In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import itertools
import matplotlib.pyplot as plt
import string
import re
import collections
from sklearn import preprocessing

%matplotlib inline
```

In [2]:
```
!pip install keras
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: keras in c:\users\burak\appdata\roaming\python\python
39\site-packages (2.6.0)
```

In [3]:
```
# READ DATA
train_df = pd.read_json('train.json.zip')
test_df = pd.read_json('test.json.zip')
```

TRAIN DATA FEATURE ENGINEERING

In [4]:
```
# convert TARGET to the numeric
train_df['interest_level'] = train_df['interest_level'].apply(lambda x: 0 if x=='low
                                                               else 1 if x=='medium'
                                                               else 2)
# REMOVE UNNECESSARY WORDS FROM DESCRIPTION
train_df['description'] = train_df['description'].apply(lambda x: x.replace("<br />"
train_df['description'] = train_df['description'].apply(lambda x: x.replace("br", ""
train_df['description'] = train_df['description'].apply(lambda x: x.replace("<p><a",

#basic features
train_df['rooms'] = train_df['bedrooms'] + train_df['bathrooms']

# count of photos #
train_df["num_photos"] = train_df["photos"].apply(len)

# count of "features" #
train_df["num_features"] = train_df["features"].apply(len)

# count of words present in description column #
train_df["num_description_words"] = train_df["description"].apply(lambda x: len(x.sp

# description contains email
regex = r'[\w\.-]+@[\w\.-]+'
train_df['has_email'] = train_df['description'].apply(lambda x: 1 if re.findall(rege

# description contains phone
train_df['has_phone'] = train_df['description'].apply(lambda x:re.sub('['+string.pun
        .apply(lambda x: [s for s in x if s.isdigit()])\
        .apply(lambda x: len([s for s in x if len(str(s))==10]))\
        .apply(lambda x: 1 if x>0 else 0)

# CONVERT LOWER ALL OF WORDS
train_df[["features"]] = train_df[["features"]].apply(
    lambda _: [list(map(str.strip, map(str.lower, x))) for x in _])
```

TEST DATA FEATURE ENGINEERING

In [5]:
```
# REMOVE UNNECESSARY WORDS FROM DESCRIPTION
test_df['description'] = test_df['description'].apply(lambda x: x.replace("<br />",
test_df['description'] = test_df['description'].apply(lambda x: x.replace("br", ""))
test_df['description'] = test_df['description'].apply(lambda x: x.replace("<p><a", "

#basic features
test_df['rooms'] = test_df['bedrooms'] + test_df['bathrooms']

# count of photos #
test_df["num_photos"] = test_df["photos"].apply(len)

# count of "features" #
test_df["num_features"] = test_df["features"].apply(len)

# count of words present in description column #
test_df["num_description_words"] = test_df["description"].apply(lambda x: len(x.spli

# description contains email
regex = r'[\w\.-]+@[\w\.-]+'
test_df['has_email'] = test_df['description'].apply(lambda x: 1 if re.findall(regex,

# description contains phone
test_df['has_phone'] = test_df['description'].apply(lambda x:re.sub('['+string.punct
        .apply(lambda x: [s for s in x if s.isdigit()])\
        .apply(lambda x: len([s for s in x if len(str(s))==10]))\
        .apply(lambda x: 1 if x>0 else 0)

# CONVERT LOWER ALL OF WORDS
test_df[["features"]] = test_df[["features"]].apply(
    lambda _: [list(map(str.strip, map(str.lower, x))) for x in _])
```

MOST FREQUENT FEATURES EXTRACTION

In [6]:
```
feature_value_train = train_df['features'].tolist()
feature_value_test = test_df['features'].tolist()

feature_value_train
feature_value_test

feature_lst_train = []
feature_lst_test = []

for i in range(len(feature_value_train)):
    feature_lst_train += feature_value_train[i]

for i in range(len(feature_value_test)):
    feature_lst_test += feature_value_test[i]

uniq_feature_train = list(set(feature_lst_train))
uniq_feature_test = list(set(feature_lst_test))


# see the frequency of each feature
def most_common(lst):
    features = collections.Counter(lst)
    feature_value = features.keys()
    frequency = features.values()
```

```
    data = [('feature_value', feature_value),
            ('frequency', frequency),]
    df = pd.DataFrame.from_dict(dict(data))
    return df.sort_values(by = 'frequency', ascending = False)

df_features_train = most_common(feature_lst_train)
df_features_test = most_common(feature_lst_test)


def newColumn(name, df, series):
    feature = pd.Series(0,df.index,name = name)# data : 0
    for row,word in enumerate(series):
        if name in word:
            feature.iloc[row] = 1
    df[name] = feature # feature : series ; value in series : 1 or 0
    return df

# select features based on frequency
facilities = ['elevator', 'cats allowed', 'hardwood floors', 'dogs allowed', 'doorma
for name in facilities:
    train_df = newColumn(name, train_df, train_df['features'])
    test_df = newColumn(name, test_df, test_df['features'])
```

LABEL ECONDING FOR CATEGORICAL VARIABLES

In [7]:

```
categorical = ["display_address", "manager_id", "building_id", "street_address"]
for f in categorical:
        if train_df[f].dtype=='object':
            #print(f)
            lbl = preprocessing.LabelEncoder()
            lbl.fit(list(train_df[f].values) + list(test_df[f].values))
            train_df[f] = lbl.transform(list(train_df[f].values))
            test_df[f] = lbl.transform(list(test_df[f].values))
```

LOGARITHMIC EXPRESSION TO THE PRICE COLUMN

In [8]:

```
train_df['price'] = np.log10(train_df['price'])
test_df['price'] = np.log10(test_df['price'])
```

DROP UNNECESSARY COLUMNS

In [9]:

```
# TRAINING DATASET
train_df.drop('created', axis=1, inplace=True)
train_df.drop('description', axis=1, inplace=True)
train_df.drop('features', axis=1, inplace=True)
train_df.drop('photos', axis=1, inplace=True)


