Import libraries

In [73]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn import metrics
from sklearn.ensemble import RandomForestRegressor
```

In [74]:
```
df = pd.read_csv('temps.csv')
df.head()
```

Out[74]:

	year	month	day	week	temp_2	temp_1	average	actual	forecast_noaa	forecast_acc	forecast_under	friend
0	2016	1	1	Fri	45	45	45.6	45	43	50	44	29
1	2016	1	2	Sat	44	45	45.7	44	41	50	44	61
2	2016	1	3	Sun	45	44	45.8	41	43	46	47	56
3	2016	1	4	Mon	44	41	45.9	40	44	48	46	53
4	2016	1	5	Tues	41	40	46.0	44	46	46	46	41

In [75]:
```
df.shape
```

Out[75]:
```
(348, 12)
```

In [76]:
```
df.describe()
```

Out[76]:

	year	month	day	temp_2	temp_1	average	actual	forecast_noaa	forecast_acc	forecast_under	frie
count	348.0	348.000000	348.000000	348.000000	348.000000	348.000000	348.000000	348.000000	348.000000	348.000000	348.000(
mean	2016.0	6.477011	15.514368	62.652299	62.701149	59.760632	62.543103	57.238506	62.373563	59.772989	60.034
std	0.0	3.498380	8.772982	12.165398	12.120542	10.527306	11.794146	10.605746	10.549381	10.705256	15.626
min	2016.0	1.000000	1.000000	35.000000	35.000000	45.100000	35.000000	41.000000	46.000000	44.000000	28.000(
25%	2016.0	3.000000	8.000000	54.000000	54.000000	49.975000	54.000000	48.000000	53.000000	50.000000	47.750(
50%	2016.0	6.000000	15.000000	62.500000	62.500000	58.200000	62.500000	56.000000	61.000000	58.000000	60.000(
75%	2016.0	10.000000	23.000000	71.000000	71.000000	69.025000	71.000000	66.000000	72.000000	69.000000	71.000(
max	2016.0	12.000000	31.000000	117.000000	117.000000	77.400000	92.000000	77.000000	82.000000	79.000000	95.000(

In [77]:
```
# convert categorical to numerical features

df = pd.get_dummies(df)
df.head()
```

Out[77]:

	year	month	day	temp_2	temp_1	average	actual	forecast_noaa	forecast_acc	forecast_under	friend	week_Fri	week_Mon	week_Sat
0	2016	1	1	45	45	45.6	45	43	50	44	29	1	0	0
1	2016	1	2	44	45	45.7	44	41	50	44	61	0	0	1
2	2016	1	3	45	44	45.8	41	43	46	47	56	0	0	0
3	2016	1	4	44	41	45.9	40	44	48	46	53	0	1	0
4	2016	1	5	41	40	46.0	44	46	46	46	41	0	0	0

In [78]:
```
df.shape
```

Out[78]: (348, 18)

In [79]:
```
1 df.columns
```

Out[79]:
```
Index(['year', 'month', 'day', 'temp_2', 'temp_1', 'average', 'actual',
       'forecast_noaa', 'forecast_acc', 'forecast_under', 'friend', 'week_Fri',
       'week_Mon', 'week_Sat', 'week_Sun', 'week_Thurs', 'week_Tues',
       'week_Wed'],
      dtype='object')
```

In [80]:
```
1 df['day'].value_counts()
```

Out[80]:
```
16    12
7     12
12    12
11    12
10    12
9     12
8     12
23    12
6     12
5     12
4     12
3     12
28    12
15    12
14    11
2     11
13    11
1     11
17    11
18    11
19    11
20    11
21    11
22    11
24    11
25    11
26    11
27    11
30    10
29    10
31     6
Name: day, dtype: int64
```

In [81]:
```
df['month'].value_counts()
```

Out[81]:
```
12    31
7     31
5     31
3     31
1     31
11    30
10    30
6     30
4     30
9     28
2     26
8     19
Name: month, dtype: int64
```

In [82]:
```
# drop 'year' features
df.drop(['year'],axis = 1,inplace = True)
df.head()
```

Out[82]:

	month	day	temp_2	temp_1	average	actual	forecast_noaa	forecast_acc	forecast_under	friend	week_Fri	week_Mon	week_Sat	week
0	1	1	45	45	45.6	45	43	50	44	29	1	0	0	
1	1	2	44	45	45.7	44	41	50	44	61	0	0	1	
2	1	3	45	44	45.8	41	43	46	47	56	0	0	0	
3	1	4	44	41	45.9	40	44	48	46	53	0	1	0	
4	1	5	41	40	46.0	44	46	46	46	41	0	0	0	

In [83]:
```
df.shape
```

Out[83]:
```
(348, 17)
```

In [84]:
```
# seperate out features and target value from dataset

X = df.drop(['actual'],axis = 1).values
y = df['actual'].values
```

In [85]:
```
# split the data in training and testing set

X_train, X_test, y_train,y_test = train_test_split(X,y, test_size = 0.25, random_state = 42)
```

In [86]:
```
print("X_train shape : " , X_train.shape)
print("X_test shape : " , X_test.shape)
print("y_train shape : " , y_train.shape)
print("y_test shape : " , y_test.shape)
```

```
X_train shape :  (261, 16)
X_test shape :  (87, 16)
y_train shape :  (261,)
y_test shape :  (87,)
```

In [87]:
```
# RF model

rf = RandomForestRegressor(n_estimators=1000,random_state=42)

#fit model

rf.fit(X_train,y_train)
```

Out[87]:
```
RandomForestRegressor(n_estimators=1000, random_state=42)
```

In [88]:
```
# prediction
y_pred = rf.predict(X_test)
y_pred
```

Out[88]:
```
array([69.894, 61.311, 51.838, 61.331, 66.474, 70.284, 78.954, 75.945,
       62.044, 74.06 , 63.679, 72.146, 38.642, 62.558, 71.664, 55.993,
       60.951, 57.006, 56.676, 76.123, 63.684, 54.362, 66.548, 62.506,
       58.657, 53.029, 66.651, 46.469, 62.18 , 80.157, 73.759, 64.273,
       55.326, 82.128, 74.137, 61.627, 53.678, 51.405, 68.91 , 42.386,
       70.363, 57.358, 75.855, 42.474, 61.107, 73.991, 52.664, 81.469,
       53.237, 42.449, 46.478, 42.242, 64.18 , 65.781, 74.088, 61.41 ,
       55.166, 59.937, 54.497, 59.633, 65.539, 50.212, 60.757, 70.168,
       60.099, 59.281, 71.771, 69.866, 76.804, 41.387, 76.789, 56.868,
       60.416, 50.491, 54.489, 63.883, 43.877, 74.416, 47.341, 52.38 ,
       53.485, 68.207, 73.444, 72.496, 63.22 , 57.148, 45.948])
```

In [89]:
```
# calculate RMSE

rmse = np.sqrt(metrics.mean_squared_error(y_test,y_pred))
print(rmse)
```

```
5.091044648124332
```

In [ ]:
```

```

In [90]:

```
# merge predicted and actual value in one dataframe

y_pred_df = pd.DataFrame(y_pred)
y_pred_df['Actual'] = y_test
y_pred_df.columns = ['Predicted','Actual']
y_pred_df
```

Out[90]:

	Predicted	Actual
0	69.894	66
1	61.311	61
2	51.838	52
3	61.331	66
4	66.474	70
...	...	...
82	73.444	81
83	72.496	67
84	63.220	66
85	57.148	57
86	45.948	45

87 rows × 2 columns

In [91]:

```
# error

error = abs(y_pred-y_test)
```

In [92]:
```
error
```

Out[92]:
```
array([ 3.894,  0.311,  0.162,  4.669,  3.526, 11.716,  6.046,  8.055,
        2.956, 17.94 ,  2.679, 12.854,  5.358,  2.442,  2.664,  6.007,
        3.049,  1.006,  3.676,  2.877,  0.684,  2.638,  0.452,  0.506,
        0.343,  2.971,  1.651,  5.531,  3.82 ,  4.157,  9.759,  3.273,
        7.326,  1.128,  2.863,  4.627,  4.322,  4.405,  0.91 ,  8.614,
        6.637,  1.358,  2.855,  8.526,  2.107, 13.009,  5.336,  0.469,
        4.763,  0.449,  2.522,  2.242,  0.82 ,  1.781,  4.088,  3.59 ,
        2.166,  2.937,  1.497,  0.367,  1.461,  1.212,  7.757,  1.168,
        5.099,  8.719,  4.229,  0.866,  1.196,  5.387,  2.789,  0.132,
        8.584,  0.491,  1.511,  3.117,  4.123,  5.584,  0.659,  3.38 ,
        3.515,  8.793,  7.556,  5.496,  2.78 ,  0.148,  0.948])
```

In [93]:
```
# mean absolute error
mse = np.mean(error)
print("MSE : ",mse)
```

```
MSE :  3.8630574712643666
```

In [94]:
```
# MAPE : mean absolute percentage error

mape = 100*(error/y_test)
mape
```

Out[94]:
```
array([ 5.9       ,  0.50983607,  0.31153846,  7.07424242,  5.03714286,
       14.28780488,  7.11294118,  9.58928571,  4.54769231, 19.5       ,
        4.39180328, 15.12235294, 12.17727273,  3.75692308,  3.86086957,
        9.68870968,  4.7640625 ,  1.79642857,  6.93584906,  3.64177215,
        1.08571429,  4.62807018,  0.67462687,  0.81612903,  0.58135593,
        5.30535714,  2.54      , 10.63653846,  5.78787879,  5.46973684,
       15.2484375 ,  5.36557377, 15.2625    ,  1.39259259,  3.71818182,
        8.11754386,  7.45172414,  9.37234043,  1.33823529, 16.89019608,
        8.61948052,  2.425     ,  3.9109589 , 16.71764706,  3.57118644,
       14.95287356,  9.2       ,  0.57901235,  8.21206897,  1.06904762,
        5.14693878,  5.605     ,  1.26153846,  2.7828125 ,  5.84      ,
        5.52307692,  4.08679245,  5.15263158,  2.8245283 ,  0.61166667,
        2.18059701,  2.47346939, 14.63584906,  1.69275362,  9.27090909,
       12.82205882,  5.56447368,  1.25507246,  1.53333333, 14.96388889,
        3.76891892,  0.23157895, 12.44057971,  0.982     ,  2.69821429,
        4.65223881,  8.58958333,  6.98      ,  1.37291667,  6.89795918,
        6.16666667, 11.41948052,  9.32839506,  8.20298507,  4.21212121,
        0.25964912,  2.10666667])
```

In [95]:
```
# accuracy

acc = 100- np.mean(mape)
print("Accuracy : ",acc)
```

```
Accuracy :  93.94846113730775
```

In [ ]:
```

```

feature importance

In [96]:
```
importance = list(rf.feature_importances_)
print(importance)
```

```
[0.010322601403532283, 0.02111366527196822, 0.021110269148599918, 0.6555698213907486, 0.14948039120753628, 0.04601374758544169, 0.03517063342900543, 0.02318439434529083, 0.02054749470049068, 0.0034748931143383653, 0.00252835863556795, 0.003593012624168681, 0.0022740438819965005, 0.0012834507255272789, 0.00232653540191857, 0.0020066871338688596]
```

In [97]:
```
df.columns
```

Out[97]:
```
Index(['month', 'day', 'temp_2', 'temp_1', 'average', 'actual',
       'forecast_noaa', 'forecast_acc', 'forecast_under', 'friend', 'week_Fri',
       'week_Mon', 'week_Sat', 'week_Sun', 'week_Thurs', 'week_Tues',
       'week_Wed'],
      dtype='object')
```

In [98]:
```
features = ['month', 'day', 'temp_2', 'temp_1', 'average',
       'forecast_noaa', 'forecast_acc', 'forecast_under', 'friend', 'week_Fri',
       'week_Mon', 'week_Sat', 'week_Sun', 'week_Thurs', 'week_Tues',
       'week_Wed']
```

In [99]:
```
feature_importance = [(feature, round(importance, 2)) for feature, importance in zip(features, impor
```

In [100]:
```
1 feature_importance
```

Out[100]:
```
[('month', 0.01),
 ('day', 0.02),
 ('temp_2', 0.02),
 ('temp_1', 0.66),
 ('average', 0.15),
 ('forecast_noaa', 0.05),
 ('forecast_acc', 0.04),
 ('forecast_under', 0.02),
 ('friend', 0.02),
 ('week_Fri', 0.0),
 ('week_Mon', 0.0),
 ('week_Sat', 0.0),
 ('week_Sun', 0.0),
 ('week_Thurs', 0.0),
 ('week_Tues', 0.0),
 ('week_Wed', 0.0)]
```

In [101]:
```
1 feature_importance[0][1]
```

Out[101]:
```
0.01
```

In [102]:

```
# sorting

feature_importance_sorted = sorted(feature_importance, key = lambda x: x[1],reverse = True)
feature_importance_sorted
```

Out[102]:

```
[('temp_1', 0.66),
 ('average', 0.15),
 ('forecast_noaa', 0.05),
 ('forecast_acc', 0.04),
 ('day', 0.02),
 ('temp_2', 0.02),
 ('forecast_under', 0.02),
 ('friend', 0.02),
 ('month', 0.01),
 ('week_Fri', 0.0),
 ('week_Mon', 0.0),
 ('week_Sat', 0.0),
 ('week_Sun', 0.0),
 ('week_Thurs', 0.0),
 ('week_Tues', 0.0),
 ('week_Wed', 0.0)]
```

In [103]:
```
1 x_value
```

Out[103]:
```
['month',
 'day',
 'temp_2',
 'temp_1',
 'average',
 'forecast_noaa',
 'forecast_acc',
 'forecast_under',
 'friend',
 'week_Fri',
 'week_Mon',
 'week_Sat',
 'week_Sun',
 'week_Thurs',
 'week_Tues',
 'week_Wed']
```

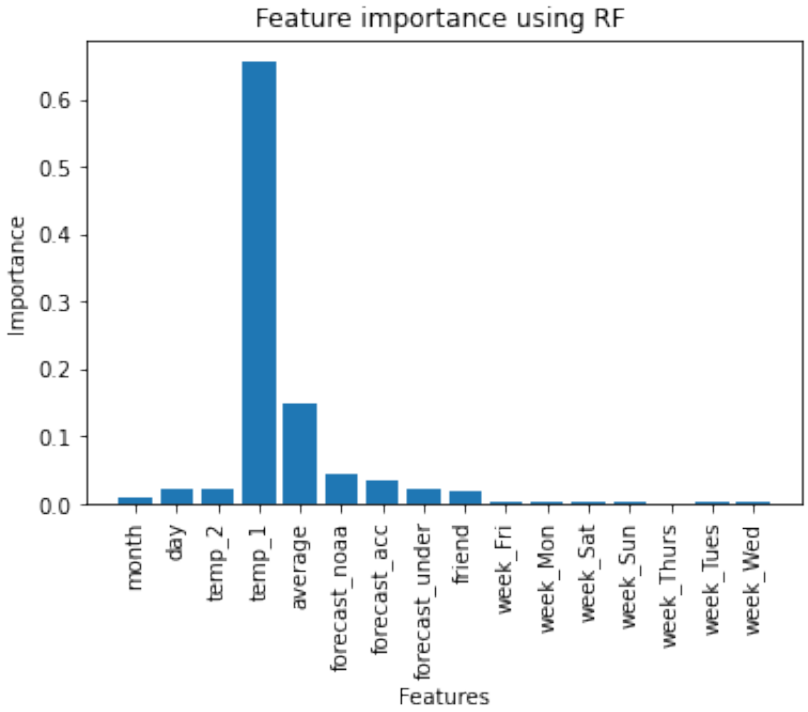
In [104]:
```
1 y
```

Out[104]:
```
array([45, 44, 41, 40, 44, 51, 45, 48, 50, 52, 45, 49, 55, 49, 48, 54, 50,
       54, 48, 52, 52, 57, 48, 51, 54, 56, 57, 56, 52, 48, 47, 46, 51, 49,
       49, 53, 49, 51, 57, 62, 56, 55, 58, 55, 56, 57, 53, 51, 53, 51, 51,
       60, 59, 61, 60, 57, 53, 58, 55, 59, 57, 64, 60, 53, 54, 55, 56, 55,
       52, 54, 49, 51, 53, 58, 63, 61, 55, 56, 57, 53, 54, 57, 59, 51, 56,
       64, 68, 73, 71, 63, 69, 60, 57, 68, 77, 76, 66, 59, 58, 60, 59, 59,
       60, 68, 77, 89, 81, 81, 73, 64, 65, 55, 59, 60, 61, 64, 61, 68, 77,
       87, 74, 60, 68, 77, 82, 63, 67, 75, 81, 77, 82, 65, 57, 60, 71, 64,
       63, 66, 59, 66, 65, 66, 66, 65, 64, 64, 64, 71, 79, 75, 71, 80, 81,
       92, 86, 85, 67, 65, 67, 65, 70, 66, 60, 67, 71, 67, 65, 70, 76, 73,
       75, 68, 69, 71, 78, 85, 79, 74, 73, 76, 76, 71, 68, 69, 76, 68, 74,
       71, 74, 74, 77, 75, 77, 76, 72, 80, 73, 78, 82, 81, 71, 75, 80, 85,
       79, 83, 85, 88, 76, 73, 77, 73, 75, 80, 79, 72, 72, 73, 72, 76, 80,
       87, 90, 83, 84, 81, 79, 75, 70, 67, 68, 68, 68, 67, 72, 74, 77, 70,
       74, 75, 79, 71, 75, 68, 69, 71, 67, 68, 67, 64, 67, 76, 77, 69, 68,
       66, 67, 63, 65, 61, 63, 66, 63, 64, 68, 57, 60, 62, 66, 60, 60, 62,
       60, 60, 61, 58, 62, 59, 62, 62, 61, 65, 58, 60, 65, 68, 59, 57, 57,
       65, 65, 58, 61, 63, 71, 65, 64, 63, 59, 55, 57, 55, 50, 52, 55, 57,
       55, 54, 54, 49, 52, 52, 53, 48, 52, 52, 52, 46, 50, 49, 46, 40, 42,
       40, 41, 36, 44, 44, 43, 40, 39, 39, 35, 35, 39, 46, 51, 49, 45, 40,
       41, 42, 42, 47, 48, 48, 57, 40])
```

In [105]:

```
x_value = features
y = importance

plt.bar(x_value,y)
plt.xticks(x_value,rotation = 'vertical')
plt.title("Feature importance using RF ")
plt.xlabel("Features")
plt.ylabel("Importance")
plt.show()
```



In [106]:

```
# we can eleminate the features with least importance and can
# rebuild model again considering importance features
```

In [ ]:

```

```

Hyper parameter tuning

In [109]:
```
print(rf.get_params())
```

```
{'bootstrap': True, 'ccp_alpha': 0.0, 'criterion': 'mse', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 1000, 'n_jobs': None, 'oob_score': False, 'random_state': 42, 'verbose': 0, 'warm_start': False}
```

In [110]:
```
# Using randomized search method
```

In [114]:
```
# number of trees
n_estimators = [int(x) for x in np.linspace(start = 200, stop = 1000,num = 10)]

# number of features
max_features = ['auto','srqt']

#Maxumum number of levels in tree
max_depth = [int(y) for y in np.linspace(5,55,num = 5)]

# min number of samples required to split node
min_samples_split = [2,5,7,10]

# Min number of samples required at each leaf node
min_samples_leaf = [1,2,4]
```

In [130]:
```
[int(y) for y in np.linspace(5,55,num = 5)]
```

Out[130]:
```
[5, 17, 30, 42, 55]
```

In [115]:
```
# create random grid

random_grid = {'n_estimators':n_estimators,
               'max_features':max_features,
               'max_depth':max_depth,
               'min_samples_split':min_samples_split,
               'min_samples_leaf':min_samples_leaf
}
```

In [116]:
```
print(random_grid)
```

```
{'n_estimators': [200, 288, 377, 466, 555, 644, 733, 822, 911, 1000], 'max_features': ['auto', 'srqt'],
'max_depth': [5, 17, 30, 42, 55], 'min_samples_split': [2, 5, 7, 10], 'min_samples_leaf': [1, 2, 4]}
```

In [117]:
```
from sklearn.model_selection import RandomizedSearchCV
```

In [118]:
```
rf_random = RandomizedSearchCV(estimator=rf,param_distributions=random_grid,
                               n_iter=100,scoring='neg_mean_absolute_error',cv =3,
                               verbose = 2, random_state=42,return_train_score=True)
```

In [119]:
```
# fit model

rf_random.fit(X_train,y_train)
```

```
  File "/Users/kunalshriwas/opt/anaconda3/lib/python3.8/site-packages/sklearn/ensemble/_forest.py", lin
e 168, in _parallel_build_trees
    tree.fit(X, y, sample_weight=curr_sample_weight, check_input=False)
  File "/Users/kunalshriwas/opt/anaconda3/lib/python3.8/site-packages/sklearn/tree/_classes.py", line 1
242, in fit
    super().fit(
  File "/Users/kunalshriwas/opt/anaconda3/lib/python3.8/site-packages/sklearn/tree/_classes.py", line 2
55, in fit
    raise ValueError("Invalid value for max_features. "
ValueError: Invalid value for max_features. Allowed string values are 'auto', 'sqrt' or 'log2'.

  warnings.warn("Estimator fit failed. The score on this train-test"
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.6s remaining:    0.0s

[CV]  n_estimators=911, min_samples_split=5, min_samples_leaf=4, max_features=srqt, max_depth=55, total
=   0.6s
[CV] n_estimators=911, min_samples_split=5, min_samples_leaf=4, max_features=srqt, max_depth=55

/Users/kunalshriwas/opt/anaconda3/lib/python3.8/site-packages/sklearn/model_selection/_validation.py:54
8: FitFailedWarning: Estimator fit failed. The score on this train-test partition for these parameters
```

In [120]:
```
rf_random.best_params_
```

Out[120]:
```
{'n_estimators': 466,
 'min_samples_split': 2,
 'min_samples_leaf': 2,
 'max_features': 'auto',
 'max_depth': 5}
```

In [121]:
```
# create function to evaluate model

def evaluate(model,test_features,test_labels):
    pred = model.predict(test_features)
    error = abs(pred-test_labels)
    mape = 100*np.mean(error/test_labels)
    acc = 100-mape
    print("Accuracy = ",acc)
    return acc
```

In [122]:
```
# evaluating random search model
best_random = rf_random.best_estimator_
random_acc = evaluate(best_random,X_test,y_test)
```

```
Accuracy =  93.9595789343464
```

In [125]:
```
y_pred_random = best_random.predict(X_test)
```

In [127]:
```
rmse_random = np.sqrt(metrics.mean_squared_error(y_test,y_pred_random))
print(rmse_random)
```

```
5.0241467373347515
```

In [ ]:
```

```

In [128]:
```
# using Grid search cv method
```

In [129]:
```
from sklearn.model_selection import GridSearchCV
```

In [131]:
```
parameters = {"max_depth": [1,3,5,7,9,10],
              "min_samples_leaf" :[1,2,4,5,6],
              "min_samples_split":[6,8,10,12],
              "max_features":['auto','sqrt'],
              "n_estimators":[100,300,500,700]

}
```

In [132]:
```
grid_search = GridSearchCV(estimator = rf,param_grid=parameters,
                           cv = 3, verbose = 2,return_train_score=True)
```

In [133]:
```
# fit grid search
grid_search.fit(X_train,y_train)
```

```
Fitting 3 folds for each of 960 candidates, totalling 2880 fits
[CV] max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=100
[CV]  max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=100, total=
0.3s
[CV] max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=100

[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.3s remaining:    0.0s

[CV]  max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=100, total=
0.2s
[CV] max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=100
[CV]  max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=100, total=
0.2s
[CV] max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=300
[CV]  max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=300, total=
0.9s
[CV] max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=300
[CV]  max_depth=1, max_features=auto, min_samples_leaf=1, min_samples_split=6, n_estimators=300, total=
0.5s
```

In [138]:
```
# best params

grid_search.best_params_
```

Out[138]:
```
{'max_depth': 9,
 'max_features': 'sqrt',
 'min_samples_leaf': 1,
 'min_samples_split': 6,
 'n_estimators': 300}
```

In [139]:
```
# evaluating random search model
best_grid = grid_search.best_estimator_
grid_acc = evaluate(best_grid,X_test,y_test)
print(grid_acc)
```

```
Accuracy =  94.16006127042304
94.16006127042304
```

In [140]:
```
y_pred_grid = best_grid.predict(X_test)
```

In [141]:
```
rmse_grid = np.sqrt(metrics.mean_squared_error(y_test,y_pred_grid))
print(rmse_grid)
```

```
5.042465724412032
```

In [ ]:

In [ ]:

In [ ]: