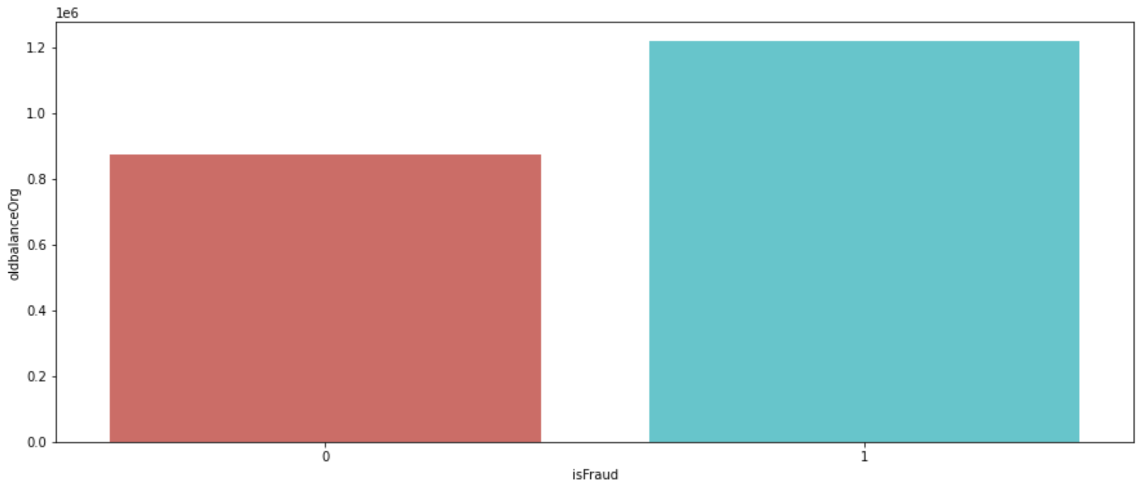
In [44]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['isFraud'], y = df['amount'], data = df, ci = None, palette = 'hls')
plt.show()
```



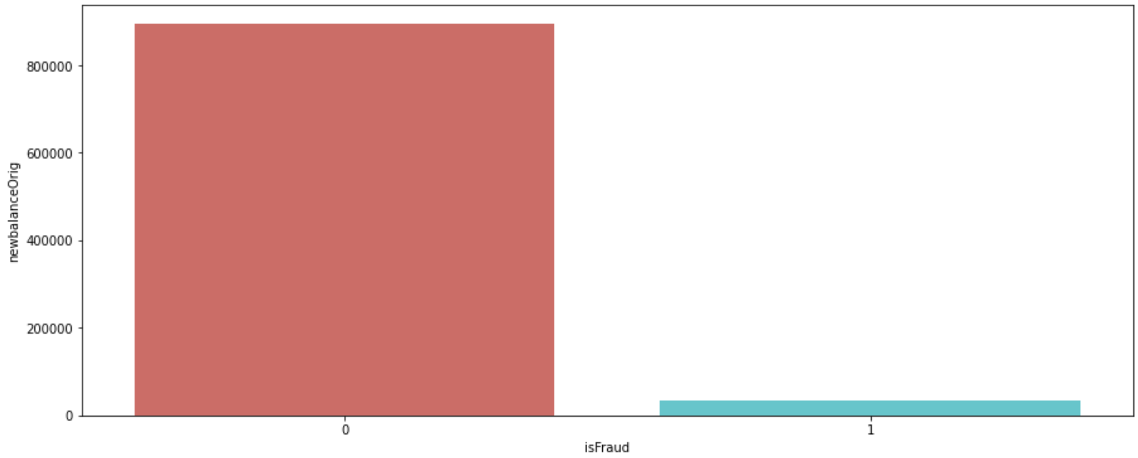
In [45]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['isFraud'], y = df['oldbalanceOrg'], data = df, ci = None, palette =
plt.show()
```



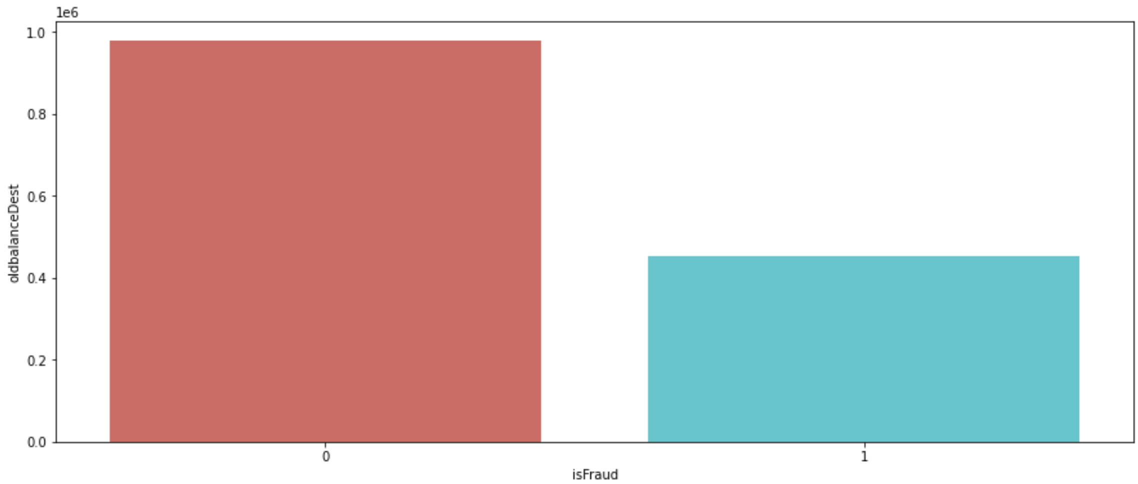
In [46]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['isFraud'], y = df['newbalanceOrig'], data = df, ci = None, palette =
plt.show()
```



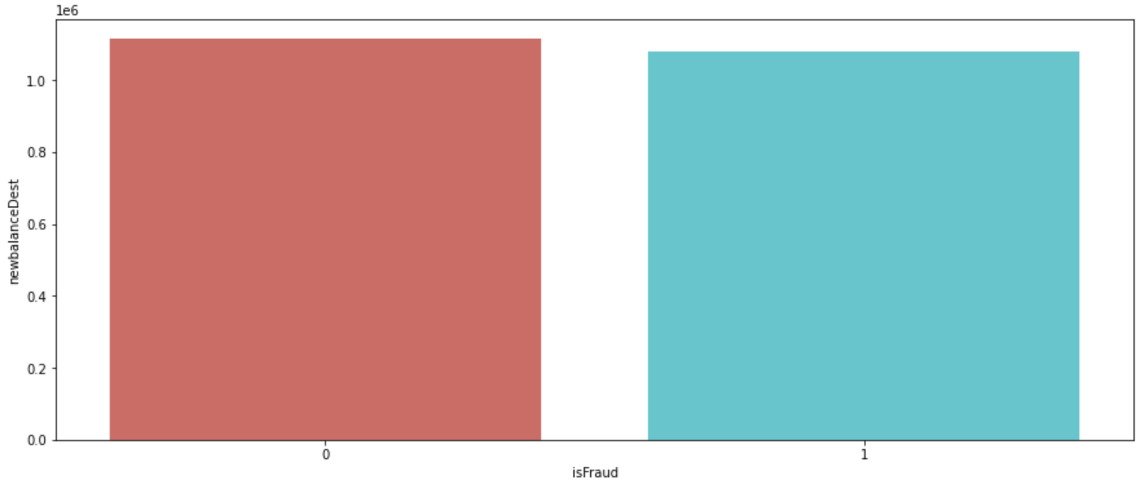
In [47]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['isFraud'], y = df['oldbalanceDest'], data = df, ci = None, palette =
plt.show()
```



