ISE 529 Final Project - Mercedes-Benz Greener Manufacturing

Section: Wednesday

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In [1]:
```
import pandas as pd
import numpy as np
import random as rnd

import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline

from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC, LinearSVC
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.linear_model import Perceptron
from sklearn.linear_model import SGDClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn import preprocessing
from sklearn.preprocessing import LabelEncoder
import xgboost as xgb
from sklearn.metrics import mean_squared_error
```

In [2]:
```
train_df = pd.read_csv('train.csv')
test_df = pd.read_csv('test.csv')
combine = [train_df,test_df]
```

In [3]:
```
# preview the data get a sense of what it looks like
train_df.head(3)
```

Out[3]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	...	X375	X376	X377	X378	X379	X380	X38
0	0	130.81	k	v	at	a	d	u	j	o	...	0	0	1	0	0	0	
1	6	88.53	k	t	av	e	d	y	l	o	...	1	0	0	0	0	0	
2	7	76.26	az	w	n	c	d	x	j	x	...	0	0	0	0	0	0	

3 rows × 378 columns

In [4]:
```
train_df.tail(3)
```

Out[4]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	...	X375	X376	X377	X378	X379	X380
4206	8412	109.22	ak	v	r	a	d	aa	g	e	...	0	0	1	0	0	0
4207	8415	87.48	al	r	e	f	d	aa	l	u	...	0	0	0	0	0	0
4208	8417	110.85	z	r	ae	c	d	aa	g	w	...	1	0	0	0	0	0

3 rows × 378 columns

In [5]:
```
train_df.info()
print('_'*40)
test_df.info()
```

```
<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

________________________________________
<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 [6]:
```
train_df.describe()
```

Out[6]:

	ID	y	X10	X11	X12	X13	X14	
count	4209.000000	4209.000000	4209.000000	4209.0	4209.000000	4209.000000	4209.000000	4
mean	4205.960798	100.669318	0.013305	0.0	0.075077	0.057971	0.428130	
std	2437.608688	12.679381	0.114590	0.0	0.263547	0.233716	0.494867	
min	0.000000	72.110000	0.000000	0.0	0.000000	0.000000	0.000000	
25%	2095.000000	90.820000	0.000000	0.0	0.000000	0.000000	0.000000	
50%	4220.000000	99.150000	0.000000	0.0	0.000000	0.000000	0.000000	
75%	6314.000000	109.010000	0.000000	0.0	0.000000	0.000000	1.000000	
max	8417.000000	265.320000	1.000000	0.0	1.000000	1.000000	1.000000	

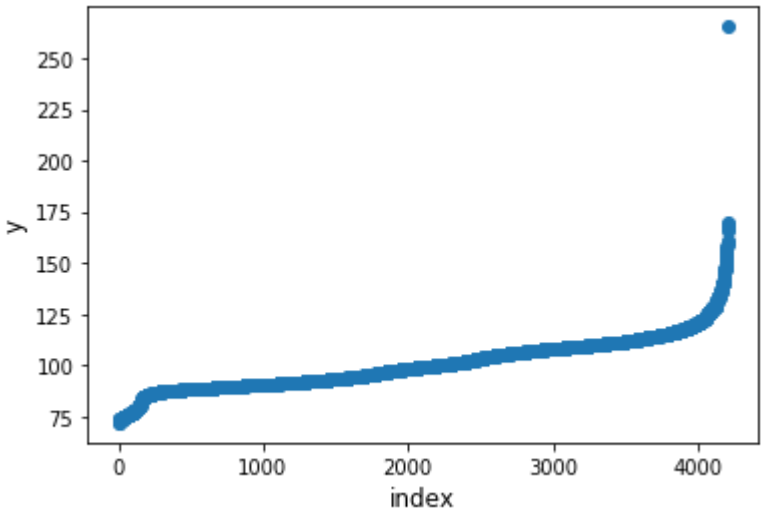
8 rows × 370 columns

In [7]:
```
#locate 0 element
train_df.describe(include=['0'])
```

Out[7]:

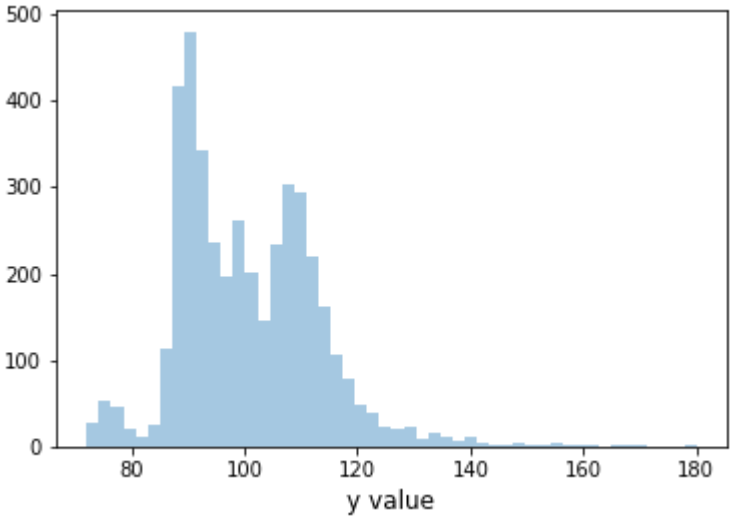
	X0	X1	X2	X3	X4	X5	X6	X8
count	4209	4209	4209	4209	4209	4209	4209	4209
unique	47	27	44	7	4	29	12	25
top	z	aa	as	c	d	w	g	j
freq	360	833	1659	1942	4205	231	1042	277

In [9]:
```
#Find an outlier
plt.figure(figsize=(6,4))
plt.scatter(range(train_df.shape[0]), np.sort(train_df.y.values))
plt.xlabel('index', fontsize=12)
plt.ylabel('y', fontsize=12)
plt.show()
```



In [12]:
```
ulimit = 180
train_df.loc[train_df['y']>ulimit] = ulimit