# TEST DATASET
test_df.drop('created', axis=1, inplace=True)
test_df.drop('description', axis=1, inplace=True)
test_df.drop('features', axis=1, inplace=True)
test_df.drop('photos', axis=1, inplace=True)
```

REGRESSION FOR PRICE

In [10]:
```
from sklearn.model_selection import train_test_split
from sklearn.metrics import make_scorer, mean_absolute_error, mean_squared_error
from sklearn.preprocessing import StandardScaler
from sklearn.pipeline import Pipeline
import xgboost as xgb
from sklearn.linear_model import LinearRegression
from sklearn.ensemble import RandomForestRegressor
from sklearn.svm import SVR
import optuna
import math

X = train_df.drop(['price'], axis = 1)
y = train_df.price
X_train, X_test, y_train, y_test = train_test_split(X, y,
                                                    test_size = .3,
                                                    random_state = 5)
```

In [11]:
```
class Optimizer:
    def __init__(self, metric, trials=30):
        self.metric = metric
        self.trials = trials

    def objective(self, trial):
        model = create_model(trial)
        model.fit(X, y)
        preds = model.predict(X_test)
        return mean_absolute_error(y_test, preds)

    def optimize(self):
        study = optuna.create_study(direction="minimize")
        study.optimize(self.objective, n_trials=self.trials)
        return study
```

- XGB REGRESSOR OPTUNA PREDICTION

In [12]:
```
def create_model(trial):
    params = {
         'n_estimators': trial.suggest_int('n_estimators', 50, 300),
         'booster':trial.suggest_categorical('booster', ['gbtree', 'dart', 'gblinear
         'learning_rate':trial.suggest_loguniform("learning_rate", 0.001, 0.1),
         'max_depth':trial.suggest_int("max_depth", 3, 19),
         'subsample':trial.suggest_uniform("subsample", 0.0, 1.0),
         'colsample_bytree':trial.suggest_uniform("colsample_bytree", 0.0, 1.0),
    }
    model = xgb.XGBRegressor(**params)
    return model

optimizer = Optimizer('mae')
xgb_opt_study = optimizer.optimize()
xgb_opt_params = xgb_opt_study.best_params
xgb_opt = xgb.XGBRegressor(**xgb_opt_params)   # Model
xgb_opt.fit(X, y)
preds = xgb_opt.predict(X_test)

print("Number of finished trials: ", len(xgb_opt_study.trials))
print("Best trial:")
xgb_trial = xgb_opt_study.best_trial
```

```
print("  Value: {}".format(xgb_trial.value))
print("  Params: ")
for key, value in xgb_trial.params.items():
    print("    {}: {}".format(key, value))
```

```
[I 2021-09-28 18:16:31,160] A new study created in memory with name: no-name-4e4d1ac
b-627a-4a26-a46f-efe213208e3d
[18:16:32] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.4.0/sr
c/learner.cc:573:
Parameters: { "colsample_bytree", "max_depth", "subsample" } 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 thi
s
  verification. Please open an issue if you find above cases.


[I 2021-09-28 18:16:33,597] Trial 0 finished with value: 0.20134641659672164 and par
ameters: {'n_estimators': 278, 'booster': 'gblinear', 'learning_rate': 0.01085038543
5729906, 'max_depth': 16, 'subsample': 0.5602141623432176, 'colsample_bytree': 0.355
0977713232587}. Best is trial 0 with value: 0.20134641659672164.
[I 2021-09-28 18:16:35,576] Trial 1 finished with value: 2.2956628268885737 and para
meters: {'n_estimators': 155, 'booster': 'gbtree', 'learning_rate': 0.00176262584569
47554, 'max_depth': 13, 'subsample': 0.12389182216881356, 'colsample_bytree': 0.9802
211044683887}. Best is trial 0 with value: 0.20134641659672164.
[18:16:35] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.4.0/sr
c/learner.cc:573:
Parameters: { "colsample_bytree", "max_depth", "subsample" } 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 thi
s
  verification. Please open an issue if you find above cases.


[I 2021-09-28 18:16:35,872] Trial 2 finished with value: 0.15561609354979272 and par
ameters: {'n_estimators': 57, 'booster': 'gblinear', 'learning_rate': 0.090909373553
95878, 'max_depth': 16, 'subsample': 0.08121130392713005, 'colsample_bytree': 0.1491
8326225588963}. Best is trial 2 with value: 0.15561609354979272.
[I 2021-09-28 18:18:00,390] Trial 3 finished with value: 0.3052427650754199 and para
meters: {'n_estimators': 287, 'booster': 'dart', 'learning_rate': 0.0079587196305816
26, 'max_depth': 18, 'subsample': 0.8765308177857986, 'colsample_bytree': 0.93177306
25597962}. Best is trial 2 with value: 0.15561609354979272.
[18:18:00] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.4.0/sr
c/learner.cc:573:
Parameters: { "colsample_bytree", "max_depth", "subsample" } 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 thi
s
  verification. Please open an issue if you find above cases.


[I 2021-09-28 18:18:01,239] Trial 4 finished with value: 0.40488819871813514 and par
ameters: {'n_estimators': 178, 'booster': 'gblinear', 'learning_rate': 0.00260855479
37412775, 'max_depth': 14, 'subsample': 0.49805551421137795, 'colsample_bytree': 0.1
7339968259869198}. Best is trial 2 with value: 0.15561609354979272.
[18:18:01] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.4.0/sr
c/learner.cc:573:
Parameters: { "colsample_bytree", "max_depth", "subsample" } 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 thi
```

```
s
  verification. Please open an issue if you find above cases.


[I 2021-09-28 18:18:02,139] Trial 5 finished with value: 0.13816810202554713 and par
ameters: {'n_estimators': 201, 'booster': 'gblinear', 'learning_rate': 0.03879494773
2943376, 'max_depth': 8, 'subsample': 0.35475333088057637, 'colsample_bytree': 0.256
5025039121238}. Best is trial 5 with value: 0.13816810202554713.
[18:18:02] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.4.0/sr
c/learner.cc:573:
Parameters: { "colsample_bytree", "max_depth", "subsample" } 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 thi
s
  verification. Please open an issue if you find above cases.


[I 2021-09-28 18:18:02,490] Trial 6 finished with value: 0.4834928994833425 and para
meters: {'n_estimators': 62, 'booster': 'gblinear', 'learning_rate': 0.0042201977332
75148, 'max_depth': 11, 'subsample': 0.6216350798688095, 'colsample_bytree': 0.99841
09085549255}. Best is trial 5 with value: 0.13816810202554713.
[I 2021-09-28 18:18:43,808] Trial 7 finished with value: 0.11297685221950249 and par
ameters: {'n_estimators': 217, 'booster': 'dart', 'learning_rate': 0.015151791535627
462, 'max_depth': 5, 'subsample': 0.5160642108567114, 'colsample_bytree': 0.86304066
04673362}. Best is trial 7 with value: 0.11297685221950249.
[I 2021-09-28 18:19:36,483] Trial 8 finished with value: 0.587421074343272 and param
eters: {'n_estimators': 283, 'booster': 'dart', 'learning_rate': 0.0057664942466969
2, 'max_depth': 10, 'subsample': 0.22941534976802191, 'colsample_bytree': 0.03948503
2651099816}. Best is trial 7 with value: 0.11297685221950249.
[I 2021-09-28 18:19:59,349] Trial 9 finished with value: 0.3752740532354861 and para
meters: {'n_estimators': 177, 'booster': 'dart', 'learning_rate': 0.0117080490953980
24, 'max_depth': 8, 'subsample': 0.6508432364626597, 'colsample_bytree': 0.144157775
4608615}. Best is trial 7 with value: 0.11297685221950249.
[I 2021-09-28 18:20:03,548] Trial 10 finished with value: 0.05846550366026192 and pa
rameters: {'n_estimators': 220, 'booster': 'gbtree', 'learning_rate': 0.031072838638
982535, 'max_depth': 3, 'subsample': 0.9739075319493142, 'colsample_bytree': 0.73167
50435989867}. Best is trial 10 with value: 0.05846550366026192.
[I 2021-09-28 18:20:07,604] Trial 11 finished with value: 0.05961254492565995 and pa
rameters: {'n_estimators': 222, 'booster': 'gbtree', 'learning_rate': 0.026154039179
83725, 'max_depth': 3, 'subsample': 0.8837444104425657, 'colsample_bytree': 0.695991
6409461873}. Best is trial 10 with value: 0.05846550366026192.
[I 2021-09-28 18:20:12,953] Trial 12 finished with value: 0.05440713988499602 and pa
rameters: {'n_estimators': 235, 'booster': 'gbtree', 'learning_rate': 0.029584357751
60548, 'max_depth': 4, 'subsample': 0.9907991054391596, 'colsample_bytree': 0.667113
2017849196}. Best is trial 12 with value: 0.05440713988499602.
[I 2021-09-28 18:20:17,407] Trial 13 finished with value: 0.05589097448741416 and pa
rameters: {'n_estimators': 248, 'booster': 'gbtree', 'learning_rate': 0.044373825262
74447, 'max_depth': 3, 'subsample': 0.9618254747270856, 'colsample_bytree': 0.634491
6812214643}. Best is trial 12 with value: 0.05440713988499602.
[I 2021-09-28 18:20:24,430] Trial 14 finished with value: 0.04022213537566826 and pa
rameters: {'n_estimators': 253, 'booster': 'gbtree', 'learning_rate': 0.089785903661
10982, 'max_depth': 6, 'subsample': 0.7716875269000669, 'colsample_bytree': 0.543603
7326637597}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:20:28,015] Trial 15 finished with value: 0.0449710808895469 and par
ameters: {'n_estimators': 127, 'booster': 'gbtree', 'learning_rate': 0.0985052394161
6411, 'max_depth': 6, 'subsample': 0.7599080218866521, 'colsample_bytree': 0.5108174
045821224}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:20:31,786] Trial 16 finished with value: 0.04196246933119493 and pa
rameters: {'n_estimators': 120, 'booster': 'gbtree', 'learning_rate': 0.097309996829
30463, 'max_depth': 7, 'subsample': 0.7654431080408227, 'colsample_bytree': 0.450826
6581809238}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:20:34,724] Trial 17 finished with value: 0.04783377273787802 and pa
rameters: {'n_estimators': 97, 'booster': 'gbtree', 'learning_rate': 0.0616471832686
9186, 'max_depth': 7, 'subsample': 0.7562047614354799, 'colsample_bytree': 0.4280063
4464333054}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:20:39,299] Trial 18 finished with value: 0.2573179828551095 and par
ameters: {'n_estimators': 125, 'booster': 'gbtree', 'learning_rate': 0.0195210059229
```

```
04056, 'max_depth': 10, 'subsample': 0.738950164845094, 'colsample_bytree': 0.561531
3311039767}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:20:41,515] Trial 19 finished with value: 0.0498002440186108 and par
ameters: {'n_estimators': 100, 'booster': 'gbtree', 'learning_rate': 0.0775197347403
0392, 'max_depth': 6, 'subsample': 0.3913503295763943, 'colsample_bytree': 0.3600833
427997985}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:20:45,969] Trial 20 finished with value: 2.5927745786430667 and par
ameters: {'n_estimators': 150, 'booster': 'gbtree', 'learning_rate': 0.0010101409088
855192, 'max_depth': 9, 'subsample': 0.8366964282452021, 'colsample_bytree': 0.77389
93980165132}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:20:49,537] Trial 21 finished with value: 0.04504765923783559 and pa
rameters: {'n_estimators': 122, 'booster': 'gbtree', 'learning_rate': 0.098257150938
41987, 'max_depth': 6, 'subsample': 0.7665183954252648, 'colsample_bytree': 0.488585
83926791616}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:20:51,712] Trial 22 finished with value: 0.05496122255004031 and pa
rameters: {'n_estimators': 89, 'booster': 'gbtree', 'learning_rate': 0.0559709064563
0203, 'max_depth': 5, 'subsample': 0.6845158499401646, 'colsample_bytree': 0.5407083
206683605}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:20:56,024] Trial 23 finished with value: 0.044778300574801345 and p
arameters: {'n_estimators': 137, 'booster': 'gbtree', 'learning_rate': 0.05609235140
891544, 'max_depth': 7, 'subsample': 0.8146225026290295, 'colsample_bytree': 0.45498
724489223946}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:21:01,272] Trial 24 finished with value: 0.041108460163965924 and p
arameters: {'n_estimators': 153, 'booster': 'gbtree', 'learning_rate': 0.05685621306
0306075, 'max_depth': 8, 'subsample': 0.8414360426972909, 'colsample_bytree': 0.3931
8736502790197}. Best is trial 14 with value: 0.04022213537566826.
[I 2021-09-28 18:21:10,635] Trial 25 finished with value: 0.024229346488486608 and p
arameters: {'n_estimators': 160, 'booster': 'gbtree', 'learning_rate': 0.06583246456
067667, 'max_depth': 12, 'subsample': 0.8801614460408014, 'colsample_bytree': 0.3311
9447295024507}. Best is trial 25 with value: 0.024229346488486608.
[I 2021-09-28 18:21:18,351] Trial 26 finished with value: 0.05687636824942095 and pa
rameters: {'n_estimators': 189, 'booster': 'gbtree', 'learning_rate': 0.021762146750
683796, 'max_depth': 12, 'subsample': 0.8828824994281316, 'colsample_bytree': 0.3025
267796350044}. Best is trial 25 with value: 0.024229346488486608.
[I 2021-09-28 18:21:30,871] Trial 27 finished with value: 0.024906468124432417 and p
arameters: {'n_estimators': 159, 'booster': 'gbtree', 'learning_rate': 0.03832800201
6806466, 'max_depth': 14, 'subsample': 0.9169339786465963, 'colsample_bytree': 0.600
8439542939819}. Best is trial 25 with value: 0.024229346488486608.
[I 2021-09-28 18:21:59,196] Trial 28 finished with value: 0.011530626244851312 and p
arameters: {'n_estimators': 258, 'booster': 'gbtree', 'learning_rate': 0.04059823671
520865, 'max_depth': 15, 'subsample': 0.917745748048933, 'colsample_bytree': 0.80428
4637877227}. Best is trial 28 with value: 0.011530626244851312.
[I 2021-09-28 18:23:14,494] Trial 29 finished with value: 0.052272952032318465 and p
arameters: {'n_estimators': 266, 'booster': 'dart', 'learning_rate': 0.0154860648716
88618, 'max_depth': 15, 'subsample': 0.9106236541450503, 'colsample_bytree': 0.86973
94147238559}. Best is trial 28 with value: 0.011530626244851312.
Number of finished trials:  30
Best trial:
  Value: 0.011530626244851312
  Params:
    n_estimators: 258
    booster: gbtree
    learning_rate: 0.04059823671520865
    max_depth: 15
    subsample: 0.917745748048933
    colsample_bytree: 0.804284637877227
```

- RANDOM FOREST OPTUNA PREDICTION

In [13]:

```
def create_model(trial):
    params = {
        'n_estimators': trial.suggest_int('n_estimators', 50, 300),
        'max_depth': trial.suggest_int('max_depth',3 ,19),
        'min_samples_leaf': trial.suggest_int('min_samples_leaf', 1, 10),
        'max_features': trial.suggest_categorical("max_features", ["auto", "sqrt", "
    }
    model = RandomForestRegressor(**params)
```

```
    return model

optimizer = Optimizer('mae')
rf_opt_study = optimizer.optimize()
rf_opt_params = rf_opt_study.best_params
rf_opt = RandomForestRegressor(**rf_opt_params)
rf_opt.fit(X, y)
preds = rf_opt.predict(X_test)

print("Number of finished trials: ", len(rf_opt_study.trials))
print("Best trial:")
rf_trial = rf_opt_study.best_trial

print("  Value: {}".format(rf_trial.value))
print("  Params: ")
for key, value in rf_trial.params.items():
    print("    {}: {}".format(key, value))
```

```
[I 2021-09-28 18:23:43,132] A new study created in memory with name: no-name-725abcb
7-f8b2-48e1-9cfd-a4a151f1f2fb
[I 2021-09-28 18:24:03,182] Trial 0 finished with value: 0.04507073876475043 and par
ameters: {'n_estimators': 225, 'max_depth': 16, 'min_samples_leaf': 8, 'max_feature
s': 'log2'}. Best is trial 0 with value: 0.04507073876475043.
[I 2021-09-28 18:24:09,884] Trial 1 finished with value: 0.06796315399765382 and par
ameters: {'n_estimators': 137, 'max_depth': 7, 'min_samples_leaf': 10, 'max_feature
s': 'log2'}. Best is trial 0 with value: 0.04507073876475043.
[I 2021-09-28 18:24:21,458] Trial 2 finished with value: 0.0451363711803877 and para
meters: {'n_estimators': 129, 'max_depth': 16, 'min_samples_leaf': 8, 'max_feature
s': 'log2'}. Best is trial 0 with value: 0.04507073876475043.
[I 2021-09-28 18:24:28,186] Trial 3 finished with value: 0.04327169272641093 and par
ameters: {'n_estimators': 74, 'max_depth': 16, 'min_samples_leaf': 6, 'max_feature
s': 'log2'}. Best is trial 3 with value: 0.04327169272641093.
[I 2021-09-28 18:24:57,681] Trial 4 finished with value: 0.08651551967499212 and par
ameters: {'n_estimators': 259, 'max_depth': 3, 'min_samples_leaf': 8, 'max_feature
s': 'auto'}. Best is trial 3 with value: 0.04327169272641093.
[I 2021-09-28 18:25:07,537] Trial 5 finished with value: 0.07975035863039677 and par
ameters: {'n_estimators': 281, 'max_depth': 4, 'min_samples_leaf': 3, 'max_feature
s': 'sqrt'}. Best is trial 3 with value: 0.04327169272641093.
[I 2021-09-28 18:25:14,439] Trial 6 finished with value: 0.06897011075236997 and par
ameters: {'n_estimators': 139, 'max_depth': 6, 'min_samples_leaf': 7, 'max_feature
s': 'sqrt'}. Best is trial 3 with value: 0.04327169272641093.
[I 2021-09-28 18:25:29,941] Trial 7 finished with value: 0.04940570513981448 and par
ameters: {'n_estimators': 193, 'max_depth': 13, 'min_samples_leaf': 7, 'max_feature
s': 'log2'}. Best is trial 3 with value: 0.04327169272641093.
[I 2021-09-28 18:25:35,167] Trial 8 finished with value: 0.04462446110000857 and par
ameters: {'n_estimators': 58, 'max_depth': 18, 'min_samples_leaf': 9, 'max_feature
s': 'log2'}. Best is trial 3 with value: 0.04327169272641093.
[I 2021-09-28 18:25:41,766] Trial 9 finished with value: 0.05594679041460658 and par
ameters: {'n_estimators': 83, 'max_depth': 10, 'min_samples_leaf': 8, 'max_feature
s': 'sqrt'}. Best is trial 3 with value: 0.04327169272641093.
[I 2021-09-28 18:26:20,345] Trial 10 finished with value: 0.044146380202439994 and p
arameters: {'n_estimators': 95, 'max_depth': 12, 'min_samples_leaf': 4, 'max_feature
s': 'auto'}. Best is trial 3 with value: 0.04327169272641093.
[I 2021-09-28 18:26:56,809] Trial 11 finished with value: 0.04078416046650607 and pa
rameters: {'n_estimators': 82, 'max_depth': 13, 'min_samples_leaf': 4, 'max_feature
s': 'auto'}. Best is trial 11 with value: 0.04078416046650607.
[I 2021-09-28 18:27:28,580] Trial 12 finished with value: 0.036379234566074246 and p
arameters: {'n_estimators': 66, 'max_depth': 14, 'min_samples_leaf': 1, 'max_feature
s': 'auto'}. Best is trial 12 with value: 0.036379234566074246.
[I 2021-09-28 18:27:45,231] Trial 13 finished with value: 0.05566574766605242 and pa
rameters: {'n_estimators': 50, 'max_depth': 9, 'min_samples_leaf': 1, 'max_feature
s': 'auto'}. Best is trial 12 with value: 0.036379234566074246.
[I 2021-09-28 18:28:39,872] Trial 14 finished with value: 0.036337307732971565 and p
arameters: {'n_estimators': 115, 'max_depth': 14, 'min_samples_leaf': 1, 'max_featur
es': 'auto'}. Best is trial 14 with value: 0.036337307732971565.
[I 2021-09-28 18:29:48,939] Trial 15 finished with value: 0.02183871966090859 and pa
rameters: {'n_estimators': 116, 'max_depth': 19, 'min_samples_leaf': 1, 'max_feature
s': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
```

```
[I 2021-09-28 18:31:24,434] Trial 16 finished with value: 0.023103929565742993 and p
arameters: {'n_estimators': 169, 'max_depth': 19, 'min_samples_leaf': 2, 'max_featur
es': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:33:00,742] Trial 17 finished with value: 0.02494869709816693 and pa
rameters: {'n_estimators': 176, 'max_depth': 19, 'min_samples_leaf': 3, 'max_feature
s': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:34:32,957] Trial 18 finished with value: 0.023097918001432672 and p
arameters: {'n_estimators': 163, 'max_depth': 19, 'min_samples_leaf': 2, 'max_featur
es': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:36:20,203] Trial 19 finished with value: 0.031340922033522706 and p
arameters: {'n_estimators': 214, 'max_depth': 17, 'min_samples_leaf': 5, 'max_featur
es': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:37:49,175] Trial 20 finished with value: 0.023120239448811534 and p
arameters: {'n_estimators': 158, 'max_depth': 19, 'min_samples_leaf': 2, 'max_featur
es': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:39:30,687] Trial 21 finished with value: 0.023046318103145377 and p
arameters: {'n_estimators': 179, 'max_depth': 19, 'min_samples_leaf': 2, 'max_featur
es': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:41:17,787] Trial 22 finished with value: 0.027433104456267298 and p
arameters: {'n_estimators': 198, 'max_depth': 17, 'min_samples_leaf': 2, 'max_featur
es': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:42:10,916] Trial 23 finished with value: 0.03384885198319794 and pa
rameters: {'n_estimators': 110, 'max_depth': 15, 'min_samples_leaf': 3, 'max_feature
s': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:43:35,370] Trial 24 finished with value: 0.024997969528377007 and p
arameters: {'n_estimators': 149, 'max_depth': 18, 'min_samples_leaf': 2, 'max_featur
es': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:43:58,333] Trial 25 finished with value: 0.03533720374958584 and pa
rameters: {'n_estimators': 182, 'max_depth': 18, 'min_samples_leaf': 4, 'max_feature
s': 'sqrt'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:46:18,894] Trial 26 finished with value: 0.026565067187329847 and p
arameters: {'n_estimators': 247, 'max_depth': 17, 'min_samples_leaf': 1, 'max_featur
es': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:47:21,714] Trial 27 finished with value: 0.02876393371673733 and pa
rameters: {'n_estimators': 114, 'max_depth': 19, 'min_samples_leaf': 5, 'max_feature
s': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:49:09,639] Trial 28 finished with value: 0.03381863915618033 and pa
rameters: {'n_estimators': 213, 'max_depth': 15, 'min_samples_leaf': 3, 'max_feature
s': 'auto'}. Best is trial 15 with value: 0.02183871966090859.
[I 2021-09-28 18:49:39,772] Trial 29 finished with value: 0.035166408223321344 and p
arameters: {'n_estimators': 237, 'max_depth': 16, 'min_samples_leaf': 2, 'max_featur
es': 'sqrt'}. Best is trial 15 with value: 0.02183871966090859.
Number of finished trials:  30
Best trial:
  Value: 0.02183871966090859
  Params:
    n_estimators: 116
    max_depth: 19
    min_samples_leaf: 1
    max_features: auto
```

- LINEAR REGRESSION OPTUNA PREDICTION

In [15]:

```
def create_model(trial):
    params = {
        'copy_X': trial.suggest_categorical("copy_X", ["True", "False"]),
        'fit_intercept': trial.suggest_categorical("fit_intercept", ["True", "False"
        'n_jobs': trial.suggest_int('n_jobs',-1 ,3),
    }
    model = LinearRegression(**params)
    return model

optimizer = Optimizer('mae')
lr_opt_study = optimizer.optimize()
lr_opt_params = lr_opt_study.best_params
lr_opt = LinearRegression(**lr_opt_params)
lr_opt.fit(X, y)
```

```
preds = lr_opt.predict(X_test)

print("Number of finished trials: ", len(lr_opt_study.trials))
print("Best trial:")
lr_trial = lr_opt_study.best_trial

print("  Value: {}".format(lr_trial.value))
print("  Params: ")
for key, value in lr_trial.params.items():
    print("    {}: {}".format(key, value))
```

```
[I 2021-09-28 18:51:22,470] A new study created in memory with name: no-name-c274156
e-4c6c-4aa0-8a81-782de0c30417
[I 2021-09-28 18:51:22,532] Trial 0 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 2}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:22,580] Trial 1 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'True', 'fit_intercept': 'False', 'n_jobs': 2}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:22,629] Trial 2 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'True', 'fit_intercept': 'False', 'n_jobs': -1}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:22,679] Trial 3 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'True', 'fit_intercept': 'False', 'n_jobs': 1}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:22,727] Trial 4 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': -1}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:22,774] Trial 5 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'False', 'fit_intercept': 'False', 'n_jobs': 0}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:22,822] Trial 6 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'False', 'fit_intercept': 'False', 'n_jobs': 1}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:22,871] Trial 7 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 3}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:22,923] Trial 8 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'True', 'fit_intercept': 'True', 'n_jobs': 1}. Best is trial 0 w
ith value: 0.08446668127102264.
[I 2021-09-28 18:51:22,972] Trial 9 finished with value: 0.08446668127102264 and par
ameters: {'copy_X': 'True', 'fit_intercept': 'False', 'n_jobs': 2}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,024] Trial 10 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 3}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,078] Trial 11 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'True', 'fit_intercept': 'True', 'n_jobs': 2}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,138] Trial 12 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'False', 'n_jobs': 2}. Best is trial
 0 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,202] Trial 13 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'True', 'fit_intercept': 'True', 'n_jobs': 2}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,255] Trial 14 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'True', 'fit_intercept': 'True', 'n_jobs': 3}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,314] Trial 15 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'False', 'n_jobs': 0}. Best is trial
 0 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,369] Trial 16 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'False', 'n_jobs': 2}. Best is trial
 0 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,431] Trial 17 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'True', 'fit_intercept': 'True', 'n_jobs': 3}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,497] Trial 18 finished with value: 0.08446668127102264 and pa
```

```
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 0}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,563] Trial 19 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'False', 'n_jobs': 2}. Best is trial
 0 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,628] Trial 20 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'True', 'fit_intercept': 'True', 'n_jobs': 3}. Best is trial 0
 with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,686] Trial 21 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 0}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,742] Trial 22 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 0}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,797] Trial 23 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 3}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,850] Trial 24 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 1}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,913] Trial 25 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 0}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:23,969] Trial 26 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': -1}. Best is trial
 0 with value: 0.08446668127102264.
[I 2021-09-28 18:51:24,023] Trial 27 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 1}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:24,078] Trial 28 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': 1}. Best is trial 0
with value: 0.08446668127102264.
[I 2021-09-28 18:51:24,139] Trial 29 finished with value: 0.08446668127102264 and pa
rameters: {'copy_X': 'False', 'fit_intercept': 'True', 'n_jobs': -1}. Best is trial
 0 with value: 0.08446668127102264.
Number of finished trials:  30
Best trial:
  Value: 0.08446668127102264
  Params:
    copy_X: False
    fit_intercept: True
    n_jobs: 2
```

Let me show description of price

In [16]:
```
train_df['price'].describe()
```

Out[16]:
```
count    49352.000000
mean         3.517365
std          0.187979
min          1.633468
25%          3.397940
50%          3.498311
75%          3.612784
max          6.652246
Name: price, dtype: float64
```

- Pipeline for storing models

In [17]:
```
pipeline_models = []

xgb_default = xgb.XGBRegressor()
rf_default = RandomForestRegressor()
lr_default = LinearRegression()
svm_default = SVR()
```

```
models = [xgb_default, xgb_opt,
          rf_default, rf_opt,
          lr_default, lr_opt,
          svm_default]

model_names = ['XGB Regression (default)', 'XGB Regression (opt)',
               'Random Forest (default)', 'Random Forest (opt)',
               'Linear Regression (default)', 'Linear Regression (opt)',
               'Support Vector Machine (default)']

## Assign each model to a pipeline
for name, model in zip(model_names,models):
    pipeline = ("Scaled_"+ name,
                Pipeline([("Scaler",StandardScaler()),
                          (name,model)
                         ]))
    pipeline_models.append(pipeline)
```

- Evaluate scores

- BEFORE PREDICTION INVERSE LOG10

In [18]:
```
train_df['price'] = 10 ** train_df['price']
test_df['price'] = 10 ** test_df['price']
```

In [19]:
```
train_df['price']
```

Out[19]:
```
4         2400.0
6         3800.0
9         3495.0
10        3000.0
15        2795.0
           ...
124000    2800.0
124002    2395.0
124004    1850.0
124008    4195.0
124009    4280.0
Name: price, Length: 49352, dtype: float64
```

In [20]:
```
from sklearn.model_selection import KFold
from sklearn.model_selection import cross_val_score, cross_validate

## Create a dataframe to store all the models' cross validation score
evaluate = pd.DataFrame(columns=["model","cv_MAE", "cv_RMSE"])
kfold = KFold(n_splits=5, shuffle=True, random_state=42)

## Encoded dataset
for name,model in pipeline_models:
    scores = cross_validate(model, X, y, cv=kfold, n_jobs=-1,
                            scoring=('neg_root_mean_squared_error', 'neg_mean_absolute_

    row = evaluate.shape[0]
    evaluate.loc[row,"model"] = name
    evaluate.loc[row,"cv_MAE"] = round(abs(scores['test_neg_mean_absolute_error']).m
    evaluate.loc[row,"cv_RMSE"] = round(abs(scores['test_neg_root_mean_squared_error
```

In [21]:
```
evaluate
```

Out[21]:

	model	cv_MAE	cv_RMSE
0	Scaled_XGB Regression (default)	746.231	17043.802
1	Scaled_XGB Regression (opt)	616.097	17431.662
2	Scaled_Random Forest (default)	683.183	17333.613
3	Scaled_Random Forest (opt)	698.806	17190.847
4	Scaled_Linear Regression (default)	1182.765	16114.983
5	Scaled_Linear Regression (opt)	1182.765	16114.983
6	Scaled_Support Vector Machine (default)	1122.515	16241.87

- MAE score visualization

In [22]:

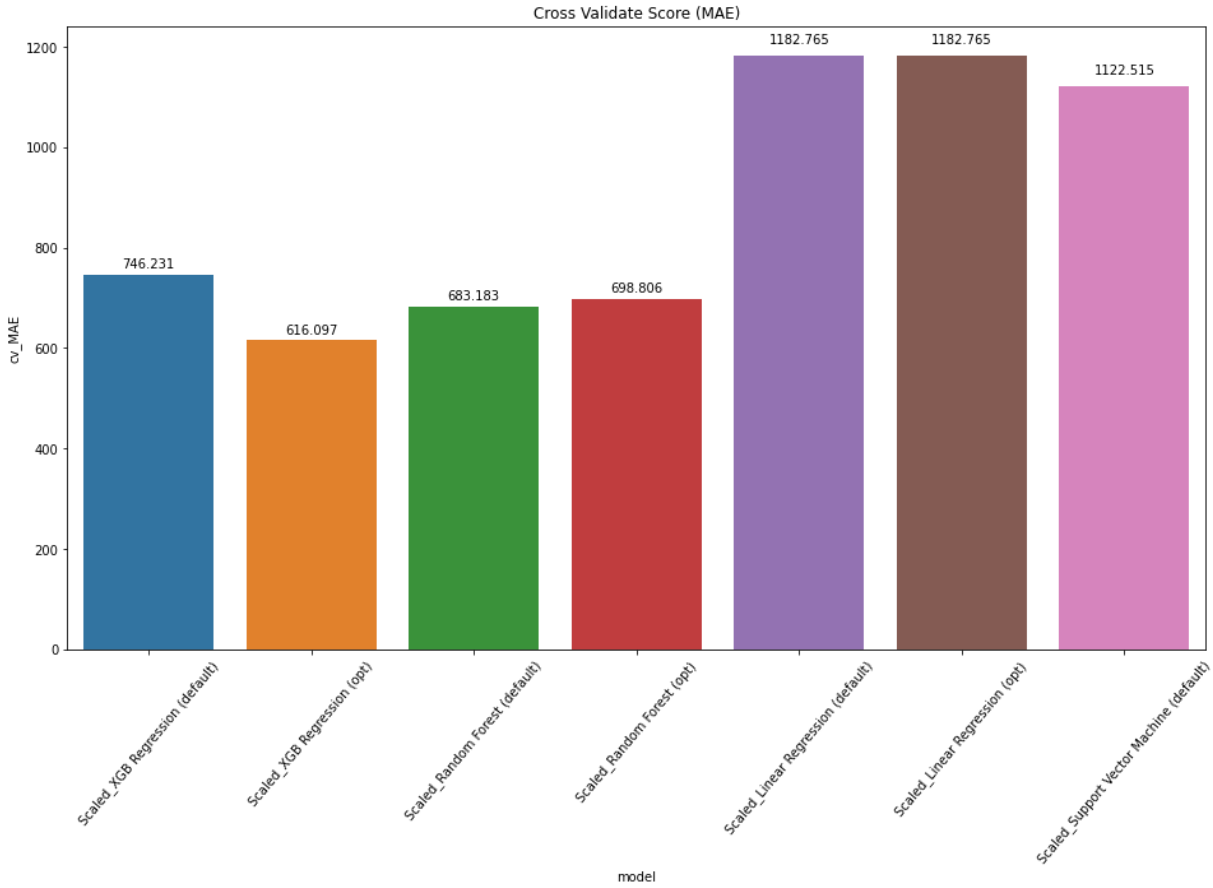
```
## Visualization
fig, ax = plt.subplots(figsize=(16,9))

## Encoded dataset
bar = sns.barplot(evaluate["model"], evaluate["cv_MAE"])
for rec in bar.patches:
    height = rec.get_height()
    ax.text(rec.get_x() + rec.get_width()/2, height*1.02,height,ha="center")
ax.set_title("Cross Validate Score (MAE)")
ax.set_xticklabels(evaluate["model"].to_list(),rotation =50)
```

```
C:\Users\burak\AppData\Roaming\Python\Python39\site-packages\seaborn\_decorators.py:
36: FutureWarning: Pass the following variables as keyword args: x, y. From version
0.12, the only valid positional argument will be `data`, and passing other arguments
without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[22]:

```
[Text(0, 0, 'Scaled_XGB Regression (default)'),
 Text(1, 0, 'Scaled_XGB Regression (opt)'),
 Text(2, 0, 'Scaled_Random Forest (default)'),
 Text(3, 0, 'Scaled_Random Forest (opt)'),
 Text(4, 0, 'Scaled_Linear Regression (default)'),
 Text(5, 0, 'Scaled_Linear Regression (opt)'),
 Text(6, 0, 'Scaled_Support Vector Machine (default)')]
```



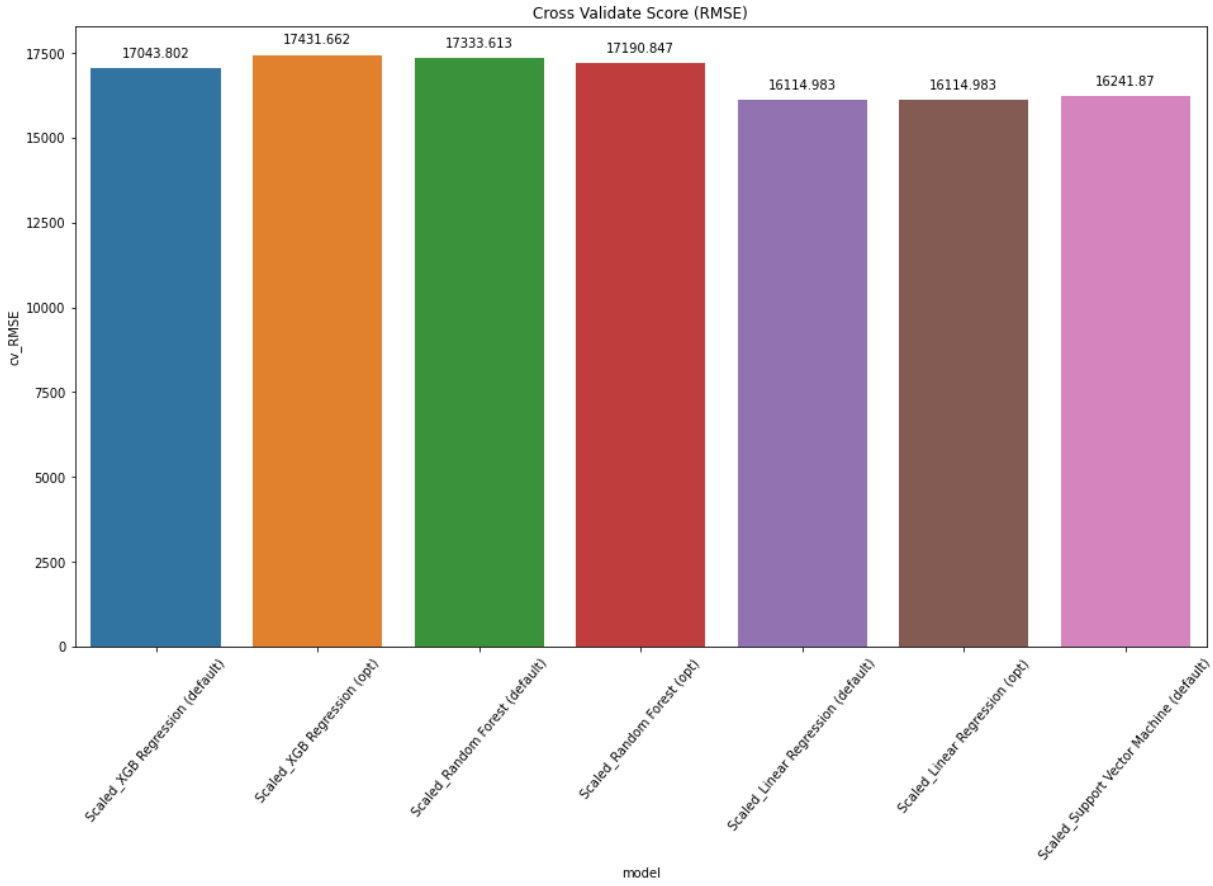
- RMSE score visualization

In [23]:
```
## Visualization
fig, ax = plt.subplots(figsize=(16,9))

## Encoded dataset
bar = sns.barplot(evaluate["model"], evaluate["cv_RMSE"])
for rec in bar.patches:
    height = rec.get_height()
    ax.text(rec.get_x() + rec.get_width()/2, height*1.02,height,ha="center")
ax.set_title("Cross Validate Score (RMSE)")
ax.set_xticklabels(evaluate["model"].to_list(),rotation =50)
```

```
C:\Users\burak\AppData\Roaming\Python\Python39\site-packages\seaborn\_decorators.py:
36: FutureWarning: Pass the following variables as keyword args: x, y. From version
0.12, the only valid positional argument will be `data`, and passing other arguments
without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[23]:
```
[Text(0, 0, 'Scaled_XGB Regression (default)'),
 Text(1, 0, 'Scaled_XGB Regression (opt)'),
 Text(2, 0, 'Scaled_Random Forest (default)'),
 Text(3, 0, 'Scaled_Random Forest (opt)'),
 Text(4, 0, 'Scaled_Linear Regression (default)'),
 Text(5, 0, 'Scaled_Linear Regression (opt)'),
 Text(6, 0, 'Scaled_Support Vector Machine (default)')]
```


Cross Validate Score (RMSE)
cv_RMSE
model
17043.802
17431.662
17333.613
17190.847
16114.983
16114.983
16241.87
0
2500
5000
7500
10000
12500
15000
17500
Scaled_XGB Regression (default)
Scaled_XGB Regression (opt)
Scaled_Random Forest (default)
Scaled_Random Forest (opt)
Scaled_Linear Regression (default)
Scaled_Linear Regression (opt)
Scaled_Support Vector Machine (default)