```
[1]  #As PDF because Plotly plots don't work in GitHub preview
     #See notebook here:
     https://github.com/exoflow/VisualizingFraudTransactions/blob/mast
     er/fraud_transactions_tsne_scikit.ipynb
```

```
[2]  #Data source:
     #https://www.kaggle.com/c/ieee-fraud-detection/data
```

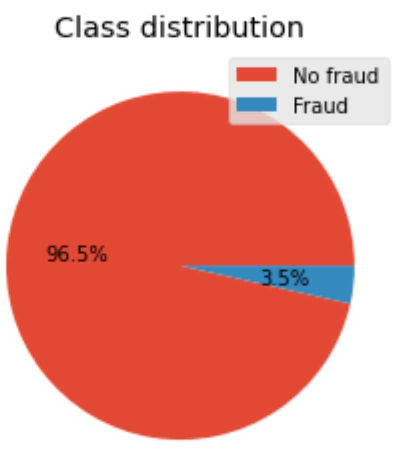
```
[3]  import pandas as pd
     import numpy as np
     import matplotlib.pyplot as plt
     import seaborn as sns
     import plotly.express as px
     from sklearn.ensemble import GradientBoostingClassifier
     from sklearn.manifold import TSNE
     from sklearn.metrics import f1_score
     from sklearn.model_selection import cross_val_score
     from sklearn.svm import SVC
     plt.style.use('ggplot')
```

Loading data

```
[4]  train = pd.read_csv('../Desktop/train_transaction.csv')
     print("{} rows and {}
     columns".format(train.shape[0],train.shape[1]))
```

```
590540 rows and 394 columns
```

```
[5]  #Checking for class imbalance
     plt.pie(train['isFraud'].value_counts(), autopct='%.1f%%')
     plt.legend(['No fraud','Fraud'])
     plt.title('Class distribution')
     plt.show()
```



Preprocessing

```
[6]   #Selecting numeric features and imputing missing values
      train = train.select_dtypes(include=np.number)

      for col in train.columns:
          train[col] = train[col].fillna(0)
```

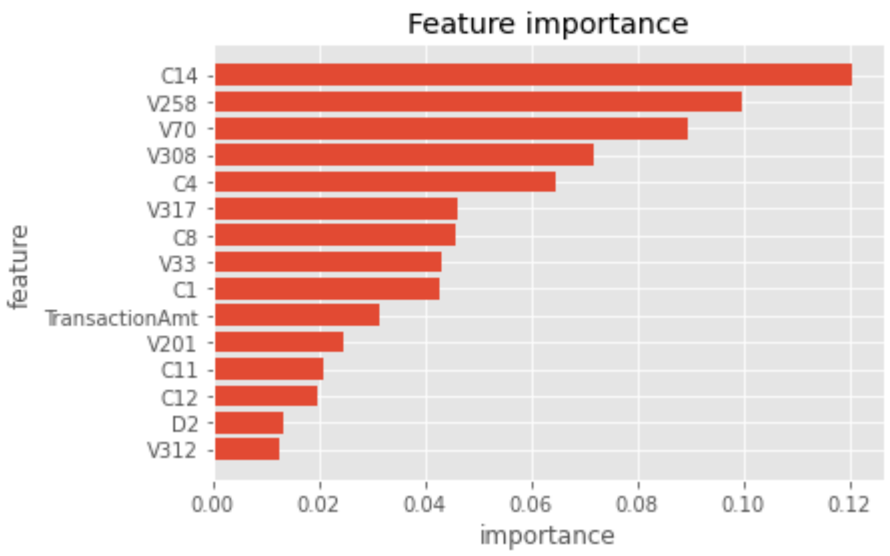
```
[7]   #Sampling for a class-balanced dataframe
      fraud1 = train[train['isFraud']==1]
      fraud0 = train[train['isFraud']==0].sample(n=len(fraud1))
      train = fraud1.append(fraud0).sample(frac=0.2) #Fraction optional
```

```
[8]   #Finding important features with Gradient boosting
      features = train.drop('isFraud', axis=1)
      target = train['isFraud']

      gbc = GradientBoostingClassifier()
      gbc.fit(features, target)
```

```
GradientBoostingClassifier(ccp_alpha=0.0, criterion='friedman_mse',
init=None,
                           learning_rate=0.1, loss='deviance',
max_depth=3,
                           max_features=None, max_leaf_nodes=None,
                           min_impurity_decrease=0.0,
min_impurity_split=None,
                           min_samples_leaf=1, min_samples_split=2,
                           min_weight_fraction_leaf=0.0,
n_estimators=100,
                           n_iter_no_change=None, presort='deprecated',
                           random_state=None, subsample=1.0, tol=0.0001,
                           validation_fraction=0.1, verbose=0,
                           warm_start=False)
```

```
[9]   #Top features dataframe
      top_features = pd.DataFrame(list(zip(list(features.columns),
      gbc.feature_importances_)), columns =
      ['feature','importance']).sort_values('importance', ascending =
      False).reset_index(drop = True).head(15)
```