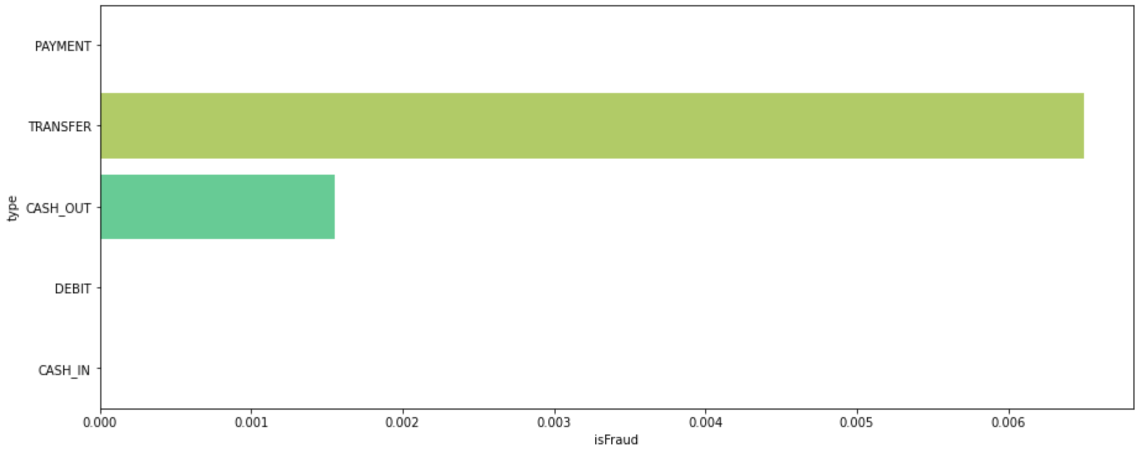
In [48]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['isFraud'], y = df['newbalanceDest'], data = df, ci = None, palette =
plt.show()
```



In [49]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df['isFraud'], y = df['type'], data = df, ci = None, palette = 'hls')
plt.show()
```



In [50]:

```
df = df.drop(['nameOrig', 'nameDest', 'isFlaggedFraud'], axis = 1)
```

In [51]:

```
df_corr = df.corr()
```

In [52]:

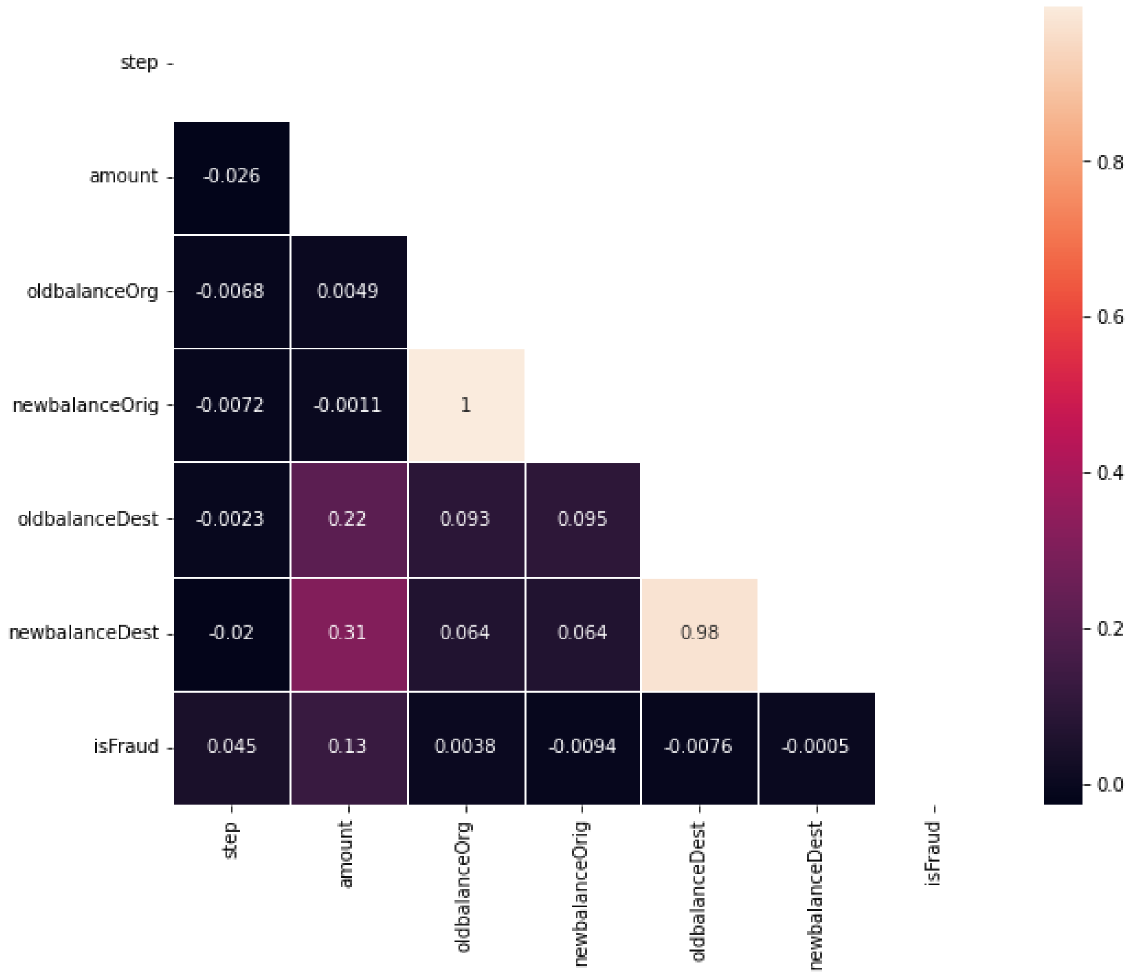
```
df_corr
```

Out[52]:

	step	amount	oldbalanceOrg	newbalanceOrig	oldbalanceDest	newb
step	1.000000	-0.025996	-0.006780	-0.007180	-0.002251	
amount	-0.025996	1.000000	0.004864	-0.001133	0.215558	
oldbalanceOrg	-0.006780	0.004864	1.000000	0.999047	0.093305	
newbalanceOrig	-0.007180	-0.001133	0.999047	1.000000	0.095182	
oldbalanceDest	-0.002251	0.215558	0.093305	0.095182	1.000000	
newbalanceDest	-0.019503	0.311936	0.064049	0.063725	0.978403	
isFraud	0.045030	0.128862	0.003829	-0.009438	-0.007552	