plt.figure(figsize=(6,4))
sns.distplot(train_df.y.values, bins=50, kde=False)
plt.xlabel('y value', fontsize=12)
plt.show()
```



In [15]:
```
dtype_df = train_df.dtypes.reset_index()
dtype_df.columns = ["Count", "Column Type"]
dtype_df.groupby("Column Type").aggregate('count').reset_index()
```

Out[15]:

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

1. Feature Analysis

369 int64 = actually binary values

1 float64 = target variable

8 ibject = categorical features

In [18]:
```
dtype_df.iloc[:10,:].transpose()
#Identify that from X0 to X8 are categorical columns
```

Out[18]:

	0	1	2	3	4	5	6	7	8	9
Count	ID	y	X0	X1	X2	X3	X4	X5	X6	X8
Column Type	int64	float64	object	object	object	object	object	object	object	object

X0,X1,X2,X3,X4,X5,X6,X7,X8 are categorical columns

In [19]:
```
#check for missing value
missing_df = train_df.isnull().sum(axis=0).reset_index()
missing_df.columns = ['column_name', 'missing_count']
missing_df = missing_df.loc[missing_df['missing_count']>0]
missing_df = missing_df.sort_values(by='missing_count')
missing_df
```

Out[19]:

column_name	missing_count

There is no missing value in the given dataset

In [20]:
```
train_df_copy = train_df.copy()
train_df_copy.head(3)
```

Out[20]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	...	X375	X376	X377	X378	X379	X380	X38
0	0	130.81	k	v	at	a	d	u	j	o	...	0	0	1	0	0	0	
1	6	88.53	k	t	av	e	d	y	l	o	...	1	0	0	0	0	0	
2	7	76.26	az	w	n	c	d	x	j	x	...	0	0	0	0	0	0	

3 rows × 378 columns

2. Converting all Categorical variables

In [21]:
```
def to_one_hot(column, df):
    """
    Replaces a given column with N new one-hot encoded columns.
    N = number of unique values of given column.
    """
    # Get unique values of column
    unique_vals = df[column].unique()
    # Add a new zero-filled column for each unique value
    for val in unique_vals:
        new_column_name = column + val
        df[new_column_name] = 0
    # Put 1s to new columns:
    row_idx = 0
    for categ_val in df[column].values:
        column_name = column + categ_val
        df.at[row_idx, column_name] = 1
        row_idx += 1
    # Remove the column with categorical values
    df.drop(column, axis=1, inplace=True)

    print("Replaced categorical column {} with {} new columns."
          .format(column, len(unique_vals)))

    return df
```

In [22]:
```
def all_to_one_hot(df):
    """
    Replaces all categorical columns by one-hot encoded columns.
    See: to_one_hot(column, df)
    """
    # Get a list of categorical column names
    categorical_columns = list(train_df.select_dtypes(include=['object']))
    print("These {} categorical columns will be replaced: {}"
          .format(len(categorical_columns), categorical_columns))
    for column in categorical_columns:
        df = to_one_hot(column, df)
    print("New shape of dataframe after all replacements: ", df.shape)
    return df
```

In [23]:
```
#convert all categorical features
train_df = all_to_one_hot(train_df)
train_df.head()
```

```
These 8 categorical columns will be replaced: ['X0', 'X1', 'X2', 'X3', 'X4', 'X5', 'X
6', 'X8']
Replaced categorical column X0 with 47 new columns.
Replaced categorical column X1 with 27 new columns.
Replaced categorical column X2 with 44 new columns.
Replaced categorical column X3 with 7 new columns.
Replaced categorical column X4 with 4 new columns.
Replaced categorical column X5 with 29 new columns.
Replaced categorical column X6 with 12 new columns.
Replaced categorical column X8 with 25 new columns.
New shape of dataframe after all replacements:  (4209, 565)
```

Out[23]:

	ID	y	X10	X11	X12	X13	X14	X15	X16	X17	...	X8q	X8w	X8g	X8y	X8l	X8f	X
0	0	130.81	0	0	0	1	0	0	0	0	...	0	0	0	0	0	0	
1	6	88.53	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	
2	7	76.26	0	0	0	0	0	0	0	1	...	0	0	0	0	0	0	
3	9	80.62	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	
4	13	78.02	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	

5 rows × 565 columns

In [24]:
```
train_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4209 entries, 0 to 4208
Columns: 565 entries, ID to X8c
dtypes: float64(1), int64(564)
memory usage: 18.1 MB
```

3. Dimensionality Reduction

-Discard the ones with only 1 value

-Remove ID column

-Remove outliers

In [25]:
```
def get_constant_columns(df):
    constant_columns = []
    for column in list(df):
        if len(df[column].unique()) == 1:
            constant_columns.append(column)
    print("Constant columns ({}): {}"
          .format(len(constant_columns), constant_columns))
    return constant_columns
```

In [26]:
```
constant_columns = get_constant_columns(train_df)
```

```
Constant columns (12): ['X11', 'X93', 'X107', 'X233', 'X235', 'X268', 'X289', 'X290',
'X293', 'X297', 'X330', 'X347']
```

In [27]:
```
def drop_columns(df, columns):
    for column in columns:
        df.drop(column, axis=1, inplace=True)
    print("Dropped {} columns: {}".format(len(columns), columns))
    return df
```

In [28]:
```
train_df = drop_columns(train_df, constant_columns)
train_df.head(3)
```

```
Dropped 12 columns: ['X11', 'X93', 'X107', 'X233', 'X235', 'X268', 'X289', 'X290', 'X
293', 'X297', 'X330', 'X347']
```

Out[28]:

	ID	y	X10	X12	X13	X14	X15	X16	X17	X18	...	X8q	X8w	X8g	X8y	X8l	X8f	X
0	0	130.81	0	0	1	0	0	0	0	1	...	0	0	0	0	0	0	
1	6	88.53	0	0	0	0	0	0	0	1	...	0	0	0	0	0	0	
2	7	76.26	0	0	0	0	0	0	1	0	...	0	0	0	0	0	0	

3 rows × 553 columns

In [29]:
```
outlier_row_index = train_df['y'].idxmax()
train_df = train_df.drop(train_df.index[outlier_row_index])
print("Removed outlier at row index {}. New shape of dataframe = {}"
      .format(outlier_row_index, train_df.shape))
```

```
Removed outlier at row index 883. New shape of dataframe = (4208, 553)
```

In [30]:
```
train_df = train_df.drop('ID', axis = 1)
print("Removed the ID column. New shape of dataframe = {}"
      .format(train_df.shape))
train_df.head(3)
```

```
Removed the ID column. New shape of dataframe = (4208, 552)
```

Out[30]:

	y	X10	X12	X13	X14	X15	X16	X17	X18	X19	...	X8q	X8w	X8g	X8y	X8l	X8f
0	130.81	0	0	1	0	0	0	0	1	0	...	0	0	0	0	0	0
1	88.53	0	0	0	0	0	0	0	1	0	...	0	0	0	0	0	0
2	76.26	0	0	0	0	0	0	1	0	0	...	0	0	0	0	0	0

3 rows × 552 columns

Feature selecting(one-hot encode)

In [31]:
```
train_y = train_df['y'].values
train_X = train_df.drop(["y"], axis=1)
```

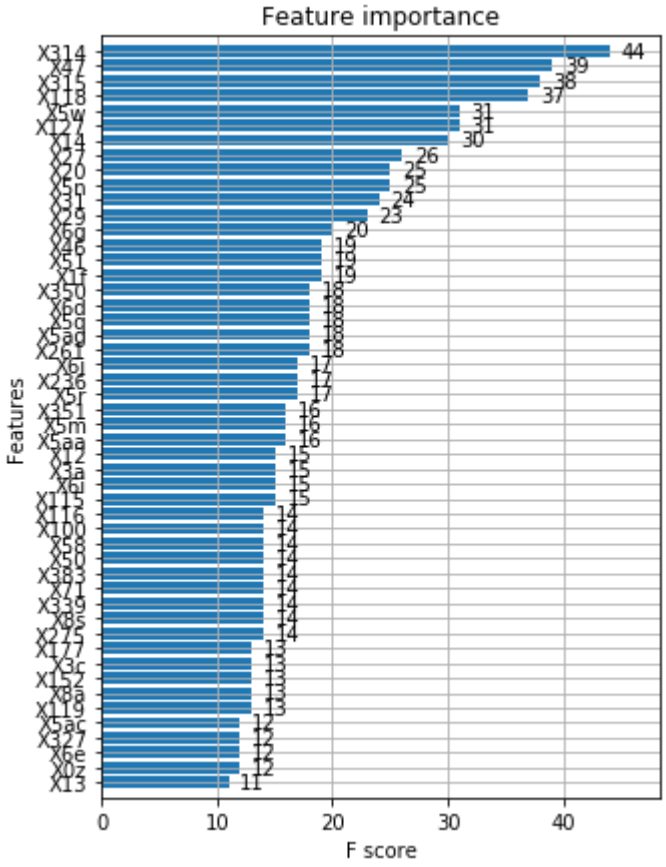
Feature importance with xgb model

In [32]:
```
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_score, maximize=True)
```