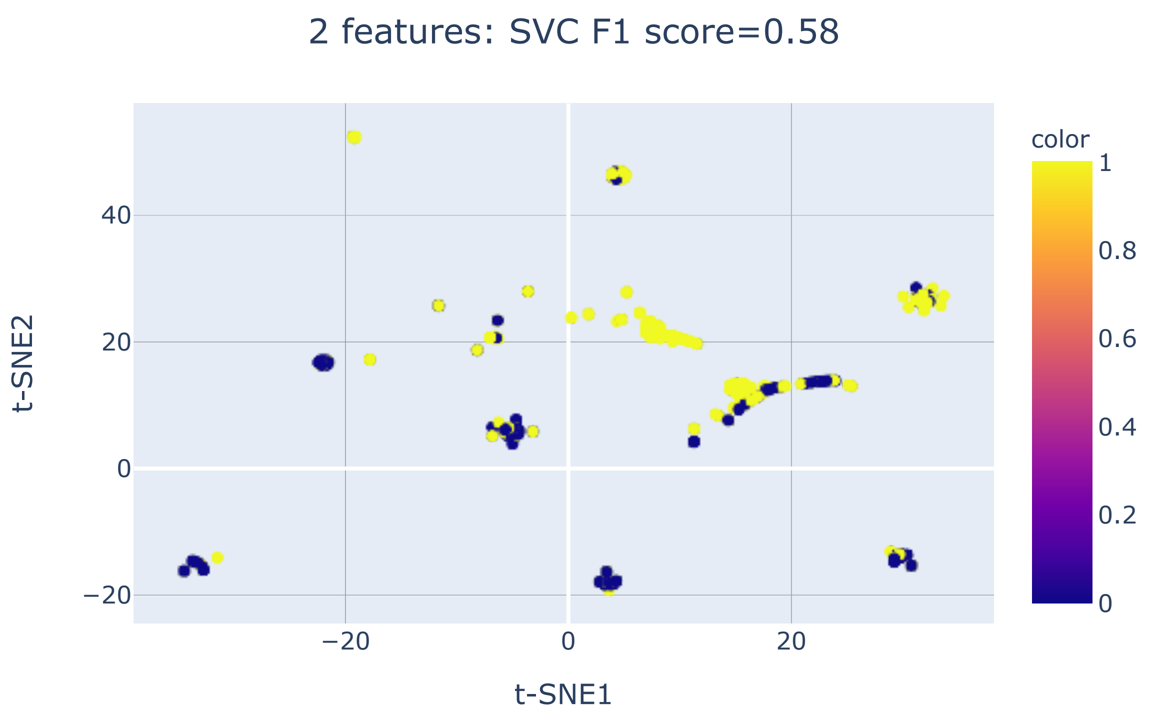
```
[10]  #Plotting top features
      x = 'feature'
      y = 'importance'
      fig, ax = plt.subplots()
      plt.barh(top_features[x],top_features[y])
      plt.title('Feature importance')
      plt.xlabel(y)
      plt.ylabel(x)
      ax.invert_yaxis()
```

