Mercedes-Benz Greener Manufacturing

DESCRIPTION

Reduce the time a Mercedes-Benz spends on the test bench.

Problem Statement Scenario: Since the first automobile, the Benz Patent Motor Car in 1886, Mercedes-Benz has stood for important automotive innovations. These include the passenger safety cell with a crumple zone, the airbag, and intelligent assistance systems. Mercedes-Benz applies for nearly 2000 patents per year, making the brand the European leader among premium carmakers. Mercedes-Benz is the leader in the premium car industry. With a huge selection of features and options, customers can choose the customized Mercedes-Benz of their dreams.

To ensure the safety and reliability of every unique car configuration before they hit the road, the company's engineers have developed a robust testing system. As one of the world's biggest manufacturers of premium cars, safety and efficiency are paramount on Mercedes-Benz's production lines. However, optimizing the speed of their testing system for many possible feature combinations is complex and time-consuming without a powerful algorithmic approach.

You are required to reduce the time that cars spend on the test bench. Others will work with a dataset representing different permutations of features in a Mercedes-Benz car to predict the time it takes to pass testing. Optimal algorithms will contribute to faster testing, resulting in lower carbon dioxide emissions without reducing Mercedes-Benz's standards.

Following actions should be performed:

1. If for any column(s), the variance is equal to zero, then you need to remove those variable(s).
2. Check for null and unique values for test and train sets.
3. Apply label encoder.
4. Perform dimensionality reduction.
5. Predict your test_df values using XGBoost.

Data and Library acquisition and preliminary analysis

In [1]:

```
# Importing the required libraries

import pandas as pd
import numpy as np
from IPython.core.interactiveshell import InteractiveShell
InteractiveShell.ast_node_interactivity = 'all'
import matplotlib.pyplot as plt
import seaborn as sns
```

```
C:\Users\C. Dev\Anaconda3\lib\site-packages\statsmodels\tools\_testing.py:19: FutureWarning: pandas.
util.testing is deprecated. Use the functions in the public API at pandas.testing instead.
  import pandas.util.testing as tm
```

In [2]:

```
# Reading the train and test dataset and storing them in two different dataframes (train_data and test_data)

train_data = pd.read_csv(r"C:\Users\C. Dev\Desktop\train.csv")
test_data = pd.read_csv(r"C:\Users\C. Dev\Desktop\test.csv")
```

In [3]:

```
# Checking the head and shapes of train_data and test_data

train_data.head()
train_data.shape
test_data.head()
test_data.shape
```

Out[3]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	...	X375	X376	X377	X378	X379	X380	X382	X383	X384	X385
0	0	130.81	k	v	at	a	d	u	j	o	...	0	0	1	0	0	0	0	0	0	0
1	6	88.53	k	t	av	e	d	y	l	o	...	1	0	0	0	0	0	0	0	0	0
2	7	76.26	az	w	n	c	d	x	j	x	...	0	0	0	0	0	0	1	0	0	0
3	9	80.62	az	t	n	f	d	x	l	e	...	0	0	0	0	0	0	0	0	0	0
4	13	78.02	az	v	n	f	d	h	d	n	...	0	0	0	0	0	0	0	0	0	0

5 rows × 378 columns

Out[3]:

(4209, 378)

Out[3]:

	ID	X0	X1	X2	X3	X4	X5	X6	X8	X10	...	X375	X376	X377	X378	X379	X380	X382	X383	X384	X385
0	1	az	v	n	f	d	t	a	w	0	...	0	0	0	1	0	0	0	0	0	0
1	2	t	b	ai	a	d	b	g	y	0	...	0	0	1	0	0	0	0	0	0	0
2	3	az	v	as	f	d	a	j	j	0	...	0	0	0	1	0	0	0	0	0	0
3	4	az	l	n	f	d	z	l	n	0	...	0	0	0	1	0	0	0	0	0	0
4	5	w	s	as	c	d	y	i	m	0	...	1	0	0	0	0	0	0	0	0	0

5 rows × 377 columns

Out[3]:

(4209, 377)

Data Analysis

In [4]:

```
# Describing train_data and test_data

train_data.describe()
train_data.info()
test_data.describe()
test_data.info()
```

Out[4]:

	ID	y	X10	X11	X12	X13	X14	X15	X16	X17	...
count	4209.000000	4209.000000	4209.000000	4209.0	4209.000000	4209.000000	4209.000000	4209.000000	4209.000000	4209.000000	...
mean	4205.960798	100.669318	0.013305	0.0	0.075077	0.057971	0.428130	0.000475	0.002613	0.007603	...
std	2437.608688	12.679381	0.114590	0.0	0.263547	0.233716	0.494867	0.021796	0.051061	0.086872	...
min	0.000000	72.110000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...
25%	2095.000000	90.820000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...
50%	4220.000000	99.150000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...
75%	6314.000000	109.010000	0.000000	0.0	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000	...
max	8417.000000	265.320000	1.000000	0.0	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	...

8 rows × 370 columns

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4209 entries, 0 to 4208
Columns: 378 entries, ID to X385
dtypes: float64(1), int64(369), object(8)
memory usage: 12.1+ MB
```

Out[4]:

	ID	X10	X11	X12	X13	X14	X15	X16	X17	X1
count	4209.000000	4209.000000	4209.000000	4209.000000	4209.000000	4209.000000	4209.000000	4209.000000	4209.000000	4209.00000
mean	4211.039202	0.019007	0.000238	0.074364	0.061060	0.427893	0.000713	0.002613	0.008791	0.01021
std	2423.078926	0.136565	0.015414	0.262394	0.239468	0.494832	0.026691	0.051061	0.093357	0.10057
min	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.00000
25%	2115.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.00000
50%	4202.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.00000
75%	6310.000000	0.000000	0.000000	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000	0.00000
max	8416.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.00000

8 rows × 369 columns

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4209 entries, 0 to 4208
Columns: 377 entries, ID to X385
dtypes: int64(369), object(8)
memory usage: 12.1+ MB
```

In [5]:

```
# Concatenating train_data and test_data into a new dataframe (new_dataset)

train_new_data = train_data.drop('y',axis =1)
new_dataset = pd.concat([train_new_data,test_data])
new_dataset.head()
```

Out[5]:

	ID	X0	X1	X2	X3	X4	X5	X6	X8	X10	...	X375	X376	X377	X378	X379	X380	X382	X383	X384	X385
0	0	k	v	at	a	d	u	j	o	0	...	0	0	1	0	0	0	0	0	0	0
1	6	k	t	av	e	d	y	l	o	0	...	1	0	0	0	0	0	0	0	0	0
2	7	az	w	n	c	d	x	j	x	0	...	0	0	0	0	0	0	1	0	0	0
3	9	az	t	n	f	d	x	l	e	0	...	0	0	0	0	0	0	0	0	0	0
4	13	az	v	n	f	d	h	d	n	0	...	0	0	0	0	0	0	0	0	0	0

5 rows × 377 columns

In [6]:

```
# Check for null and unique values for test and train sets.

for i in train_data.columns:
    train_data[i].unique()
for i in test_data.columns:
    test_data[i].unique()

train_data.isnull().sum()
test_data.isnull().sum()
```

Out[6]:

```
array([   0,    6,    7, ..., 8412, 8415, 8417], dtype=int64)
```

Out[6]:

```
array([130.81,  88.53,  76.26, ...,  85.71, 108.77,  87.48])
```

Out[6]:

```
array(['k', 'az', 't', 'al', 'o', 'w', 'j', 'h', 's', 'n', 'ay', 'f', 'x',
       'y', 'aj', 'ak', 'am', 'z', 'q', 'at', 'ap', 'v', 'af', 'a', 'e',
       'ai', 'd', 'aq', 'c', 'aa', 'ba', 'as', 'i', 'r', 'b', 'ax', 'bc',
       'u', 'ad', 'au', 'm', 'l', 'aw', 'ao', 'ac', 'g', 'ab'],
      dtype=object)
```

Out[6]:

```
array(['v', 't', 'w', 'b', 'r', 'l', 's', 'aa', 'c', 'a', 'e', 'h', 'z',
       'j', 'o', 'u', 'p', 'n', 'i', 'y', 'd', 'f', 'm', 'k', 'g', 'q',
       'ab'], dtype=object)
```

Out[6]:

```
array(['at', 'av', 'n', 'e', 'as', 'aq', 'r', 'ai', 'ak', 'm', 'a', 'k',
       'ae', 's', 'f', 'd', 'ag', 'ay', 'ac', 'ap', 'g', 'i', 'aw', 'y',
       'b', 'ao', 'al', 'h', 'x', 'au', 't', 'an', 'z', 'ah', 'p', 'am',
       'j', 'q', 'af', 'l', 'aa', 'c', 'o', 'ar'], dtype=object)
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Out[6]:

```
array(['a', 'e', 'c', 'f', 'd', 'b', 'g'], dtype=object)
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Out[6]:

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array(['d', 'b', 'c', 'a'], dtype=object)
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Out[6]:

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array(['u', 'y', 'x', 'h', 'g', 'f', 'j', 'i', 'd', 'c', 'af', 'ag', 'ab',
       'ac', 'ad', 'ae', 'ah', 'l', 'k', 'n', 'm', 'p', 'q', 's', 'r',
       'v', 'w', 'o', 'aa'], dtype=object)
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Out[6]:

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array(['j', 'l', 'd', 'h', 'i', 'a', 'g', 'c', 'k', 'e', 'f', 'b'],
      dtype=object)
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Out[6]:

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array(['o', 'x', 'e', 'n', 's', 'a', 'h', 'p', 'm', 'k', 'd', 'i', 'v',
       'j', 'b', 'q', 'w', 'g', 'y', 'l', 'f', 'u', 'r', 't', 'c'],
      dtype=object)
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array([0, 1], dtype=int64)
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array([   1,    2,    3, ..., 8413, 8414, 8416], dtype=int64)
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Out[6]:

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array(['az', 't', 'w', 'y', 'x', 'f', 'ap', 'o', 'ay', 'al', 'h', 'z',
       'aj', 'd', 'v', 'ak', 'ba', 'n', 'j', 's', 'af', 'ax', 'at', 'aq',
       'av', 'm', 'k', 'a', 'e', 'ai', 'i', 'ag', 'b', 'am', 'aw', 'as',
       'r', 'ao', 'u', 'l', 'c', 'ad', 'au', 'bc', 'g', 'an', 'ae', 'p',
       'bb'], dtype=object)
```

Out[6]:

```
array(['v', 'b', 'l', 's', 'aa', 'r', 'a', 'i', 'p', 'c', 'o', 'm', 'z',
       'e', 'h', 'w', 'g', 'k', 'y', 't', 'u', 'd', 'j', 'q', 'n', 'f',
       'ab'], dtype=object)
```

Out[6]:

```
array(['n', 'ai', 'as', 'ae', 's', 'b', 'e', 'ak', 'm', 'a', 'aq', 'ag',
       'r', 'k', 'aj', 'ay', 'ao', 'an', 'ac', 'af', 'ax', 'h', 'i', 'f',
       'ap', 'p', 'au', 't', 'z', 'y', 'aw', 'd', 'at', 'g', 'am', 'j',
       'x', 'ab', 'w', 'q', 'ah', 'ad', 'al', 'av', 'u'], dtype=object)
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Out[6]:

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array(['f', 'a', 'c', 'e', 'd', 'g', 'b'], dtype=object)
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Out[6]:

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array(['d', 'b', 'a', 'c'], dtype=object)
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array(['t', 'b', 'a', 'z', 'y', 'x', 'h', 'g', 'f', 'j', 'i', 'd', 'c',
       'af', 'ag', 'ab', 'ac', 'ad', 'ae', 'ah', 'l', 'k', 'n', 'm', 'p',
       'q', 's', 'r', 'v', 'w', 'o', 'aa'], dtype=object)
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Out[6]:

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array(['a', 'g', 'j', 'l', 'i', 'd', 'f', 'h', 'c', 'k', 'e', 'b'],
      dtype=object)
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array(['w', 'y', 'j', 'n', 'm', 's', 'a', 'v', 'r', 'o', 't', 'h', 'c',
       'k', 'p', 'u', 'd', 'g', 'b', 'q', 'e', 'l', 'f', 'i', 'x'],
      dtype=object)
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Out[6]:

```
ID      0
y       0
X0      0
X1      0
X2      0
       ..
X380    0
X382    0
X383    0
X384    0
X385    0
Length: 378, dtype: int64
```

Out[6]:

```
ID      0
X0      0
X1      0
X2      0
X3      0
       ..
X380    0
X382    0
X383    0
X384    0
X385    0
Length: 377, dtype: int64
```

In [7]:

```
# Checking whether any column has all zero values

zero_cols = [cols for cols in new_dataset.columns if (new_dataset[cols] == 0).all()]
print(zero_cols)
```

```
[]
```

In [8]:

```
# Finding out the categorical columns

cat_cols = [cols for cols in new_dataset.columns if (new_dataset[cols].dtypes == 'object')]
cat_cols
```

Out[8]:

```
['X0', 'X1', 'X2', 'X3', 'X4', 'X5', 'X6', 'X8']
```

In [9]:

```
# Finding out the numerical columns

num_cols = [cols for cols in new_dataset.columns if (new_dataset[cols].dtypes == 'int64')]
print(num_cols)
```

```
['ID', 'X10', 'X11', 'X12', 'X13', 'X14', 'X15', 'X16', 'X17', 'X18', 'X19', 'X20', 'X21', 'X22', 'X
23', 'X24', 'X26', 'X27', 'X28', 'X29', 'X30', 'X31', 'X32', 'X33', 'X34', 'X35', 'X36', 'X37', 'X38
', 'X39', 'X40', 'X41', 'X42', 'X43', 'X44', 'X45', 'X46', 'X47', 'X48', 'X49', 'X50', 'X51', 'X52',
'X53', 'X54', 'X55', 'X56', 'X57', 'X58', 'X59', 'X60', 'X61', 'X62', 'X63', 'X64', 'X65', 'X66', 'X
67', 'X68', 'X69', 'X70', 'X71', 'X73', 'X74', 'X75', 'X76', 'X77', 'X78', 'X79', 'X80', 'X81', 'X82
', 'X83', 'X84', 'X85', 'X86', 'X87', 'X88', 'X89', 'X90', 'X91', 'X92', 'X93', 'X94', 'X95', 'X96',
'X97', 'X98', 'X99', 'X100', 'X101', 'X102', 'X103', 'X104', 'X105', 'X106', 'X107', 'X108', 'X109',
'X110', 'X111', 'X112', 'X113', 'X114', 'X115', 'X116', 'X117', 'X118', 'X119', 'X120', 'X122', 'X12
3', 'X124', 'X125', 'X126', 'X127', 'X128', 'X129', 'X130', 'X131', 'X132', 'X133', 'X134', 'X135',
'X136', 'X137', 'X138', 'X139', 'X140', 'X141', 'X142', 'X143', 'X144', 'X145', 'X146', 'X147', 'X14
8', 'X150', 'X151', 'X152', 'X153', 'X154', 'X155', 'X156', 'X157', 'X158', 'X159', 'X160', 'X161',
'X162', 'X163', 'X164', 'X165', 'X166', 'X167', 'X168', 'X169', 'X170', 'X171', 'X172', 'X173', 'X17
4', 'X175', 'X176', 'X177', 'X178', 'X179', 'X180', 'X181', 'X182', 'X183', 'X184', 'X185', 'X186',
'X187', 'X189', 'X190', 'X191', 'X192', 'X194', 'X195', 'X196', 'X197', 'X198', 'X199', 'X200', 'X20
1', 'X202', 'X203', 'X204', 'X205', 'X206', 'X207', 'X208', 'X209', 'X210', 'X211', 'X212', 'X213',
'X214', 'X215', 'X216', 'X217', 'X218', 'X219', 'X220', 'X221', 'X222', 'X223', 'X224', 'X225', 'X22
6', 'X227', 'X228', 'X229', 'X230', 'X231', 'X232', 'X233', 'X234', 'X235', 'X236', 'X237', 'X238',
'X239', 'X240', 'X241', 'X242', 'X243', 'X244', 'X245', 'X246', 'X247', 'X248', 'X249', 'X250', 'X25
1', 'X252', 'X253', 'X254', 'X255', 'X256', 'X257', 'X258', 'X259', 'X260', 'X261', 'X262', 'X263',
'X264', 'X265', 'X266', 'X267', 'X268', 'X269', 'X270', 'X271', 'X272', 'X273', 'X274', 'X275', 'X27
6', 'X277', 'X278', 'X279', 'X280', 'X281', 'X282', 'X283', 'X284', 'X285', 'X286', 'X287', 'X288',
'X289', 'X290', 'X291', 'X292', 'X293', 'X294', 'X295', 'X296', 'X297', 'X298', 'X299', 'X300', 'X30
1', 'X302', 'X304', 'X305', 'X306', 'X307', 'X308', 'X309', 'X310', 'X311', 'X312', 'X313', 'X314',
'X315', 'X316', 'X317', 'X318', 'X319', 'X320', 'X321', 'X322', 'X323', 'X324', 'X325', 'X326', 'X32
7', 'X328', 'X329', 'X330', 'X331', 'X332', 'X333', 'X334', 'X335', 'X336', 'X337', 'X338', 'X339',
'X340', 'X341', 'X342', 'X343', 'X344', 'X345', 'X346', 'X347', 'X348', 'X349', 'X350', 'X351', 'X35
2', 'X353', 'X354', 'X355', 'X356', 'X357', 'X358', 'X359', 'X360', 'X361', 'X362', 'X363', 'X364',
'X365', 'X366', 'X367', 'X368', 'X369', 'X370', 'X371', 'X372', 'X373', 'X374', 'X375', 'X376', 'X37
7', 'X378', 'X379', 'X380', 'X382', 'X383', 'X384', 'X385']
```

In [10]:

```
# If for any column(s), the variance is equal to zero, then you need to remove those variable(s).

num_data = new_dataset.drop(cat_cols,axis =1)
zero_var = [col for col in num_data.columns if num_data[col].var() == 0]
zero_var
```

Out[10]:

```
[]
```

In [11]:

```
# Checking the unique values present in the categorical columns

for i in cat_cols:
    print(new_dataset[i].unique())
```

```
['k' 'az' 't' 'al' 'o' 'w' 'j' 'h' 's' 'n' 'ay' 'f' 'x' 'y' 'aj' 'ak' 'am'
 'z' 'q' 'at' 'ap' 'v' 'af' 'a' 'e' 'ai' 'd' 'aq' 'c' 'aa' 'ba' 'as' 'i'
 'r' 'b' 'ax' 'bc' 'u' 'ad' 'au' 'm' 'l' 'aw' 'ao' 'ac' 'g' 'ab' 'av' 'ag'
 'an' 'ae' 'p' 'bb']
['v' 't' 'w' 'b' 'r' 'l' 's' 'aa' 'c' 'a' 'e' 'h' 'z' 'j' 'o' 'u' 'p' 'n'
 'i' 'y' 'd' 'f' 'm' 'k' 'g' 'q' 'ab']
['at' 'av' 'n' 'e' 'as' 'aq' 'r' 'ai' 'ak' 'm' 'a' 'k' 'ae' 's' 'f' 'd'
 'ag' 'ay' 'ac' 'ap' 'g' 'i' 'aw' 'y' 'b' 'ao' 'al' 'h' 'x' 'au' 't' 'an'
 'z' 'ah' 'p' 'am' 'j' 'q' 'af' 'l' 'aa' 'c' 'o' 'ar' 'aj' 'ax' 'ab' 'w'
 'ad' 'u']
['a' 'e' 'c' 'f' 'd' 'b' 'g']
['d' 'b' 'c' 'a']
['u' 'y' 'x' 'h' 'g' 'f' 'j' 'i' 'd' 'c' 'af' 'ag' 'ab' 'ac' 'ad' 'ae'
 'ah' 'l' 'k' 'n' 'm' 'p' 'q' 's' 'r' 'v' 'w' 'o' 'aa' 't' 'b' 'a' 'z']
['j' 'l' 'd' 'h' 'i' 'a' 'g' 'c' 'k' 'e' 'f' 'b']
['o' 'x' 'e' 'n' 's' 'a' 'h' 'p' 'm' 'k' 'd' 'i' 'v' 'j' 'b' 'q' 'w' 'g'
 'y' 'l' 'f' 'u' 'r' 't' 'c']
```

Data Visualisation

In [12]:

```
# Plotting count plots for the categorical data

for i in cat_cols:
    sns.set_style("darkgrid")
    f, ax = plt.subplots(figsize=(15, 15))
    sns.countplot(y=i, data=new_dataset,  order = new_dataset[i].value_counts().index,  color="c");
```

Out[12]:

```
<AxesSubplot:xlabel='count', ylabel='X0'>
```

Out[12]:

```
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```

Out[12]:

```
<AxesSubplot:xlabel='count', ylabel='X2'>
```

Out[12]:

```
<AxesSubplot:xlabel='count', ylabel='X3'>
```

Out[12]:

```
<AxesSubplot:xlabel='count', ylabel='X4'>
```

Out[12]:

```
<AxesSubplot:xlabel='count', ylabel='X5'>
```

Out[12]:

```
<AxesSubplot:xlabel='count', ylabel='X6'>
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Out[12]:

```
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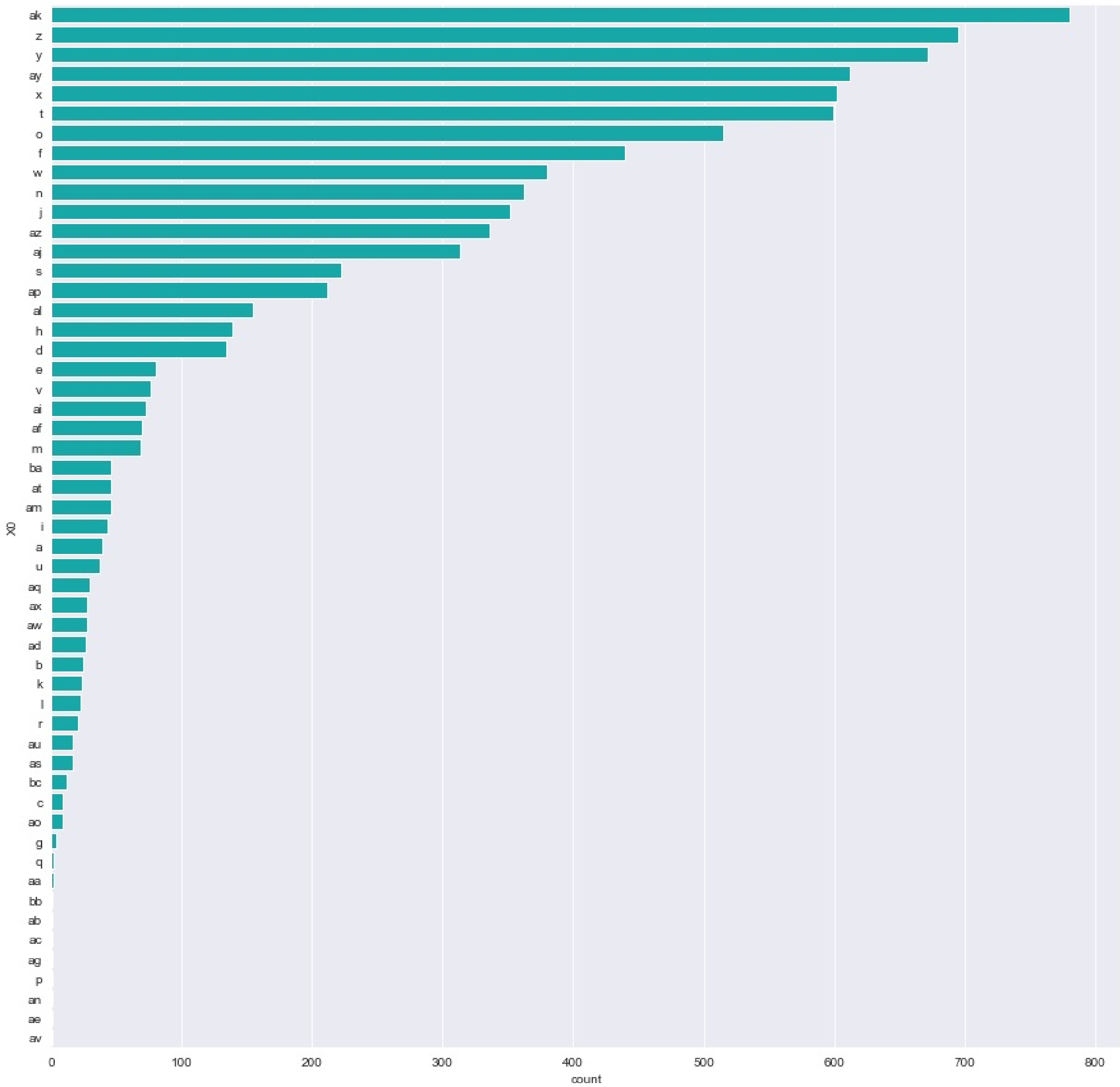

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w
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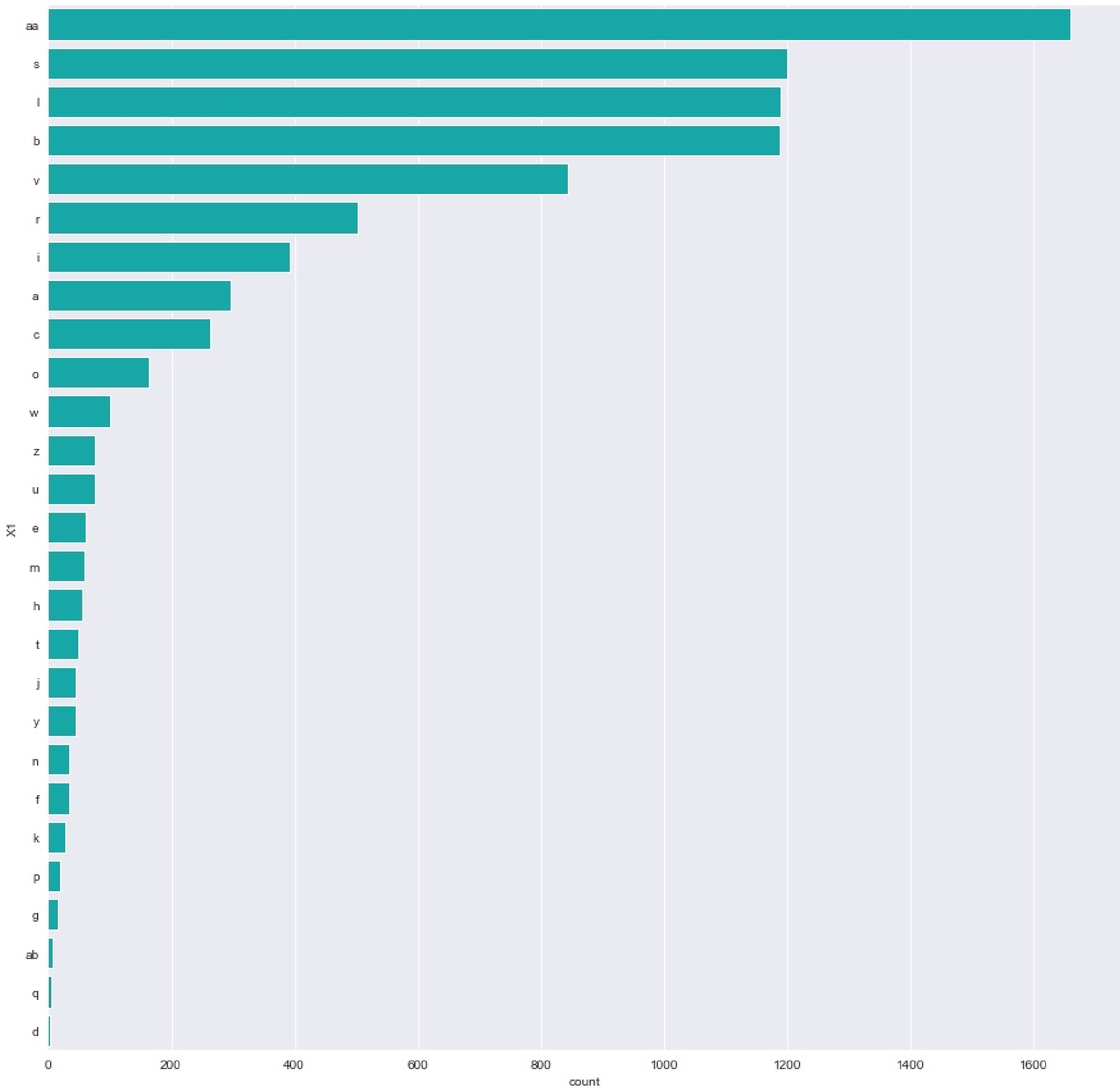
600
700
800
count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X1
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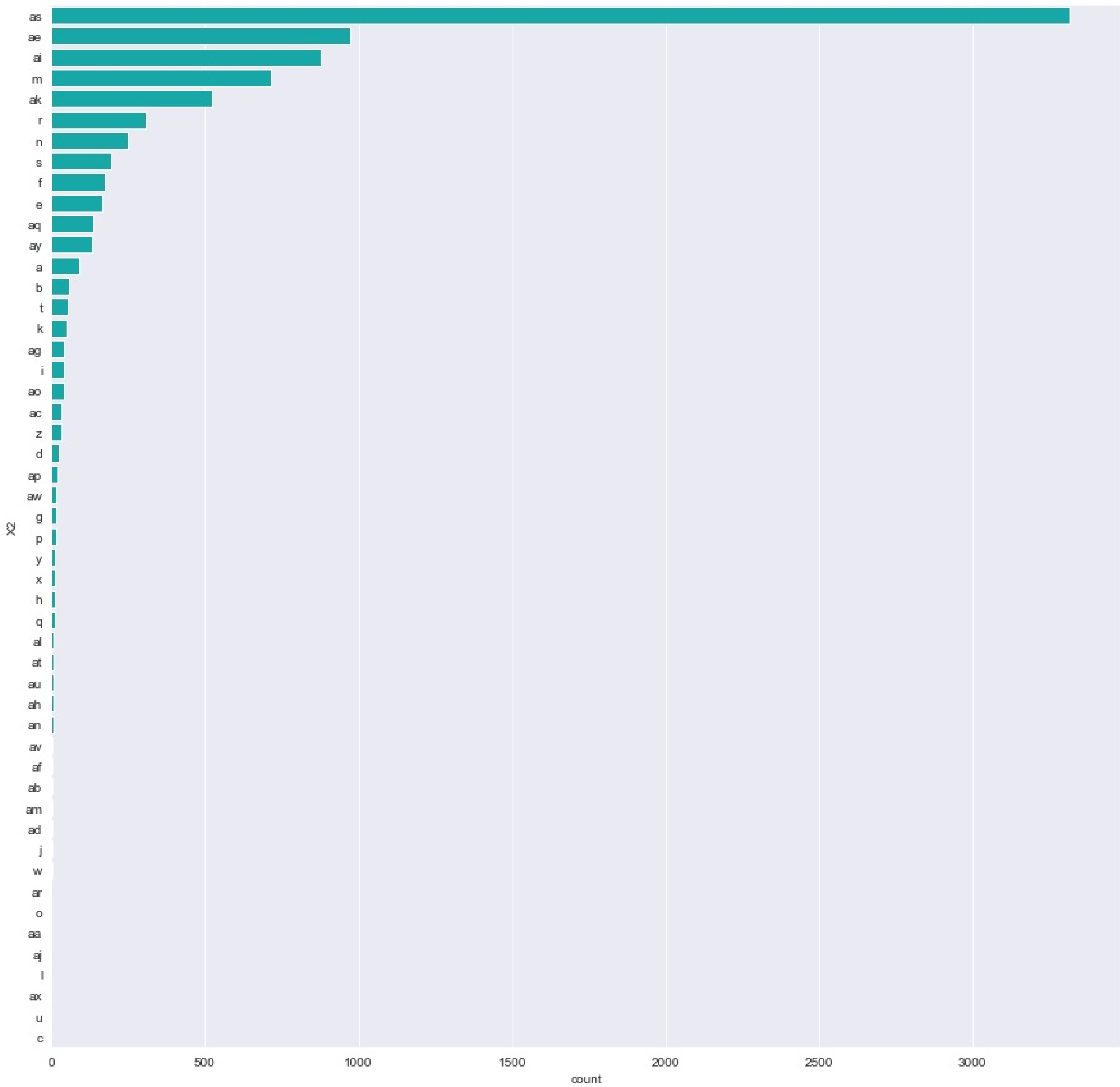
1200
1400
1600
count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at
au
ah
an
av
af
ab
am
ad
j
w
ar
o
aa
aj
l
ax
u
c
X2
0
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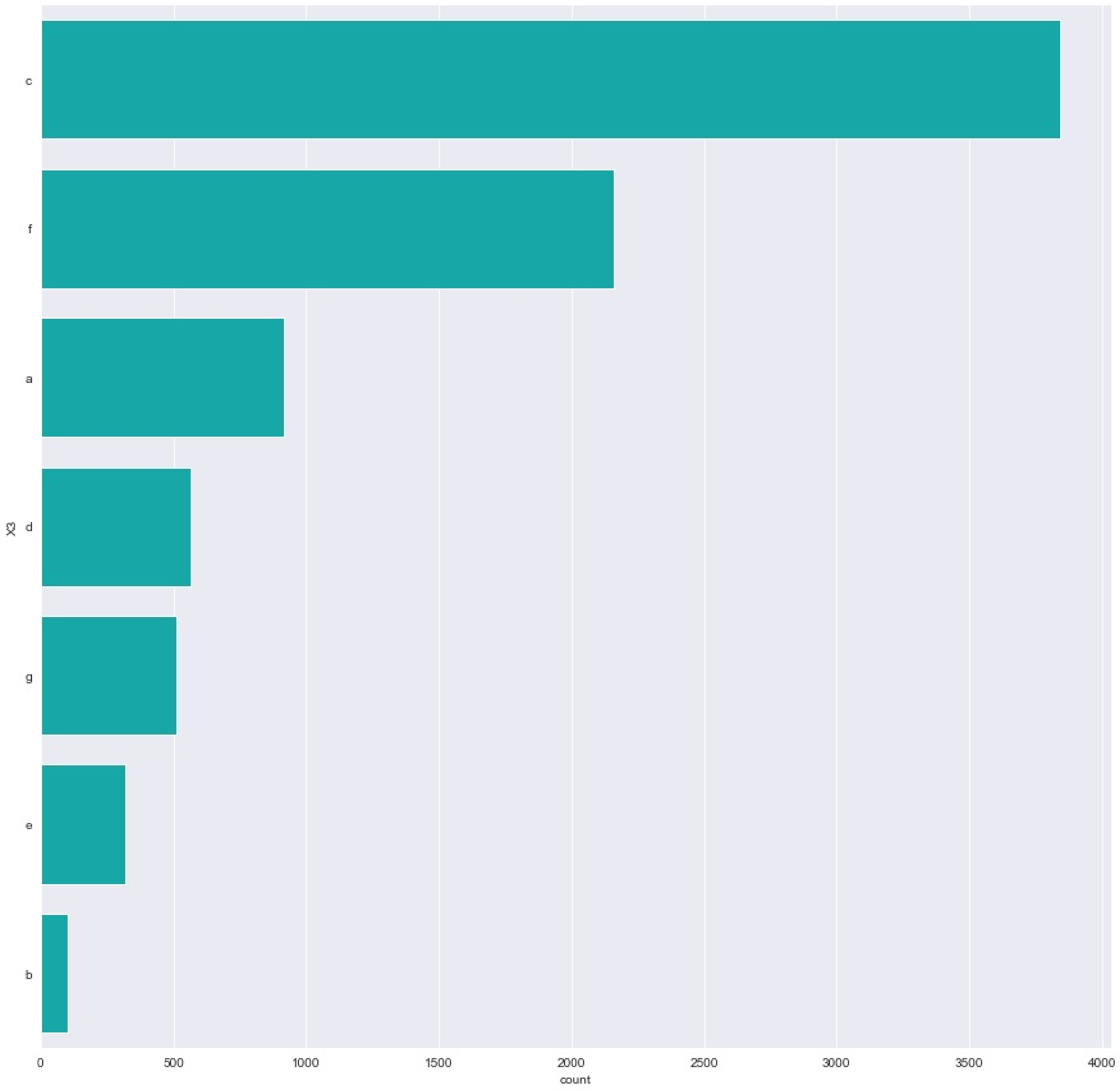
1500
2000
2500
3000
count



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a
d
g
e
b
X3
0
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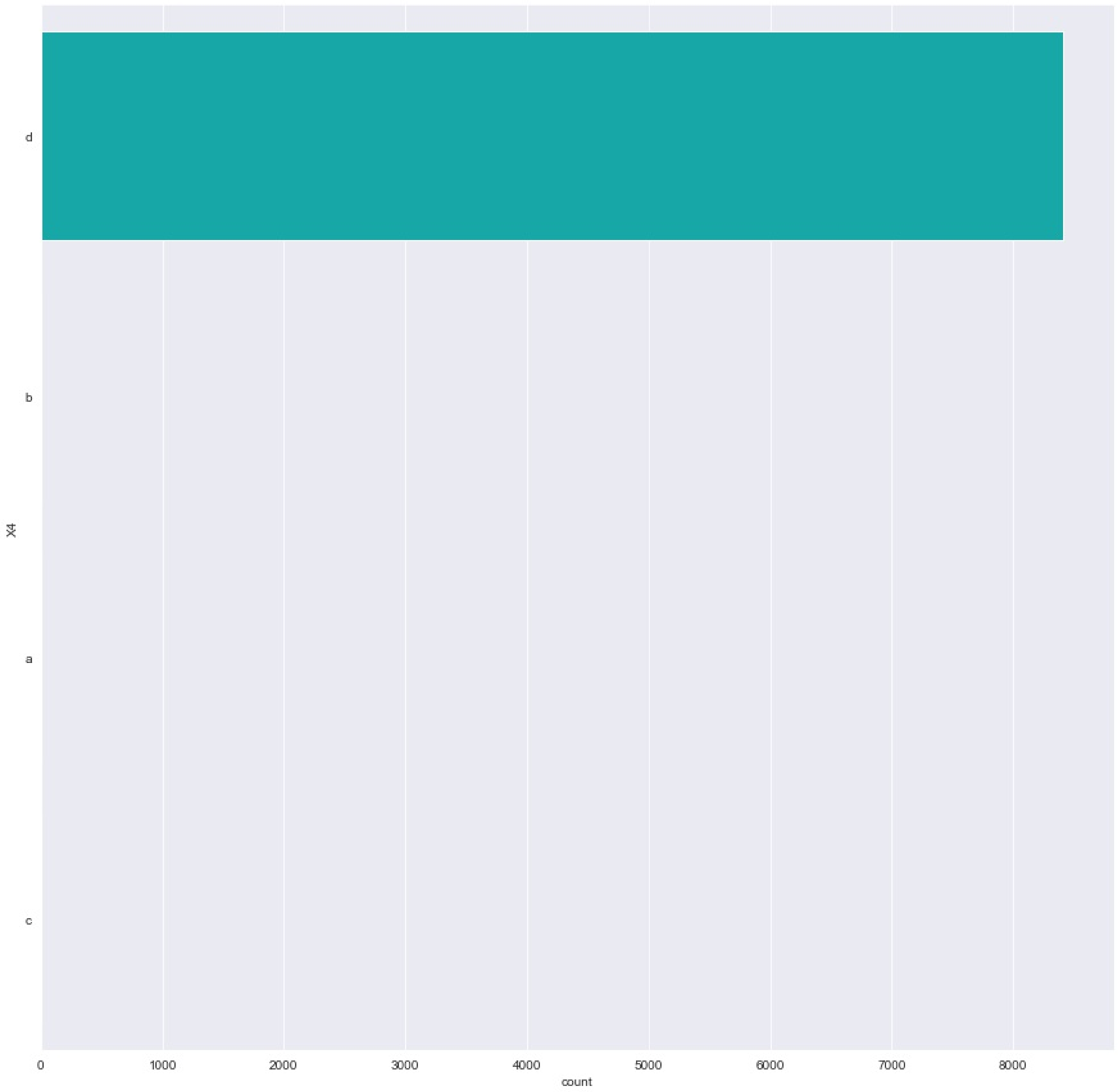
1500
2000
2500
3000
3500
4000
count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c
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7000
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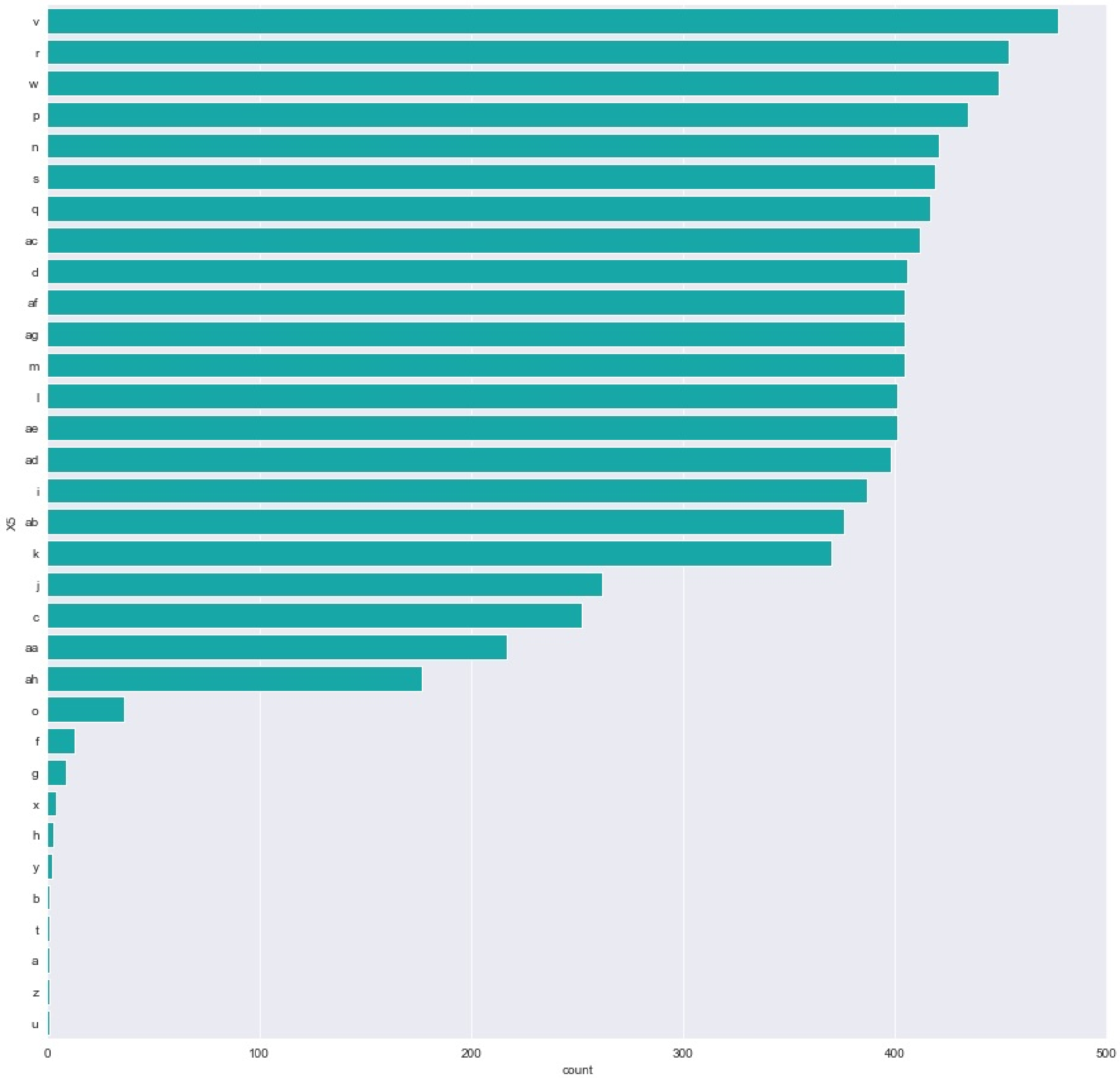
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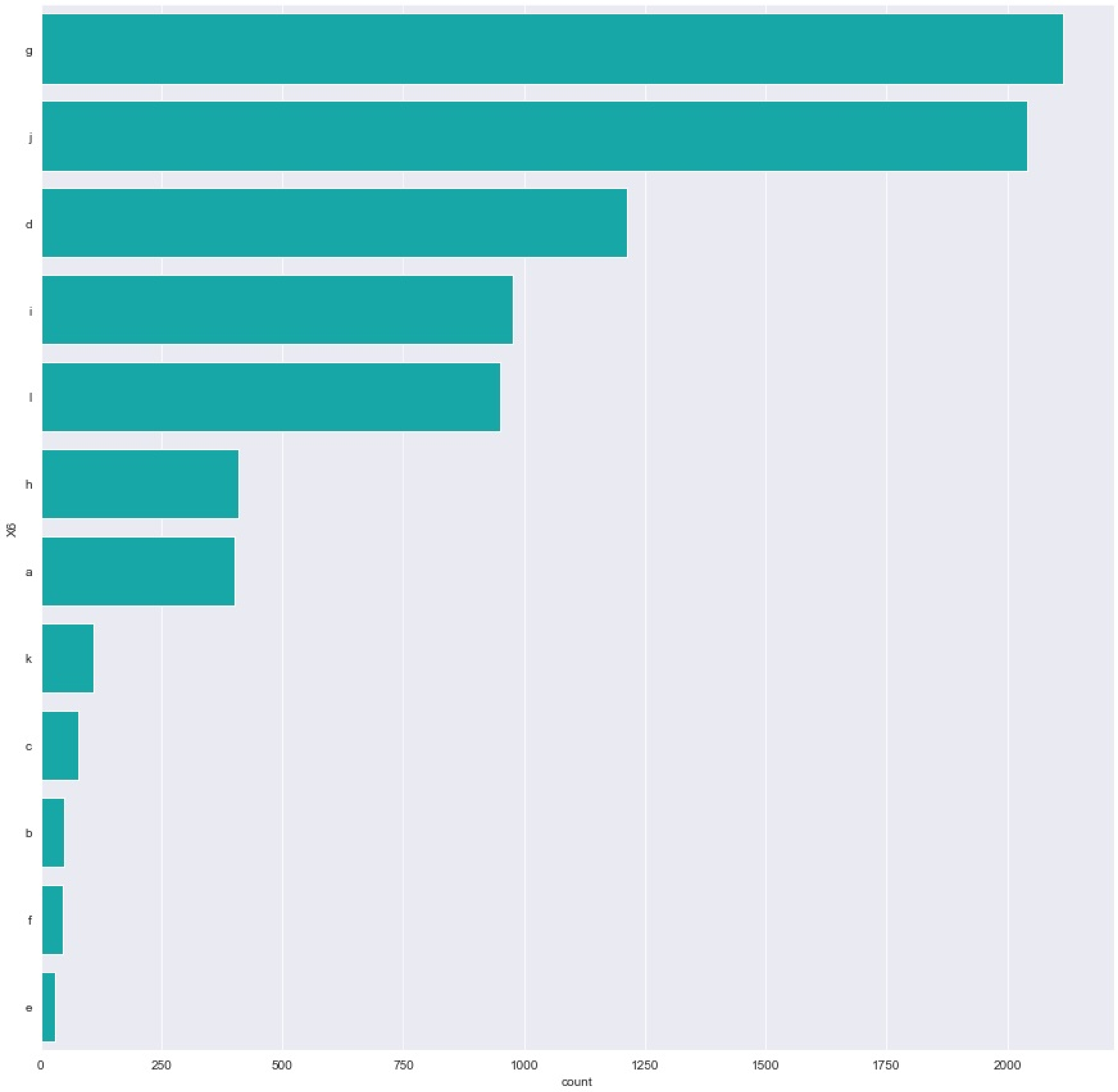
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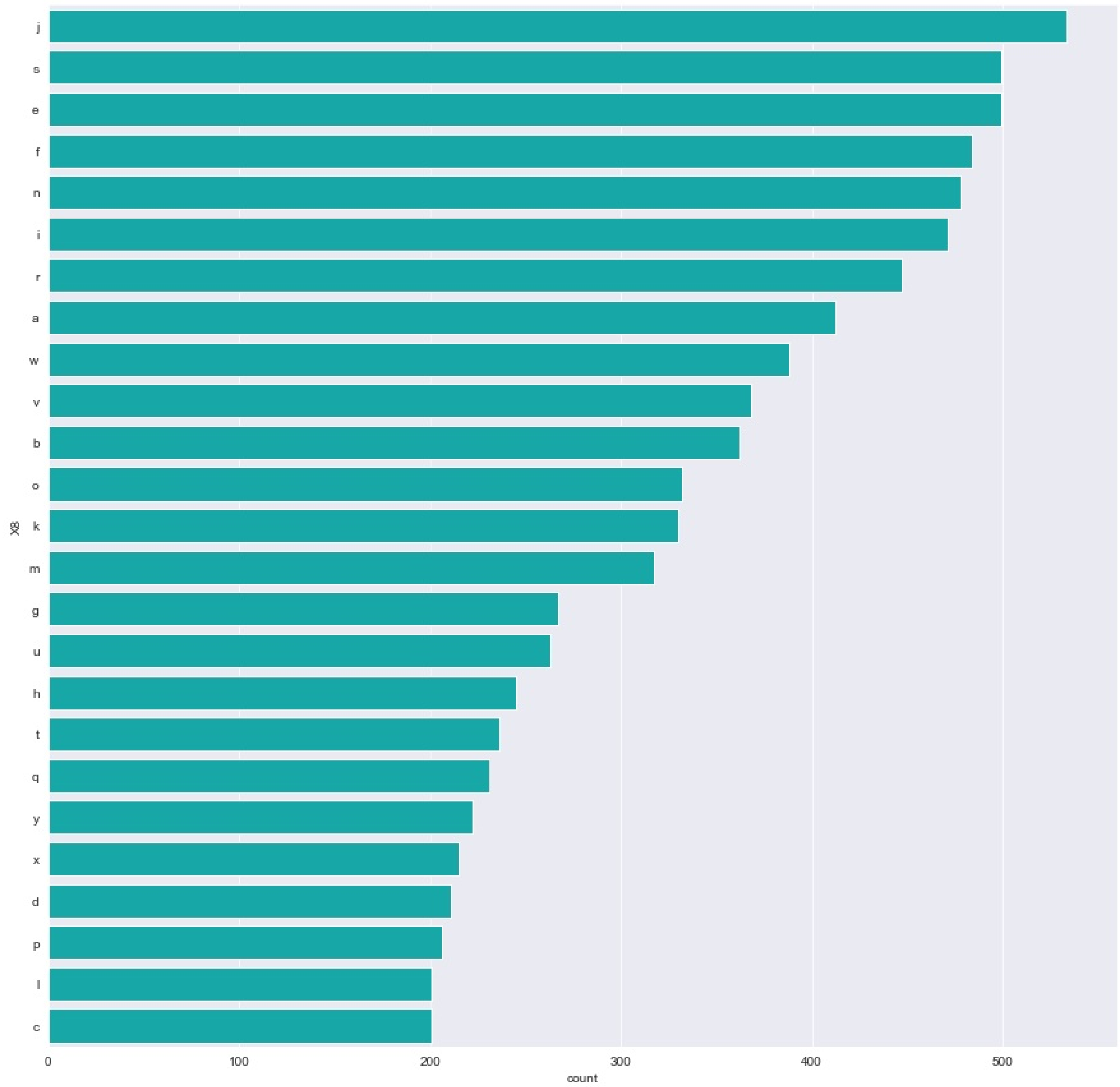
1500
1750
2000
count



In [13]:

```
# Plotting horizontal bar chart (stacked) for numerical data
one_count_list = []
zero_count_list = []
for col in num_cols:
    zero_count_list.append((new_dataset[col]==0).sum())
    one_count_list.append((new_dataset[col]==1).sum())

N = len(num_cols)
ind = np.arange(N)
width = 0.50

plt.figure(figsize=(20,100))
p1 = plt.barh(ind, zero_count_list, width, color='red')
p2 = plt.barh(ind, one_count_list, width, left=zero_count_list, color="blue")
plt.yticks(ind, num_cols)
plt.legend((p1[0], p2[0]), ('Zero count', 'One Count'))
plt.show()
```

Out[13]:

```
<Figure size 1440x7200 with 0 Axes>
```

Out[13]:

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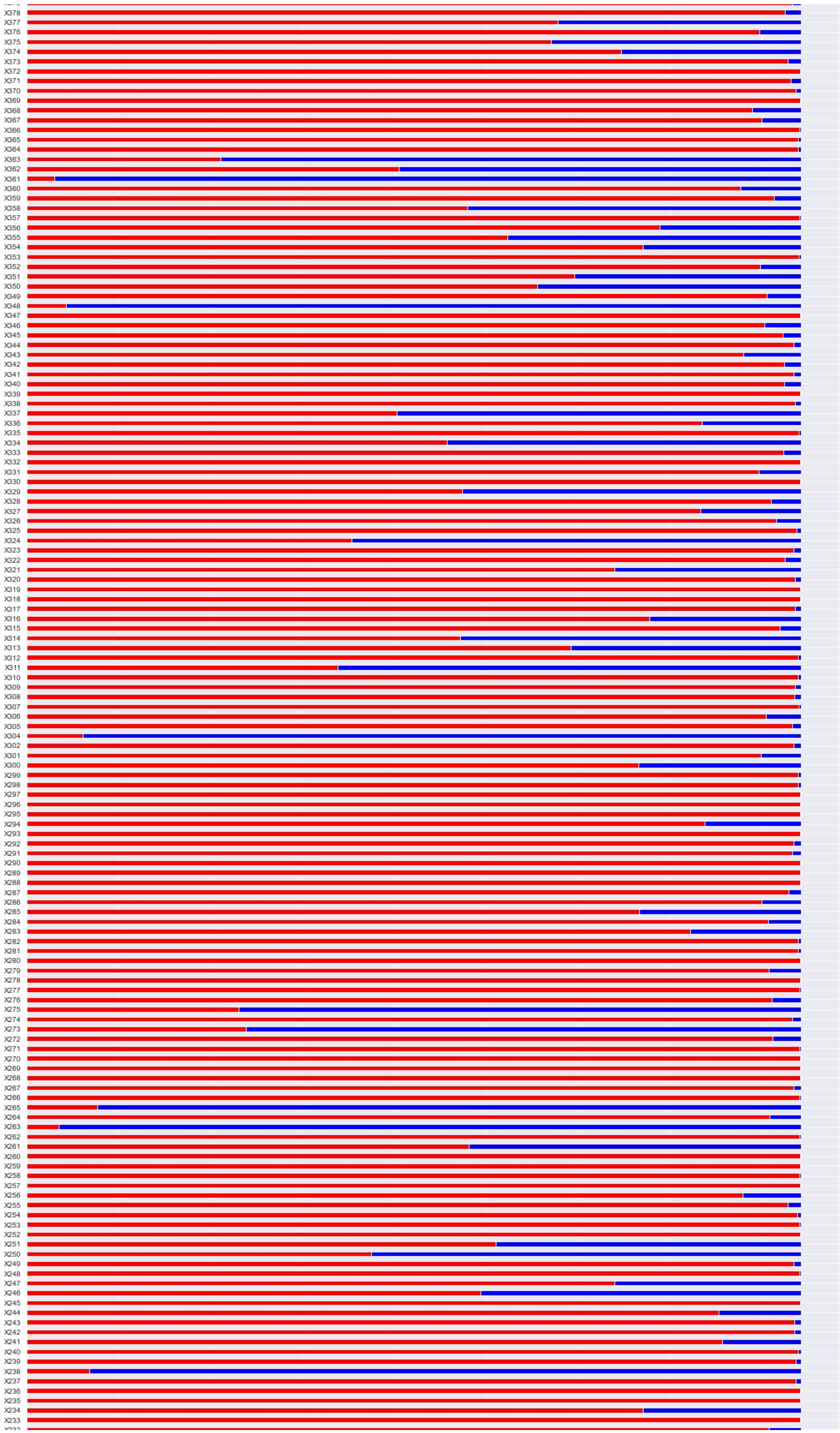
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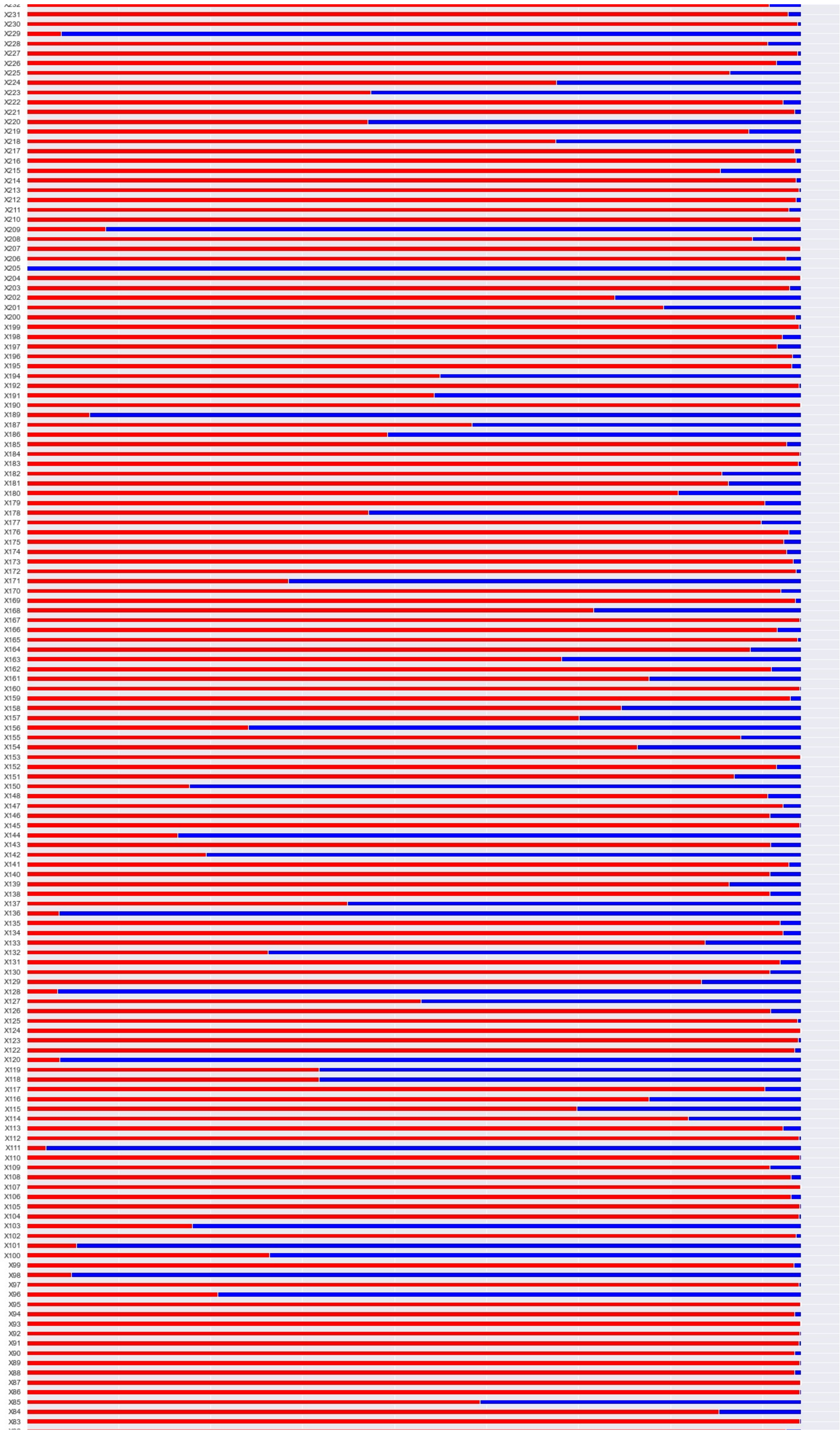
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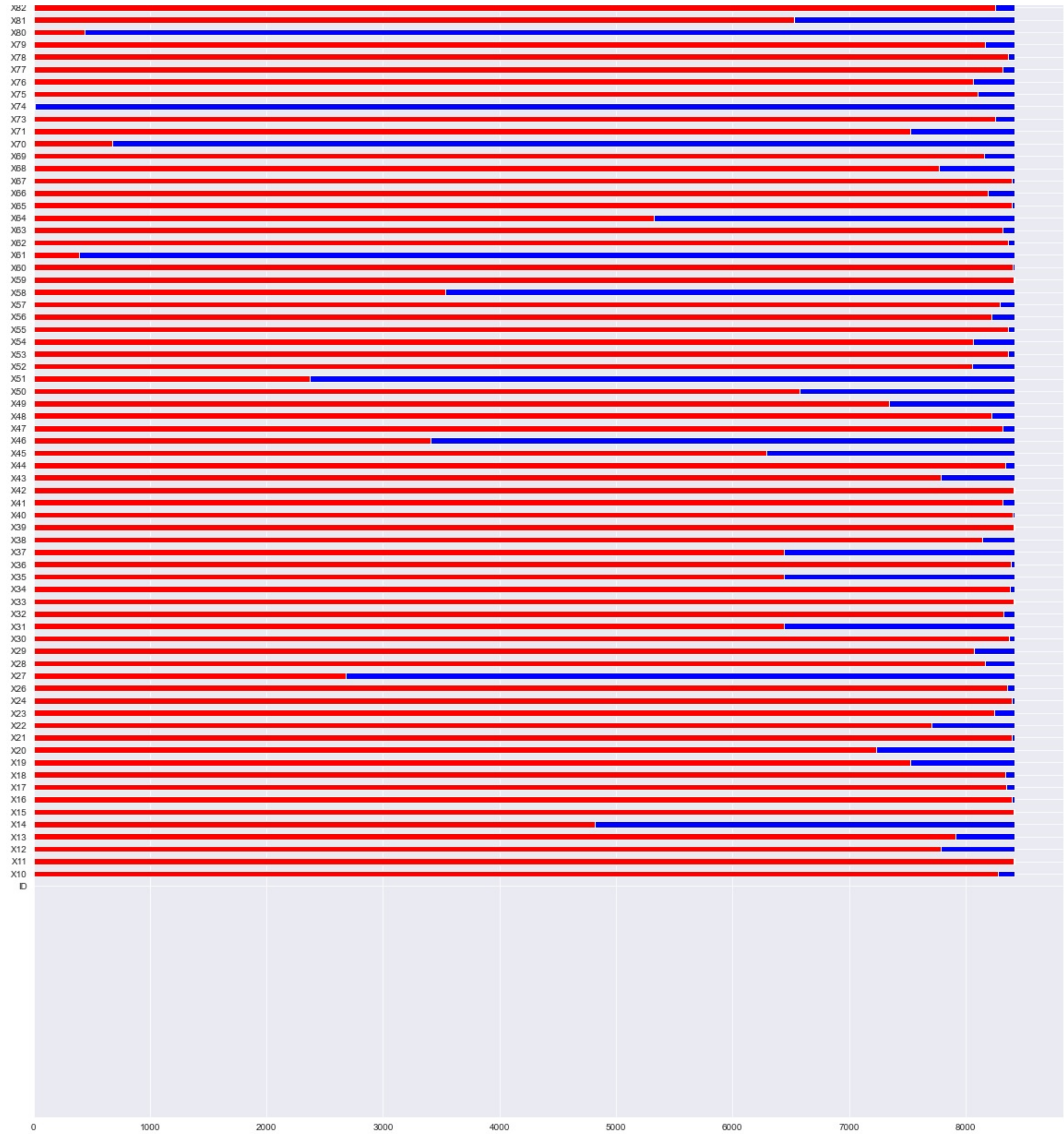

Data Preparation

In [14]:

```
# Apply label encoder

from sklearn.preprocessing import LabelEncoder

lb = LabelEncoder()
for i in cat_cols:
    lb.fit(new_dataset[i])
    train_data[i] = lb.transform(train_data[i].astype('str'))
    test_data[i] = lb.transform(test_data[i].astype('str'))
```

Out[14]:

```
LabelEncoder()
```

Out[14]:

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LabelEncoder()
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Out[14]:

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LabelEncoder()
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Out[14]:

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LabelEncoder()
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Out[14]:

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LabelEncoder()
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Out[14]:

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LabelEncoder()
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Out[14]:

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LabelEncoder()
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Out[14]:

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LabelEncoder()
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In [15]:

```
# Checking the train_data and test_data

train_data.sort_index(axis=1, inplace=True)
test_data.sort_index(axis=1,inplace=True)
train_data.head()
test_data.head()
```

Out[15]:

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1	6	37	21	0	1	1	0	0	0	0	...	0	0	0	0	0	1	0	1	0	88.53
2	7	24	24	0	0	1	0	0	0	0	...	0	0	0	0	0	1	0	1	0	76.26
3	9	24	21	0	0	1	0	0	0	0	...	0	0	0	0	0	1	0	1	0	80.62
4	13	24	23	0	0	1	0	0	0	0	...	0	0	0	0	0	1	0	1	0	78.02

5 rows × 378 columns

Out[15]:

	ID	X0	X1	X10	X100	X101	X102	X103	X104	X105	...	X90	X91	X92	X93	X94	X95	X96	X97	X98	X99
0	1	24	23	0	0	1	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
1	2	46	3	0	0	1	0	1	0	0	...	0	0	0	0	0	0	0	0	1	0
2	3	24	23	0	1	1	0	1	0	0	...	0	0	0	0	0	0	1	0	1	0
3	4	24	13	0	0	1	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
4	5	49	20	0	1	1	0	1	0	0	...	0	0	0	0	0	0	1	0	1	0

5 rows × 377 columns

In [16]:

```
# Dropping the column "ID" from both train_data and test_data

train_data = train_data.drop(["ID"], axis=1)
test_data = test_data.drop(["ID"], axis=1)
train_data

# Dropping column "y" from train_data and storing the rest of the data into x variable also storing the "y" colum
n data in y
#variable

x = train_data.drop(['y'],axis = 1)
y = train_data['y']
x
y
```

Out[16]:

	X0	X1	X10	X100	X101	X102	X103	X104	X105	X106	...	X91	X92	X93	X94	X95	X96	X97	X98	X99	y
0	37	23	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	130.81
1	37	21	0	1	1	0	0	0	0	0	...	0	0	0	0	0	1	0	1	0	88.53
2	24	24	0	0	1	0	0	0	0	0	...	0	0	0	0	0	1	0	1	0	76.26
3	24	21	0	0	1	0	0	0	0	0	...	0	0	0	0	0	1	0	1	0	80.62
4	24	23	0	0	1	0	0	0	0	0	...	0	0	0	0	0	1	0	1	0	78.02
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4204	10	20	0	1	1	0	1	0	0	0	...	0	0	0	0	0	1	0	1	0	107.39
4205	36	16	0	0	0	1	0	0	0	0	...	0	0	0	0	0	0	0	1	0	108.77
4206	10	23	0	1	1	0	1	0	0	0	...	0	0	0	0	0	1	0	1	0	109.22
4207	11	19	0	0	1	0	0	0	0	0	...	0	0	0	0	0	0	0	1	0	87.48
4208	52	19	0	1	1	0	1	0	0	0	...	0	0	0	0	0	1	0	1	0	110.85

4209 rows × 377 columns

Out[16]:

	X0	X1	X10	X100	X101	X102	X103	X104	X105	X106	...	X90	X91	X92	X93	X94	X95	X96	X97	X98	X99
0	37	23	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
1	37	21	0	1	1	0	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
2	24	24	0	0	1	0	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
3	24	21	0	0	1	0	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
4	24	23	0	0	1	0	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4204	10	20	0	1	1	0	1	0	0	0	...	0	0	0	0	0	0	1	0	1	0
4205	36	16	0	0	0	1	0	0	0	0	...	0	0	0	0	0	0	0	0	1	0
4206	10	23	0	1	1	0	1	0	0	0	...	0	0	0	0	0	0	1	0	1	0
4207	11	19	0	0	1	0	0	0	0	0	...	0	0	0	0	0	0	0	0	1	0
4208	52	19	0	1	1	0	1	0	0	0	...	0	0	0	0	0	0	1	0	1	0

4209 rows × 376 columns

Out[16]:

```
0       130.81
1        88.53
2        76.26
3        80.62
4        78.02
         ...  
4204    107.39
4205    108.77
4206    109.22
4207     87.48
4208    110.85
Name: y, Length: 4209, dtype: float64
```

In [18]:

```
# Splitting the data into training and testing data

from sklearn.model_selection import train_test_split

test = test_data.values

x_train, x_test, y_train, y_test = train_test_split(x,y, test_size = 0.3)
x_train.shape
y_train.shape
x_test.shape
y_test.shape

x
y
test
```

Out[18]:

```
(2946, 376)
```

Out[18]:

```
(2946,)
```

Out[18]:

```
(1263, 376)
```

Out[18]:

```
(1263,)
```

Out[18]:

	X0	X1	X10	X100	X101	X102	X103	X104	X105	X106	...	X90	X91	X92	X93	X94	X95	X96	X97	X98	X99
0	37	23	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
1	37	21	0	1	1	0	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
2	24	24	0	0	1	0	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
3	24	21	0	0	1	0	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
4	24	23	0	0	1	0	0	0	0	0	...	0	0	0	0	0	0	1	0	1	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4204	10	20	0	1	1	0	1	0	0	0	...	0	0	0	0	0	0	1	0	1	0
4205	36	16	0	0	0	1	0	0	0	0	...	0	0	0	0	0	0	0	0	1	0
4206	10	23	0	1	1	0	1	0	0	0	...	0	0	0	0	0	0	1	0	1	0
4207	11	19	0	0	1	0	0	0	0	0	...	0	0	0	0	0	0	0	0	1	0
4208	52	19	0	1	1	0	1	0	0	0	...	0	0	0	0	0	0	1	0	1	0

4209 rows × 376 columns

Out[18]:

```
0       130.81
1        88.53
2        76.26
3        80.62
4        78.02
         ...  
4204    107.39
4205    108.77
4206    109.22
4207     87.48
4208    110.85
Name: y, Length: 4209, dtype: float64
```

Out[18]:

```
array([[24, 23,  0, ...,  0,  1,  0],
       [46,  3,  0, ...,  0,  1,  0],
       [24, 23,  0, ...,  0,  1,  0],
       ...,
       [51, 23,  0, ...,  0,  1,  0],
       [10, 23,  0, ...,  0,  1,  0],
       [46,  1,  0, ...,  0,  1,  0]], dtype=int64)
```

Feature Engineering

In [19]:

```
# Applying StandardScaler to standardize the train an test set

from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
x_train = sc.fit_transform(x_train)
x_test = sc.fit_transform(x_test)
```

In [26]:

```
# Applying PCA for feature selection

from sklearn.decomposition import PCA

pca = PCA(n_components=12)
x_train1 = pca.fit_transform(x_train)
x_test1 = pca.fit_transform(x_test)
pca.explained_variance_ratio_
```

Out[26]:

```
array([0.06851874, 0.05965272, 0.0478273 , 0.03747134, 0.03418013,
       0.03273601, 0.02936726, 0.02281833, 0.01982128, 0.01877915,
       0.01819401, 0.01729655])
```

Model Initialisation, Prediction and Evaluation

In [ ]:

```
# Applying XGBoost model for Regression and prediction

import xgboost as xgb

model = xgb.XGBRegressor()

model.fit(x_train,y_train)
preds = model.predict(x_test)
preds
```

In [28]:

```
# Calculating the Root Mean Squared Error (RMSE) for the predicted data

from sklearn.metrics import mean_squared_error
rmse = np.sqrt(mean_squared_error(y_test, preds))
print("RMSE: %f" % (rmse))
```

```
RMSE: 9.126421
```

In [23]:

```
# Deploying Cross Validation algorithm to minimise the train and test RMSE

dtrain = xgb.DMatrix(x_train, y_train)
dtest = xgb.DMatrix(test)

xgb_params = {
    'n_trees': 500,
    'eta': 0.005,
    'max_depth':6,
    'alpha':40,
    'lambda':20,
    'subsample': 0.5,
    'objective': 'reg:linear',
    'eval_metric': 'rmse',
    'base_score': np.mean(y_train), # base prediction = mean(target)
    'silent': 1}


cv_result = xgb.cv(xgb_params,dtrain,num_boost_round=500,verbose_eval=50,show_stdv=False)

num_boost_rounds = len(cv_result)
print(num_boost_rounds)

# Train model
model = xgb.train(dict(xgb_params, silent=0), dtrain, num_boost_round=num_boost_rounds)
```

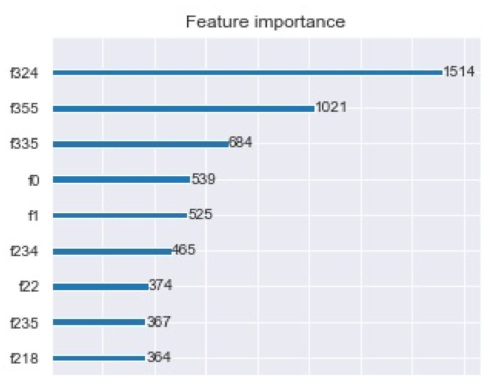
```
[14:29:26] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.1.0/src/objective/regre
ssion_obj.cu:170: reg:linear is now deprecated in favor of reg:squarederror.
[14:29:26] WARNING: C:\Users\Administrator\workspace\xgboost-win64_release_1.1.0\src\learner.cc:480:
Parameters: { n_trees, silent } might not be used.

  This may not be accurate due to some parameters are only used in language bindings but
  passed down to XGBoost core.  Or some parameters are not used but slip through this
  verification. Please open an issue if you find above cases.


[14:29:26] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.1.0/src/objective/regre
ssion_obj.cu:170: reg:linear is now deprecated in favor of reg:squarederror.
[14:29:26] WARNING: C:\Users\Administrator\workspace\xgboost-win64_release_1.1.0\src\learner.cc:480:
Parameters: { n_trees, silent } might not be used.

  This may not be accurate due to some parameters are only used in language bindings but
  passed down to XGBoost core.  Or some parameters are not used but slip through this
  verification. Please open an issue if you find above cases.


[14:29:26] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.1.0/src/objective/regre
ssion_obj.cu:170: reg:linear is now deprecated in favor of reg:squarederror.
[14:29:26] WARNING: C:\Users\Administrator\workspace\xgboost-win64_release_1.1.0\src\learner.cc:480:
Parameters: { n_trees, silent } might not be used.

  This may not be accurate due to some parameters are only used in language bindings but
  passed down to XGBoost core.  Or some parameters are not used but slip through this
  verification. Please open an issue if you find above cases.


[0]	train-rmse:12.68694	test-rmse:12.67955
[50]	train-rmse:11.43149	test-rmse:11.45535
[100]	train-rmse:10.52449	test-rmse:10.58425
[150]	train-rmse:9.87441	test-rmse:9.97525
[200]	train-rmse:9.40894	test-rmse:9.55372
[250]	train-rmse:9.07258	test-rmse:9.26559
[300]	train-rmse:8.82530	test-rmse:9.06595
[350]	train-rmse:8.63944	test-rmse:8.92732
[400]	train-rmse:8.49331	test-rmse:8.83110
[450]	train-rmse:8.37628	test-rmse:8.76283
[499]	train-rmse:8.28045	test-rmse:8.71617
500
[14:29:59] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.1.0/src/objective/regre
ssion_obj.cu:170: reg:linear is now deprecated in favor of reg:squarederror.
[14:29:59] WARNING: C:\Users\Administrator\workspace\xgboost-win64_release_1.1.0\src\learner.cc:480:
Parameters: { n_trees, silent } might not be used.

  This may not be accurate due to some parameters are only used in language bindings but
  passed down to XGBoost core.  Or some parameters are not used but slip through this
  verification. Please open an issue if you find above cases.


[14:30:15] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.1.0/src/objective/regre
ssion_obj.cu:170: reg:linear is now deprecated in favor of reg:squarederror.
```

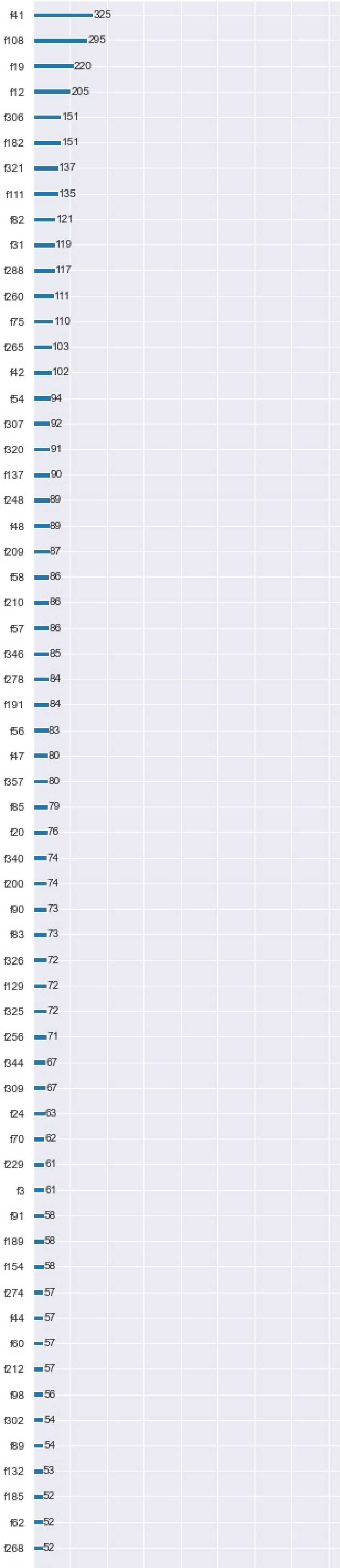
In [24]:

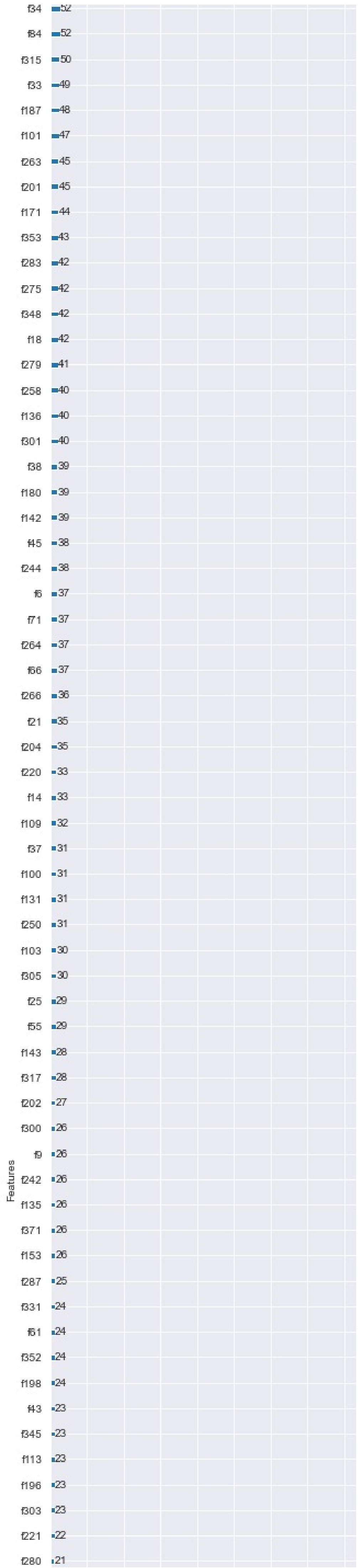
```python
# Plotting the feature with their F-Score and checking which are the most important features

import matplotlib.pyplot as plt

f, ax = plt.subplots(figsize=(5, 100))
xgb.plot_importance(model,ax)
plt.show()
```

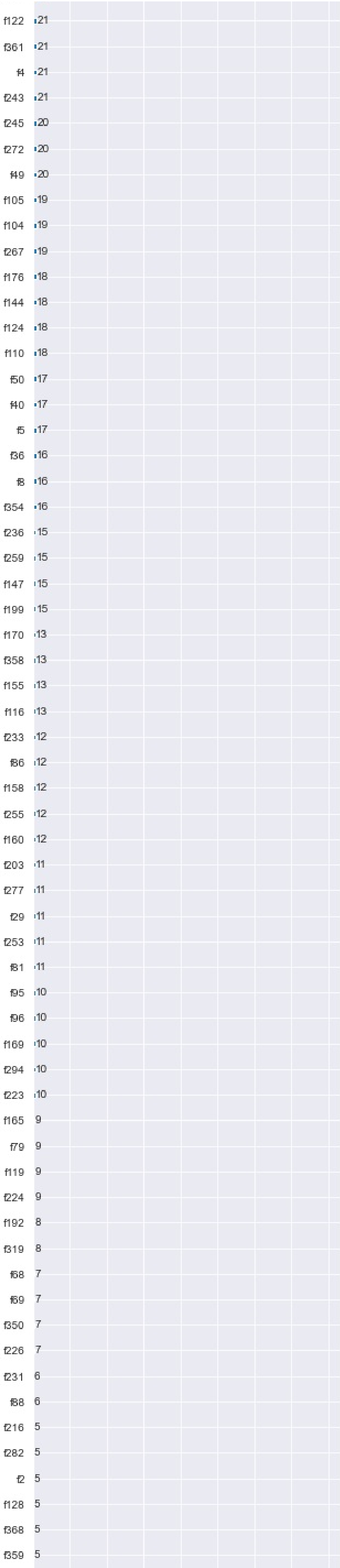
Out[24]:

```
<AxesSubplot:title={'center':'Feature importance'}, xlabel='F score', ylabel='Features'>
```

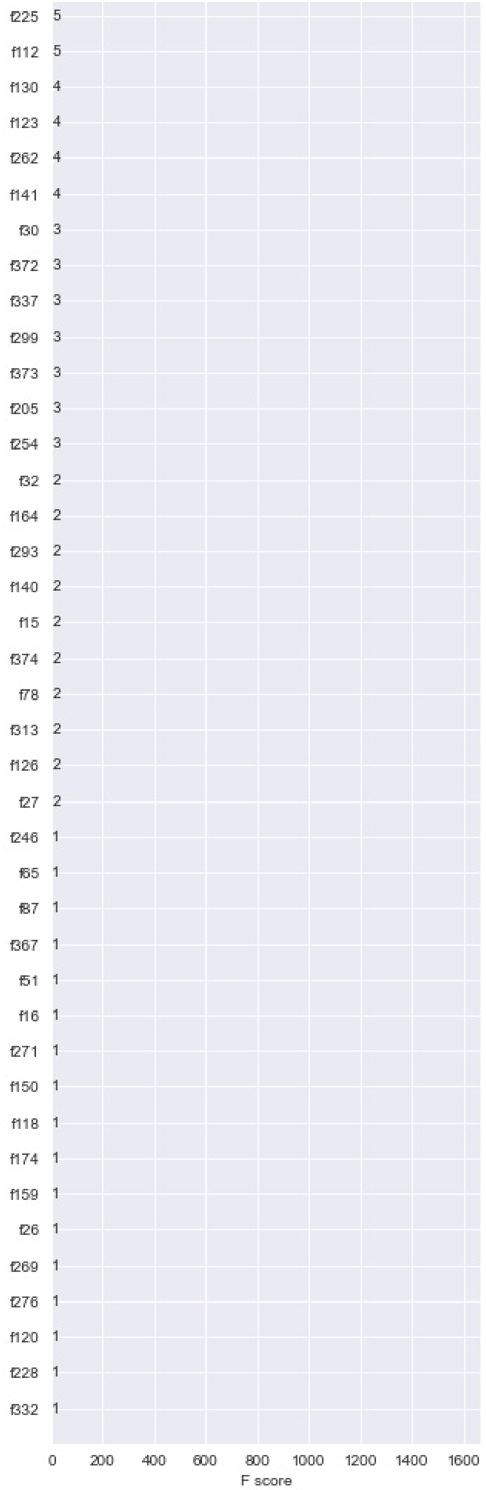



f41 325
f108 295
f19 220
f12 205
f306 151
f182 151
f321 137
f111 135
f82 121
f31 119
f288 117
f260 111
f75 110
f265 103
f42 102
f54 94
f307 92
f320 91
f137 90
f248 89
f48 89
f209 87
f58 86
f210 86
f57 86
f346 85
f278 84
f191 84
f56 83
f47 80
f357 80
f85 79
f20 76
f340 74
f200 74
f90 73
f83 73
f326 72
f129 72
f325 72
f256 71
f344 67
f309 67
f24 63
f70 62
f229 61
f3 61
f91 58
f189 58
f154 58
f274 57
f44 57
f60 57
f212 57
f98 56
f302 54
f89 54
f132 53
f185 52
f62 52
f268 52


Features
f34 52
f84 52
f315 50
f33 49
f187 48
f101 47
f263 45
f201 45
f171 44
f353 43
f283 42
f275 42
f348 42
f18 42
f279 41
f258 40
f136 40
f301 40
f38 39
f180 39
f142 39
f45 38
f244 38
f6 37
f71 37
f264 37
f66 37
f266 36
f21 35
f204 35
f220 33
f14 33
f109 32
f37 31
f100 31
f131 31
f250 31
f103 30
f305 30
f25 29
f55 29
f143 28
f317 28
f202 27
f300 26
f9 26
f242 26
f135 26
f371 26
f153 26
f287 25
f331 24
f61 24
f352 24
f198 24
f43 23
f345 23
f113 23
f196 23
f303 23
f221 22
f280 21



f122 21
f361 21
f4 21
f243 21
f245 20
f272 20
f49 20
f105 19
f104 19
f267 19
f176 18
f144 18
f124 18
f110 18
f50 17
f40 17
f5 17
f36 16
f8 16
f354 16
f236 15
f259 15
f147 15
f199 15
f170 13
f358 13
f155 13
f116 13
f233 12
f86 12
f158 12
f255 12
f160 12
f203 11
f277 11
f29 11
f253 11
f81 11
f95 10
f96 10
f169 10
f294 10
f223 10
f165 9
f79 9
f119 9
f224 9
f192 8
f319 8
f68 7
f69 7
f350 7
f226 7
f231 6
f88 6
f216 5
f282 5
f2 5
f128 5
f368 5
f359 5



Model Testing

In [25]:

```
# Predict your test_df values using XGBoost

test_df_predictions = model.predict(dtest)
test_df_predictions
```

Out[25]:

```
array([ 96.14065 ,  95.031906,  97.126144, ...,  95.85386 , 106.1074  ,
        95.22096 ], dtype=float32)
```

In [ ]:

```

```