In [53]:

```
plt.figure(figsize=(10, 8))
matrix = np.triu(df_corr)
sns.heatmap(df_corr, annot=True, linewidth=.8, mask=matrix, cmap="rocket");
plt.show()
```



In [54]:

```
df_new = df.copy()
```

In [55]:

```
df_new['step_day_of_week'] = df_new['step'] % 7
df_new['step_month'] = (df_new['step'] - 1) // 30 + 1

df_new['log_amount'] = np.log1p(df_new['amount'])
df_new['sqrt_amount'] = np.sqrt(df_new['amount'])

df_new['balance_diff_orig'] = df_new['newbalanceOrig'] - df_new['oldbalanceOrg']
df_new['balance_diff_dest'] = df_new['newbalanceDest'] - df_new['oldbalanceDest']

df_encoded = pd.get_dummies(df_new['type'], prefix='type', drop_first=True)
df_new = pd.concat([df_new, df_encoded], axis=1)

df_new['amount_mean_rolling'] = df_new['amount'].rolling(window=3).mean()
df_new['amount_sum_7_days'] = df_new['amount'].rolling(window=7).sum()

df_new['amount_oldbalanceOrg'] = df_new['amount'] * df_new['oldbalanceOrg']
df_new['amount_newbalanceOrig'] = df_new['amount'] * df_new['newbalanceOrig']
```

In [56]:

```
df_new.head()
```

Out[56]:

	step	type	amount	oldbalanceOrg	newbalanceOrig	oldbalanceDest	newbalanceD
0	1	PAYMENT	9839.64	170136.0	160296.36	0.0	
1	1	PAYMENT	1864.28	21249.0	19384.72	0.0	
2	1	TRANSFER	181.00	181.0	0.00	0.0	
3	1	CASH_OUT	181.00	181.0	0.00	21182.0	
4	1	PAYMENT	11668.14	41554.0	29885.86	0.0	

5 rows × 22 columns

In [57]:

```
df_new.tail()
```

Out[57]:

	step	type	amount	oldbalanceOrg	newbalanceOrig	oldbalanceDest	newb
1048570	95	CASH_OUT	132557.35	479803.00	347245.65	484329.37	
1048571	95	PAYMENT	9917.36	90545.00	80627.64	0.00	
1048572	95	PAYMENT	14140.05	20545.00	6404.95	0.00	
1048573	95	PAYMENT	10020.05	90605.00	80584.95	0.00	
1048574	95	PAYMENT	11450.03	80584.95	69134.92	0.00	

5 rows × 22 columns

In [58]:

```
df_new.shape
```

Out[58]:

```
(1048575, 22)
```

In [59]:

```
df_new.columns
```

Out[59]:

```
Index(['step', 'type', 'amount', 'oldbalanceOrg', 'newbalanceOrig',
       'oldbalanceDest', 'newbalanceDest', 'isFraud', 'step_day_of_week',
       'step_month', 'log_amount', 'sqrt_amount', 'balance_diff_orig',
       'balance_diff_dest', 'type_CASH_OUT', 'type_DEBIT', 'type_PAYMENT',
       'type_TRANSFER', 'amount_mean_rolling', 'amount_sum_7_days',
       'amount_oldbalanceOrg', 'amount_newbalanceOrig'],
      dtype='object')
```

In [60]:

```
df_new.duplicated().sum()
```

Out[60]:

```
0
```

In [61]:

```
df_new.isnull().sum()
```

Out[61]:

```
step                    0
type                    0
amount                  0
oldbalanceOrg           0
newbalanceOrig          0
oldbalanceDest          0
newbalanceDest          0
isFraud                 0
step_day_of_week        0
step_month              0
log_amount              0
sqrt_amount             0
balance_diff_orig       0
balance_diff_dest       0
type_CASH_OUT           0
type_DEBIT              0
type_PAYMENT            0
type_TRANSFER           0
amount_mean_rolling     2
amount_sum_7_days       6
amount_oldbalanceOrg    0
amount_newbalanceOrig   0
dtype: int64
```

In [62]:

```
df_new = df_new.dropna()
```

In [63]:

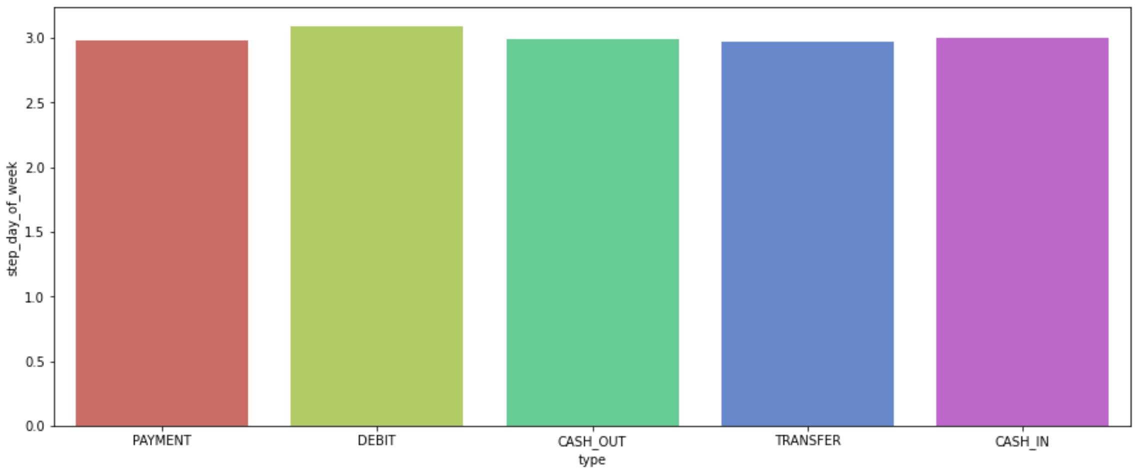
```
df_new.isnull().sum()
```

Out[63]:

```
step                    0
type                    0
amount                  0
oldbalanceOrg           0
newbalanceOrig          0
oldbalanceDest          0
newbalanceDest          0
isFraud                 0
step_day_of_week        0
step_month              0
log_amount              0
sqrt_amount             0
balance_diff_orig       0
balance_diff_dest       0
type_CASH_OUT           0
type_DEBIT              0
type_PAYMENT            0
type_TRANSFER           0
amount_mean_rolling     0
amount_sum_7_days       0
amount_oldbalanceOrg    0
amount_newbalanceOrig   0
dtype: int64
```

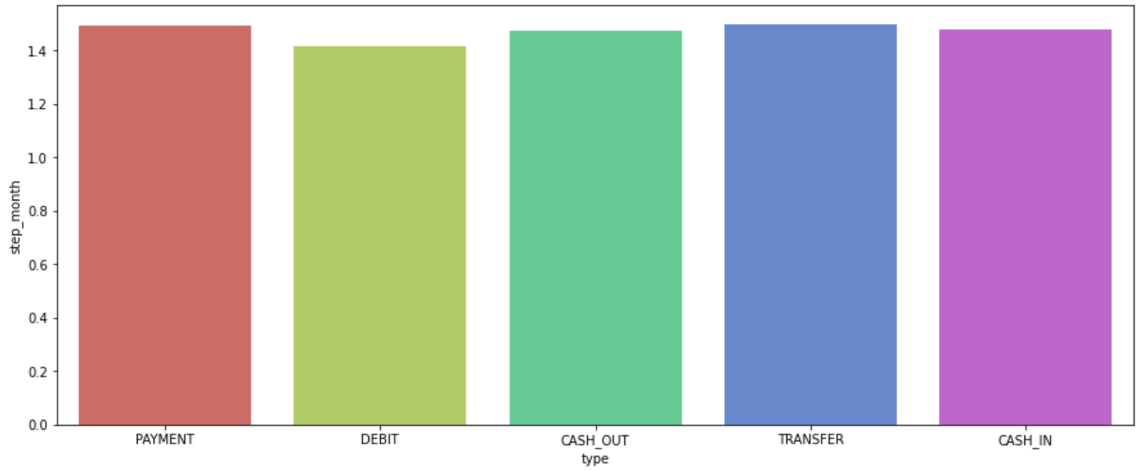
In [64]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df_new['type'], y = df_new['step_day_of_week'], data = df, ci = None, pa
plt.show()
```



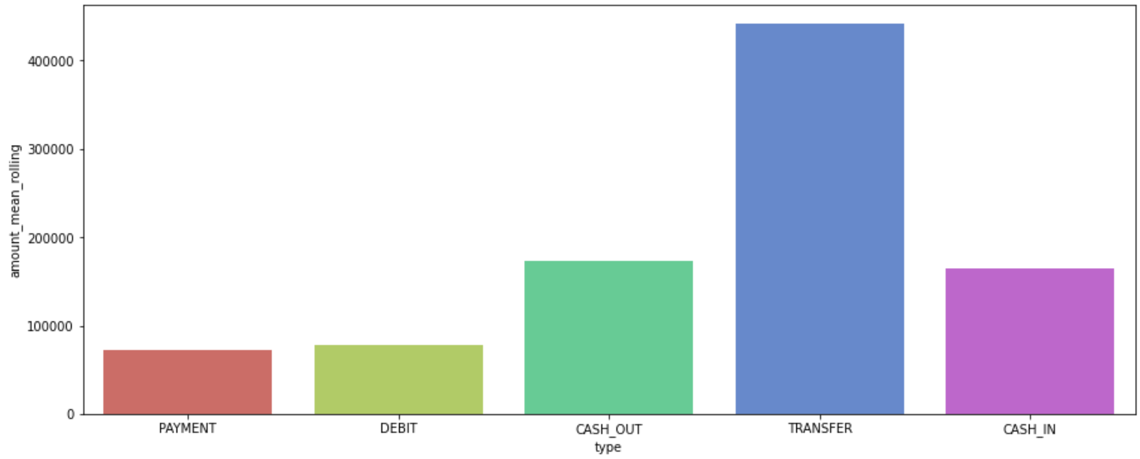
In [65]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df_new['type'], y = df_new['step_month'], data = df, ci = None, palette
plt.show()
```



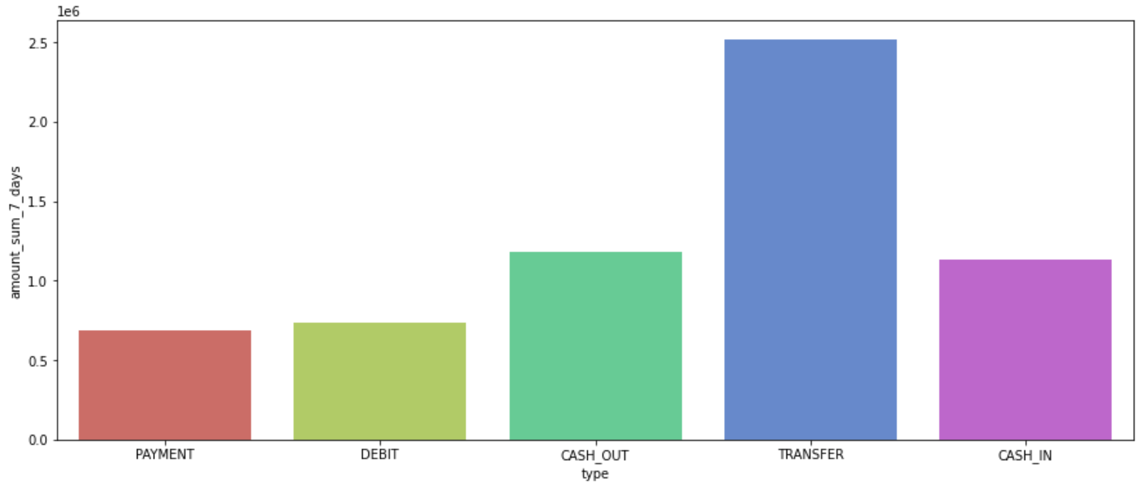
In [66]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df_new['type'], y = df_new['amount_mean_rolling'], data = df, ci = None,
plt.show()
```



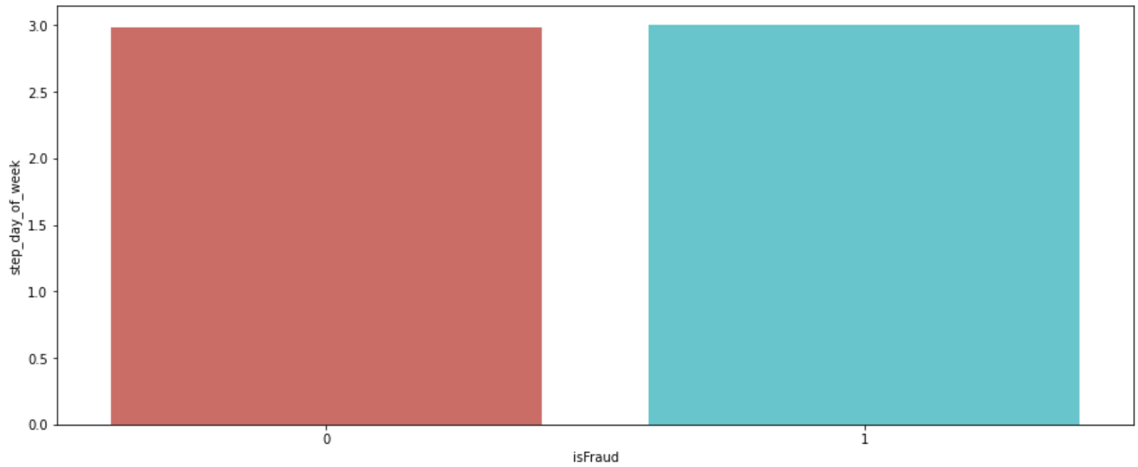
In [67]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df_new['type'], y = df_new['amount_sum_7_days'], data = df, ci = None, p
plt.show()
```



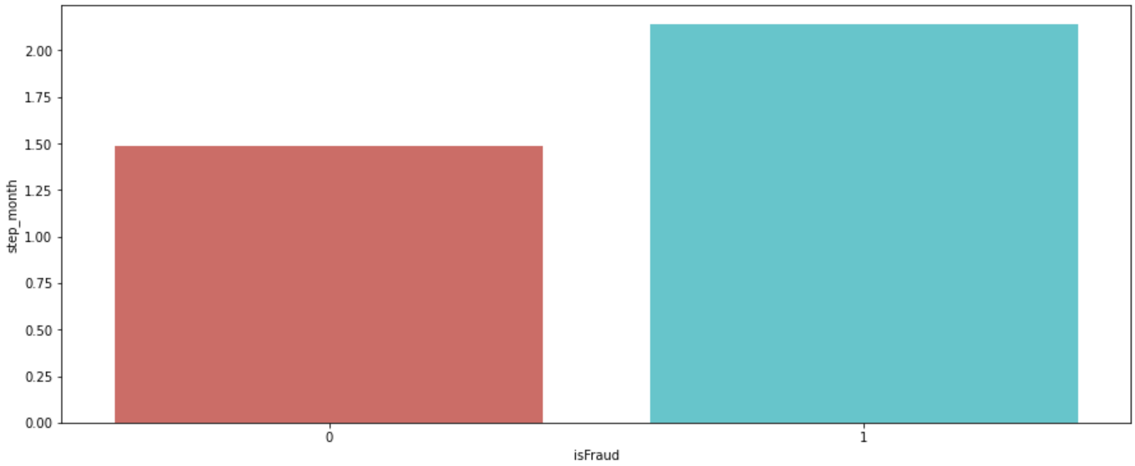
In [68]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df_new['isFraud'], y = df_new['step_day_of_week'], data = df, ci = None,
plt.show()
```



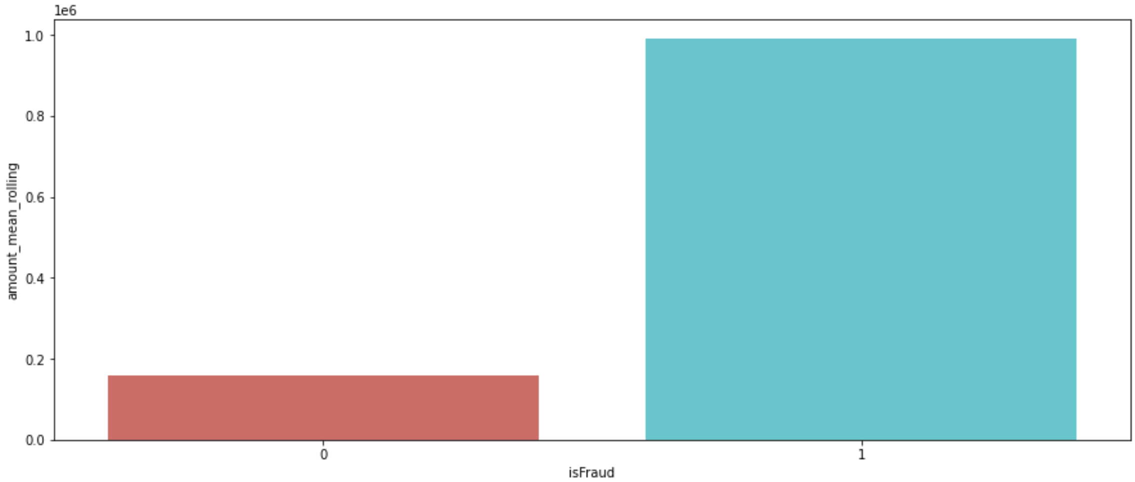
In [69]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df_new['isFraud'], y = df_new['step_month'], data = df, ci = None, palet
plt.show()
```



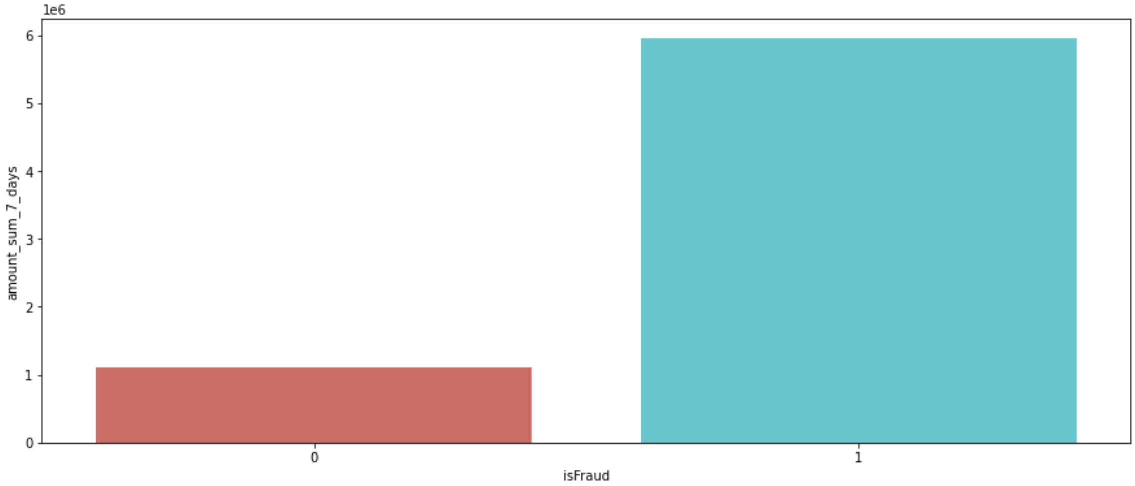
In [70]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df_new['isFraud'], y = df_new['amount_mean_rolling'], data = df, ci = No
plt.show()
```



In [71]:

```
plt.figure(figsize=(15,6))
sns.barplot(x = df_new['isFraud'], y = df_new['amount_sum_7_days'], data = df, ci = None
plt.show()
```



In [72]:

```
df_new_corr = df_new.corr()
```

In [73]:

```
df_new_corr
```

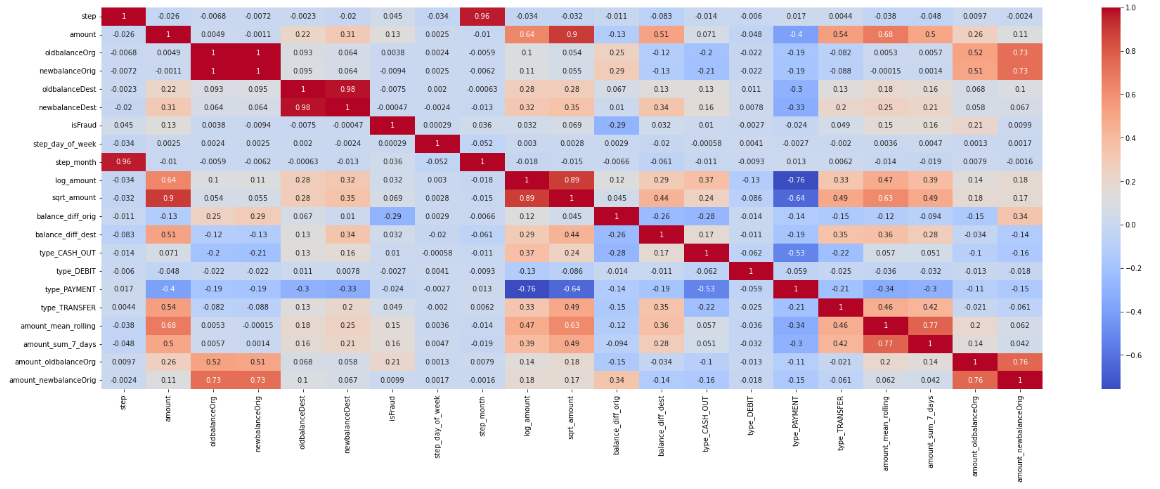
Out[73]:

	step	amount	oldbalanceOrg	newbalanceOrig	oldbalanceDes
step	1.000000	-0.026001	-0.006783	-0.007183	-0.00225
amount	-0.026001	1.000000	0.004863	-0.001134	0.21555
oldbalanceOrg	-0.006783	0.004863	1.000000	0.999047	0.09330
newbalanceOrig	-0.007183	-0.001134	0.999047	1.000000	0.09518
oldbalanceDest	-0.002255	0.215557	0.093304	0.095182	1.00000
newbalanceDest	-0.019507	0.311935	0.064048	0.063724	0.97840
isFraud	0.045166	0.129010	0.003850	-0.009429	-0.00753
step_day_of_week	-0.033655	0.002464	0.002415	0.002517	0.00198
step_month	0.964296	-0.009953	-0.005937	-0.006164	-0.00062
log_amount	-0.033575	0.638907	0.104502	0.108696	0.27658
sqrt_amount	-0.032407	0.895740	0.053510	0.054902	0.27555
balance_diff_orig	-0.010709	-0.131802	0.248333	0.290369	0.06681
balance_diff_dest	-0.083242	0.513276	-0.118078	-0.128185	0.13414
type_CASH_OUT	-0.013750	0.071254	-0.204550	-0.214549	0.13011
type_DEBIT	-0.005993	-0.047878	-0.022109	-0.022489	0.01070
type_PAYMENT	0.017109	-0.397463	-0.186253	-0.190113	-0.30395
type_TRANSFER	0.004378	0.539283	-0.081976	-0.087814	0.13036
amount_mean_rolling	-0.037664	0.678452	0.005336	-0.000148	0.18448
amount_sum_7_days	-0.048438	0.501775	0.005716	0.001390	0.16220
amount_oldbalanceOrg	0.009659	0.260743	0.523720	0.510700	0.06836
amount_newbalanceOrig	-0.002375	0.110406	0.725490	0.732029	0.10001

21 rows × 21 columns

In [74]:

```
plt.figure(figsize=(30, 10))
sns.heatmap(df_new_corr, annot=True, cmap='coolwarm')
plt.show()
```



In [75]:

```
correlation_with_target = df_new.corr()['isFraud'].abs().sort_values(ascending=False)
print(correlation_with_target)
```

```
isFraud                  1.000000
balance_diff_orig        0.293716
amount_oldbalanceOrg     0.209847
amount_sum_7_days        0.160763
amount_mean_rolling      0.150127
amount                   0.129010
sqrt_amount              0.068574
type_TRANSFER            0.049235
step                     0.045166
step_month               0.036389
balance_diff_dest        0.032079
log_amount               0.031955
type_PAYMENT             0.023546
type_CASH_OUT            0.010320
amount_newbalanceOrig    0.009880
newbalanceOrig           0.009429
oldbalanceDest           0.007534
oldbalanceOrg            0.003850
type_DEBIT               0.002739
newbalanceDest           0.000469
step_day_of_week         0.000289
Name: isFraud, dtype: float64
```

In [76]:

```
correlation_threshold = 0.01
low_correlation_features = correlation_with_target[correlation_with_target < correlation
features_to_drop = low_correlation_features.index.tolist()
print(features_to_drop)
```

```
['amount_newbalanceOrig', 'newbalanceOrig', 'oldbalanceDest', 'oldbalanceO
rg', 'type_DEBIT', 'newbalanceDest', 'step_day_of_week']
```

In [77]:

```
df_new = df_new.drop(['amount_newbalanceOrig', 'newbalanceOrig', 'oldbalanceDest', 'oldb
```

In [78]:

```
df_new.shape
```

Out[78]:

```
(1048569, 15)
```

In [79]:

```
df_new.columns
```

Out[79]:

```
Index(['step', 'type', 'amount', 'isFraud', 'step_month', 'log_amount',
       'sqrt_amount', 'balance_diff_orig', 'balance_diff_dest',
       'type_CASH_OUT', 'type_PAYMENT', 'type_TRANSFER', 'amount_mean_roll
ing',
       'amount_sum_7_days', 'amount_oldbalanceOrg'],
      dtype='object')
```

In [80]:

```
correlation_matrix = df_new.corr()
```

In [81]:

```
correlation_matrix
```

Out[81]:

	step	amount	isFraud	step_month	log_amount	sqrt_amour
step	1.000000	-0.026001	0.045166	0.964296	-0.033575	-0.03240
amount	-0.026001	1.000000	0.129010	-0.009953	0.638907	0.89574
isFraud	0.045166	0.129010	1.000000	0.036389	0.031955	0.06857
step_month	0.964296	-0.009953	0.036389	1.000000	-0.018203	-0.01484
log_amount	-0.033575	0.638907	0.031955	-0.018203	1.000000	0.88584
sqrt_amount	-0.032407	0.895740	0.068574	-0.014844	0.885849	1.00000
balance_diff_orig	-0.010709	-0.131802	-0.293716	-0.006641	0.121255	0.04531
balance_diff_dest	-0.083242	0.513276	0.032079	-0.061202	0.292970	0.43805
type_CASH_OUT	-0.013750	0.071254	0.010320	-0.011449	0.371926	0.24433
type_PAYMENT	0.017109	-0.397463	-0.023546	0.012545	-0.758246	-0.64186
type_TRANSFER	0.004378	0.539283	0.049235	0.006219	0.333290	0.49194
amount_mean_rolling	-0.037664	0.678452	0.150127	-0.014417	0.472605	0.62666
amount_sum_7_days	-0.048438	0.501775	0.160763	-0.018511	0.390330	0.48699
amount_oldbalanceOrg	0.009659	0.260743	0.209847	0.007881	0.142036	0.18252

In [82]:

```
correlation_threshold = 0.7
mask = correlation_matrix.abs() >= correlation_threshold
features_to_drop = set()
for i in range(len(correlation_matrix.columns)):
    for j in range(i+1, len(correlation_matrix.columns)):
        if mask.iloc[i, j]:
            colname_i = correlation_matrix.columns[i]
            colname_j = correlation_matrix.columns[j]
            if colname_i not in features_to_drop:
                features_to_drop.add(colname_j)
```

In [83]:

```
features_to_drop
```

Out[83]:

```
{'amount_sum_7_days', 'sqrt_amount', 'step_month', 'type_PAYMENT'}
```

In [84]:

```
df_new = df_new.drop(['amount_sum_7_days', 'sqrt_amount', 'step_month', 'type_PAYMENT'],
```

In [85]:

```
df_new = df_new.drop(['step', 'type'], axis = 1)
```

In [86]:

```
df_new.head()
```

Out[86]:

	amount	isFraud	log_amount	balance_diff_orig	balance_diff_dest	type_CASH_OUT	typ
6	7107.77	0	8.869085	-7107.77	0.00	0	
7	7861.64	0	8.969878	-7861.64	0.00	0	
8	4024.36	0	8.300370	-2671.00	0.00	0	
9	5337.77	0	8.582751	-5337.77	-1549.21	0	
10	9644.94	0	9.174292	-4465.00	147137.12	0	

In [87]:

```
df_new.tail()
```

Out[87]:

	amount	isFraud	log_amount	balance_diff_orig	balance_diff_dest	type_CASH_O
1048570	132557.35	0	11.794778	-132557.35	132557.35	
1048571	9917.36	0	9.202143	-9917.36	0.00	
1048572	14140.05	0	9.556837	-14140.05	0.00	
1048573	10020.05	0	9.212443	-10020.05	0.00	
1048574	11450.03	0	9.345835	-11450.03	0.00	

In [88]:

```
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()
features_to_scale = ['amount', 'log_amount', 'balance_diff_orig', 'balance_diff_dest', '
scaled_features = scaler.fit_transform(df_new[features_to_scale])
scaled_df = df_new.copy()
scaled_df[features_to_scale] = scaled_features
```

In [89]:

```
scaled_df
```

Out[89]:

	amount	isFraud	log_amount	balance_diff_orig	balance_diff_dest	type_CASH_OU
6	0.000711	0	0.547581	0.847360	0.252186	
7	0.000786	0	0.553872	0.847296	0.252186	
8	0.000402	0	0.512087	0.847734	0.252186	
9	0.000534	0	0.529711	0.847509	0.252156	
10	0.000964	0	0.566629	0.847583	0.255018	
...	...	...	...	...	...	.
1048570	0.013256	0	0.730177	0.836763	0.254738	
1048571	0.000992	0	0.568368	0.847122	0.252186	
1048572	0.001414	0	0.590505	0.846766	0.252186	
1048573	0.001002	0	0.569010	0.847114	0.252186	
1048574	0.001145	0	0.577336	0.846993	0.252186	

1048569 rows × 9 columns

In [90]:

```
X = scaled_df.drop('isFraud', axis = 1)
y = scaled_df['isFraud']
```

In [91]:

```
from imblearn.over_sampling import SMOTE
```

In [92]:

```
smote = SMOTE()
X_resampled, y_resampled = smote.fit_resample(X, y)
```

In [93]:

```
from sklearn.model_selection import train_test_split
```

In [94]:

```
X_train, X_test, y_train, y_test = train_test_split(X_resampled, y_resampled, test_size=
```

In [95]:

```
y_resampled.value_counts()
```

Out[95]:

```
0    1047429
1    1047429
Name: isFraud, dtype: int64
```

In [96]:

```
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
import xgboost as xgb
```

In [97]:

```
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score, pre
```

In [98]:

```
logreg = LogisticRegression()
logreg.fit(X_train, y_train)
```

Out[98]:

```
LogisticRegression()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [99]:

```
logreg_y_pred = logreg.predict(X_test)
```

In [100]:

```
print("Logistic Regression:")
print("Accuracy:", accuracy_score(y_test, logreg_y_pred))
print("Precision:", precision_score(y_test, logreg_y_pred))
print("Recall:", recall_score(y_test, logreg_y_pred))
print("F1 Score:", f1_score(y_test, logreg_y_pred))
print("Confusion Matrix:")
print(confusion_matrix(y_test, logreg_y_pred))
print("Classification Report:")
print(classification_report(y_test, logreg_y_pred))
print()
```

```
Logistic Regression:
Accuracy: 0.9473425431771096
Precision: 0.9171058253809998
Recall: 0.9835884020889224
F1 Score: 0.9491843983066073
Confusion Matrix:
[[190862  18624]
 [  3438 206048]]
Classification Report:
              precision    recall  f1-score   support

           0       0.98      0.91      0.95    209486
           1       0.92      0.98      0.95    209486

    accuracy                           0.95    418972
   macro avg       0.95      0.95      0.95    418972
weighted avg       0.95      0.95      0.95    418972
```

In [101]:

```
log_accuracy = accuracy_score(y_test, logreg_y_pred)
```

In [102]:

```
dt = DecisionTreeClassifier()
dt.fit(X_train, y_train)
```

Out[102]:

```
DecisionTreeClassifier()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [103]:

```
dt_y_pred = dt.predict(X_test)
```

In [104]:

```
print("Decision Trees:")
print("Accuracy:", accuracy_score(y_test, dt_y_pred))
print("Precision:", precision_score(y_test, dt_y_pred))
print("Recall:", recall_score(y_test, dt_y_pred))
print("F1 Score:", f1_score(y_test, dt_y_pred))
print("Confusion Matrix:")
print(confusion_matrix(y_test, dt_y_pred))
print("Classification Report:")
print(classification_report(y_test, dt_y_pred))
print()
```

```
Decision Trees:
Accuracy: 0.997737318961649
Precision: 0.9972009231708248
Recall: 0.99827673448345
F1 Score: 0.9977385388289066
Confusion Matrix:
[[208899    587]
 [   361 209125]]
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00    209486
           1       1.00      1.00      1.00    209486

    accuracy                           1.00    418972
   macro avg       1.00      1.00      1.00    418972
weighted avg       1.00      1.00      1.00    418972
```

In [105]:

```
dt_accuracy = accuracy_score(y_test, dt_y_pred)
```

In [106]:

```
xgb_model = xgb.XGBClassifier()
xgb_model.fit(X_train, y_train)
```

Out[106]:

```
XGBClassifier(base_score=0.5, booster='gbtree', callbacks=None,
              colsample_bylevel=1, colsample_bynode=1, colsample_bytree=1,
              early_stopping_rounds=None, enable_categorical=False,
              eval_metric=None, gamma=0, gpu_id=-1, grow_policy='depthwis
e',
              importance_type=None, interaction_constraints='',
              learning_rate=0.300000012, max_bin=256, max_cat_to_onehot=4,
              max_delta_step=0, max_depth=6, max_leaves=0, min_child_weigh
t=1,
              missing=nan, monotone_constraints='()', n_estimators=100,
              n_jobs=0, num_parallel_tree=1, predictor='auto', random_stat
e=0,
              reg_alpha=0, reg_lambda=1, ...)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [107]:

```
xgb_y_pred = xgb_model.predict(X_test)
```

In [108]:

```
print("XGBoost:")
print("Accuracy:", accuracy_score(y_test, xgb_y_pred))
print("Precision:", precision_score(y_test, xgb_y_pred))
print("Recall:", recall_score(y_test, xgb_y_pred))
print("F1 Score:", f1_score(y_test, xgb_y_pred))
print("Confusion Matrix:")
print(confusion_matrix(y_test, xgb_y_pred))
print("Classification Report:")
print(classification_report(y_test, xgb_y_pred))
print()
```

```
XGBoost:
Accuracy: 0.9933432305738809
Precision: 0.9939681007164672
Recall: 0.992710730072654
F1 Score: 0.9933390174991102
Confusion Matrix:
[[208224   1262]
 [  1527 207959]]
Classification Report:
              precision    recall  f1-score   support

           0       0.99      0.99      0.99    209486
           1       0.99      0.99      0.99    209486

    accuracy                           0.99    418972
   macro avg       0.99      0.99      0.99    418972
weighted avg       0.99      0.99      0.99    418972
```

In [109]:

```
xgb_accuracy = accuracy_score(y_test, xgb_y_pred)
```

In [110]:

```
labels = ['Logistic Regression', 'Decision Tree', 'XGBoost']
accuracies = [log_accuracy, dt_accuracy, xgb_accuracy]

fig = go.Figure(data=[go.Bar(x=labels, y=accuracies)])
fig.update_layout(title='Accuracy Comparison',
                  xaxis_title='Classifier',
                  yaxis_title='Accuracy',
                  yaxis_range=[0, 1])

fig.show()
```

In [111]:

```
import pickle
filename = 'logistic_regression_model.pkl'
pickle.dump(logreg, open(filename, 'wb'))
```

In [113]:

```
from keras.models import Sequential
from keras.layers import Dense

model = Sequential()
model.add(Dense(64, activation='relu', input_shape=(X_train.shape[1],)))
model.add(Dense(64, activation='relu'))
model.add(Dense(1, activation='sigmoid'))

model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])

model.fit(X_train, y_train, epochs=10, batch_size=32, validation_data=(X_test, y_test))
```

```
Epoch 1/10
52372/52372 [==============================] - 149s 3ms/step - loss: 0.185
3 - accuracy: 0.9206 - val_loss: 0.2021 - val_accuracy: 0.9075
Epoch 2/10
52372/52372 [==============================] - 173s 3ms/step - loss: 0.143
5 - accuracy: 0.9427 - val_loss: 0.1201 - val_accuracy: 0.9573
Epoch 3/10
52372/52372 [==============================] - 146s 3ms/step - loss: 0.131
1 - accuracy: 0.9486 - val_loss: 0.1126 - val_accuracy: 0.9603
Epoch 4/10
52372/52372 [==============================] - 147s 3ms/step - loss: 0.124
6 - accuracy: 0.9516 - val_loss: 0.1241 - val_accuracy: 0.9509
Epoch 5/10
52372/52372 [==============================] - 146s 3ms/step - loss: 0.120
2 - accuracy: 0.9537 - val_loss: 0.1051 - val_accuracy: 0.9606
Epoch 6/10
52372/52372 [==============================] - 144s 3ms/step - loss: 0.116
8 - accuracy: 0.9552 - val_loss: 0.1067 - val_accuracy: 0.9632
Epoch 7/10
52372/52372 [==============================] - 145s 3ms/step - loss: 0.113
4 - accuracy: 0.9567 - val_loss: 0.1070 - val_accuracy: 0.9612
Epoch 8/10
52372/52372 [==============================] - 144s 3ms/step - loss: 0.110
0 - accuracy: 0.9582 - val_loss: 0.0988 - val_accuracy: 0.9639
Epoch 9/10
52372/52372 [==============================] - 151s 3ms/step - loss: 0.108
3 - accuracy: 0.9590 - val_loss: 0.0951 - val_accuracy: 0.9645
Epoch 10/10
52372/52372 [==============================] - 2132s 41ms/step - loss: 0.1
059 - accuracy: 0.9600 - val_loss: 0.1182 - val_accuracy: 0.9526
```

Out[113]:

```
<keras.callbacks.History at 0x2998e579940>
```

In [114]:

```
loss, accuracy = model.evaluate(X_test, y_test)
print("Test Loss:", loss)
print("Test Accuracy:", accuracy)
```

```
13093/13093 [==============================] - 27s 2ms/step - loss: 0.1182
- accuracy: 0.9526
Test Loss: 0.11822345852851868
Test Accuracy: 0.9526054263114929
```