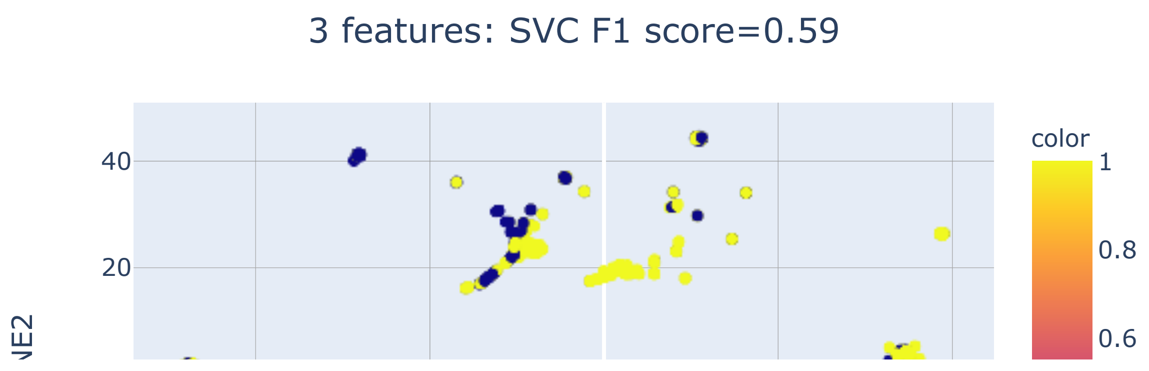


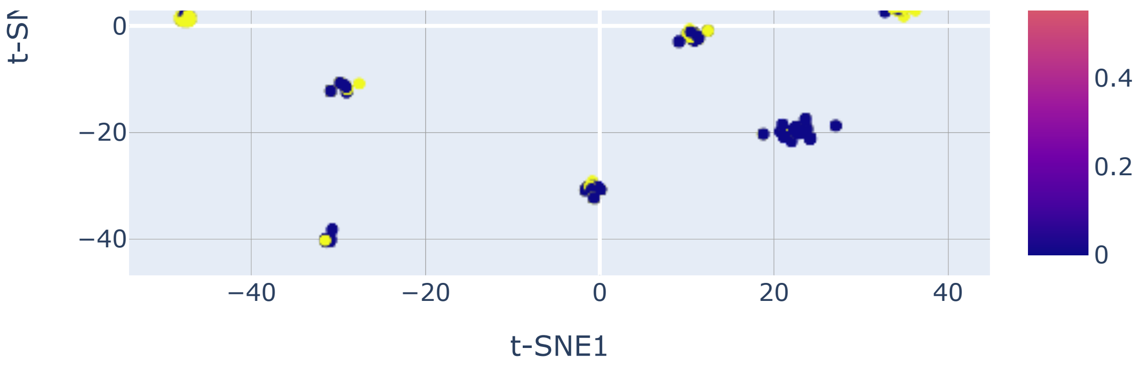
Plotting t-SNE

```
[11]  #Looping through number of features
      for n in range(2,10):
          #Optional sample for faster iterations
          sample = 2000
          features =
      train[top_features['feature'].head(n).unique()].head(sample)
          target = train['isFraud'].head(sample)
```

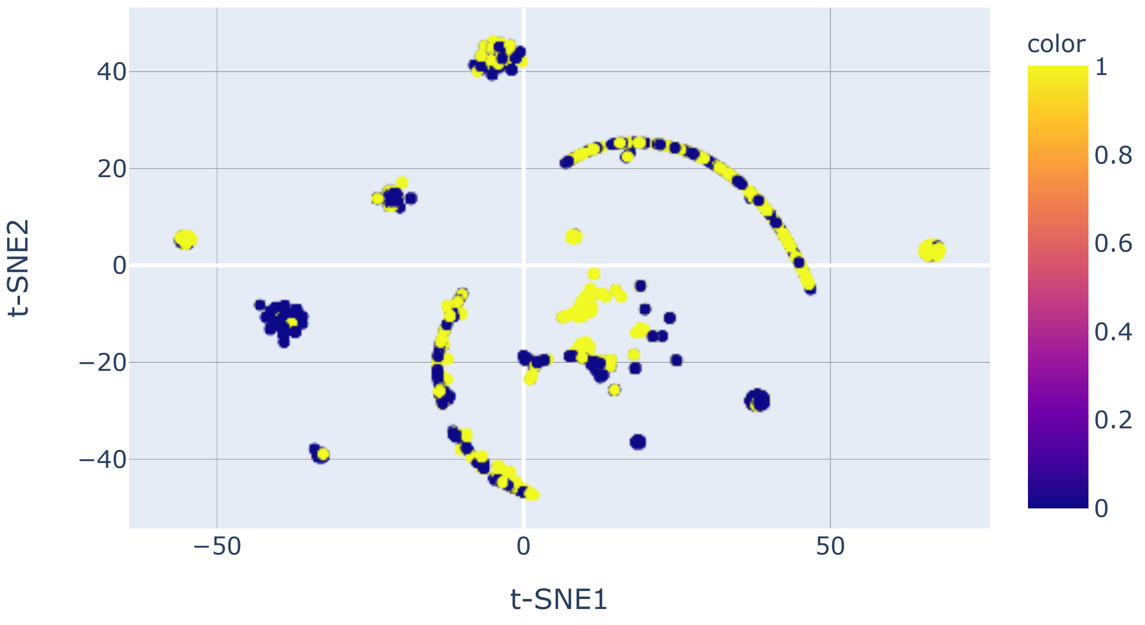
```
    #Dimensionality reduction to 2 components
    tsne = TSNE(n_components=2, init='random', random_state=0)
    result2d = tsne.fit_transform(features)

    #Cross validating with a SVC
    features2d = pd.DataFrame(result2d)
    cv = cross_val_score(SVC(), features2d, target, cv=10,
scoring = 'f1')
    f1 = round(np.mean(cv),2)

    fig = px.scatter(pd.DataFrame(result2d), x=0, y=1,
color=target)
    fig.update_layout(
        width = 600,
        height = 400,
        title = str(n) + ' features: SVC F1 score=' + str(f1),
        title_x = 0.5,
        xaxis_title="t-SNE1",
        yaxis_title="t-SNE2")
    fig.show()
```



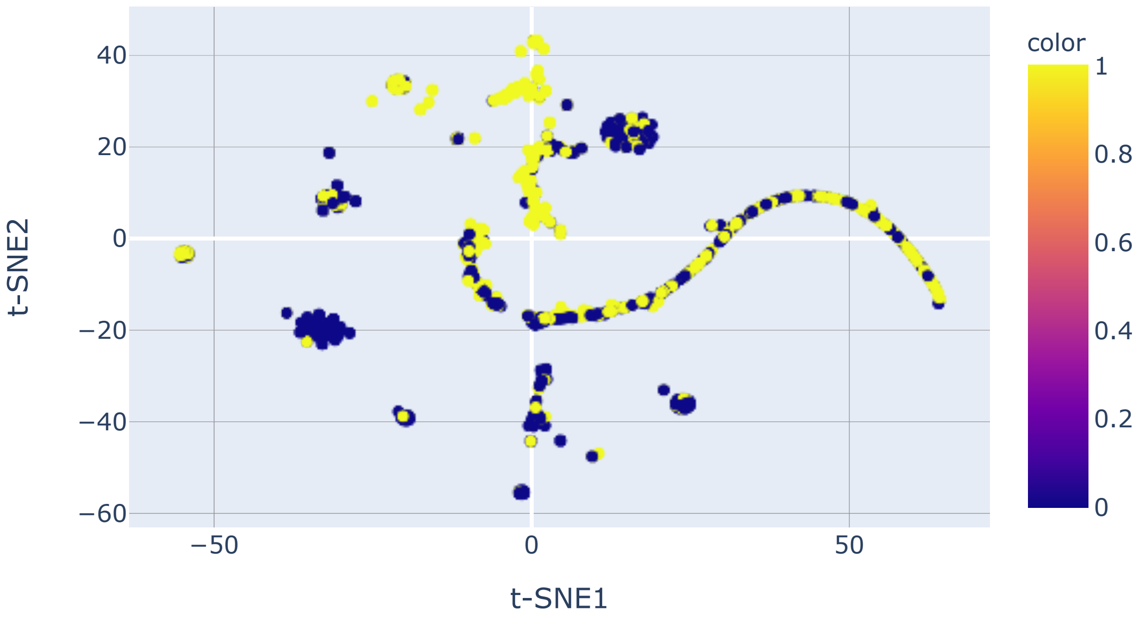




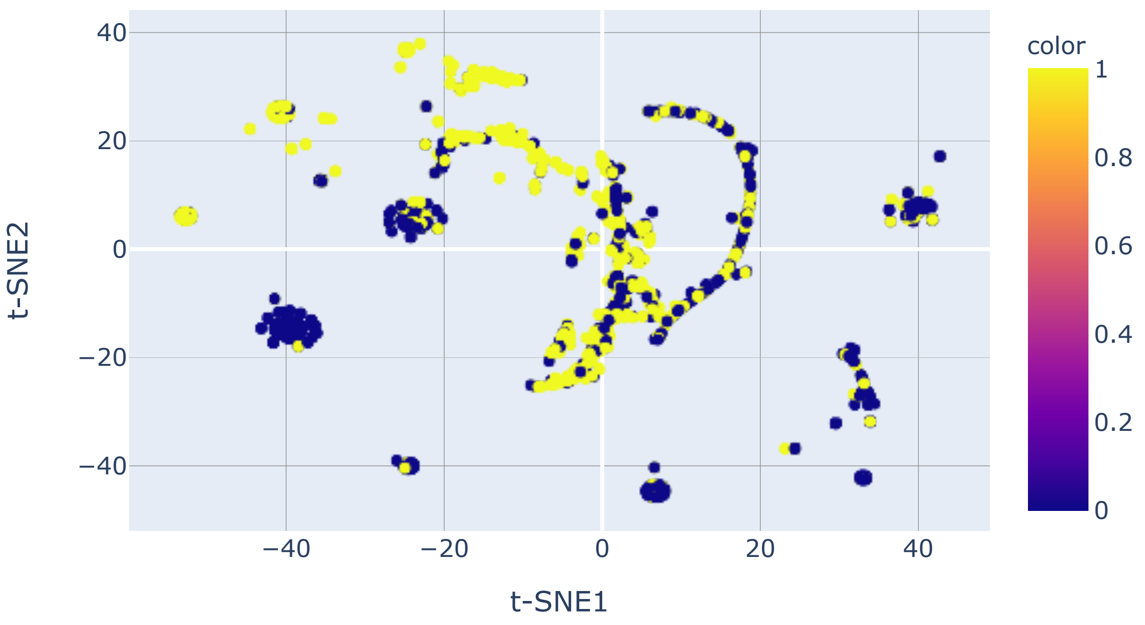
4 features: SVC F1 score=0.66



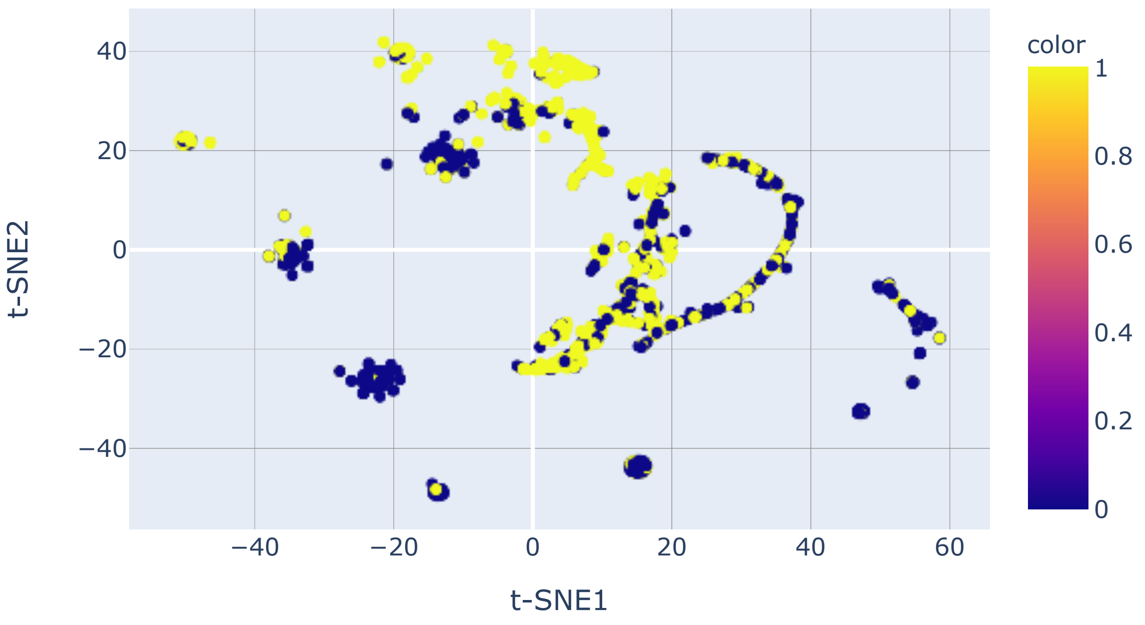
5 features: SVC F1 score=0.74



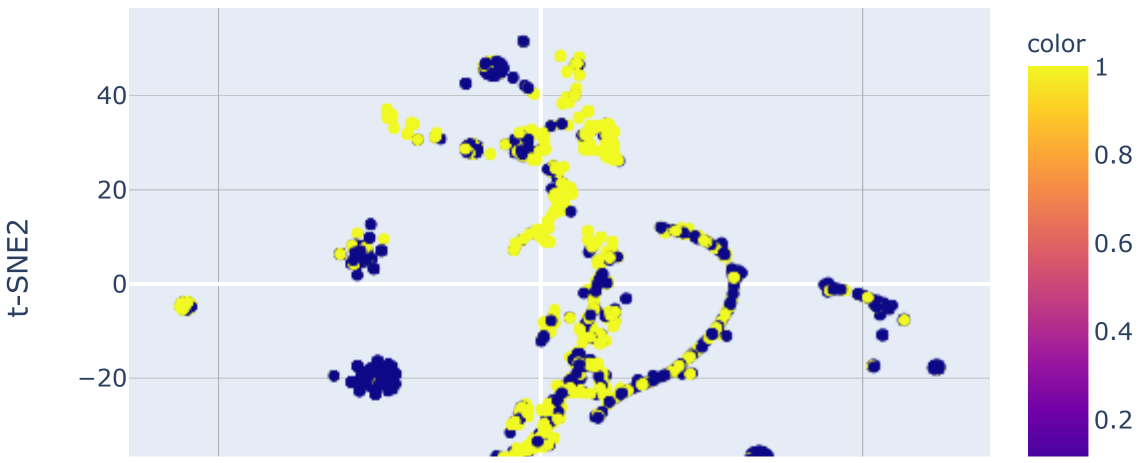
6 features: SVC F1 score=0.74

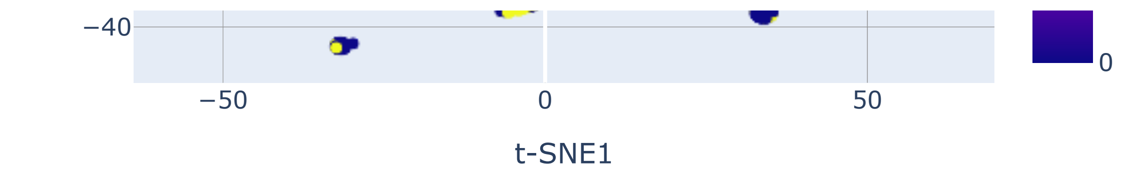


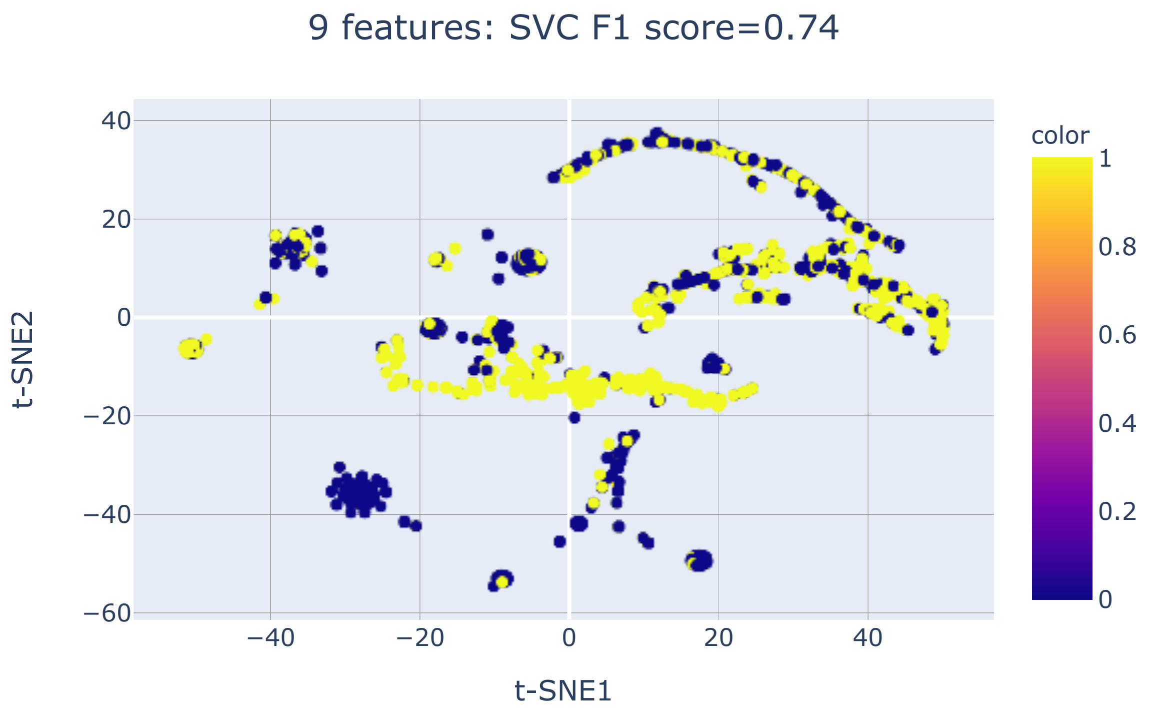
7 features: SVC F1 score=0.74



8 features: SVC F1 score=0.75







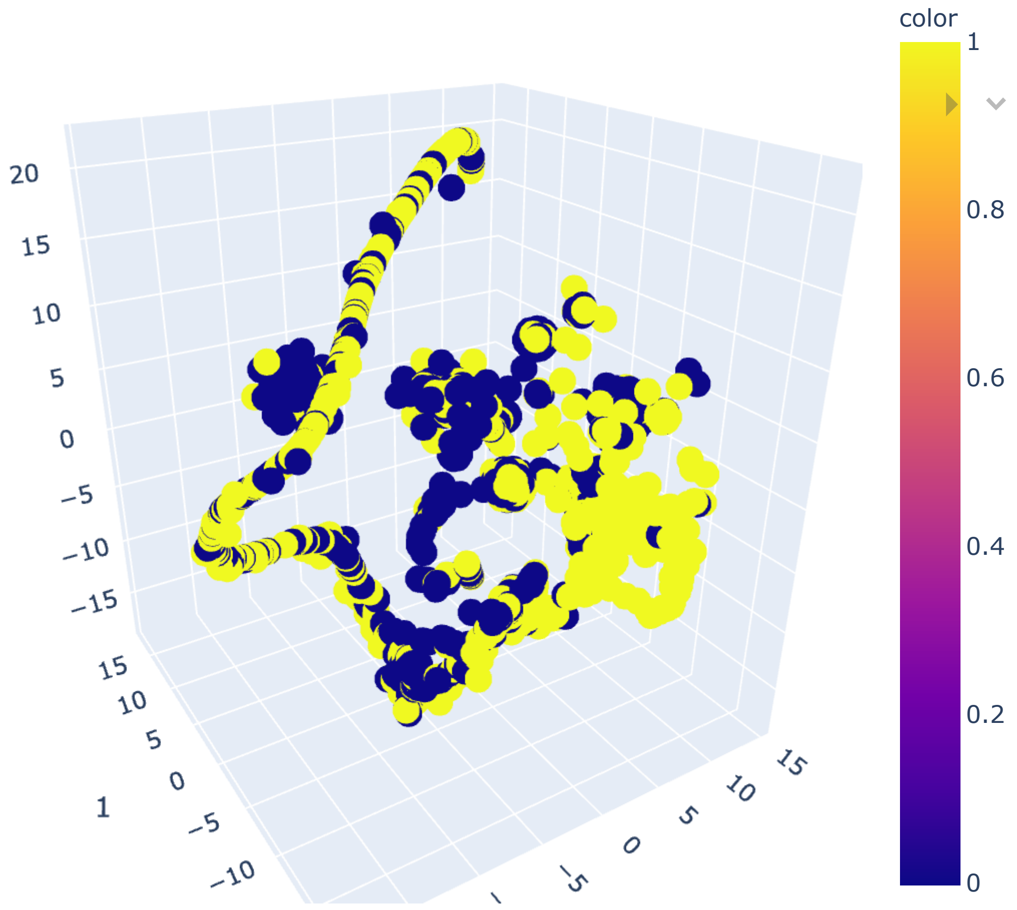
Interesting results: Fraud transactions (yellow) and non-fraud transactions (blue) seem to be seperated quite well, given that the input file contained 394 features and only generic processing was applied without prior knowledge. All features were put through a GradientBoostingClassifier for pre-selection and t-SNE for dimensionality reduction. However, t-SNE is only a tool for vizualising high dimensional data and can't be used to reduce dimensions prior to training a classifier because different initializations can get different results.

More info: https://scikit-learn.org/stable/modules/generated/sklearn.manifold.TSNE.html

```
[ ]  #Just for fun: using 3 component t-SNE for a 3D plot

     #Optional sample for faster iterations
     sample = 2000

     #Using top 8 features
     features =
     train[top_features['feature'].head(8).unique()].head(sample)
     target = train['isFraud'].head(sample)

     #Dimensionality reduction to 3 components
     tsne = TSNE(n_components=3, init='random', random_state=0)
     result3d = tsne.fit_transform(features)
```

```
#Cross validating with a SVC
features2d = pd.DataFrame(result3d)
cv = cross_val_score(SVC(), result3d, target, cv=10, scoring =
'f1')
f1 = round(np.mean(cv),2)

fig = px.scatter_3d(pd.DataFrame(result3d), x=0, y=1, z=2,
color=target)
fig.update_layout(
    width = 600,
    height = 600,
    title = '8 features visualized in 3 dimensions with t-SNE:
SVC F1 score=' + str(f1),
    title_x = 0.5,
    xaxis_title="t-SNE1",
    yaxis_title="t-SNE2")
fig.show()
```

8 features visualized in 3 dimensions with t-SNE: SVC F1 score=0.73



```
[ ]
```