```
[15:15:07] WARNING: C:/Jenkins/workspace/xgboost-win64_release_0.90/src/objective/reg
ression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
```

In [34]:
```
fig, ax = plt.subplots(figsize=(5,7))
xgb.plot_importance(model, max_num_features=50, height=0.8, ax=ax)
plt.show()
```

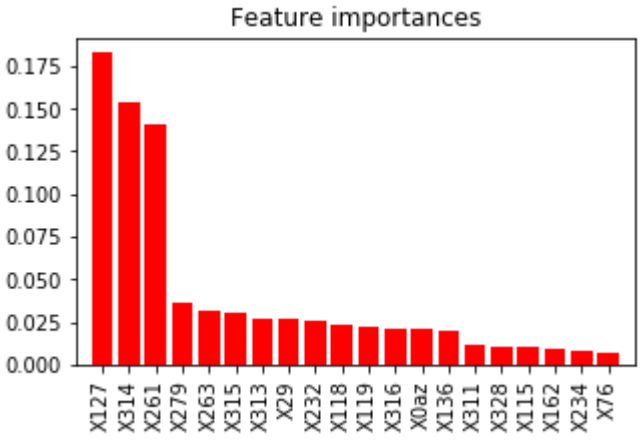


Feature importance with randomforest model

In [36]:
```
from sklearn import ensemble
model = ensemble.RandomForestRegressor(n_estimators=200,
                                       max_depth=10,
                                       min_samples_leaf=4,
                                       max_features=0.2,
                                       n_jobs=-1, random_state=0)
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=(5,3))
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()
```



Feature selecting(label Encoder)

In [37]:
```
train_df_copy.head(3)
```

Out[37]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	...	X375	X376	X377	X378	X379	X380	X38
0	0	130.81	k	v	at	a	d	u	j	o	...	0	0	1	0	0	0	
1	6	88.53	k	t	av	e	d	y	l	o	...	1	0	0	0	0	0	
2	7	76.26	az	w	n	c	d	x	j	x	...	0	0	0	0	0	0	

3 rows × 378 columns

In [38]:
```
train_df.head(3)
```

Out[38]:

	y	X10	X12	X13	X14	X15	X16	X17	X18	X19	...	X8q	X8w	X8g	X8y	X8l	X8f
0	130.81	0	0	1	0	0	0	0	1	0	...	0	0	0	0	0	0
1	88.53	0	0	0	0	0	0	0	1	0	...	0	0	0	0	0	0
2	76.26	0	0	0	0	0	0	1	0	0	...	0	0	0	0	0	0

3 rows × 552 columns

In [39]:
```
for f in ["X0", "X1", "X2", "X3", "X4", "X5", "X6", "X8"]:
        lbl = preprocessing.LabelEncoder()
        lbl.fit(list(train_df_copy[f].values))
        train_df_copy[f] = lbl.transform(list(train_df_copy[f].values))
```

In [40]:
```
train_df_copy.head(3)
```

Out[40]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	...	X375	X376	X377	X378	X379	X380	X38
0	0	130.81	32	23	17	0	3	24	9	14	...	0	0	1	0	0	0	
1	6	88.53	32	21	19	4	3	28	11	14	...	1	0	0	0	0	0	
2	7	76.26	20	24	34	2	3	27	9	23	...	0	0	0	0	0	0	

3 rows × 378 columns

In [41]:

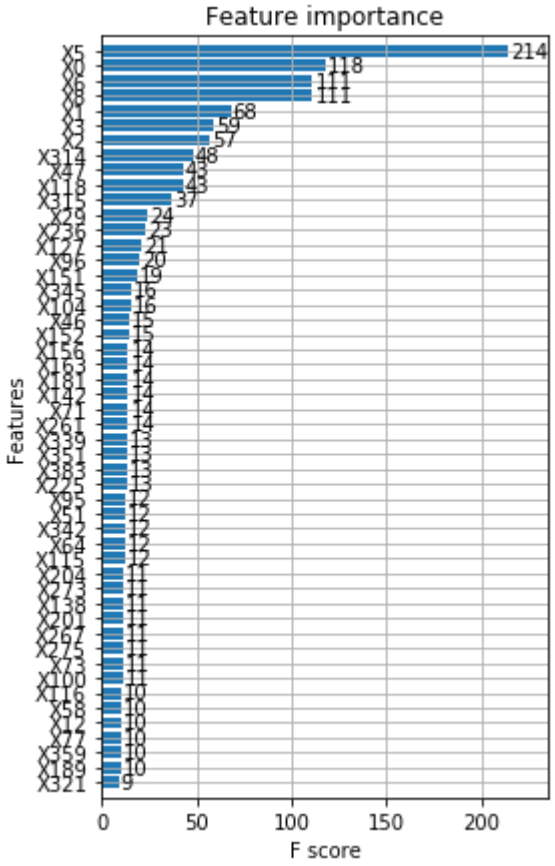
```
train_y = train_df_copy['y'].values
train_X = train_df_copy.drop(["ID", "y"], axis=1)

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_labelencoder = xgb.train(dict(xgb_params, silent=0),
                                   dtrain, num_boost_round=100,
                                   feval=xgb_r2_score,
                                   maximize=True)

# plot the important features #
fig, ax = plt.subplots(figsize=(4,7))
xgb.plot_importance(model_xgb_labelencoder,
                    max_num_features=50, height=0.8, ax=ax)
plt.show()
```

```
[15:17:03] WARNING: C:/Jenkins/workspace/xgboost-win64_release_0.90/src/objective/reg
ression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
```

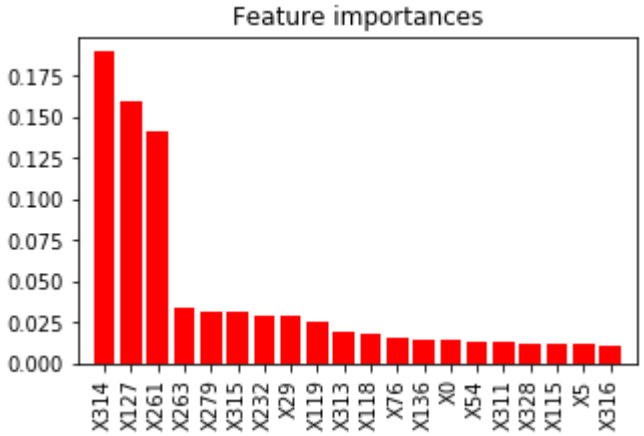


Features with Randomforest

In [42]:
```
model_rf_labelencoder = \
    ensemble.RandomForestRegressor(n_estimators=200,
                                   max_depth=10,
                                   min_samples_leaf=4,
                                   max_features=0.2,
                                   n_jobs=-1, random_state=0)
model.fit(train_X, train_y)
feat_names = train_X.columns.values
```

In [43]:
```
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=(5,3))
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()
```



Use sklearn feature selection(select by model)

In [47]:
```
from sklearn.feature_selection import SelectFromModel

rf_selector = \
    SelectFromModel(ensemble.RandomForestRegressor(n_estimators=200,
                                       max_depth=10,
                                       min_samples_leaf=4,
                                       max_features=0.2,
                                       n_jobs=-1, random_state=0))
rf_selector.fit(train_X, train_y)
rf_support = rf_selector.get_support()
rf_feature = train_X.loc[:,rf_support].columns.tolist()
print(rf_feature)
```

```
['X0', 'X1', 'X2', 'X3', 'X5', 'X6', 'X8', 'X29', 'X47', 'X54', 'X76', 'X80', 'X115',
'X118', 'X119', 'X127', 'X136', 'X162', 'X178', 'X223', 'X232', 'X234', 'X238', 'X25
0', 'X261', 'X263', 'X275', 'X276', 'X279', 'X311', 'X313', 'X314', 'X315', 'X316',
'X328', 'X348']
```

Use RFE to select features

In [49]:
```
from sklearn.feature_selection import RFE
```

In [53]:
```
rfe_selector = \
    RFE(estimator=ensemble.RandomForestRegressor(n_estimators=10),
        n_features_to_select=300, step=10, verbose=5)
```

In [55]:
```
rfe_selector.fit(train_X, train_y)
rfe_support = rfe_selector.get_support()
rfe_feature = train_X.loc[:,rfe_support].columns.tolist()
```

```
Fitting estimator with 376 features.
Fitting estimator with 366 features.
Fitting estimator with 356 features.
Fitting estimator with 346 features.
Fitting estimator with 336 features.
Fitting estimator with 326 features.
Fitting estimator with 316 features.
Fitting estimator with 306 features.
```

Modeling with feature selected by sklearn feature selection

In [56]:
```
train_df_copy.head(3)
```

Out[56]:

	ID	y	X0	X1	X2	X3	X4	X5	X6	X8	...	X375	X376	X377	X378	X379	X380	X38
0	0	130.81	32	23	17	0	3	24	9	14	...	0	0	1	0	0	0	
1	6	88.53	32	21	19	4	3	28	11	14	...	1	0	0	0	0	0	
2	7	76.26	20	24	34	2	3	27	9	23	...	0	0	0	0	0	0	

3 rows × 378 columns

In [58]:
```
#labelencode test data
test_df_copy = test_df.copy()
```

In [59]:
```
test_df_copy.head(3)
```

Out[59]:

	ID	X0	X1	X2	X3	X4	X5	X6	X8	X10	...	X375	X376	X377	X378	X379	X380	X382
0	1	az	v	n	f	d	t	a	w	0	...	0	0	0	1	0	0	0
1	2	t	b	ai	a	d	b	g	y	0	...	0	0	1	0	0	0	0
2	3	az	v	as	f	d	a	j	j	0	...	0	0	0	1	0	0	0

3 rows × 377 columns

In [60]:
```
for f in ["X0", "X1", "X2", "X3", "X4", "X5", "X6", "X8"]:
        lbl = preprocessing.LabelEncoder()
        lbl.fit(list(test_df_copy[f].values))
        test_df_copy[f] = lbl.transform(list(test_df_copy[f].values))
```

In [61]:
```
test_df_copy.head(3)
```

Out[61]:

	ID	X0	X1	X2	X3	X4	X5	X6	X8	X10	...	X375	X376	X377	X378	X379	X380	X382
0	1	21	23	34	5	3	26	0	22	0	...	0	0	0	1	0	0	0
1	2	42	3	8	0	3	9	6	24	0	...	0	0	1	0	0	0	0
2	3	21	23	17	5	3	0	9	9	0	...	0	0	0	1	0	0	0

3 rows × 377 columns

In [64]:
```
from sklearn.model_selection import train_test_split
```

In [65]:
```
x_train, x_test, y_train, y_test = \
    train_test_split(train_df_copy[rf_feature],
                     train_df_copy['y'],
                     test_size=0.2, random_state=1)
```

In [66]:
```
X_test  = test_df_copy[rf_feature]
```

In [70]:
```
#RandomForest
model1 = ensemble.RandomForestRegressor(n_estimators=200,
                                        max_depth=10,
                                        min_samples_leaf=4,
                                        max_features=0.2,
                                        n_jobs=-1, random_state=0)
model1.fit(x_train, y_train);
```

In [71]:
```
y1_prediction = model1.predict(x_test)
mean_squared_error(y_test,y1_prediction)
```

Out[71]: 66.41763559624022

In [72]:
```
#MSE is 66.41763559624022
```

In [73]:
```
p_test =model1.predict(X_test)
sklearnRandomForest = pd.DataFrame()
sklearnRandomForest['ID'] = test_df_copy['ID']
sklearnRandomForest['y'] = p_test
sklearnRandomForest.to_csv('sklearnRandomForest.csv', index=False)
```

In [75]:
```
#train xgb model
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(x_train, y_train, feature_names=x_train.columns.values)
model2 = xgb.train(dict(xgb_params, silent=0),
                   dtrain, num_boost_round=100, feval=xgb_r2_score, maximize=True)
```

```
[15:24:05] WARNING: C:/Jenkins/workspace/xgboost-win64_release_0.90/src/objective/regression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
```

In [76]:
```
dtest = xgb.DMatrix(x_test, feature_names= x_test.columns.values)
```

In [77]:
```
y2_prediction = model2.predict(dtest)
mean_squared_error(y_test,y2_prediction)
```

Out[77]: 67.82078388634886

In [78]:
```
#MSE is 67.82078388634886.
```

In [79]:
```
dtest11 = xgb.DMatrix(X_test, feature_names= X_test.columns.values)
```

In [80]:
```
p_test =model2.predict(dtest11)
sklearnxgb = pd.DataFrame()
sklearnxgb ['ID'] = test_df_copy['ID']
sklearnxgb ['y'] = p_test
sklearnxgb .to_csv('sklearnxgb .csv', index=False)
```

Model with feature selected by rfe slection

In [81]:
```
#use rfe feature fit randomforest model
X1_test  = test_df_copy[rfe_feature]
```

In [82]:
```
x1_train, x1_test, y1_train, y1_test = \
    train_test_split(train_df_copy[rfe_feature],
                     train_df_copy['y'],
                     test_size=0.2, random_state=1)
```

In [83]:
```
#RandomForest
model21 = ensemble.RandomForestRegressor(n_estimators=200,
                                         max_depth=10,
                                         min_samples_leaf=4,
                                         max_features=0.2,
                                         n_jobs=-1, random_state=0)
model21.fit(x1_train, y1_train)
```

Out[83]:
```
RandomForestRegressor(bootstrap=True, criterion='mse', max_depth=10,
                      max_features=0.2, max_leaf_nodes=None,
                      min_impurity_decrease=0.0, min_impurity_split=None,
                      min_samples_leaf=4, min_samples_split=2,
                      min_weight_fraction_leaf=0.0, n_estimators=200, n_jobs=-1,
                      oob_score=False, random_state=0, verbose=0,
                      warm_start=False)
```

In [84]:
```
y21_prediction = model21.predict(x1_test)
mean_squared_error(y1_test,y21_prediction)
```

Out[84]:
```
66.29316124637023
```

In [85]:
```
#MSE is 66.5698379702297.
```

In [86]:
```
p_test =model21.predict(X1_test)
rfeRandomForest = pd.DataFrame()
rfeRandomForest['ID'] = test_df_copy['ID']
rfeRandomForest['y'] = p_test
rfeRandomForest.to_csv('rfeRandomForest.csv', index=False)
```

In [88]:
```
#train xgb model
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
}
d1train = xgb.DMatrix(x1_train, y1_train, feature_names=x1_train.columns.values)
model22 = xgb.train(dict(xgb_params, silent=0),
                    d1train, num_boost_round=100,
                    feval=xgb_r2_score, maximize=True)
```

```
[15:25:02] WARNING: C:/Jenkins/workspace/xgboost-win64_release_0.90/src/objective/reg
ression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
```

In [89]:
```
dtest21 = xgb.DMatrix(x1_test, feature_names= x1_test.columns.values)
```

In [90]:
```
y22_prediction = model22.predict(dtest21)
mean_squared_error(y1_test,y22_prediction)
```

Out[90]: 67.73267100150915

In [91]:
```
#MSE is 67.76520234941157.
```

In [92]:
```
dtest22 = xgb.DMatrix(X1_test, feature_names= X1_test.columns.values)
```

In [93]:
```
p_test =model22.predict(dtest22)
rfexg = pd.DataFrame()
rfexg['ID'] = test_df_copy['ID']
rfexg['y'] = p_test
rfexg.to_csv('rfexg.csv', index=False)
```

Feature selecting (getdummy) and model

In [94]:
```
#use get dummy to process categorical variable get new data sets
train_df2 = pd.read_csv('train.csv')
test_df2 = pd.read_csv('test.csv')
```

In [95]:
```
test_df2["y"] = 0
test_df2 = test_df2[ ["ID", "y"] +
                    [col for col in test_df2.columns if col not in ["ID", "y"]] ]
combine2 = pd.concat([train_df2, test_df2], axis=0)
```

In [96]:
```
combine2.shape
```

Out[96]: (8418, 378)

In [97]:
```
combine2 = pd.get_dummies(combine2, columns = ["X0","X1","X2","X3","X4","X5","X6","X8"
])
```

In [98]:
```
# train_df and test_df are free of categorical variables
train_df2 = combine2.head(4209)
test_df2 = combine2.tail(4209).drop("y", axis=1)
```

In [99]:
```
train_df2.head(3)
```

Out[99]:

	ID	y	X10	X11	X12	X13	X14	X15	X16	X17	...	X8_p	X8_q	X8_r	X8_s	X8_t	X8
0	0	130.81	0	0	0	1	0	0	0	0	...	0	0	0	0	0	
1	6	88.53	0	0	0	0	0	0	0	0	...	0	0	0	0	0	
2	7	76.26	0	0	0	0	0	0	0	1	...	0	0	0	0	0	

3 rows × 581 columns

In [100]:
```
test_df2.head(3)
```

Out[100]:

	ID	X10	X11	X12	X13	X14	X15	X16	X17	X18	...	X8_p	X8_q	X8_r	X8_s	X8_t	X8_u
0	1	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
1	2	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
2	3	0	0	0	0	1	0	0	0	0	...	0	0	0	0	0	0

3 rows × 580 columns

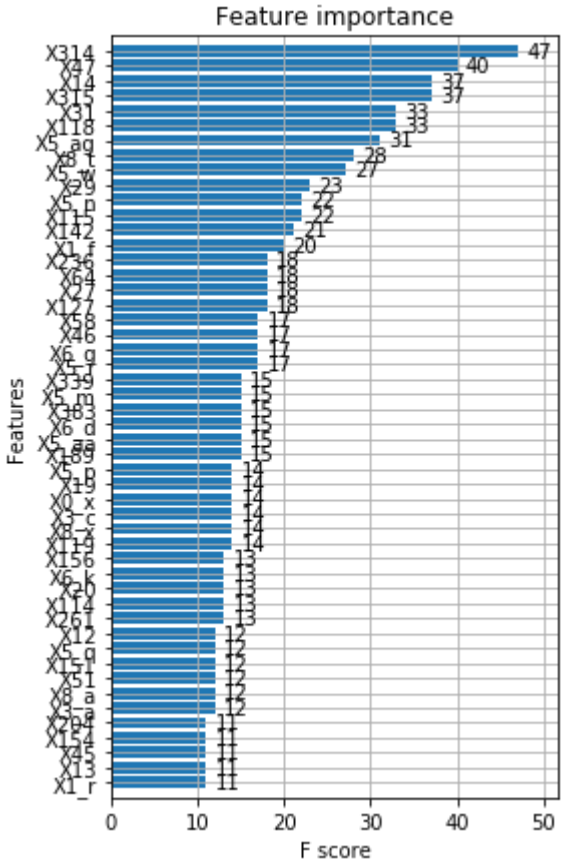
In [101]:
```
train_y = train_df2['y'].values
train_X = train_df2.drop(['ID',"y"], axis=1)
```

In [102]:
```
#fit xgb model to select features
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
_score, maximize=True)
```

```
[15:25:30] WARNING: C:/Jenkins/workspace/xgboost-win64_release_0.90/src/objective/reg
ression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
```

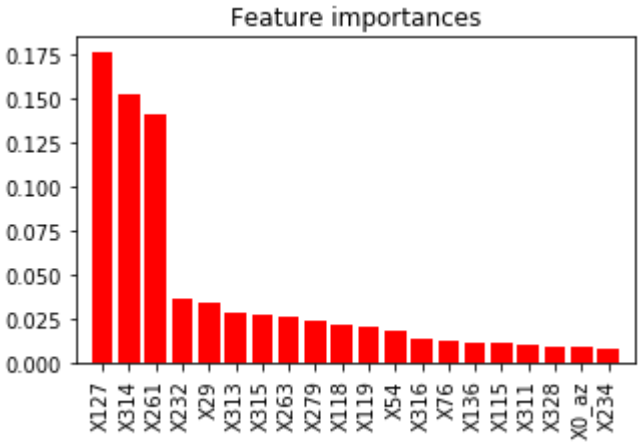
In [103]:
```
fig, ax = plt.subplots(figsize=(4,7))
xgb.plot_importance(model, max_num_features=50, height=0.8, ax=ax)
plt.show()
```



In [104]:
```
from sklearn import ensemble
model = ensemble.RandomForestRegressor(n_estimators=200,
                                       max_depth=10,
                                       min_samples_leaf=4,
                                       max_features=0.2,
                                       n_jobs=-1, random_state=0)
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=(5,3))
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 [106]:
```
# Random forest model
```

In [107]:
```
x2_train, x2_test, y2_train, y2_test = \
    train_test_split(train_df2.drop(['ID',"y"], axis=1),
                     train_df2['y'],
                     test_size=0.2, random_state=1)
```

In [108]:
```
model31 = ensemble.RandomForestRegressor(n_estimators=200,
                                         max_depth=10,
                                         min_samples_leaf=4,
                                         max_features=0.2, n_jobs=-1,
                                         random_state=0)
model31.fit(x2_train, y2_train)
```

Out[108]:
```
RandomForestRegressor(bootstrap=True, criterion='mse', max_depth=10,
                      max_features=0.2, max_leaf_nodes=None,
                      min_impurity_decrease=0.0, min_impurity_split=None,
                      min_samples_leaf=4, min_samples_split=2,
                      min_weight_fraction_leaf=0.0, n_estimators=200, n_jobs=-1,
                      oob_score=False, random_state=0, verbose=0,
                      warm_start=False)
```

In [109]:
```
X3_test  = test_df2.drop(['ID'],axis=1)
```

In [110]:
```
y31_predict = model31.predict(x2_test)
```

In [111]:
```
mean_squared_error(y2_test,y31_predict)
```

Out[111]:
```
66.38704037500776
```

In [112]:
```
#MSE is 66.38704037500776.
```

In [113]:
```
p_test =model31.predict(X3_test)
dummyRandomForest = pd.DataFrame()
dummyRandomForest['ID'] = test_df2['ID']
dummyRandomForest['y'] = p_test
dummyRandomForest.to_csv('dummyRandomForest.csv', index=False)
```

In [114]:
```
#xgb training for dummy
```

In [116]:
```
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(x2_train, y2_train, feature_names=train_X.columns.values)
model32 = xgb.train(dict(xgb_params, silent=0), dtrain,
                    num_boost_round=100, feval=xgb_r2_score, maximize=True)
```

```
[15:27:05] WARNING: C:/Jenkins/workspace/xgboost-win64_release_0.90/src/objective/reg
ression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
```

In [117]:
```
dtest32 = xgb.DMatrix(x2_test, feature_names= x2_test.columns.values)
```

In [118]:
```
y32_predict = model32.predict(dtest32)
```

In [119]:
```
mean_squared_error(y2_test,y32_predict)
```

Out[119]:
```
68.59789043470498
```

In [120]:
```
#MSE is 68.59789043470498.
```

In [121]:
```
dtest33 = xgb.DMatrix(X3_test, feature_names= X3_test.columns.values)
p_test =model32.predict(dtest33)
dummyxg = pd.DataFrame()
dummyxg['ID'] = test_df2['ID']
dummyxg['y'] = p_test
dummyxg.to_csv('dummyxg.csv', index=False)
```

XGBRegressor Tuning with GridSearchCV

In [125]:
```
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)

from sklearn.model_selection import GridSearchCV
import xgboost as xgb

param_grid = [{
    'max_depth':[3,5],
    'n_estimators':[100,200]
}]

gsc = GridSearchCV(xgb.XGBRegressor(objective ='reg:squarederror'),
                   param_grid,cv=5,scoring='r2',
                  return_train_score = True)
gsc.fit(x2_train,y2_train)
```

Out[125]:
```
GridSearchCV(cv=5, error_score='raise-deprecating',
             estimator=XGBRegressor(base_score=0.5, booster='gbtree',
                                    colsample_bylevel=1, colsample_bynode=1,
                                    colsample_bytree=1, gamma=0,
                                    importance_type='gain', learning_rate=0.1,
                                    max_delta_step=0, max_depth=3,
                                    min_child_weight=1, missing=None,
                                    n_estimators=100, n_jobs=1, nthread=None,
                                    objective='reg:squarederror',
                                    random_state=0, reg_alpha=0, reg_lambda=1,
                                    scale_pos_weight=1, seed=None, silent=None,
                                    subsample=1, verbosity=1),
             iid='warn', n_jobs=None,
             param_grid=[{'max_depth': [3, 5], 'n_estimators': [100, 200]}],
             pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
             scoring='r2', verbose=0)
```

In [126]:
```
gsc.best_params_
```

Out[126]:
```
{'max_depth': 3, 'n_estimators': 100}
```

In [127]:
```
gsc.best_score_
```

Out[127]:
```
0.5572866510984291
```

In [128]:
```
tunedxg = xgb.XGBRegressor(max_depth=3, n_estimators=100)
tunedxg.fit(x2_train, y2_train)
preds = tunedxg.predict(X3_test)
preds
```

```
[15:34:43] WARNING: C:/Jenkins/workspace/xgboost-win64_release_0.90/src/objective/reg
ression_obj.cu:152: reg:linear is now deprecated in favor of reg:squarederror.
```

Out[128]:
```
array([ 82.544205,  97.761154,  82.707535, ...,  92.12876 , 109.20823 ,
        92.85559 ], dtype=float32)
```

In [129]:
```
submission = pd.DataFrame({"ID": test_df2["ID"], "y": preds})
submission.to_csv('subn.csv', index=False)

# SCORE 0.54238
```

In [ ]: