Feature Engineering

In [1]:
```python
# Importing necessary libraries
import pandas as pd
from sklearn.preprocessing import LabelEncoder
import numpy as np
from itertools import combinations
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import TruncatedSVD
from sklearn.decomposition import PCA
import numpy as np
from category_encoders.glmm import GLMMEncoder
import matplotlib.pyplot as plt
from tqdm import tqdm
import pickle
```

Importing dataset

In [2]:
```python
#Loading dataset saved from EDA
train = pd.read_csv('preprocessed_train_eda.csv')
test = pd.read_csv('preprocessed_test_eda.csv')
```

Interaction Features (Numerical)

In [3]:
```python
# Importing top features from the EDA dataset.
rf_col = open('Top-features','rb')
features = pickle.load(rf_col,encoding = 'latin1')
```

In [4]:
```python
top_features = []
for i in features:
    if i in train.columns:
        top_features.append(i)
```

In [5]:
```python
#Creating combination of features got from EDA
two_way_list = list(combinations(top_features,2))
three_way_list = list(combinations(top_features,3))
```

In [6]:
```python
#Creating a dataframe which consists of combinations of features
train_numeric_corr = pd.DataFrame()
def interaction_features(col):
    if len(col) == 2:
        train_numeric_corr[str(col[0])+'_add_'+str(col[1])] = train[col[0]]+train[col[1]]
    else:
        train_numeric_corr[str(col[0])+'_add_'+str(col[1])+'_add_'+str(col[2])] = train[col[
0]]+train[col[1]]+train[col[2]]
```

In [7]:
```python
for i in (two_way_list+three_way_list):
    interaction_features(i)
```

In [8]:
```python
test_numeric_corr = pd.DataFrame()
def interaction_features(col):
    if len(col) == 2:
        test_numeric_corr[str(col[0])+'_add_'+str(col[1])] = test[col[0]]+test[col[1]]
    else:
        test_numeric_corr[str(col[0])+'_add_'+str(col[1])+'_add_'+str(col[2])] = test[col[0
]]+test[col[1]]+test[col[2]]
```

In [9]:
```python
for i in (two_way_list+three_way_list):
    interaction_features(i)
```

In [10]:
```python
train_numeric_corr['y'] = train['y']
```

In [11]:
```python
correlation = train_numeric_corr.corr(method = 'pearson')
```

In [12]:
```python
corr_values = list(correlation['y'].sort_values(ascending = False))
corr_cols = list(correlation['y'].sort_values(ascending = False).index)
```

In [13]:
```python
#Selecting correlation features which have correlation greater than 0.68 to target variable
 from above combinations of features
top_correlated_features = []
for i in range(len(corr_values)):
    if corr_values[i] > 0.68:
        if corr_cols[i] != 'y':
            top_correlated_features.append(corr_cols[i])
```

In [14]:
```python
len(top_correlated_features)
```

Out[14]: 19

In [15]:
```python
file = 'Corr-features'
file_dump = open(file,'wb')
pickle.dump(top_correlated_features,file_dump)
file_dump.close()
```

In [16]:
```python
train_top_corr_numeric = train_numeric_corr[top_correlated_features]
test_top_corr_numeric = test_numeric_corr[top_correlated_features]
```

PCA and TSVD for Numerical features

Creating PCA features

In [17]:
```python
numeric = list(train.select_dtypes(include = 'int64').columns)
numeric_train = train[numeric]
numeric_test = test[numeric]
```

In [18]:
```python
# Using standard scaler to normalize the data
scaler = StandardScaler()
```

In [19]:
```python
train_numeric_norm= scaler.fit_transform(numeric_train)
```

In [20]:
```python
train_numeric_norm = pd.DataFrame(train_numeric_norm,columns = numeric_train.columns)
```

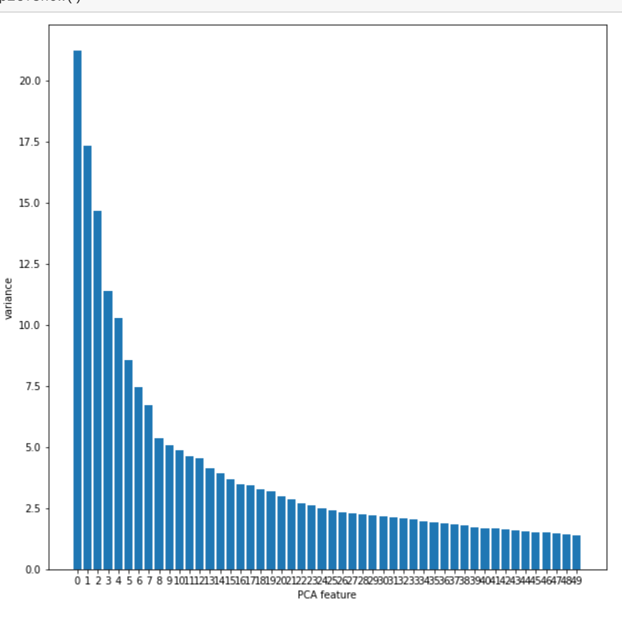
In [21]:
```python
test_numeric_norm = scaler.transform(numeric_test)
```

In [22]:
```python
test_numeric_norm = pd.DataFrame(test_numeric_norm,columns = numeric_test.columns)
```

In [164]:
```python
file = 'models/pca-scaler.sav'
file_dump = open(file,'wb')
pickle.dump(scaler,file_dump)
file_dump.close()
```

In [23]:
```python
pca = PCA(n_components = 50)
train_pca = pca.fit(train_numeric_norm)
```

In [24]:
```python
# Plot the explained variances
plt.figure(figsize = (10,10))
features = range(train_pca.n_components_)
plt.bar(features, train_pca.explained_variance_)
plt.xlabel('PCA feature')
plt.ylabel('variance')
plt.xticks(features)
plt.show()
```



From above graph we can take number of components as 6 for PCA

In [25]:
```python
n_comp = 6
pca = PCA(n_components = n_comp)
train_pca = pca.fit_transform(train_numeric_norm)
test_pca = pca.transform(test_numeric_norm)
```

In [26]:
```python
train_pca_df = pd.DataFrame()
test_pca_df = pd.DataFrame()
for i in range(1,n_comp+1):
    train_pca_df['pca'+str(i)] = train_pca[:,i-1]
    test_pca_df['pca'+str(i)] = test_pca[:,i-1]
```

In [146]:
```python
filename = 'models/pca.sav'
pickle.dump(pca,open(filename,'wb'))
```

Creating TSVD Features

Optimal Thresholding of Singular values

In [27]:
```python
## Using Truncated SVD to find the singular values and setting number of components as 100.
svd = TruncatedSVD(n_components = 150,random_state = 42)
```

In [28]:
```python
train_tsvd = svd.fit_transform(train_numeric_norm)
```

In [29]:
```python
singular_values = svd.singular_values_
```

In [30]:
```python
var_explained = svd.explained_variance_ratio_.sum()
```

Using 100 as number of components transformed data from tsvd can explain 95% of our data

In [31]:
```python
var_explained
```

Out[31]: 0.9562972630843092

Thresholding of singluar values (https://arxiv.org/pdf/1305.5870.pdf)

In [32]:
```python
def beta_cal(input_matrix):
    m = min(input_matrix.shape)
    n = max(input_matrix.shape)
    return m/n
```

In [33]:
```python
def optimal_svht_sigma(beta):
    return (0.56*beta**3)-(0.95*beta**2)+(1.82*beta)+1.43
```

In [34]:
```python
beta = beta_cal(train_numeric_norm)
print('Beta value must be in range of (0,1] and beta value is ',beta)
```

```
Beta value must be in range of (0,1] and beta value is  0.07415355269432522
```

In [35]:
```python
sigma = optimal_svht_sigma(beta)
print('w(beta) coefficient according to the paper is ',sigma)
```

```
w(beta) coefficient according to the paper is  1.55996399500429
```

In [36]:
```python
# Finding median from the singular values generated from the TSVD
sv_median = np.median(singular_values)
```

In [37]:
```python
# The threshold for the singluar values
threshold = sigma*sv_median
```

In [38]:
```python
# The number of components we can have in TSVD after thresholding.
n_comp = np.max( np.where( singular_values > threshold ) ) + 1
print('Number of components after thresholding is ',n_comp)
```

```
Number of components after thresholding is  23
```

Creating TSVD features from above n_components

In [39]:
```python
tsvd = TruncatedSVD(n_components = n_comp,random_state = 42)
```

In [40]:
```python
train_tsvd = tsvd.fit_transform(train_numeric_norm)
```

In [41]:
```python
test_tsvd = tsvd.transform(test_numeric_norm)
```

In [42]:
```python
train_tsvd_df = pd.DataFrame()
test_tsvd_df = pd.DataFrame()
for i in range(1,n_comp+1):
    train_tsvd_df['tsvd'+str(i)] = train_tsvd[:,i-1]
    test_tsvd_df['tsvd'+str(i)] = test_tsvd[:,i-1]
```

In [147]:
```python
filename = 'models/tsvd.sav'
pickle.dump(tsvd,open(filename,'wb'))
```

Datasets-1 (Label Encoding)

Label Encoding of Categorical Features

In [44]:
```python
#Loading dataset saved from EDA
train_label = pd.read_csv('preprocessed_train_eda.csv')
```

In [45]:
```python
test_label = pd.read_csv('preprocessed_test_eda.csv')
```

In [46]:
```python
categ = list(train_label.select_dtypes(include = 'object').columns)
```

In [47]:
```python
# Label encoding
def label_encode(tr,te,col_name):
    encoder = LabelEncoder()
    label_encoder = encoder.fit(tr[col_name].values)
    te[col_name] = te[col_name].map(lambda x: 'nill' if x not in label_encoder.classes_ else
x)
    label_encoder.classes_ = np.append(label_encoder.classes_, 'nill')
    tr[col_name] = label_encoder.transform(tr[col_name])
    te[col_name] = label_encoder.transform(te[col_name])
```

In [48]:
```python
# Encoding categorical columns using Label Encoder
for i in categ:
    label_encode(train_label,test_label,i)
```

In [49]:
```python
train_label.head()
```

Out[49]:

	y	X0	X1	X2	X3	X5	X6	X8	X10	X12	...	X373	X374	X375	X376	X377	X378	X379	X380	X383	X384
0	130.81	32	23	17	0	24	9	14	0	0	...	0	0	0	0	1	0	0	0	0	0
1	88.53	32	21	19	4	28	11	14	0	0	...	0	0	1	0	0	0	0	0	0	0
2	76.26	20	24	34	2	27	9	23	0	0	...	0	0	0	0	0	0	0	0	0	0
3	80.62	20	21	34	5	27	11	4	0	0	...	0	0	0	0	0	0	0	0	0	0
4	78.02	20	23	34	5	12	3	13	0	0	...	0	0	0	0	0	0	0	0	0	0

5 rows × 319 columns

In [50]:
```python
test_label.head()
```

Out[50]:

	X0	X1	X2	X3	X5	X6	X8	X10	X12	X13	...	X373	X374	X375	X376	X377	X378	X379	X380	X383	X384
0	20	23	34	5	29	0	22	0	0	0	...	0	0	0	0	0	1	0	0	0	0
1	40	3	7	0	29	6	24	0	0	0	...	0	0	0	0	1	0	0	0	0	0
2	20	23	16	5	29	9	9	0	0	0	...	0	0	0	0	0	1	0	0	0	0
3	20	13	34	5	29	11	13	0	0	0	...	0	0	0	0	0	1	0	0	0	0
4	43	20	16	2	28	8	12	0	0	0	...	0	0	1	0	0	0	0	0	0	0

5 rows × 318 columns

In [51]:
```python
# Using standard scaler to normalize the data
scaler = StandardScaler()
```

In [52]:
```python
train_label_norm= scaler.fit_transform(train_label.drop(['y'],axis = 1))
```

In [53]:
```python
train_columns = train_label.drop(['y'],axis = 1).columns
```

In [54]:
```python
train_label_norm = pd.DataFrame(train_label_norm,columns = train_columns)
```

In [55]:
```python
train_label_norm.to_csv('label_encoding/preprocessed_train_norm_label.csv',index = False)
```

In [56]:
```python
test_label_norm = scaler.transform(test_label)
```

In [57]:
```python
test_label_norm = pd.DataFrame(test_label_norm,columns = test_label.columns)
```

In [58]:
```python
test_label_norm.to_csv('label_encoding/preprocessed_test_norm_label.csv',index = False)
```

Adding Interaction variables

In [59]:
```python
train_label_corr = pd.concat([train_label,train_top_corr_numeric],axis = 1)
test_label_corr = pd.concat([test_label,test_top_corr_numeric],axis = 1)
```

In [60]:
```python
# Using standard scaler to normalize the data
scaler = StandardScaler()
```

In [61]:
```python
train_label_interaction = scaler.fit_transform(train_label_corr.drop(['y'],axis = 1))
```

In [62]:
```python
train_columns = train_label_corr.drop(['y'],axis = 1).columns
```

In [63]:
```python
train_label_interaction = pd.DataFrame(train_label_interaction,columns = train_columns)
```

In [64]:
```python
train_label_interaction.to_csv('label_encoding/preprocessed_train_label_interaction.csv',ind
ex = False)
```

In [65]:
```python
test_label_interaction = scaler.transform(test_label_corr)
```

In [66]:
```python
test_label_interaction = pd.DataFrame(test_label_interaction,columns = test_label_corr.colum
ns)
```

In [67]:
```python
test_label_interaction.to_csv('label_encoding/preprocessed_test_label_interaction.csv',index
= False)
```

Adding PCAand Interaction features

In [68]:
```python
train_label_corr_pca = pd.concat([train_label_interaction,train_pca_df],axis = 1)
test_label_corr_pca = pd.concat([test_label_interaction,test_pca_df],axis = 1)
```

In [69]:
```python
train_label_corr_pca.to_csv('label_encoding/train_label_interaction_pca.csv',index = False)
```

In [70]:
```python
test_label_corr_pca.to_csv('label_encoding/test_label_interaction_pca.csv',index = False)
```

Adding TSVD and Interaction features

In [71]:
```python
train_label_corr_tsvd = pd.concat([train_label_interaction,train_tsvd_df],axis = 1)
test_label_corr_tsvd = pd.concat([test_label_interaction,test_tsvd_df],axis = 1)
```

In [72]:
```python
train_label_corr_tsvd.to_csv('label_encoding/train_label_interaction_tsvd.csv',index = False
)
```

In [73]:
```python
test_label_corr_tsvd.to_csv('label_encoding/test_label_interaction_tsvd.csv',index = False)
```

Datasets - 2 (Mean Encoding)

In [77]:
```python
#Loading dataset saved from EDA
train_mean = pd.read_csv('preprocessed_train_eda.csv')
test_mean = pd.read_csv('preprocessed_test_eda.csv')
```

In [78]:
```python
# Getting categorical columns from the train
categ = list(train_mean.select_dtypes(include = 'object').columns)
```

In [79]:
```python
default_mean = train_mean['y'].mean()
```

In [157]:
```python
# Saving class means.
def class_means(col_name,train):
    class_mean = train.groupby(col_name)['y'].mean()
    filename = 'class-means/mean_'+str(col_name)
    pickle.dump(class_mean,open(filename,'wb'))
pickle.dump(default_mean,open('class-means/default_mean','wb'))
```

In [80]:
```python
# Creating a function to implement mean encoding of categorical features
#https://www.geeksforgeeks.org/mean-encoding-machine-learning/
def mean_encoding(col_name,tr,te):
    class_mean = tr.groupby(col_name)['y'].mean()
    tr[col_name] = [class_mean.loc[i] for i in tr[col_name].values]
    te[col_name] = [class_mean.loc[i] if i in class_mean.index else default_mean for i in te
[col_name].values]
```

In [81]:
```python
# Mean Encoding
for i in categ:
    mean_encoding(i,train_mean,test_mean)
```

In [82]:
```python
train_mean.head()
```

Out[82]:

	y	X0	X1	X2	X3	X5	X6	X8	X10	X12	...	X373	X374	X375
0	130.81	99.491818	100.983086	104.218333	102.242763	130.81	101.015569	97.746933	0	0	...	0	0	0
1	88.53	99.491818	93.723226	95.510000	100.033190	88.53	98.487815	97.746933	0	0	...	0	0	1
2	76.26	78.025543	95.764808	83.369927	101.766129	78.44	101.015569	98.078654	0	0	...	0	0	0
3	80.62	78.025543	93.723226	83.369927	96.111916	78.44	98.487815	104.737232	0	0	...	0	0	0
4	78.02	78.025543	100.983086	83.369927	96.111916	78.02	101.174141	102.194215	0	0	...	0	0	0

5 rows × 319 columns

In [83]:
```python
test_mean.head()
```

Out[83]:

	X0	X1	X2	X3	X5	X6	X8	X10	X12	X13	...	X373	X374
0	78.025543	100.983086	83.369927	96.111916	100.439938	97.802524	98.848615	0	0	0	...	0	0
1	93.538656	99.550000	93.722995	102.242763	100.439938	99.961284	101.435086	0	0	0	...	0	0
2	78.025543	100.983086	103.575961	96.111916	100.439938	101.015569	100.272428	0	0	0	...	0	0
3	78.025543	100.416661	83.369927	96.111916	100.439938	98.487815	102.194215	0	0	0	...	0	0
4	112.151000	101.868462	103.575961	101.766129	88.530000	101.226803	100.051364	0	0	0	...	0	0

5 rows × 318 columns

In [84]:
```python
# Using standard scaler to normalize the data
scaler = StandardScaler()
```

In [85]:
```python
train_mean_norm= scaler.fit_transform(train_mean.drop(['y'],axis = 1))
```

In [86]:
```python
train_columns = train_mean.drop(['y'],axis = 1).columns
```

In [87]:
```python
train_mean_norm = pd.DataFrame(train_mean_norm,columns = train_columns)
```

In [88]:
```python
test_mean_norm = scaler.transform(test_mean)
```

In [89]:
```python
test_mean_norm = pd.DataFrame(test_mean_norm,columns = test_mean.columns)
```

In [90]:
```python
train_mean_norm.to_csv('mean_encoding/preprocessed_train_norm_mean.csv',index = False)
```

In [91]:
```python
test_mean_norm.to_csv('mean_encoding/preprocessed_test_norm_mean.csv',index = False)
```

Adding Interaction variables

In [92]:
```python
train_mean_corr = pd.concat([train_mean,train_top_corr_numeric],axis = 1)
test_mean_corr = pd.concat([test_mean,test_top_corr_numeric],axis = 1)
```

In [93]:
```python
# Using standard scaler to normalize the data
scaler = StandardScaler()
```

In [94]:
```python
train_mean_interaction = scaler.fit_transform(train_mean_corr.drop(['y'],axis = 1))
```

In [95]:
```python
train_columns = train_mean_corr.drop(['y'],axis = 1).columns
```

In [96]:
```python
train_mean_interaction = pd.DataFrame(train_mean_interaction,columns = train_columns)
```

In [97]:
```python
train_mean_interaction.to_csv('mean_encoding/preprocessed_train_mean_interaction.csv',index
= False)
```

In [98]:
```python
test_mean_interaction = scaler.transform(test_mean_corr)
```

In [99]:
```python
test_mean_interaction = pd.DataFrame(test_mean_interaction,columns = test_mean_corr.columns)
```

In [100]:
```python
test_mean_interaction.to_csv('mean_encoding/preprocessed_test_mean_interaction.csv',index =
False)
```

In [163]:
```python
file = 'models/mean-scaler.sav'
file_dump = open(file,'wb')
pickle.dump(scaler,file_dump)
file_dump.close()
```

Adding PCA and Interaction features

In [101]:
```python
train_mean_corr_pca= pd.concat([train_mean_interaction,train_pca_df],axis = 1)
test_mean_corr_pca = pd.concat([test_mean_interaction,test_pca_df],axis = 1)
```

In [102]:
```python
train_mean_corr_pca.to_csv('mean_encoding/train_mean_interaction_pca.csv',index = False)
```

In [103]:
```python
test_mean_corr_pca.to_csv('mean_encoding/test_mean_interaction_pca.csv',index = False)
```

Adding TSVD and Interaction features

In [104]:
```python
train_mean_corr_tsvd = pd.concat([train_mean_interaction,train_tsvd_df],axis = 1)
test_mean_corr_tsvd = pd.concat([test_mean_interaction,test_tsvd_df],axis = 1)
```

In [105]:
```python
train_mean_corr_tsvd.to_csv('mean_encoding/train_mean_interaction_tsvd.csv',index = False)
```

In [106]:
```python
test_mean_corr_tsvd.to_csv('mean_encoding/test_mean_interaction_tsvd.csv',index = False)
```

Datasets-3 (GLMM Encoding)

In [110]:
```python
glmm_encoder = GLMMEncoder()
```

In [111]:
```python
#Loading dataset saved from EDA
train_glmm = pd.read_csv('preprocessed_train_eda.csv')
test_glmm = pd.read_csv('preprocessed_test_eda.csv')
```

In [112]:
```python
# Getting categorical columns from the train
categ = np.array(train_glmm.select_dtypes(include = 'object').columns)
```

Applying GLMM encoding of categorical variables

In [113]:
```python
train_glmm_categ = glmm_encoder.fit_transform(train_glmm[categ],train_glmm['y'])
```

```
c:\Miniconda\lib\site-packages\category_encoders\utils.py:21: FutureWarning: is_categorical i
s deprecated and will be removed in a future version.  Use is_categorical_dtype instead
  elif pd.api.types.is_categorical(cols):
```

In [114]:
```python
test_glmm_categ = glmm_encoder.transform(test_glmm[categ])
```

In [115]:
```python
for i in categ:
    train_glmm[i] = train_glmm_categ[i]
    test_glmm[i] = test_glmm_categ[i]
```

In [116]:
```python
# Using standard scaler to normalize the data
scaler = StandardScaler()
```

In [117]:
```python
train_glmm_norm= scaler.fit_transform(train_glmm.drop(['y'],axis = 1))
```

In [118]:
```python
train_columns = train_glmm.drop(['y'],axis = 1).columns
```

In [119]:
```python
train_glmm_norm = pd.DataFrame(train_glmm_norm,columns = train_columns)
```

In [120]:
```python
test_glmm_norm = scaler.transform(test_glmm)
```

In [121]:
```python
test_glmm_norm = pd.DataFrame(test_glmm_norm,columns = test_glmm.columns)
```

In [122]:
```python
train_glmm_norm.to_csv('glmm_encoding/preprocessed_train_norm_glmm.csv',index = False)
```

In [123]:
```python
test_glmm_norm.to_csv('glmm_encoding/preprocessed_test_norm_glmm.csv',index = False)
```

Adding Interaction variables

In [124]:
```python
train_glmm_corr = pd.concat([train_glmm,train_top_corr_numeric],axis = 1)
test_glmm_corr = pd.concat([test_glmm,test_top_corr_numeric],axis = 1)
```

In [125]:
```python
# Using standard scaler to normalize the data
scaler = StandardScaler()
```

In [126]:
```python
train_glmm_interaction = scaler.fit_transform(train_glmm_corr.drop(['y'],axis = 1))
```

In [127]:
```python
train_columns = train_glmm_corr.drop(['y'],axis = 1).columns
```

In [128]:
```python
train_glmm_interaction = pd.DataFrame(train_glmm_interaction,columns = train_columns)
```

In [129]:
```python
train_glmm_interaction.to_csv('glmm_encoding/preprocessed_train_glmm_interaction.csv',index
= False)
```

In [130]:
```python
test_glmm_interaction = scaler.transform(test_glmm_corr)
```

In [131]:
```python
test_glmm_interaction = pd.DataFrame(test_glmm_interaction,columns = test_glmm_corr.columns)
```

In [132]:
```python
test_glmm_interaction.to_csv('glmm_encoding/preprocessed_test_glmm_interaction.csv',index =
False)
```

Adding PCA and Interaction features

In [133]:
```python
train_glmm_corr_pca = pd.concat([train_glmm_interaction,train_pca_df],axis = 1)
test_glmm_corr_pca = pd.concat([test_glmm_interaction,test_pca_df],axis = 1)
```

In [134]:
```python
train_glmm_corr_pca.to_csv('glmm_encoding/train_glmm_interaction_pca.csv',index = False)
```

In [135]:
```python
test_glmm_corr_pca.to_csv('glmm_encoding/test_glmm_interaction_pca.csv',index = False)
```

Adding TSVD and Interaction features

In [136]:
```python
train_glmm_corr_tsvd = pd.concat([train_glmm_interaction,train_tsvd_df],axis = 1)
test_glmm_corr_tsvd = pd.concat([test_glmm_interaction,test_tsvd_df],axis = 1)
```

In [137]:
```python
train_glmm_corr_tsvd.to_csv('glmm_encoding/train_glmm_interaction_tsvd.csv',index = False)
```

In [138]:
```python
test_glmm_corr_tsvd.to_csv('glmm_encoding/test_glmm_interaction_tsvd.csv',index = False)
```

In [ ]:

In [ ]:

In [160]:
```python
test.head()
```

Out[160]:

	X0	X1	X2	X3	X5	X6	X8	X10	X12	X13	...	X373	X374	X375	X376	X377	X378	X379	X380	X383	X384
0	az	v	n	f	t	a	w	0	0	0	...	0	0	0	0	0	1	0	0	0	0
1	t	b	ai	a	b	g	y	0	0	0	...	0	0	0	0	1	0	0	0	0	0
2	az	v	as	f	a	j	j	0	0	0	...	0	0	0	0	0	1	0	0	0	0
3	az	l	n	f	z	l	n	0	0	0	...	0	0	0	0	0	1	0	0	0	0
4	w	s	as	c	y	i	m	0	0	0	...	0	0	1	0	0	0	0	0	0	0

5 rows × 318 columns

In [ ]: