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:

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

In [ ]:
```
#Let us first import the necessary modules.
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn import preprocessing
import xgboost as xgb
color = sns.color_palette()

%matplotlib inline

pd.options.mode.chained_assignment = None  # default='warn'
pd.options.display.max_columns = 999
from subprocess import check_output
```

In [35]:
```
df_train = pd.read_csv("train.csv")
df_test = pd.read_csv("test.csv")
print("Train shape : ", df_train.shape)
print("Test shape : ", df_test.shape)
```

```
Train shape :  (4209, 378)
Test shape :  (4209, 377)
```

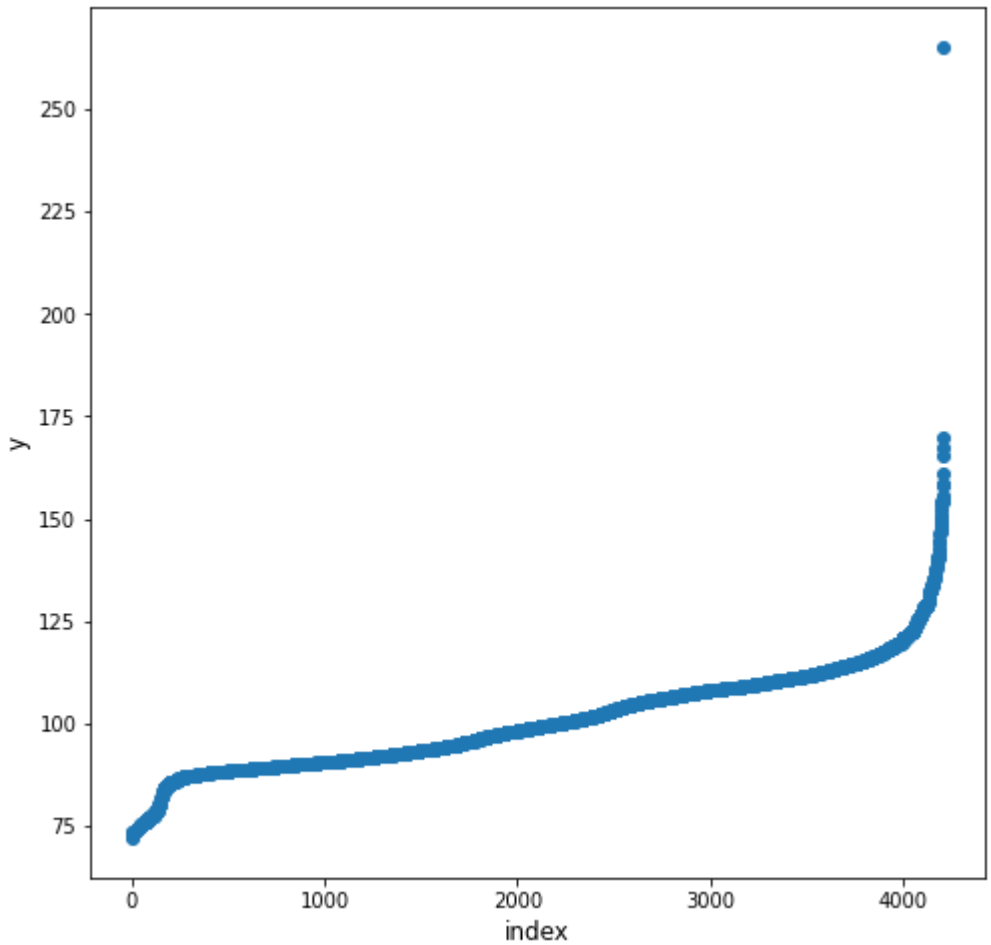
In [36]:
```
# Let us look at the top few rows.
df_train.head()
```

Out[36]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	X10	X11	X12	X13	X14	X15	X16	X17	X18	X1
0	0	130.81	k	v	at	a	d	u	j	o	0	0	0	1	0	0	0	0	1	
1	6	88.53	k	t	av	e	d	y	l	o	0	0	0	0	0	0	0	0	1	
2	7	76.26	az	w	n	c	d	x	j	x	0	0	0	0	0	0	0	1	0	
3	9	80.62	az	t	n	f	d	x	l	e	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	

In [37]:

```
plt.figure(figsize=(8,8))
plt.scatter(range(df_train.shape[0]),np.sort(df_train.y.values))
plt.xlabel('index', fontsize=12)
plt.ylabel('y', fontsize=12)
plt.show()
```

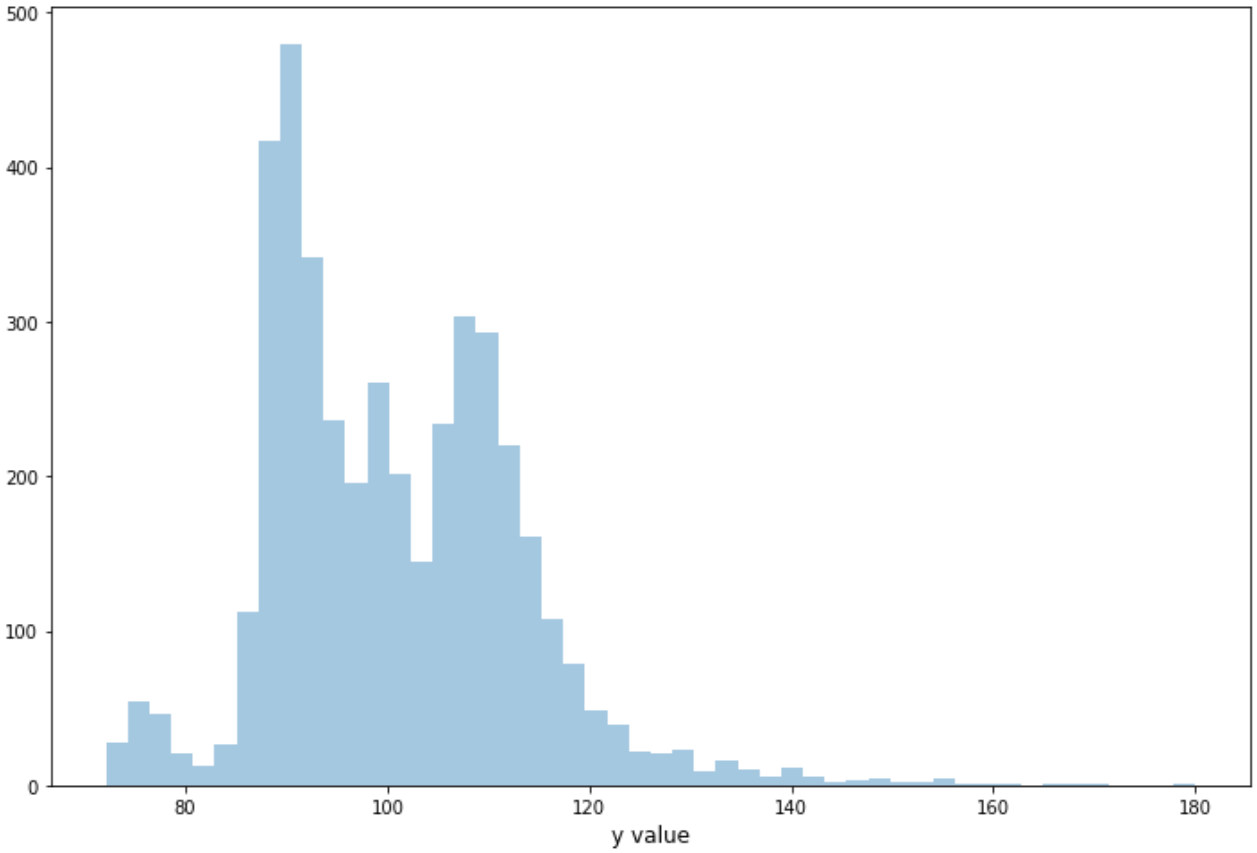


In [38]:

```
ulimit = 180
df_train['y'].iloc[df_train['y']>ulimit] = ulimit

plt.figure(figsize=(12,8))
sns.distplot(df_train.y.values, bins=50, kde=False)
plt.xlabel('y value', fontsize=12)
plt.show()
```

```
C:\Anaconda\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` i
s a deprecated function and will be removed in a future version. Please adapt your code
to use either `displot` (a figure-level function with similar flexibility) or `histplot`
(an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```



In [39]:
```
# Now let us have a look at the data type of all the variables present in the dataset
dtype_data=df_train.dtypes.reset_index()
dtype_data.columns = ["Count", "Column Type"]
dtype_data.groupby("Column Type").aggregate('count').reset_index()
```

Out[39]:

	Column Type	Count
0	int64	369
1	float64	1
2	object	8

In [40]:
```
dtype_data.loc[:10,:]
```

Out[40]:

	Count	Column Type
0	ID	int64
1	y	float64
2	X0	object
3	X1	object

	Count	Column Type
4	X2	object
5	X3	object
6	X4	object
7	X5	object
8	X6	object
9	X8	object
10	X10	int64

In [41]:
```
df_train.isnull().sum().sum()
```

Out[41]:
```
0
```

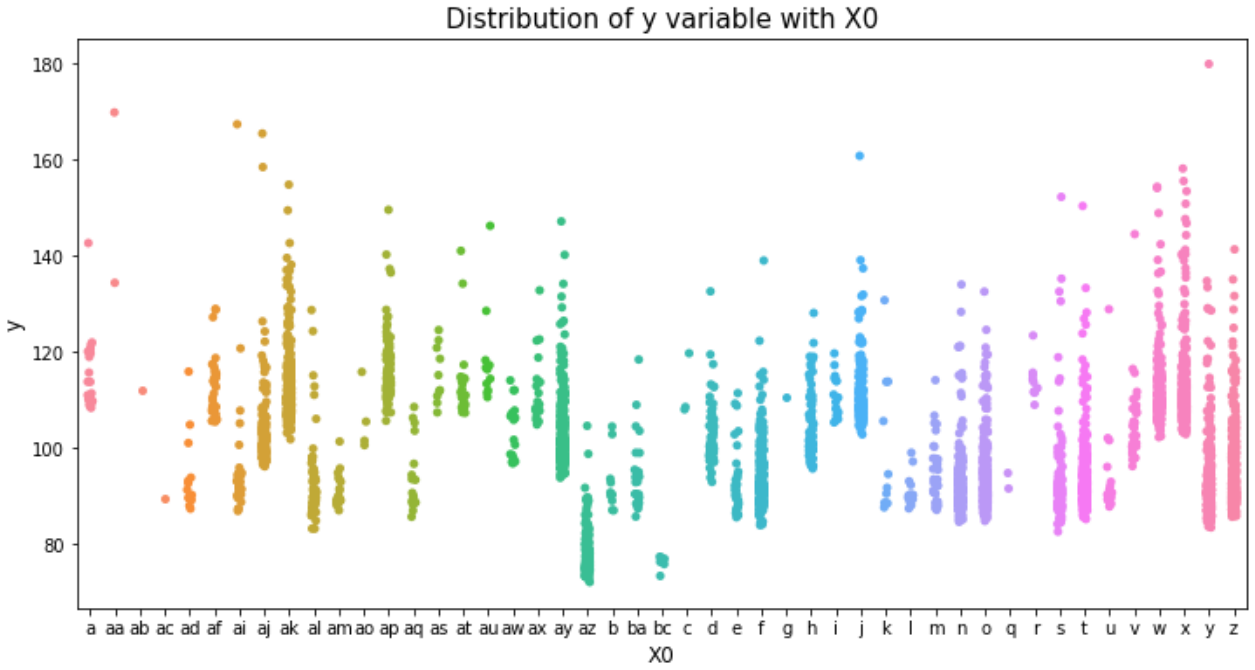
In [42]:
```
# Integer Columns Analysis
unique_value_dict = {}
for col in df_train.columns:
    if col not in ["ID", "y", "X0", "X1", "X2", "X3", "X4", "X5", "X6", "X8"]:
        unique_value = str(np.sort(df_train[col].unique()).tolist())
        t_list = unique_value_dict.get(unique_value, [])
        t_list.append(col)
        unique_value_dict[unique_value] = t_list[:]
for unique_val, columns in unique_value_dict.items():
    print("Columns containing the unique values : ",unique_val)
    print(columns)
    print("---------------------------------------------------------")
```

```
Columns containing the unique values :  [0, 1]
['X10', 'X12', 'X13', 'X14', 'X15', 'X16', 'X17', 'X18', 'X19', 'X20', 'X21', 'X22', 'X2
3', 'X24', 'X26', 'X27', 'X28', 'X29', 'X30', 'X31', 'X32', 'X33', 'X34', 'X35', 'X36',
'X37', 'X38', 'X39', 'X40', 'X41', 'X42', 'X43', 'X44', 'X45', 'X46', 'X47', 'X48', 'X4
9', 'X50', 'X51', 'X52', 'X53', 'X54', 'X55', 'X56', 'X57', 'X58', 'X59', 'X60', 'X61',
'X62', 'X63', 'X64', 'X65', 'X66', 'X67', 'X68', 'X69', 'X70', 'X71', 'X73', 'X74', 'X7
5', 'X76', 'X77', 'X78', 'X79', 'X80', 'X81', 'X82', 'X83', 'X84', 'X85', 'X86', 'X87',
'X88', 'X89', 'X90', 'X91', 'X92', 'X94', 'X95', 'X96', 'X97', 'X98', 'X99', 'X100', 'X1
01', 'X102', 'X103', 'X104', 'X105', 'X106', 'X108', 'X109', 'X110', 'X111', 'X112', 'X1
13', 'X114', 'X115', 'X116', 'X117', 'X118', 'X119', 'X120', 'X122', 'X123', 'X124', 'X1
25', 'X126', 'X127', 'X128', 'X129', 'X130', 'X131', 'X132', 'X133', 'X134', 'X135', 'X1
36', 'X137', 'X138', 'X139', 'X140', 'X141', 'X142', 'X143', 'X144', 'X145', 'X146', 'X1
47', 'X148', 'X150', 'X151', 'X152', 'X153', 'X154', 'X155', 'X156', 'X157', 'X158', 'X1
59', 'X160', 'X161', 'X162', 'X163', 'X164', 'X165', 'X166', 'X167', 'X168', 'X169', 'X1
70', 'X171', 'X172', 'X173', 'X174', 'X175', 'X176', 'X177', 'X178', 'X179', 'X180', 'X1
81', 'X182', 'X183', 'X184', 'X185', 'X186', 'X187', 'X189', 'X190', 'X191', 'X192', 'X1
94', 'X195', 'X196', 'X197', 'X198', 'X199', 'X200', 'X201', 'X202', 'X203', 'X204', 'X2
05', 'X206', 'X207', 'X208', 'X209', 'X210', 'X211', 'X212', 'X213', 'X214', 'X215', 'X2
16', 'X217', 'X218', 'X219', 'X220', 'X221', 'X222', 'X223', 'X224', 'X225', 'X226', 'X2
27', 'X228', 'X229', 'X230', 'X231', 'X232', 'X234', 'X236', 'X237', 'X238', 'X239', 'X2
40', 'X241', 'X242', 'X243', 'X244', 'X245', 'X246', 'X247', 'X248', 'X249', 'X250', 'X2
51', 'X252', 'X253', 'X254', 'X255', 'X256', 'X257', 'X258', 'X259', 'X260', 'X261', 'X2
62', 'X263', 'X264', 'X265', 'X266', 'X267', 'X269', 'X270', 'X271', 'X272', 'X273', 'X2
74', 'X275', 'X276', 'X277', 'X278', 'X279', 'X280', 'X281', 'X282', 'X283', 'X284', 'X2
85', 'X286', 'X287', 'X288', 'X291', 'X292', 'X294', 'X295', 'X296', 'X298', 'X299', 'X3
00', 'X301', 'X302', 'X304', 'X305', 'X306', 'X307', 'X308', 'X309', 'X310', 'X311', 'X3
```

```
12', 'X313', 'X314', 'X315', 'X316', 'X317', 'X318', 'X319', 'X320', 'X321', 'X322', 'X3
23', 'X324', 'X325', 'X326', 'X327', 'X328', 'X329', 'X331', 'X332', 'X333', 'X334', 'X3
35', 'X336', 'X337', 'X338', 'X339', 'X340', 'X341', 'X342', 'X343', 'X344', 'X345', 'X3
46', 'X348', 'X349', 'X350', 'X351', 'X352', 'X353', 'X354', 'X355', 'X356', 'X357', 'X3
58', 'X359', 'X360', 'X361', 'X362', 'X363', 'X364', 'X365', 'X366', 'X367', 'X368', 'X3
69', 'X370', 'X371', 'X372', 'X373', 'X374', 'X375', 'X376', 'X377', 'X378', 'X379', 'X3
80', 'X382', 'X383', 'X384', 'X385']
----------------------------------------------------------
Columns containing the unique values :  [0]
['X11', 'X93', 'X107', 'X233', 'X235', 'X268', 'X289', 'X290', 'X293', 'X297', 'X330',
'X347']
----------------------------------------------------------
```

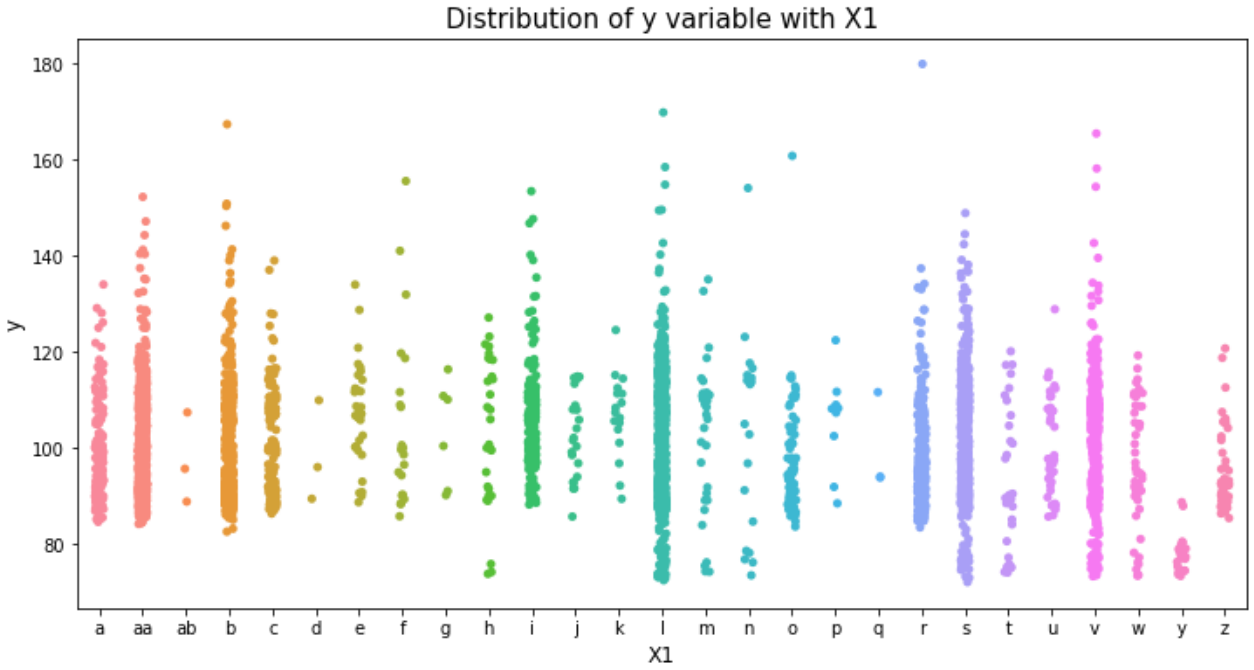
In [43]:

```
# Now let us explore the categorical columns present in the dataset.
var="X0"
colu_order=np.sort(df_train[var].unique()).tolist()
plt.figure(figsize=(12,6))
sns.stripplot(x=var,y="y",data=df_train,order=colu_order)
plt.xlabel(var,fontsize=12)
plt.ylabel("y",fontsize=12)
plt.title("Distribution of y variable with "+var, fontsize=15)
plt.show()
```



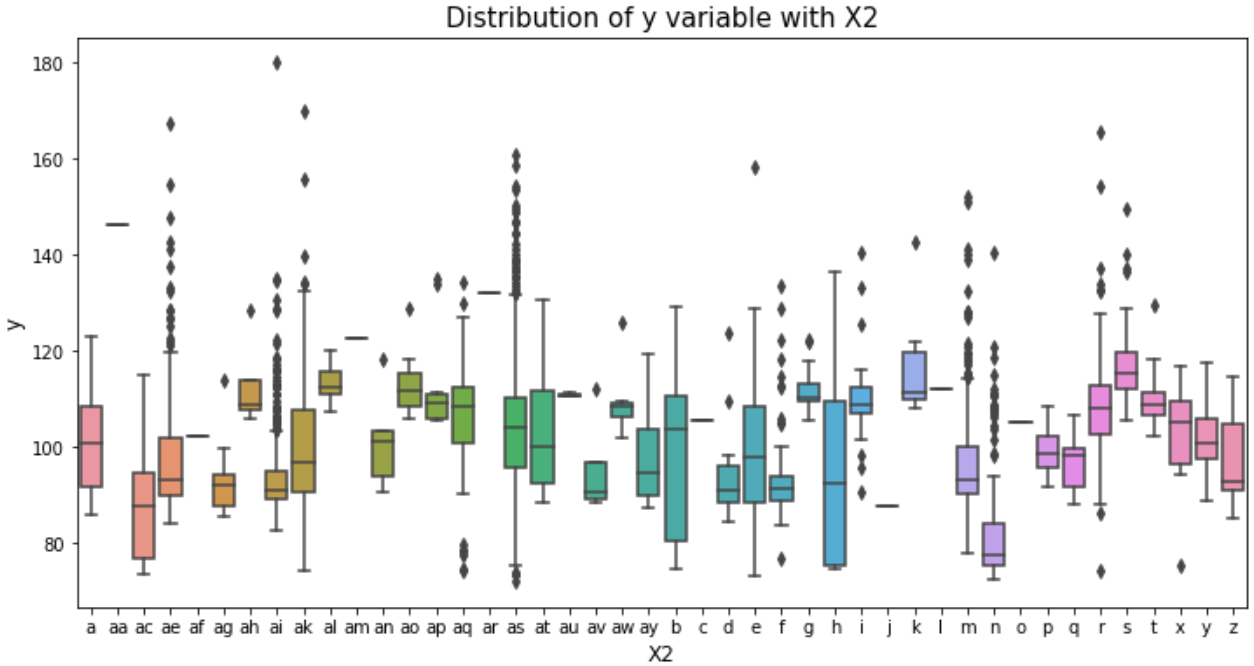
In [44]:

```
var="X1"
colu_order=np.sort(df_train[var].unique()).tolist()
plt.figure(figsize=(12,6))
sns.stripplot(x=var,y="y",data=df_train,order=colu_order)
plt.xlabel(var,fontsize=12)
plt.ylabel("y",fontsize=12)
plt.title("Distribution of y variable with "+var, fontsize=15)
plt.show()
```



In [45]:

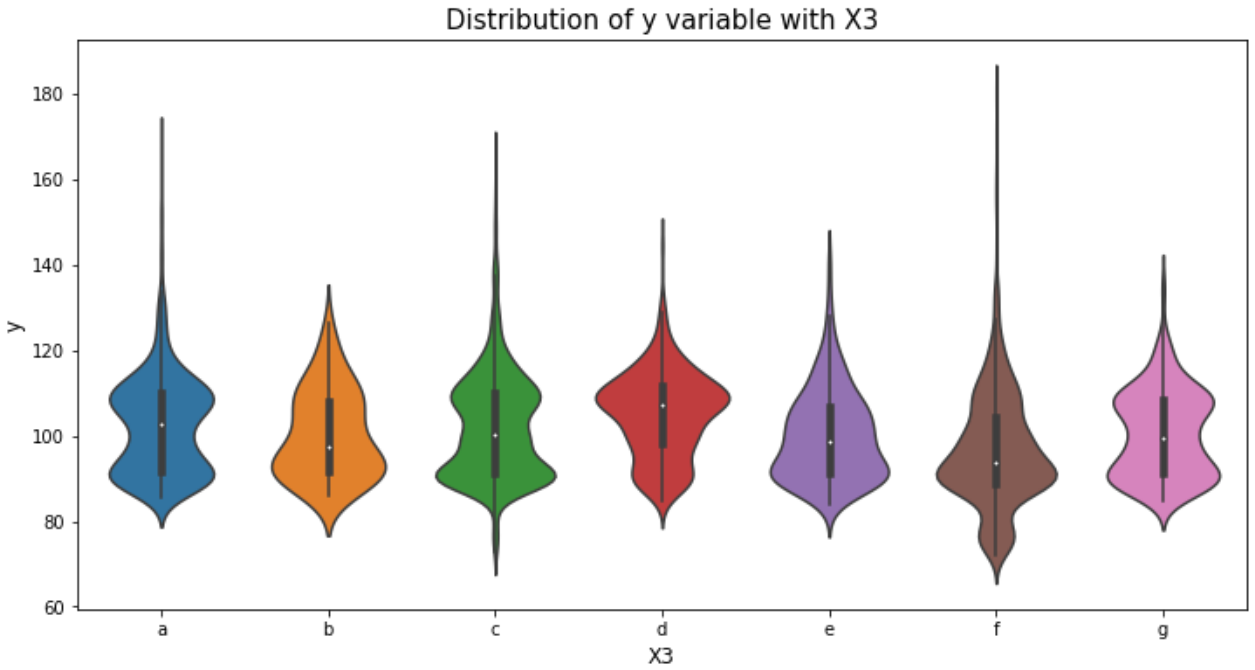
```
var="X2"
colu_order=np.sort(df_train[var].unique()).tolist()
plt.figure(figsize=(12,6))
sns.boxplot(x=var,y="y",data=df_train,order=colu_order)
plt.xlabel(var,fontsize=12)
plt.ylabel("y",fontsize=12)
plt.title("Distribution of y variable with "+var, fontsize=15)
plt.show()
```



In [46]:

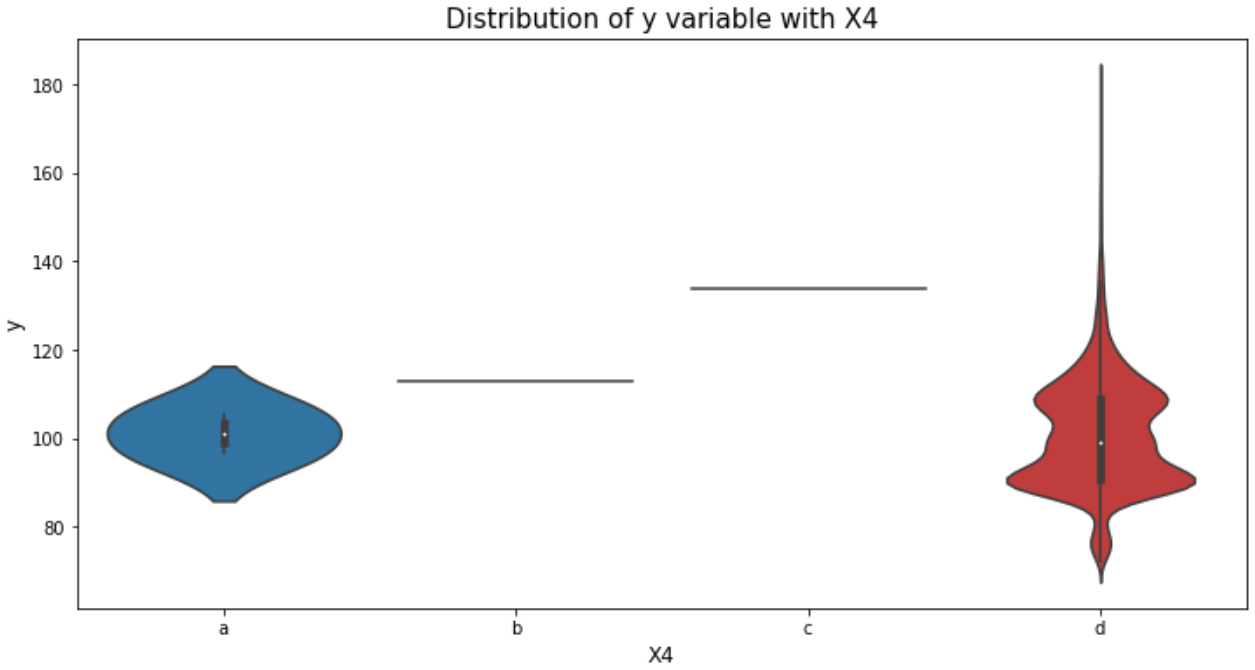
```
var="X3"
colu_order=np.sort(df_train[var].unique()).tolist()
plt.figure(figsize=(12,6))
sns.violinplot(x=var,y="y",data=df_train,order=colu_order)
plt.xlabel(var,fontsize=12)
```

```
plt.ylabel("y",fontsize=12)
plt.title("Distribution of y variable with "+var, fontsize=15)
plt.show()
```



In [47]:

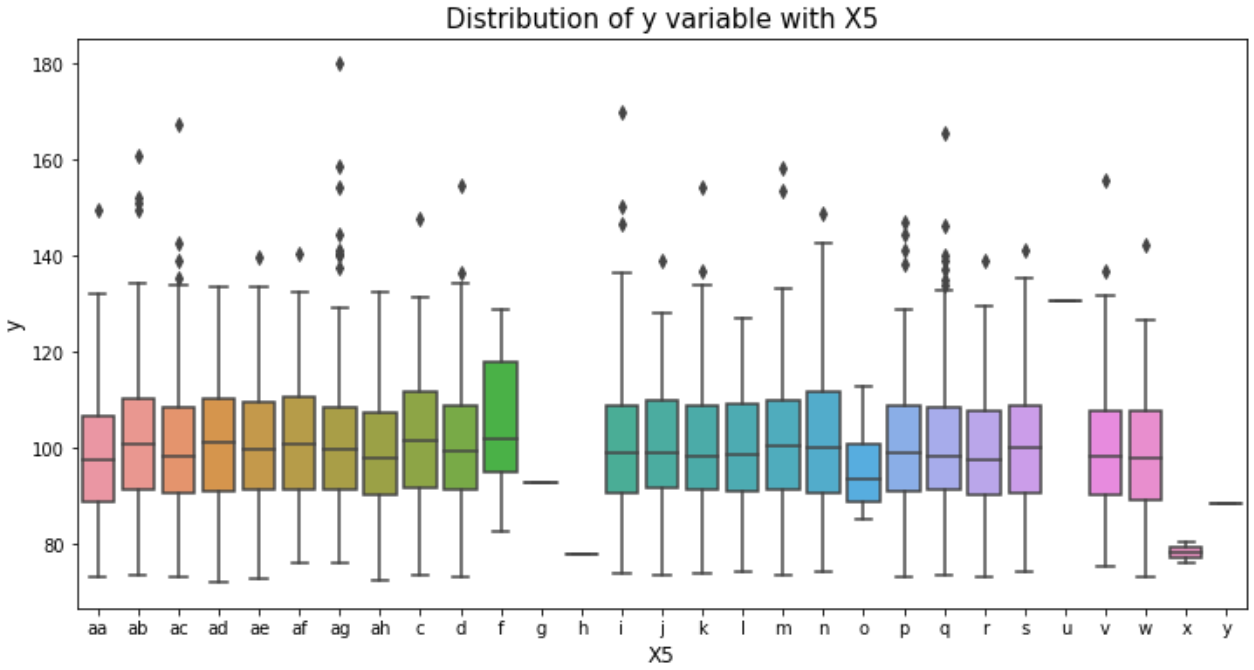
```
var="X4"
colu_order=np.sort(df_train[var].unique()).tolist()
plt.figure(figsize=(12,6))
sns.violinplot(x=var,y="y",data=df_train,order=colu_order)
plt.xlabel(var,fontsize=12)
plt.ylabel("y",fontsize=12)
plt.title("Distribution of y variable with "+var, fontsize=15)
plt.show()
```



In [48]:

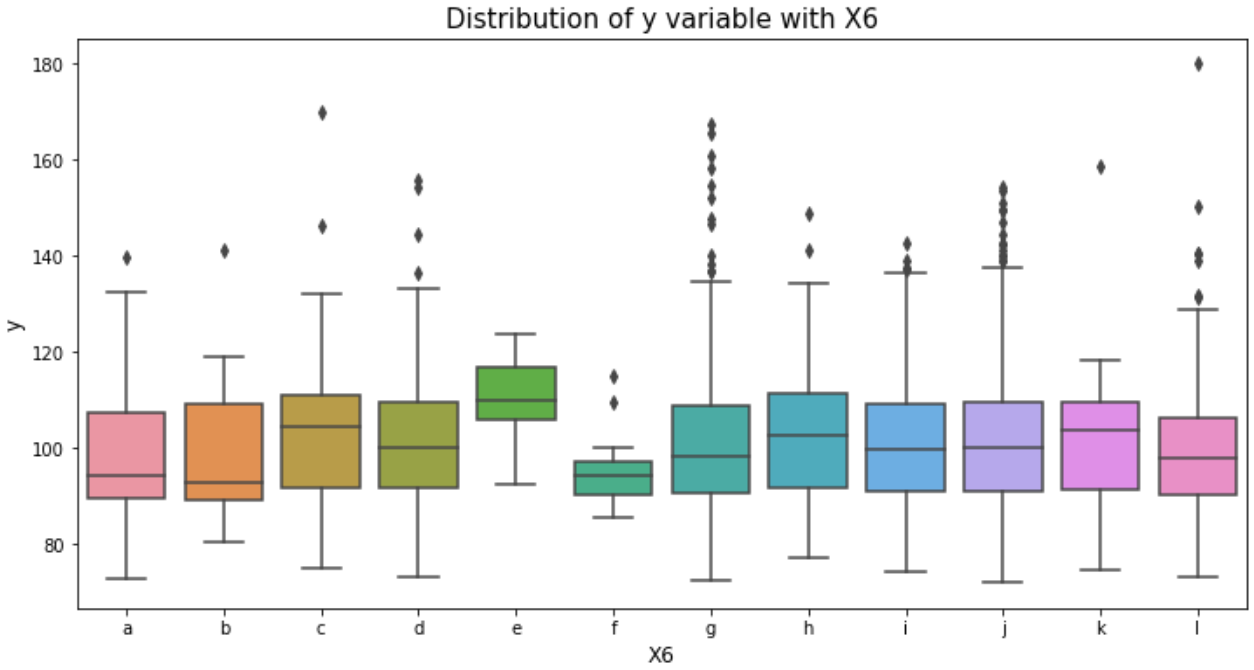
```
var="X5"
```

```
colu_order=np.sort(df_train[var].unique()).tolist()
plt.figure(figsize=(12,6))
sns.boxplot(x=var,y="y",data=df_train,order=colu_order)
plt.xlabel(var,fontsize=12)
plt.ylabel("y",fontsize=12)
plt.title("Distribution of y variable with "+var, fontsize=15)
plt.show()
```



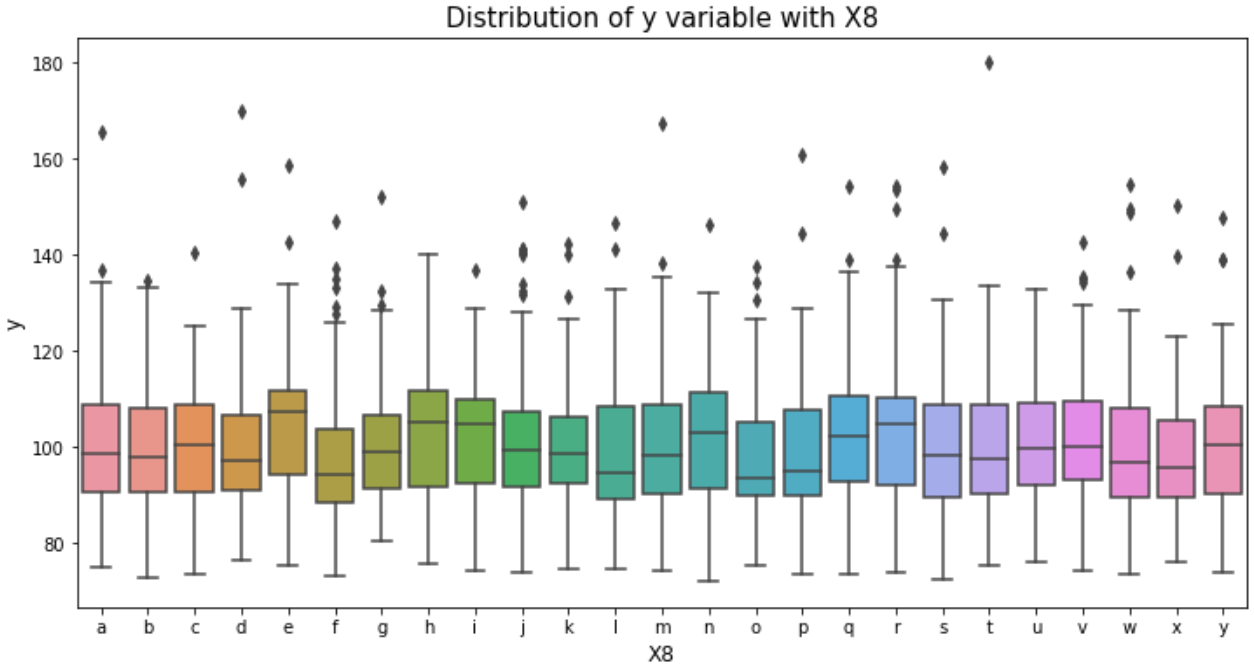
In [49]:

```
var="X6"
colu_order=np.sort(df_train[var].unique()).tolist()
plt.figure(figsize=(12,6))
sns.boxplot(x=var,y="y",data=df_train,order=colu_order)
plt.xlabel(var,fontsize=12)
plt.ylabel("y",fontsize=12)
plt.title("Distribution of y variable with "+var, fontsize=15)
plt.show()
```



In [50]:

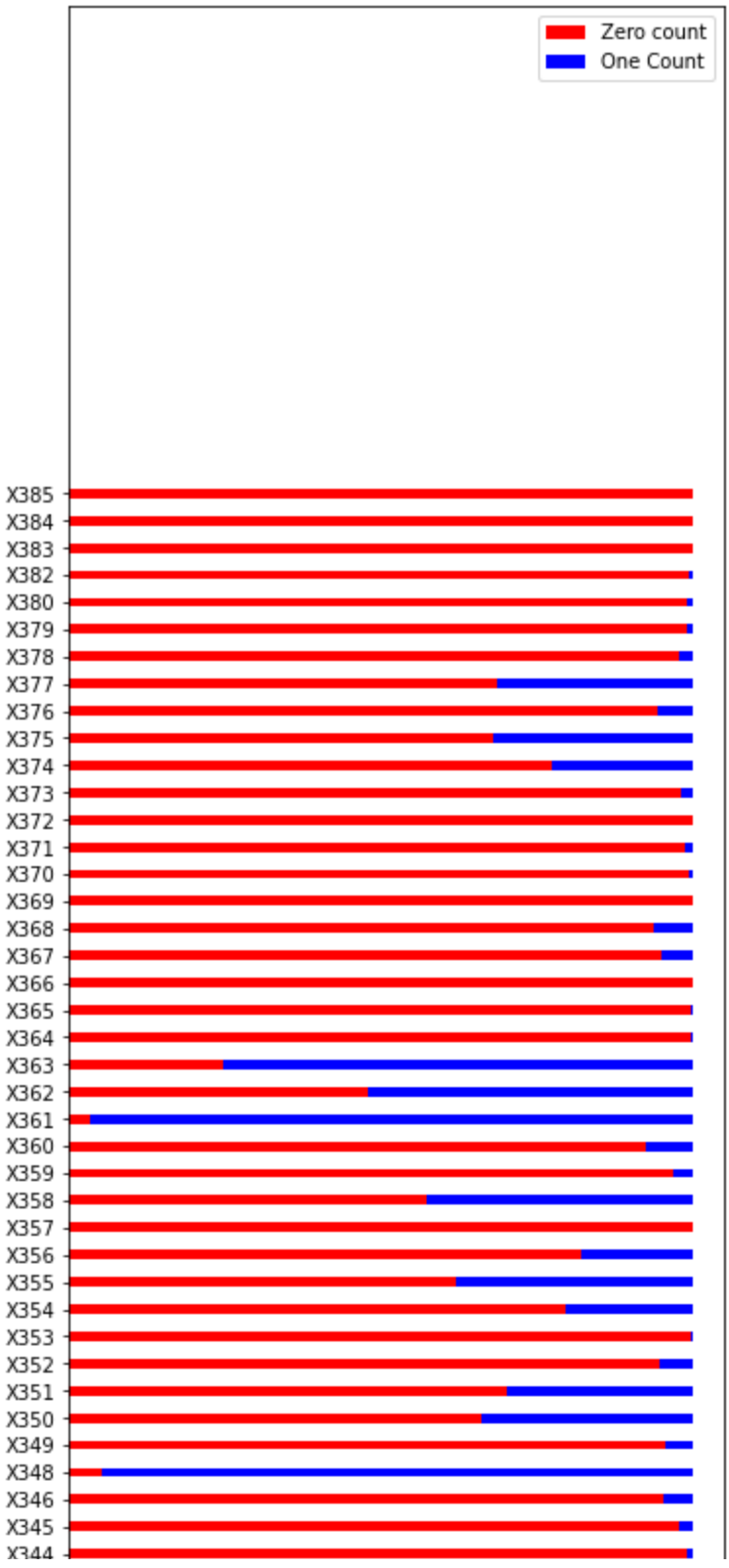
```
var="X8"
colu_order=np.sort(df_train[var].unique()).tolist()
plt.figure(figsize=(12,6))
sns.boxplot(x=var,y="y",data=df_train,order=colu_order)
plt.xlabel(var,fontsize=12)
plt.ylabel("y",fontsize=12)
plt.title("Distribution of y variable with "+var, fontsize=15)
plt.show()
```

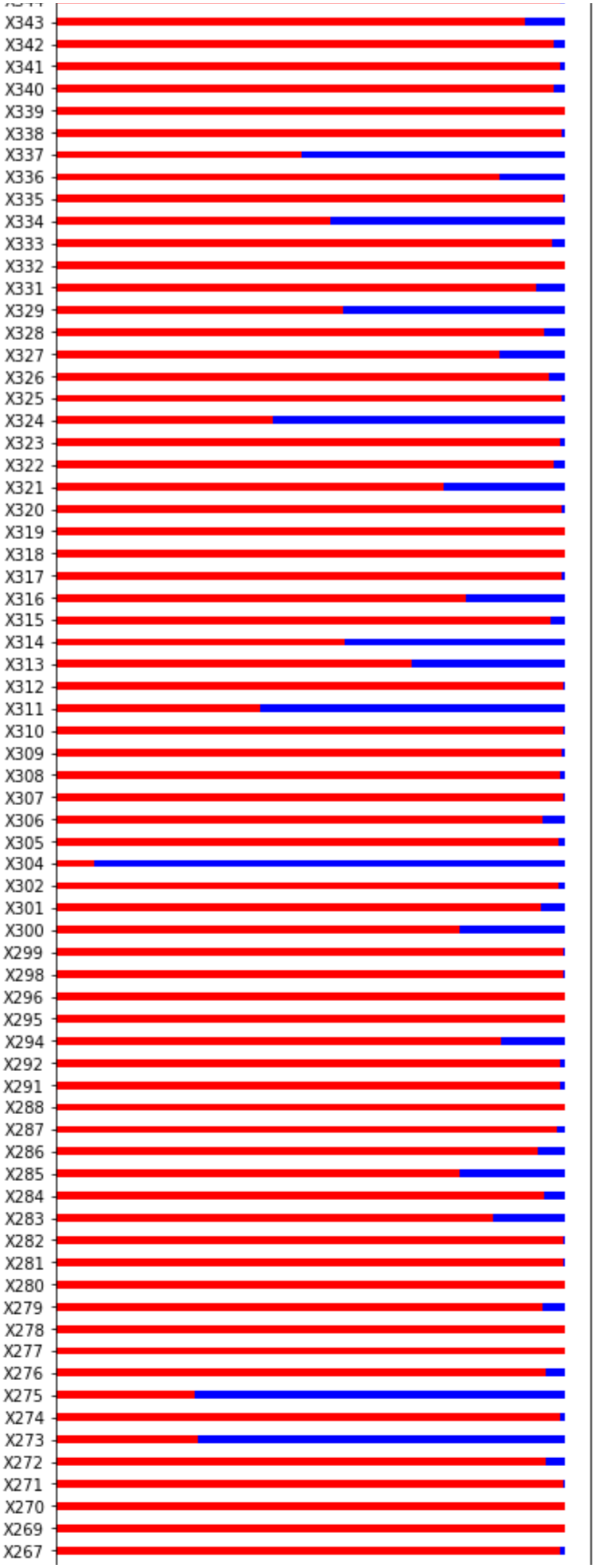


In [51]:

```
zero_list=[]
one_list=[]
col_list = unique_value_dict['[0, 1]']
for col in col_list:
    zero_list.append((df_train[col]==0).sum())
```

```
    one_list.append((df_train[col]==1).sum())
l = len(col_list)
arr = np.arange(l)
width = 0.35
plt.figure(figsize=(6,100))
plot_1 = plt.barh(arr, zero_list, width, color='red')
plot_2 = plt.barh(arr, one_list, width, left=zero_list, color="blue")
plt.yticks(arr, col_list)
plt.legend((plot_1[0], plot_2[0]), ('Zero count', 'One Count'))
plt.show()
```




X343
X342
X341
X340
X339
X338
X337
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X333
X332
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X328
X327
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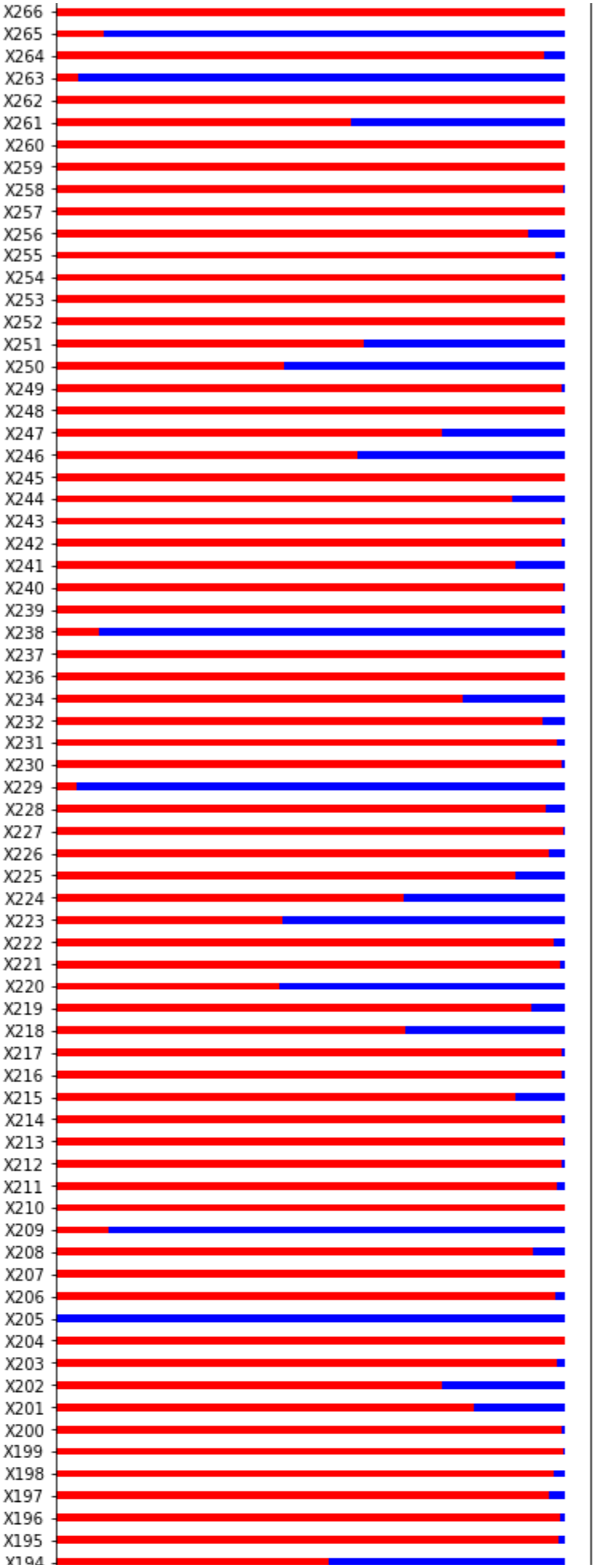
X269
X267


X266
X265
X264
X263
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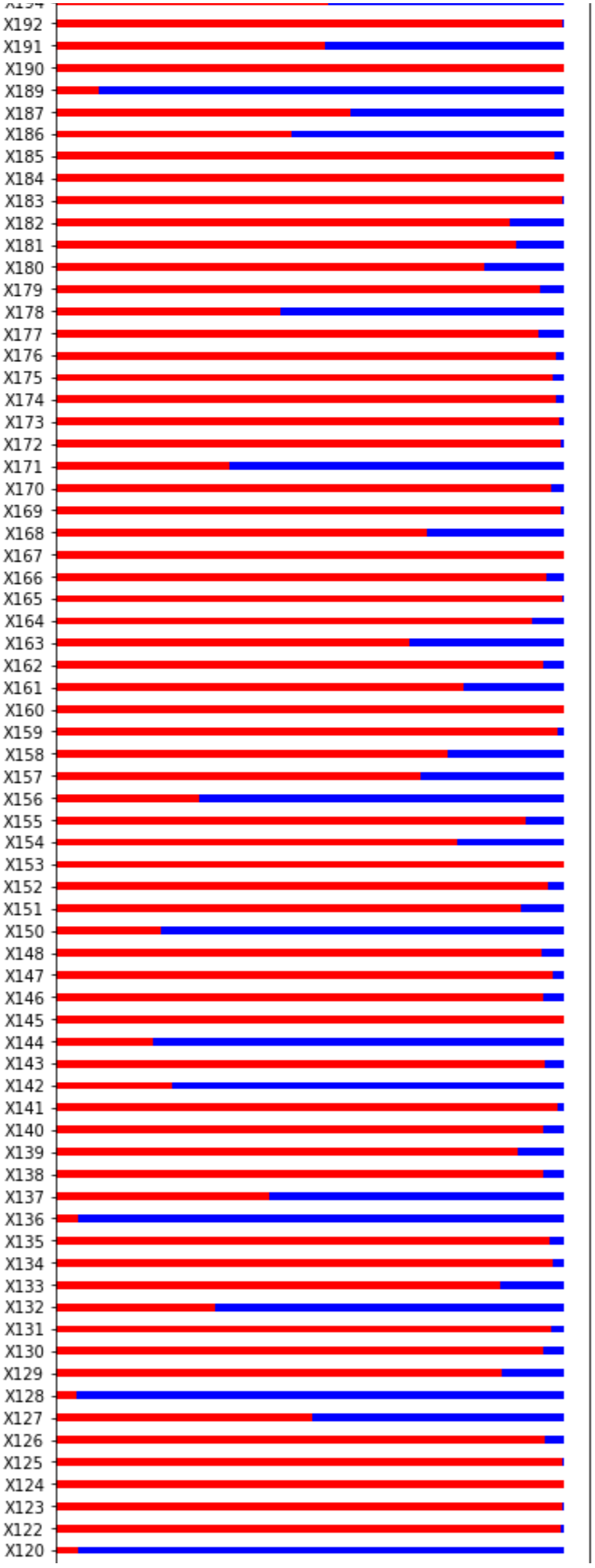
X194


X192
X191
X190
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X187
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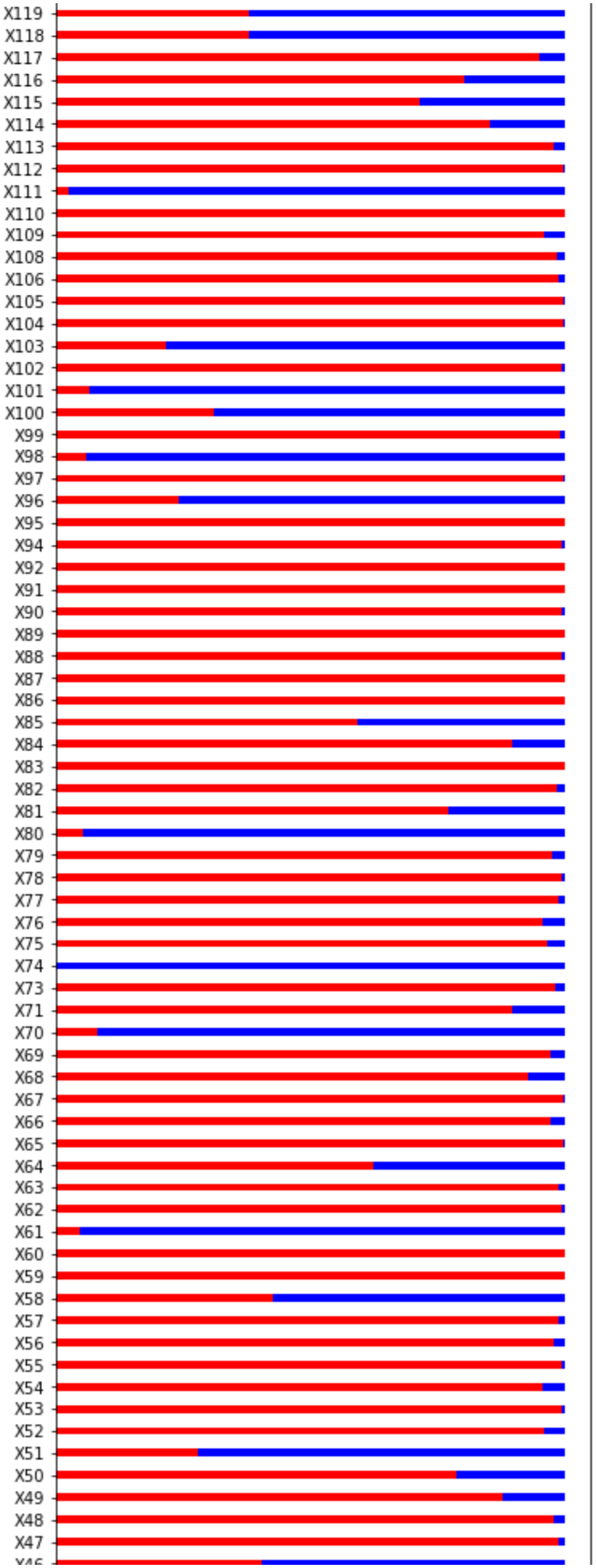
X122
X120


X119
X118
X117
X116
X115
X114
X113
X112
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X104
X103
X102
X101
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X62
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X55
X54
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X52
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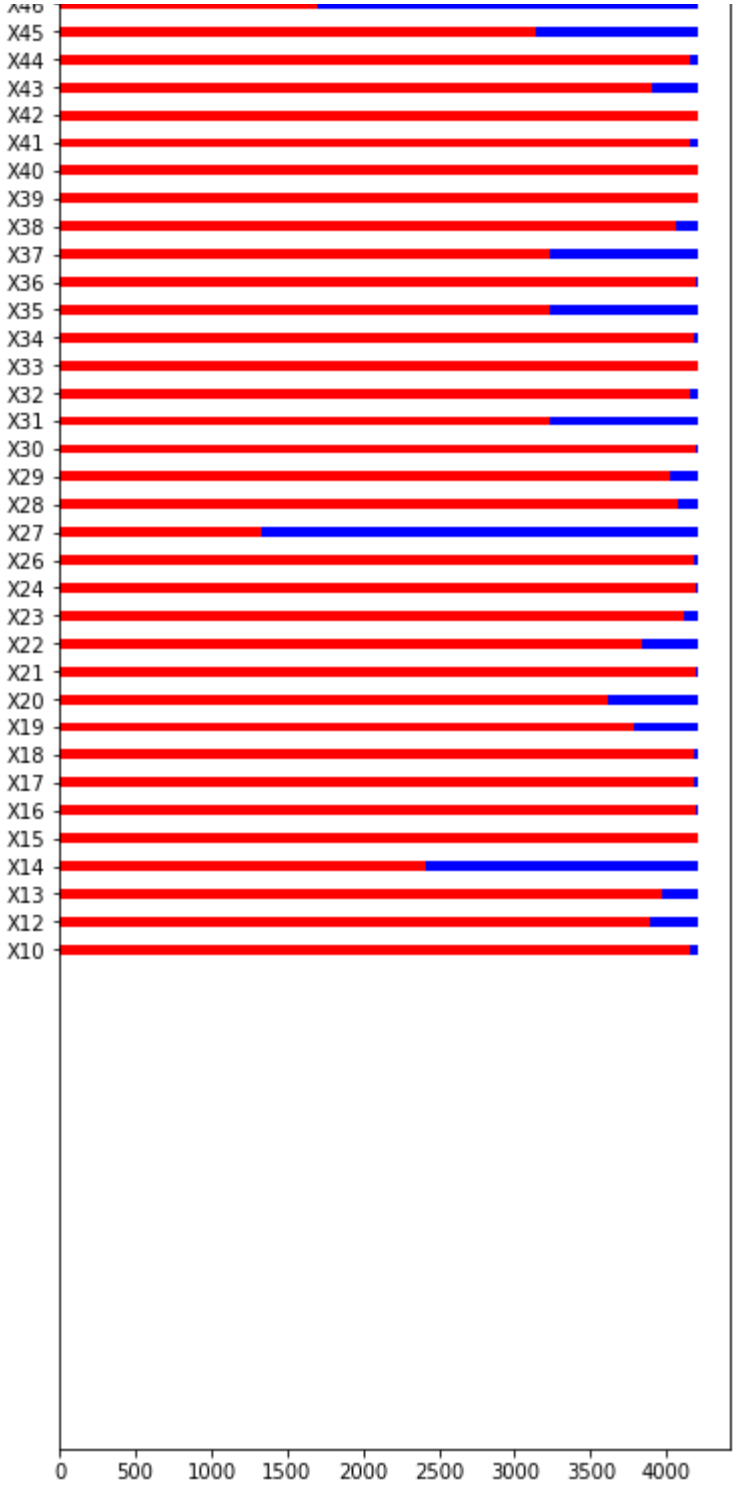
X47

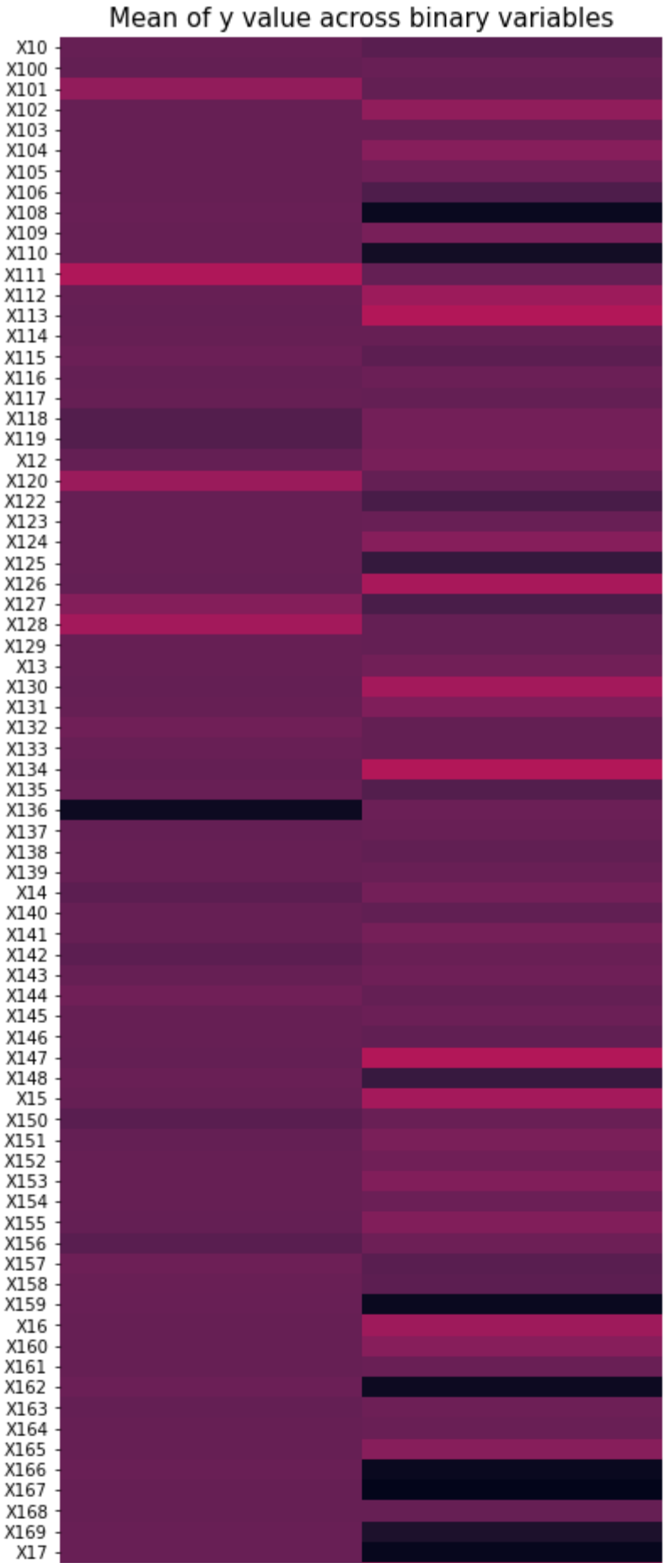


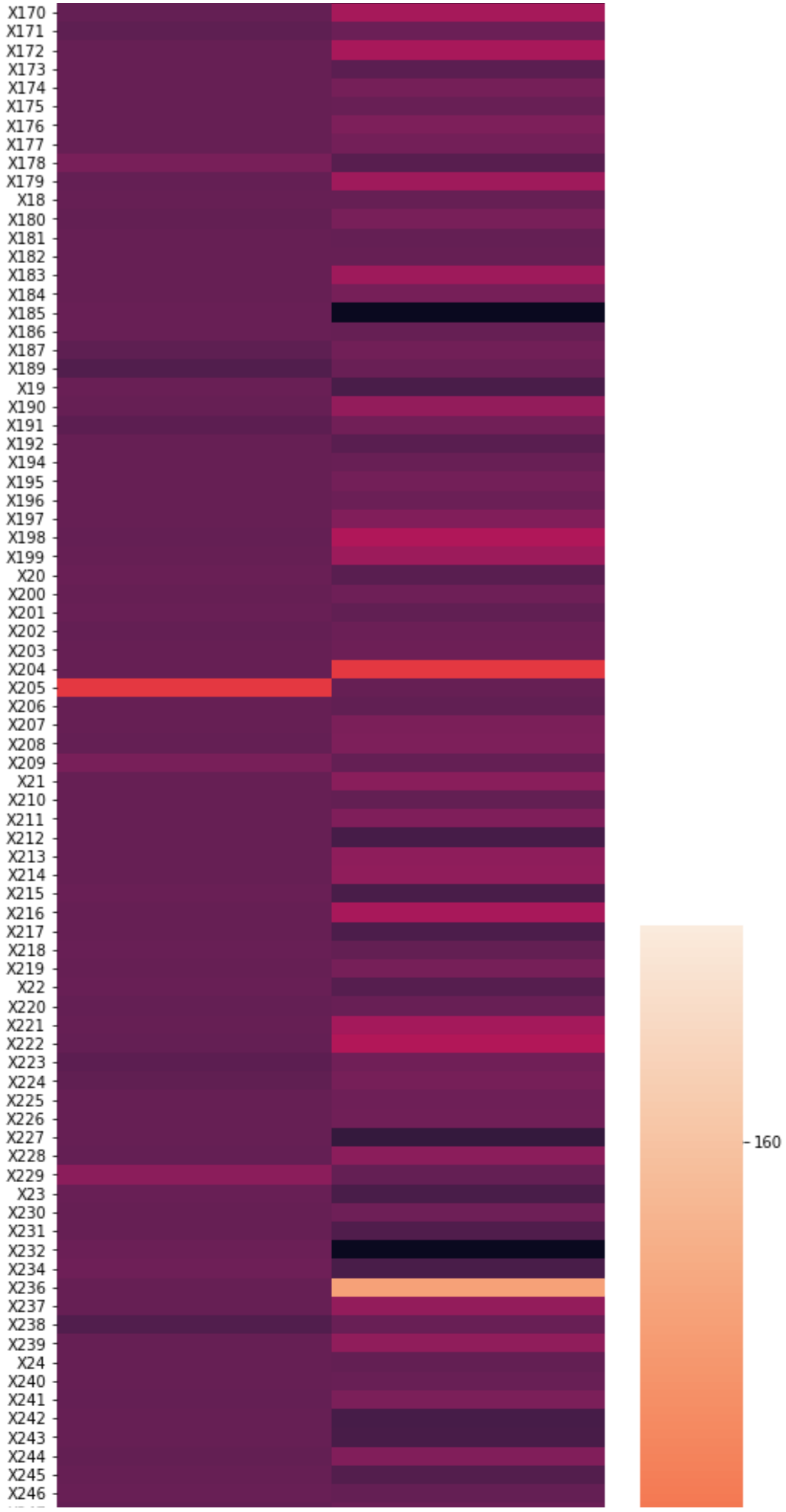
In [52]:

```
zero_mean_list = []
one_mean_list = []
cols_list = unique_value_dict['[0, 1]']
for col in cols_list:
    zero_mean_list.append(df_train.loc[df_train[col]==0].y.mean())
    one_mean_list.append(df_train.loc[df_train[col]==1].y.mean())
new_df = pd.DataFrame({"column_name":cols_list+cols_list, "value":[0]*len(cols_list) +
new_df = new_df.pivot('column_name', 'value', 'y_mean')

plt.figure(figsize=(8,80))
sns.heatmap(new_df)
```

```
plt.title("Mean of y value across binary variables", fontsize=15)
plt.show()
```

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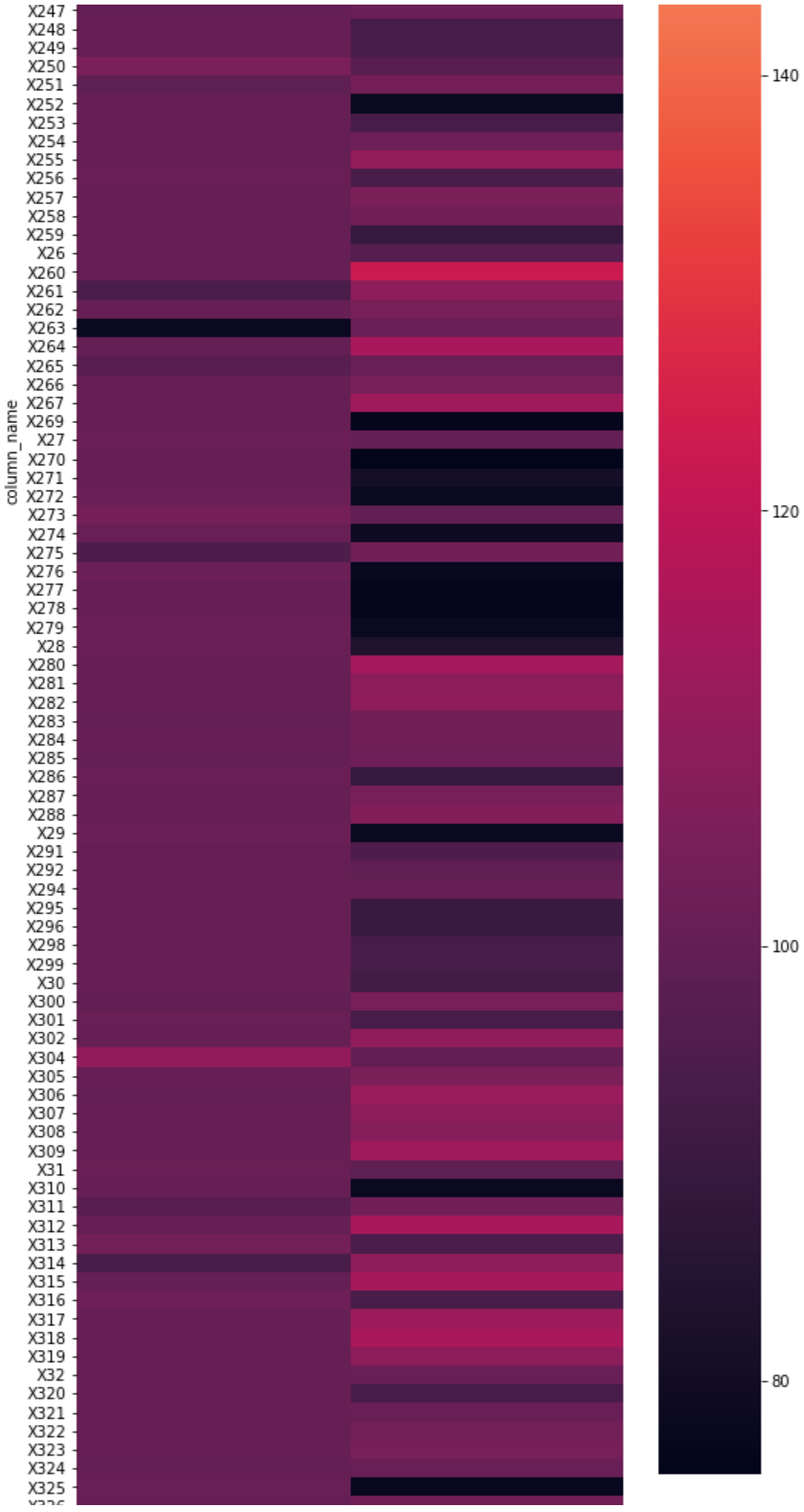
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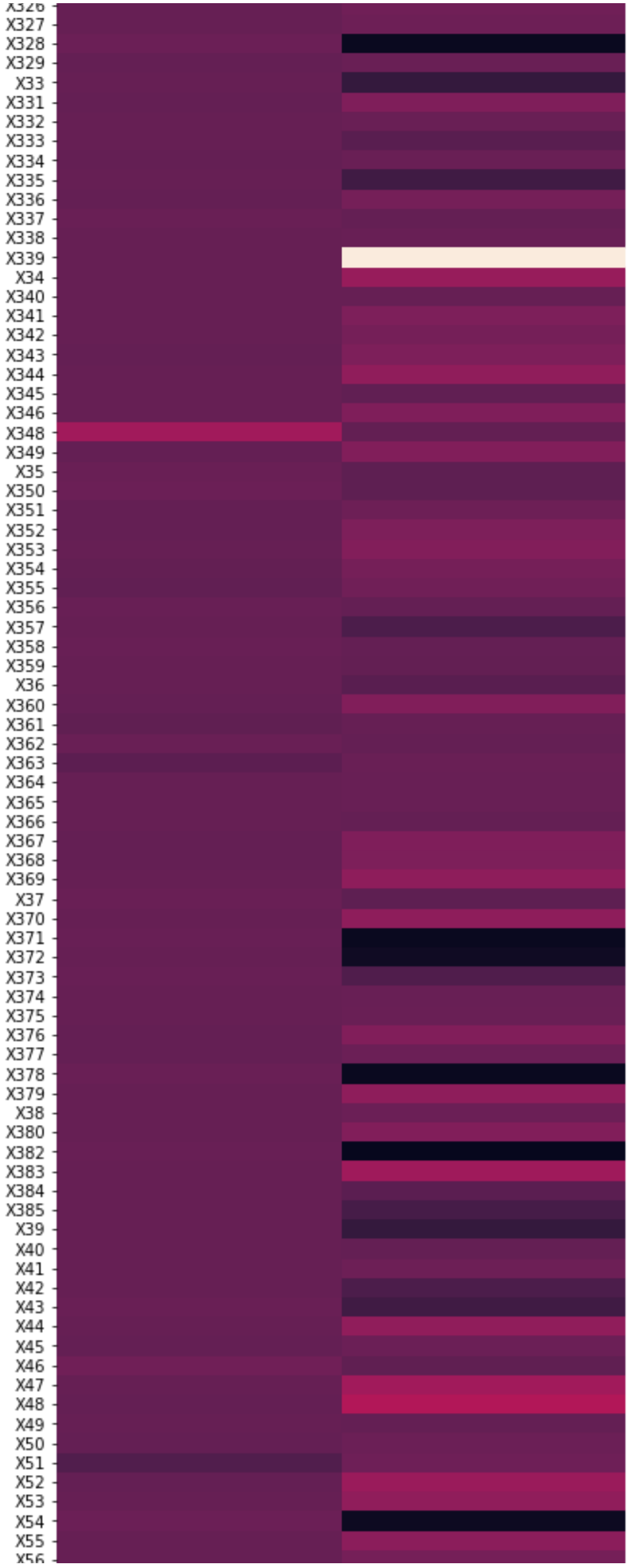
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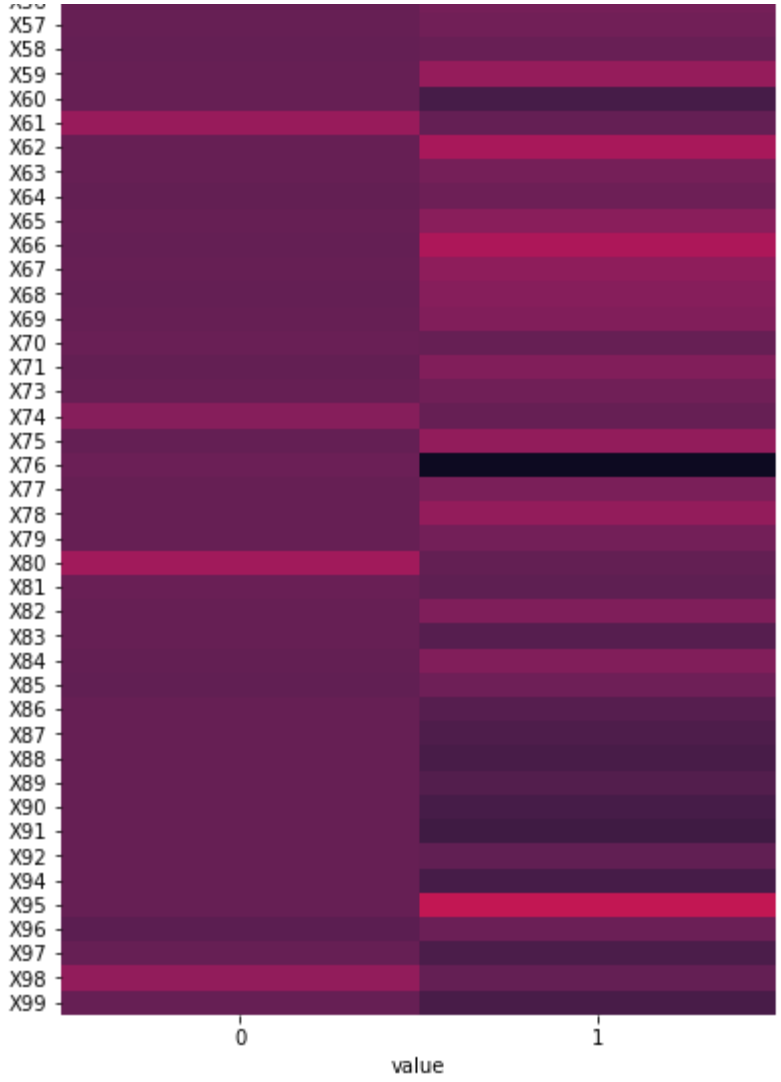
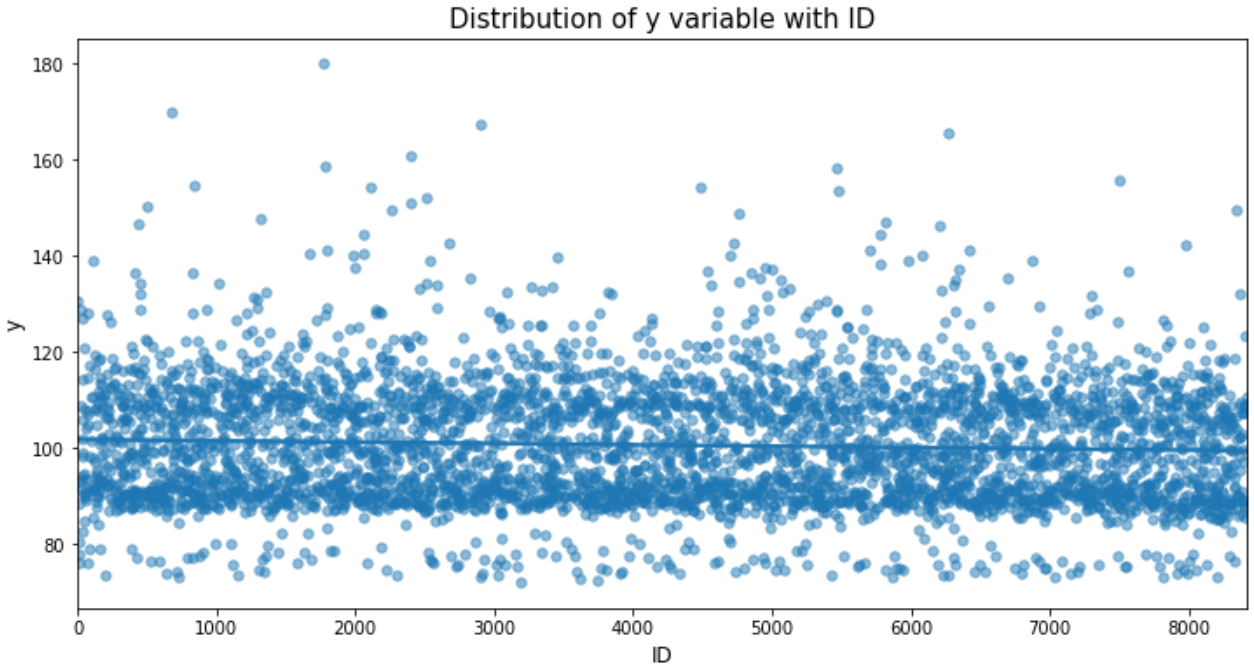


In [53]:

```
var = "ID"
plt.figure(figsize=(12,6))
sns.regplot(x=var, y='y', data=df_train, scatter_kws={'alpha':0.5, 's':30})
plt.xlabel(var, fontsize=12)
plt.ylabel('y', fontsize=12)
plt.title("Distribution of y variable with "+var, fontsize=15)
plt.show()
```

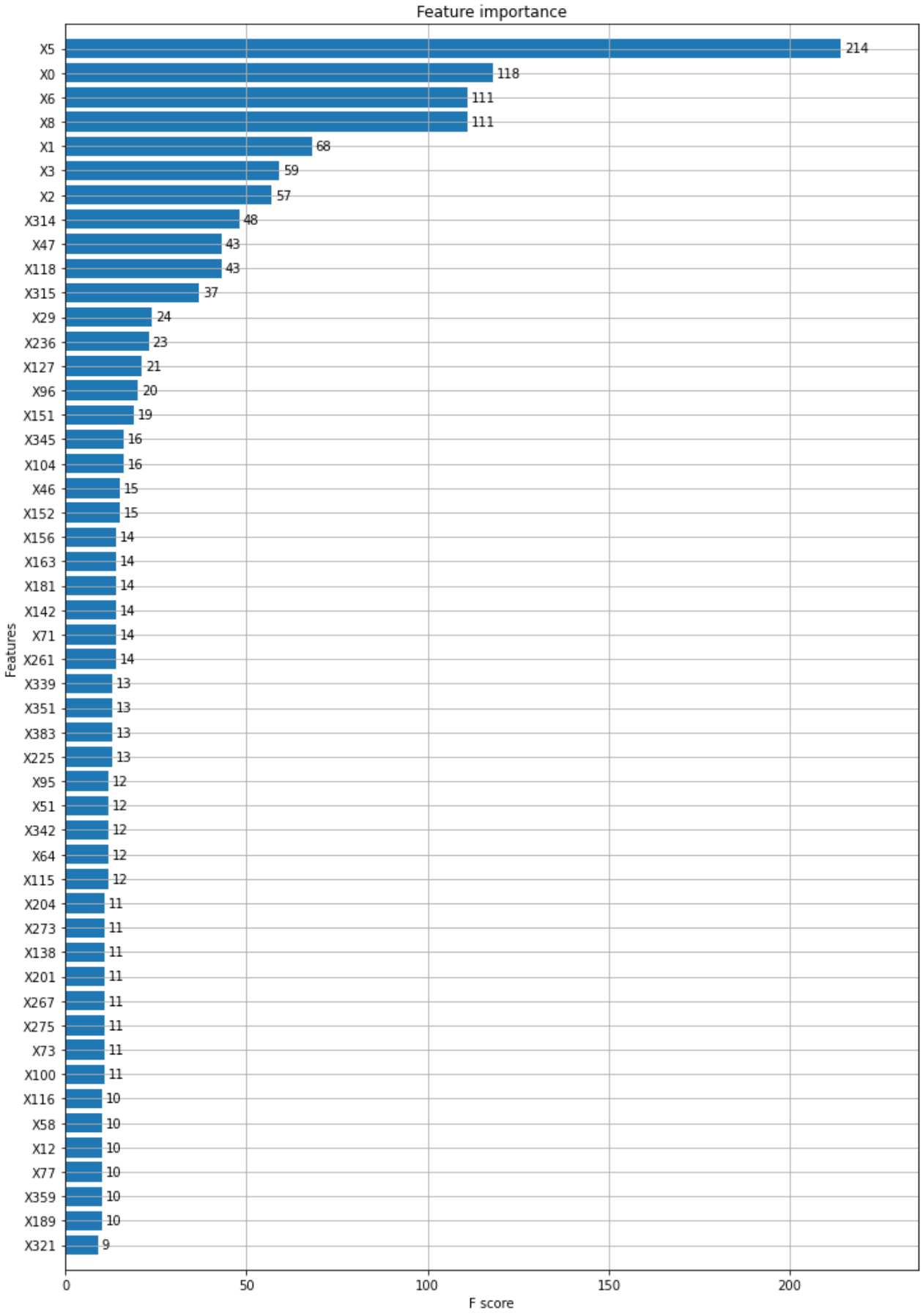


In [54]:

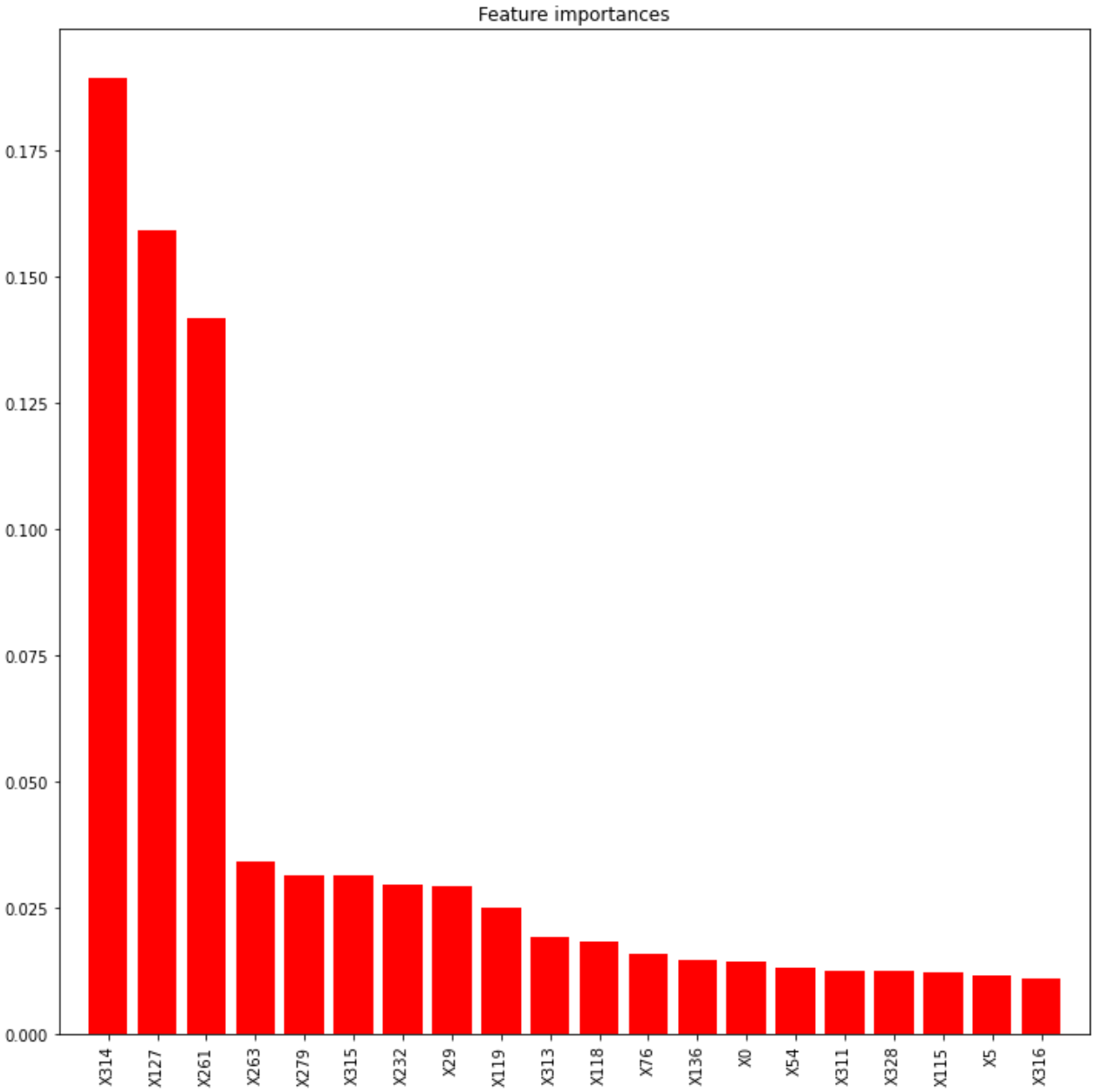
```
for f in ["X0", "X1", "X2", "X3", "X4", "X5", "X6", "X8"]:
        lbl = preprocessing.LabelEncoder()
        lbl.fit(list(df_train[f].values))
        df_train[f] = lbl.transform(list(df_train[f].values))

train_y = df_train['y'].values
train_X =df_train.drop(["ID", "y"], axis=1)

# Thanks to anokas for this #
def xgb_r2_score(preds, dtrain):
    labels = dtrain.get_label()
    return 'r2', r2_score(labels, preds)

xgb_params = {
    'eta': 0.05,
    'max_depth': 6,
    'subsample': 0.7,
    'colsample_bytree': 0.7,
    'objective': 'reg:linear',
    'silent': 1
}
dtrain = xgb.DMatrix(train_X, train_y, feature_names=train_X.columns.values)
model = xgb.train(dict(xgb_params, silent=0), dtrain, num_boost_round=100, feval=xgb_r2

# plot the important features #
fig, ax = plt.subplots(figsize=(12,18))
xgb.plot_importance(model, max_num_features=50, height=0.8, ax=ax)
plt.show()
```

```
[23:50:37] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.4.0/src/obj
ective/regression_obj.cu:171: reg:linear is now deprecated in favor of reg:squarederror.
[23:50:37] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.4.0/src/lea
rner.cc:573:
Parameters: { "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.
```



In [55]:
```
from sklearn import ensemble
model = ensemble.RandomForestRegressor(n_estimators=200, max_depth=10, min_samples_leaf
model.fit(train_X, train_y)
feat_names = train_X.columns.values

## plot the importances ##
importances = model.feature_importances_
std = np.std([tree.feature_importances_ for tree in model.estimators_], axis=0)
indices = np.argsort(importances)[::-1][:20]

plt.figure(figsize=(12,12))
plt.title("Feature importances")
plt.bar(range(len(indices)), importances[indices], color="r", align="center")
plt.xticks(range(len(indices)), feat_names[indices], rotation='vertical')
plt.xlim([-1, len(indices)])
plt.show()
```



In [ ]:
```
```

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