CS 513 Final Fall 2021

December 6, 2021

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

[2]:
```
import os
cwd = '/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data'
for dirname, _, filenames in os.walk(cwd):
    for filename in filenames:
        print(os.path.join(dirname, filename))
```

```
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/test.csv
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/train.csv
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/sample_submission.cs
v
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/ohe_cit
y_tier.sav
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/le_ADDR
ESS_classes.sav
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/le_city
_tier.sav
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/le_ADDR
ESS.sav
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/ohe_POS
TED_BY.sav
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/le_city
_tier_classes.sav
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/le_POST
ED_BY.sav
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/le_BHK_
OR_RK_classes.sav
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/le_POST
ED_BY_classes.sav
/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/TextEncoding/le_BHK_
OR_RK.sav
```

[3]:
```
data = pd.read_csv('/Users/lukemcevoy/Develop/stevens/f21/dataMining/final/data/
 ↪train.csv')
```

```
data.head()
```

[3]:

	POSTED_BY	UNDER_CONSTRUCTION	RERA	BHK_NO.	BHK_OR_RK	SQUARE_FT	READY_TO_MOVE	RESALE	ADDRESS	LONGITUDE	LATITUDE	TARGET(PRICE_IN_LACS)
0	Owner	0	0	2	BHK	1300.236407	1	1	Ksfc Layout,Bangalore	12.969910	77.597960	55.0
1	Dealer	0	0	2	BHK	1275.000000	1	1	Vishweshwara Nagar,Mysore	12.274538	76.644605	51.0
2	Owner	0	0	2	BHK	933.159722	1	1	Jigani,Bangalore	12.778033	77.632191	43.0
3	Owner	0	1	2	BHK	929.921143	1	1	Sector-1 Vaishali,Ghaziabad	28.642300	77.344500	62.5
4	Dealer	1	0	2	BHK	999.009247	0	1	New Town,Kolkata	22.592200	88.484911	60.5

[4]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 29451 entries, 0 to 29450
Data columns (total 12 columns):
 #   Column                 Non-Null Count  Dtype
---  ------                 --------------  -----
 0   POSTED_BY              29451 non-null  object
 1   UNDER_CONSTRUCTION     29451 non-null  int64
 2   RERA                   29451 non-null  int64
 3   BHK_NO.                29451 non-null  int64
 4   BHK_OR_RK              29451 non-null  object
 5   SQUARE_FT              29451 non-null  float64
 6   READY_TO_MOVE          29451 non-null  int64
 7   RESALE                 29451 non-null  int64
 8   ADDRESS                29451 non-null  object
 9   LONGITUDE              29451 non-null  float64
 10  LATITUDE               29451 non-null  float64
 11  TARGET(PRICE_IN_LACS)  29451 non-null  float64
dtypes: float64(4), int64(5), object(3)
memory usage: 2.7+ MB
```

[5]:
```
data['ADDRESS'] = data['ADDRESS'].str.split(',').apply(lambda x: x[-1])
```

[6]:
```
data['ADDRESS'].value_counts(ascending=False).head(50)
```

[6]:

Bangalore	4340
Lalitpur	2993
Mumbai	2023
Pune	1991
Noida	1767
Kolkata	1709
Maharashtra	1579
Chennai	1255
Ghaziabad	1087
Jaipur	962
Chandigarh	696
Faridabad	649
Mohali	556
Vadodara	510
Gurgaon	430
Surat	423
Nagpur	336
Lucknow	327
Indore	306
Bhubaneswar	235
Bhopal	218
Kochi	205
Visakhapatnam	179
Bhiwadi	161
Goa	149
Coimbatore	149
Dehradun	131
Ranchi	124
Mangalore	122
Gandhinagar	118
Sonipat	117
Secunderabad	109
Palghar	107
Kanpur	92
Raipur	89
Guwahati	89
Jamshedpur	86
Siliguri	83
Rajkot	83
Agra	83
Patna	82
Panchkula	82
Vijayawada	80
Aurangabad	66
Jamnagar	66
Raigad	65
Dharuhera	63

```
Thrissur            57
Durgapur            55
Gwalior             53
Name: ADDRESS, dtype: int64
```

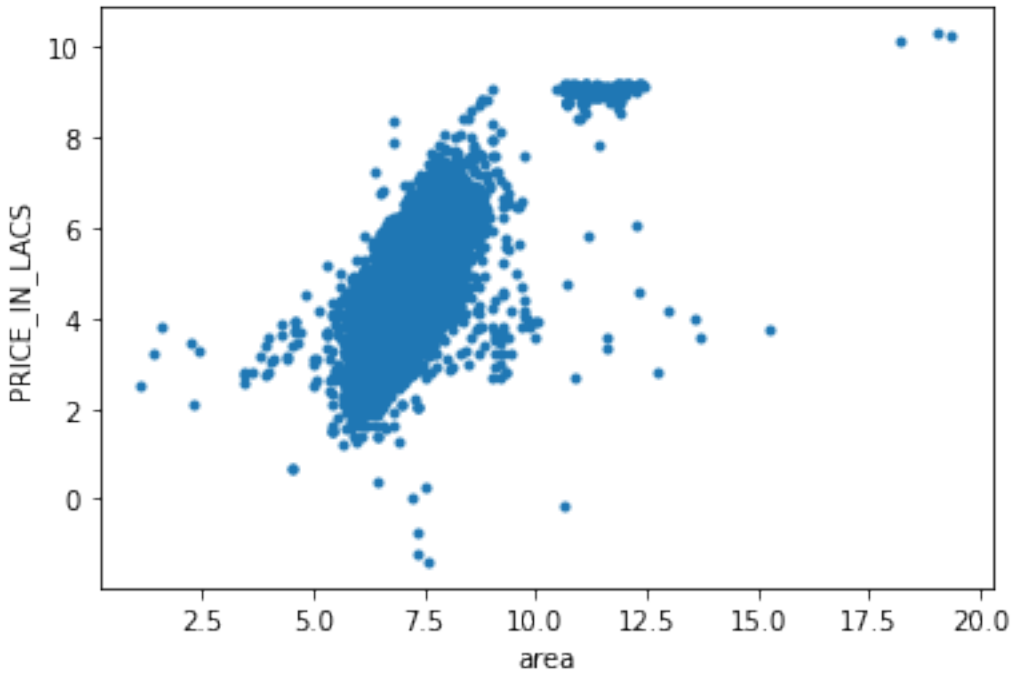
[7]:
```
def map_city(city):
    if city in ['Ahmedabad', 'Bangalore', 'Chennai', 'Delhi', 'Hyderabad',␣
 ↪'Kolkata', 'Mumbai', 'Pune', 'Maharashtra']:
        return 'tier1'
    elif city in ['Agra', 'Ajmer', 'Aligarh', 'Amravati', 'Amritsar', 'Asansol',␣
 ↪'Aurangabad', 'Bareilly',
                  'Belgaum', 'Bhavnagar', 'Bhiwandi', 'Bhopal', 'Bhubaneswar',␣
 ↪'Bikaner', 'Bilaspur', 'Bokaro Steel City',
                  'Chandigarh', 'Coimbatore', 'Cuttack', 'Dehradun', 'Dhanbad',␣
 ↪'Bhilai', 'Durgapur', 'Dindigul', 'Erode',
                  'Faridabad', 'Firozabad', 'Ghaziabad', 'Gorakhpur',␣
 ↪'Gulbarga', 'Guntur', 'Gwalior', 'Gurgaon', 'Guwahati',
                  'Hamirpur', 'Hubli-Dharwad', 'Indore', 'Jabalpur', 'Jaipur',␣
 ↪'Jalandhar', 'Jammu', 'Jamnagar', 'Jamshedpur',
                  'Jhansi', 'Jodhpur', 'Kakinada', 'Kannur', 'Kanpur', 'Karnal',␣
 ↪'Kochi', 'Kolhapur', 'Kollam', 'Kozhikode',
                  'Kurnool', 'Ludhiana', 'Lucknow', 'Madurai', 'Malappuram',␣
 ↪'Mathura', 'Mangalore', 'Meerut', 'Moradabad',
                  'Mysore', 'Nagpur', 'Nanded', 'Nashik', 'Nellore', 'Noida',␣
 ↪'Patna', 'Pondicherry', 'Purulia', 'Prayagraj',
                  'Raipur', 'Rajkot', 'Rajahmundry', 'Ranchi', 'Rourkela',␣
 ↪'Ratlam', 'Salem', 'Sangli', 'Shimla', 'Siliguri',
                  'Solapur', 'Srinagar', 'Surat', 'Thanjavur',␣
 ↪'Thiruvananthapuram', 'Thrissur', 'Tiruchirappalli', 'Tirunelveli',
                  'Tiruvannamalai', 'Ujjain', 'Bijapur', 'Vadodara', 'Varanasi',␣
 ↪'Vasai-Virar City', 'Vijayawada', 'Visakhapatnam',
                  'Vellore', 'Warangal']:
        return 'tier2'
    else:
        return 'tier3'

data['city_tier'] = data['ADDRESS'].apply(map_city)
```

[8]:
```
%matplotlib inline
data['area'] = np.log(data['SQUARE_FT'])
data['PRICE_IN_LACS'] = np.log(data['TARGET(PRICE_IN_LACS)'])
```

[9]:
```
plt.plot(data['area'], data['PRICE_IN_LACS'],'.')
plt.xlabel('area')
plt.ylabel('PRICE_IN_LACS')
```

[9]: Text(0, 0.5, 'PRICE_IN_LACS')



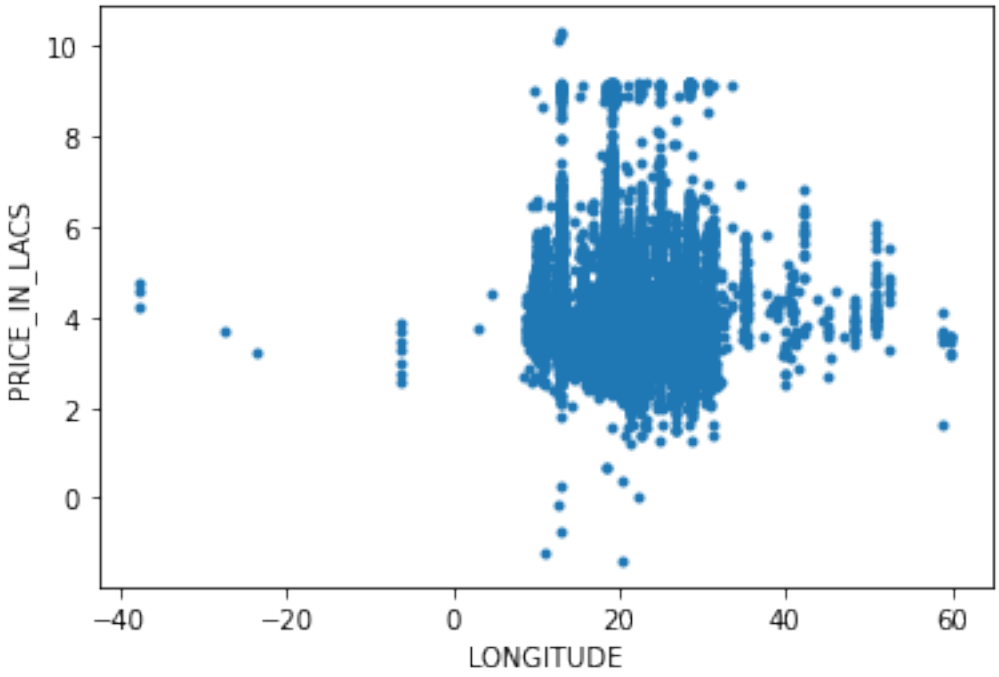
[10]:
```
print(data['PRICE_IN_LACS'])
```

```
0        4.007333
1        3.931826
2        3.761200
3        4.135167
4        4.102643
           ...
29446    3.806662
29447    2.772589
29448    3.299534
29449    4.204693
29450    3.325036
Name: PRICE_IN_LACS, Length: 29451, dtype: float64
```

[11]:
```
%matplotlib inline

plt.plot(data['LONGITUDE'], data['PRICE_IN_LACS'],'.')
plt.xlabel('LONGITUDE')
plt.ylabel('PRICE_IN_LACS')
```

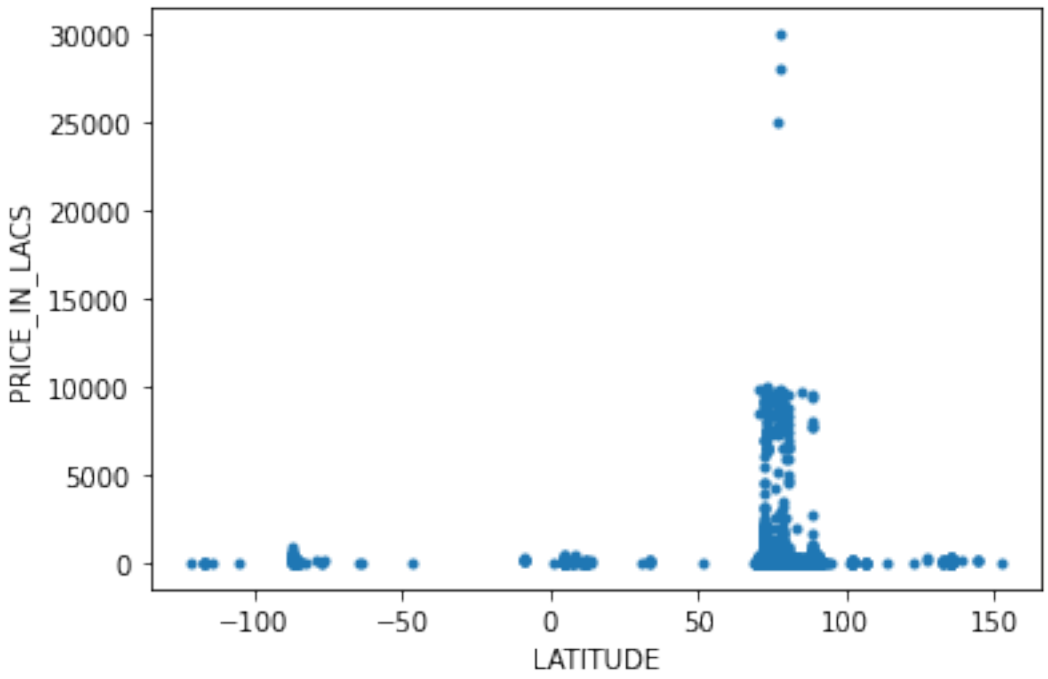
[11]: Text(0, 0.5, 'PRICE_IN_LACS')



[12]:
```
%matplotlib inline

plt.plot(data['LATITUDE'], data['TARGET(PRICE_IN_LACS)'],'.')
plt.xlabel('LATITUDE')
plt.ylabel('PRICE_IN_LACS')
```

[12]: Text(0, 0.5, 'PRICE_IN_LACS')



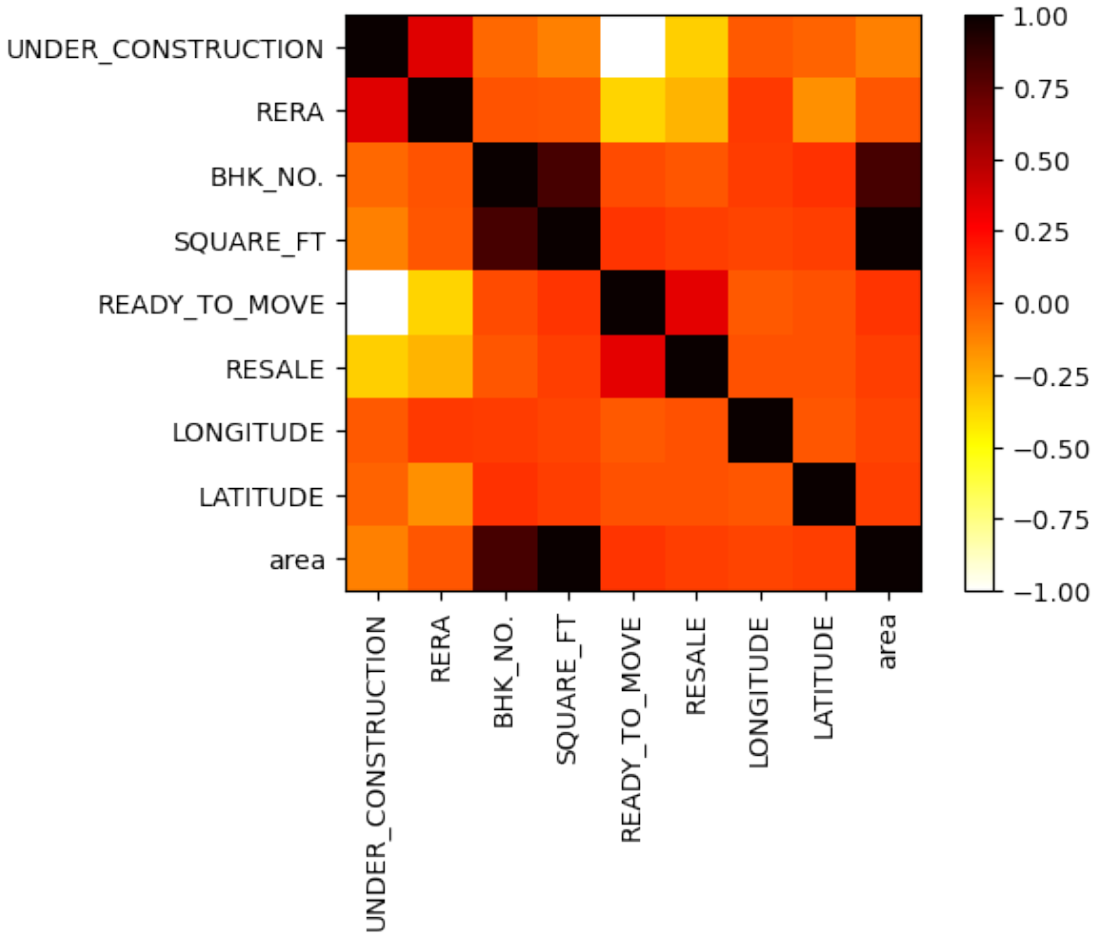
[13]:
```
import random
from matplotlib import pyplot as plt
from matplotlib import cm
from matplotlib import axes
from matplotlib.font_manager import FontProperties
```

[14]:
```
d = [[1,0.36,-0.04,-0.11, -1,-0.35,0, -0.03,-0.11],
       [0.36,1,0.02,0.01,-0.36,-0.27,0.1,-0.16,0.01],
       [-0.04,0.02,1,0.82,0.04,0.01,0.09,0.12,0.82],
       [-0.11,0.01,0.82,1,0.11,0.08,0.07,0.08,1],
       [-1,-0.36, 0.04, 0.11,1,0.35, 0,0.03, 0.11],
       [-0.35,-0.27, 0.01,0.08,0.35, 1, 0.03,0.03,0.08],
       [0,0.1,0.09,0.07,0,0.03,1,0.01,0.07],
       [-0.03,-0.16,0.12,0.08,0.03,0.03,0.01,1,0.08],
       [-0.11,0.01,0.82,1,0.11,0.08,0.07,0.08,1]]
xLabel = ['UNDER_CONSTRUCTION', 'RERA', 'BHK_NO.', 'SQUARE_FT', 'READY_TO_MOVE',␣
 ↪'RESALE', 'LONGITUDE', 'LATITUDE', 'area']
yLabel = ['UNDER_CONSTRUCTION', 'RERA', 'BHK_NO.', 'SQUARE_FT', 'READY_TO_MOVE',␣
 ↪'RESALE', 'LONGITUDE', 'LATITUDE', 'area']

d = np.array(d)
plt.figure(dpi=100)
plt.imshow(d, cmap=plt.cm.hot_r)
plt.xticks(ticks=np.arange(9),labels=xLabel,rotation=90)
```

```
plt.yticks(ticks=np.arange(9),labels=yLabel)
plt.colorbar()
```

[14]: <matplotlib.colorbar.Colorbar at 0x7ff1cf43e100>



[15]:
```
categorical_features = ['POSTED_BY', 'BHK_OR_RK', 'city_tier', 'ADDRESS']
numerical_features = ['UNDER_CONSTRUCTION', 'RERA', 'BHK_NO.', 'SQUARE_FT',␣
 ↪'READY_TO_MOVE', 'RESALE', 'LONGITUDE', 'LATITUDE', 'area']
```

[16]:
```
df = data.groupby(['ADDRESS'])['TARGET(PRICE_IN_LACS)'].describe()[['mean',␣
 ↪'count']]
df = df[df['count']>20]
```

[17]:
```
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
import joblib
```

[18]:
```
df = data.copy()
path = cwd
for i, feature in enumerate(categorical_features):
    le = LabelEncoder()
    ohe = OneHotEncoder(sparse=False)
    if not os.path.exists(os.path.join(path, "TextEncoding")):
        os.makedirs(os.path.join(path, "TextEncoding"))
    le.fit(df[feature])
    joblib.dump(le, open(os.path.join(path, "TextEncoding/le_{}.sav".
 ↪format(feature)), 'wb'))
    df[feature] = le.transform(df[feature])
    columns = list(map(lambda x: feature+' '+str(x), list(le.classes_)))[1:]
    joblib.dump(columns,
                open(os.path.join(path, "TextEncoding/le_{}_classes.sav".
 ↪format(feature)), 'wb'))
    columns = joblib.load(
        open(os.path.join(path, "TextEncoding/le_{}_classes.sav".
 ↪format(feature)), 'rb'))
    if len(le.classes_)>2 and feature!='ADDRESS':
        ohe.fit(df[[feature]])
        joblib.dump(ohe,
                    open(os.path.join(path, "TextEncoding/ohe_{}.sav".
 ↪format(feature)), 'wb'))
        tempData = ohe.transform(df[[feature]])[:, 1:]
        tempData = pd.DataFrame(tempData, columns=columns)
    else:
        tempData = df[[feature]]
    if i==0:
        encodedData = pd.DataFrame(data=tempData, columns=tempData.columns.
 ↪values.tolist())
    else:
        encodedData = pd.concat([encodedData, tempData], axis=1)
```

[19]:
```
df = df[numerical_features+['TARGET(PRICE_IN_LACS)', 'PRICE_IN_LACS']]
df = pd.concat([df, encodedData], axis=1)
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 29451 entries, 0 to 29450
Data columns (total 17 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   UNDER_CONSTRUCTION    29451 non-null  int64
 1   RERA                  29451 non-null  int64
 2   BHK_NO.               29451 non-null  int64
 3   SQUARE_FT             29451 non-null  float64
 4   READY_TO_MOVE         29451 non-null  int64
```

```
 5   RESALE                  29451 non-null  int64
 6   LONGITUDE               29451 non-null  float64
 7   LATITUDE                29451 non-null  float64
 8   area                    29451 non-null  float64
 9   TARGET(PRICE_IN_LACS)   29451 non-null  float64
 10  PRICE_IN_LACS           29451 non-null  float64
 11  POSTED_BY Dealer        29451 non-null  float64
 12  POSTED_BY Owner         29451 non-null  float64
 13  BHK_OR_RK               29451 non-null  int64
 14  city_tier tier2         29451 non-null  float64
 15  city_tier tier3         29451 non-null  float64
 16  ADDRESS                 29451 non-null  int64
dtypes: float64(10), int64(7)
memory usage: 3.8 MB
```

[20]:
```
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.linear_model import LinearRegression
from sklearn import metrics, preprocessing
from sklearn.metrics import mean_squared_error
from sklearn.preprocessing import MinMaxScaler, StandardScaler
from xgboost import XGBRegressor
```

[21]:
```
train_data = df.copy()
feature_cols = [feature for feature in train_data.columns if feature not␣
 ↪in(['READY_TO_MOVE', 'ADDRESS', 'TARGET(PRICE_IN_LACS)',
                                                                    ␣
 ↪'SQUARE_FT', 'PRICE_IN_LACS'])]
```

[22]:
```
feature_cols
```

[22]:
```
['UNDER_CONSTRUCTION',
 'RERA',
 'BHK_NO.',
 'RESALE',
 'LONGITUDE',
 'LATITUDE',
 'area',
 'POSTED_BY Dealer',
 'POSTED_BY Owner',
 'BHK_OR_RK',
 'city_tier tier2',
 'city_tier tier3']
```

[23]:
```
X = train_data[feature_cols]
y = train_data['PRICE_IN_LACS']

validation_size = 0.2
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y,␣
 ↪test_size=validation_size, random_state=0,
                                                     stratify=X[['RESALE',␣
 ↪'UNDER_CONSTRUCTION', 'RERA']])

y1 = train_data['TARGET(PRICE_IN_LACS)']
validation_size = 0.2
X_train1, X_test1, y_train1, y_test1 = train_test_split(X, y1,␣
 ↪test_size=validation_size, random_state=0,
                                                     stratify=X[['RESALE',␣
 ↪'UNDER_CONSTRUCTION', 'RERA']])
```

[24]:
```
y_test.head(20)
```

[24]:
```
22796    3.871201
20812    2.197225
10106    4.012773
28692    4.787492
2717     3.332205
14283    4.442651
28478    4.317488
9295     3.555348
3469     3.663562
27661    3.417727
22304    4.007333
17551    4.174387
2721     6.396930
219      5.075174
2195     3.496508
10245    4.174387
4435     3.860730
28505    3.688879
7691     3.401197
7004     3.970292
Name: PRICE_IN_LACS, dtype: float64
```

[25]:
```
X_test.head(20)
```

[25]:

	UNDER_CONSTRUCTION	RERA	BHK_NO.	RESALE	LONGITUDE	LATITUDE	\
22796	0	0	3	1	28.629811	77.434197	
20812	0	0	1	1	21.000000	79.000000	
10106	1	1	2	0	13.113890	77.598330	
28692	0	1	3	0	13.030600	77.648500	
2717	0	1	1	1	12.951610	80.140970	
14283	0	0	2	1	18.558319	73.775880	
28478	0	0	2	1	28.568096	77.390253	
9295	0	0	3	1	21.152819	79.069531	

```
3469                    1     1        2       1  21.094632  79.074805
27661                   0     0        2       1  22.541110  88.337780
22304                   0     0        2       1  12.928575  77.585721
17551                   0     0        2       1  22.318485  73.162544
2721                    1     0        3       1  12.978000  77.578300
219                     0     0        4       1  30.697795  76.714722
2195                    0     0        2       1  13.090000  80.270000
10245                   0     0        2       1  28.642300  77.344500
4435                    1     1        3       1  30.696627  76.693764
28505                   0     0        4       1  22.288976  73.128222
7691                    0     0        2       1  31.092793  77.134004
7004                    0     1        3       1  30.682453  76.756960

           area  POSTED_BY Dealer  POSTED_BY Owner  BHK_OR_RK  \
22796  7.453201               1.0              0.0          0
20812  6.216833               0.0              1.0          0
10106  6.801491               1.0              0.0          0
28692  7.256249               1.0              0.0          0
2717   6.429748               0.0              1.0          0
14283  7.089983               0.0              1.0          0
28478  7.034529               0.0              1.0          0
9295   7.244228               0.0              1.0          0
3469   7.047312               0.0              1.0          0
27661  6.824439               1.0              0.0          0
22304  7.032700               0.0              1.0          0
17551  7.237970               1.0              0.0          0
2721   7.591381               1.0              0.0          0
219    7.741602               1.0              0.0          0
2195   6.826594               0.0              1.0          0
10245  7.130899               1.0              0.0          0
4435   7.250690               1.0              0.0          0
28505  7.804243               1.0              0.0          0
7691   6.684612               0.0              1.0          0
7004   7.226351               0.0              1.0          0

       city_tier tier2  city_tier tier3
22796              1.0              0.0
20812              1.0              0.0
10106              0.0              0.0
28692              0.0              0.0
2717               0.0              0.0
14283              0.0              0.0
28478              1.0              0.0
9295               0.0              1.0
3469               1.0              0.0
27661              0.0              0.0
22304              0.0              0.0
```

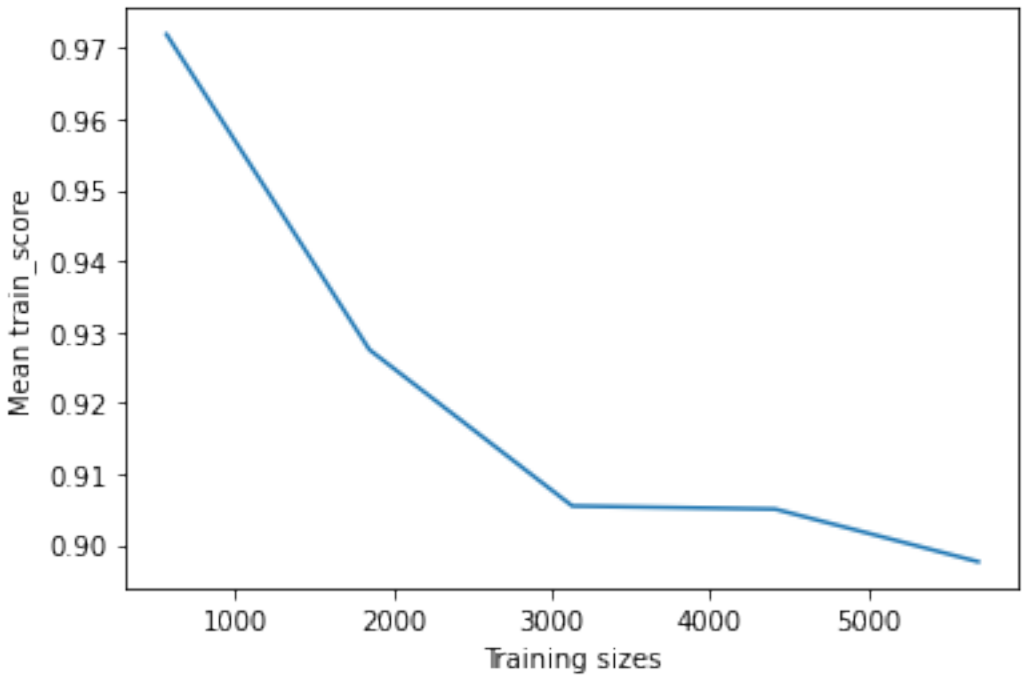
17551	1.0	0.0
2721	0.0	1.0
219	0.0	1.0
2195	0.0	0.0
10245	1.0	0.0
4435	0.0	1.0
28505	1.0	0.0
7691	1.0	0.0
7004	0.0	1.0

[26]:
```
# XGBRegressor
```

[27]:
```
model = XGBRegressor(
    n_estimators = 500,
    learning_rate=0.02,
    seed=7)
```

[28]:
```
from sklearn.model_selection import learning_curve
train_sizes, train_scores, test_scores, fit_times, _ = learning_curve(model,␣
 ↪X_test, y_test, cv=30, return_times=True)
```

[29]:
```
plt.plot(train_sizes, np.mean(train_scores, axis=1))
plt.xlabel('Training sizes')
plt.ylabel('Mean train_score')
plt.show()
```



[30]:
```
model = model.fit(
    X_train,
    y_train,
    eval_metric="rmse",
    verbose=False)
```

[31]:
```
model.score(X_test, y_test)
```

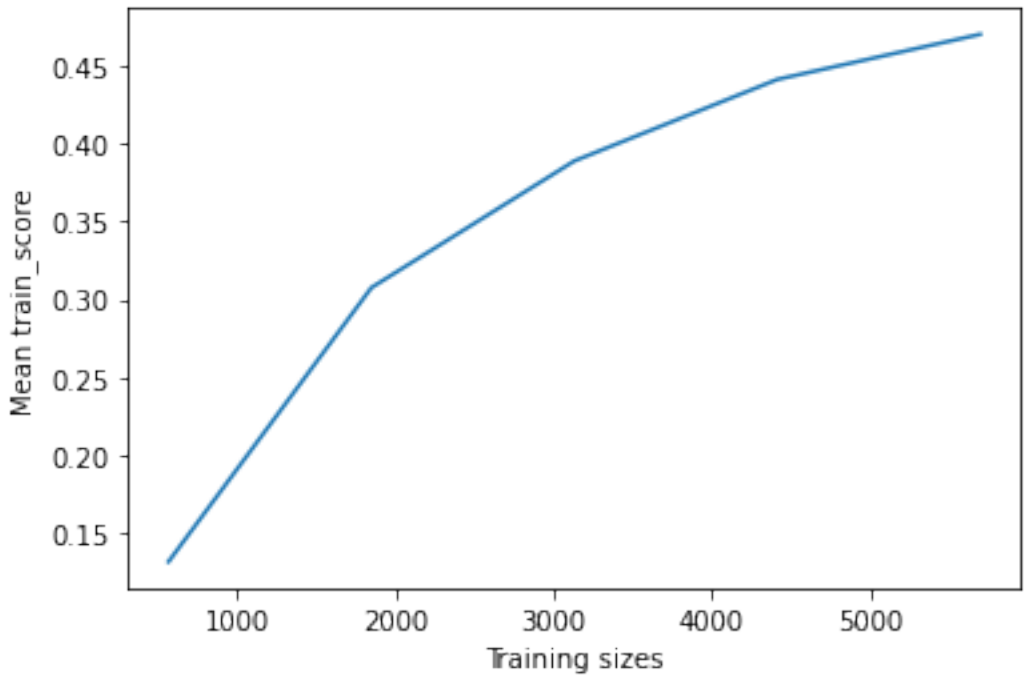
[31]:
```
0.8425897270434302
```

[32]:
```
# Support Vector Machine
```

[33]:
```
from sklearn import svm
regr = svm.SVR()
regr.fit(X_train, y_train)
regr.score(X_test, y_test)
```

[33]:
```
0.575084467803466
```

[34]:
```
train_sizes, train_scores, test_scores, fit_times, _ = learning_curve(regr,␣
 ↪X_test, y_test, cv=30, return_times=True)
plt.plot(train_sizes, np.mean(train_scores, axis=1))
plt.xlabel('Training sizes')
plt.ylabel('Mean train_score')
plt.show()
```

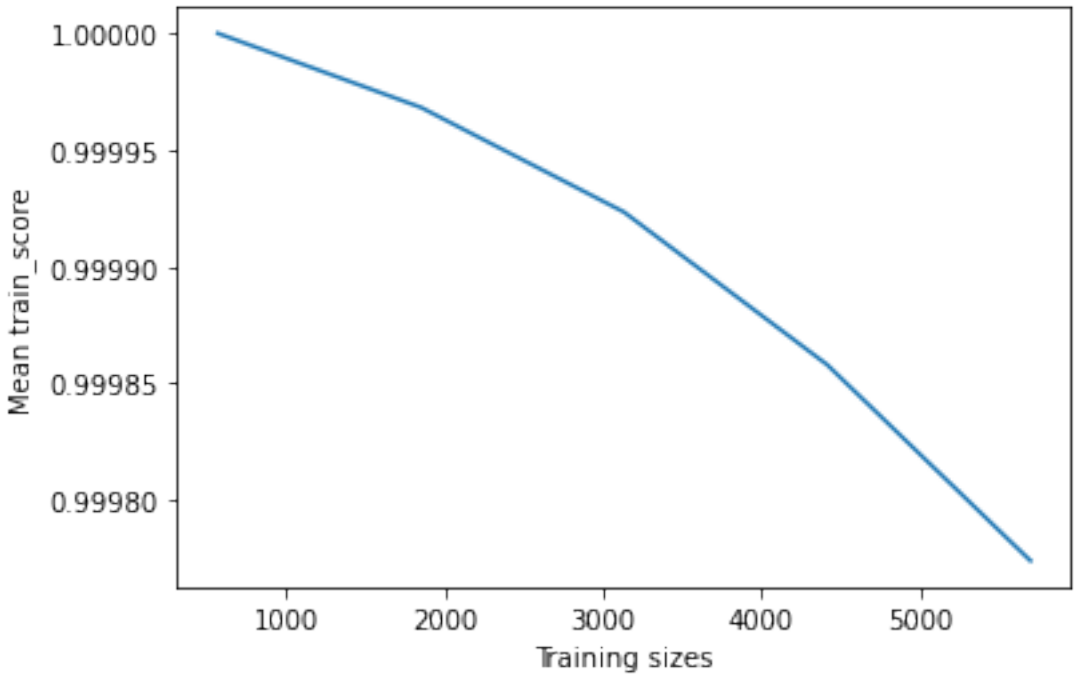


[35]:
```
# Decision Tree
```

[36]:
```
from sklearn import tree
clf = tree.DecisionTreeRegressor()
clf = clf.fit(X_train, y_train)
clf.score(X_test, y_test)
```

[36]:
```
0.7278864716523665
```

[37]:
```
train_sizes, train_scores, test_scores, fit_times, _ = learning_curve(clf,␣
↪X_test, y_test, cv=30, return_times=True)
plt.plot(train_sizes, np.mean(train_scores, axis=1))
plt.xlabel('Training sizes')
plt.ylabel('Mean train_score')
plt.show()
```

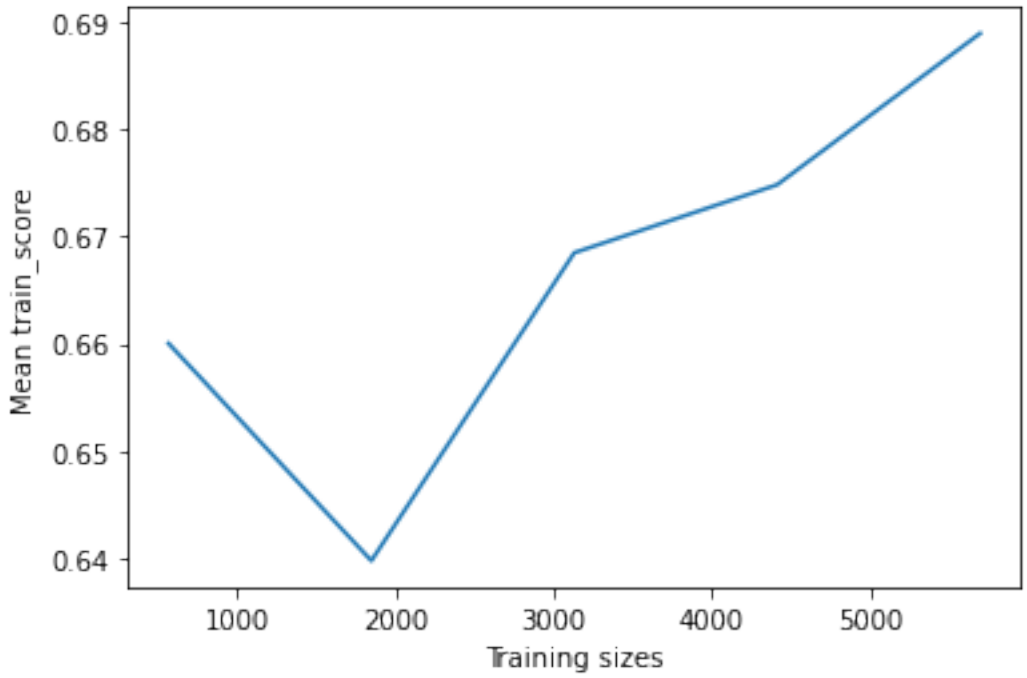


[38]:
```
# Neural Network (MLPRegressor)
```

[39]:
```
from sklearn.neural_network import MLPRegressor
nnregr = MLPRegressor(random_state=1, max_iter=100000)
nnregr.fit(X_train, y_train)
nnregr.score(X_test, y_test)
```

[39]:
```
0.6930506508632484
```

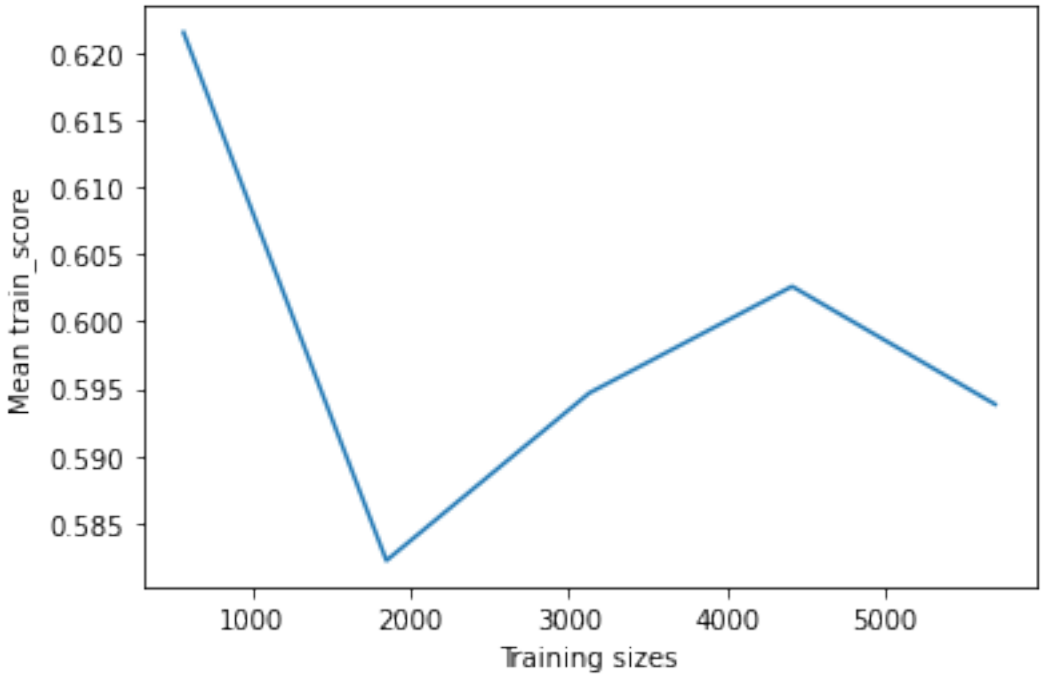
[40]:
```
train_sizes, train_scores, test_scores, fit_times, _ = learning_curve(nnregr,␣
 ↪X_test, y_test, cv=30, return_times=True)
plt.plot(train_sizes, np.mean(train_scores, axis=1))
plt.xlabel('Training sizes')
plt.ylabel('Mean train_score')
plt.show()
```



[41]:
```
from sklearn import linear_model
reg = linear_model.Lars(n_nonzero_coefs=12, normalize=False)
reg.fit(X_train, y_train)
reg.score(X_test, y_test)
```

[41]:
```
0.5890383006435391
```

[42]:
```
train_sizes, train_scores, test_scores, fit_times, _ = learning_curve(reg,␣
 ↪X_test, y_test, cv=30, return_times=True)
plt.plot(train_sizes, np.mean(train_scores, axis=1))
plt.xlabel('Training sizes')
plt.ylabel('Mean train_score')
plt.show()
```

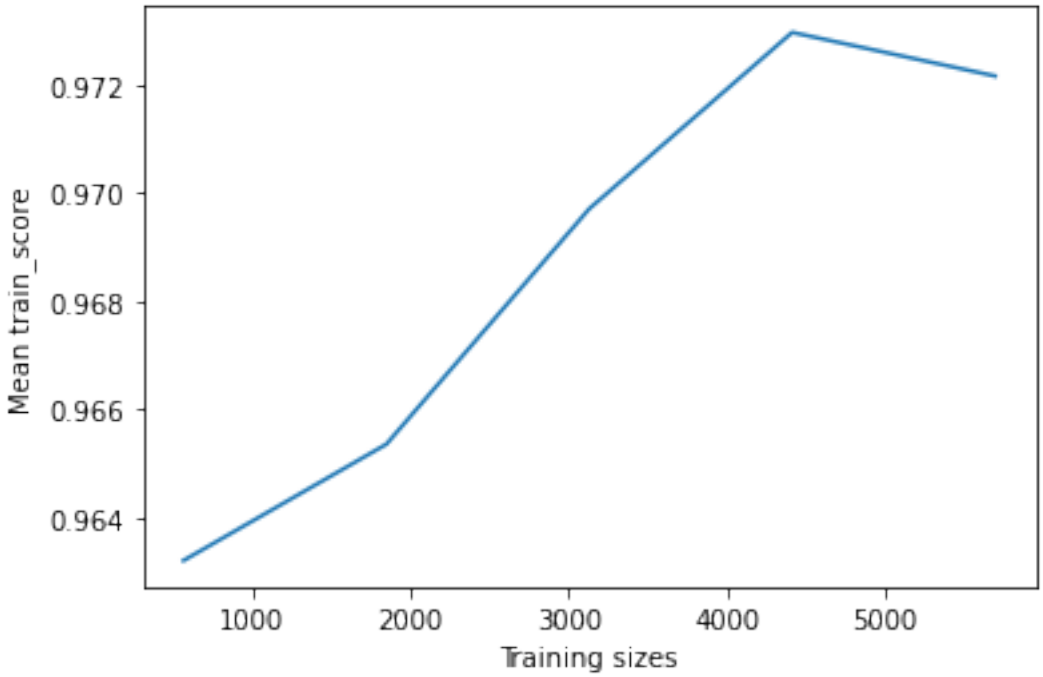


[43]:
```
# Random Forest
```

[44]:
```
from sklearn.ensemble import RandomForestRegressor
regr = RandomForestRegressor(max_depth=10000, random_state=0)
regr.fit(X_train, y_train)
regr.score(X_test, y_test)
```

[44]: 0.8502954380903031

[45]:
```
train_sizes, train_scores, test_scores, fit_times, _ = learning_curve(regr,␣
 ↪X_test, y_test, cv=30, return_times=True)
plt.plot(train_sizes, np.mean(train_scores, axis=1))
plt.xlabel('Training sizes')
plt.ylabel('Mean train_score')
plt.show()
```

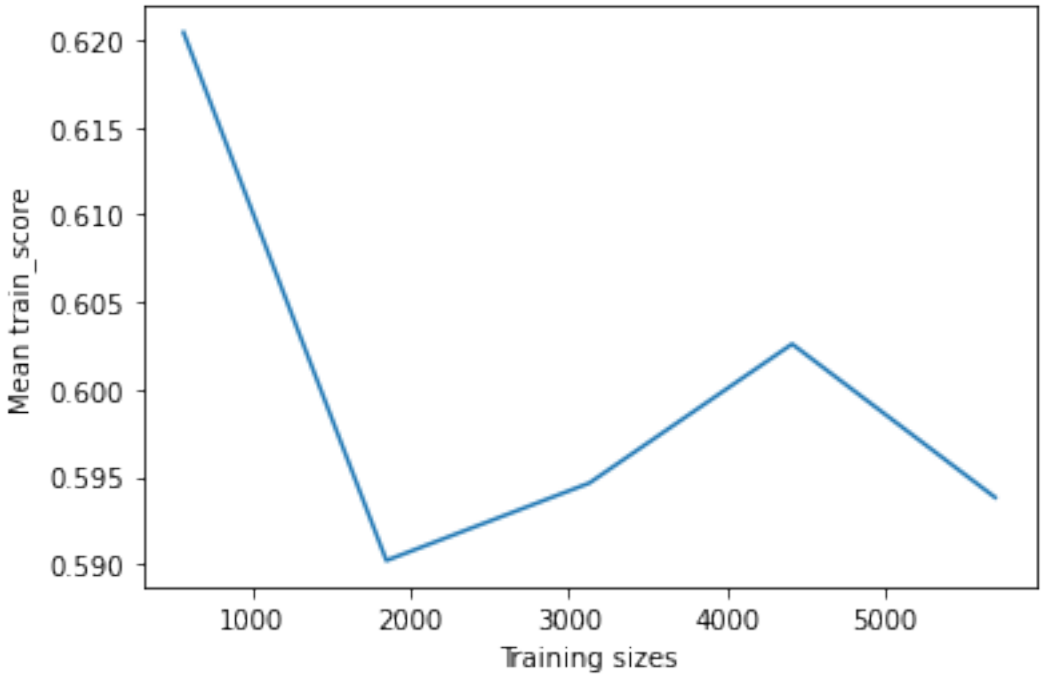


[46]:
```
# Linear Model (Baysian Ridge)
```

[47]:
```
from sklearn import linear_model
reg = linear_model.BayesianRidge()
reg.fit(X_train, y_train)
reg.score(X_test, y_test)
```

[47]:
```
0.5890179004546502
```

[48]:
```
train_sizes, train_scores, test_scores, fit_times, _ = learning_curve(reg,␣
↪X_test, y_test, cv=30, return_times=True)
plt.plot(train_sizes, np.mean(train_scores, axis=1))
plt.xlabel('Training sizes')
plt.ylabel('Mean train_score')
plt.show()
```

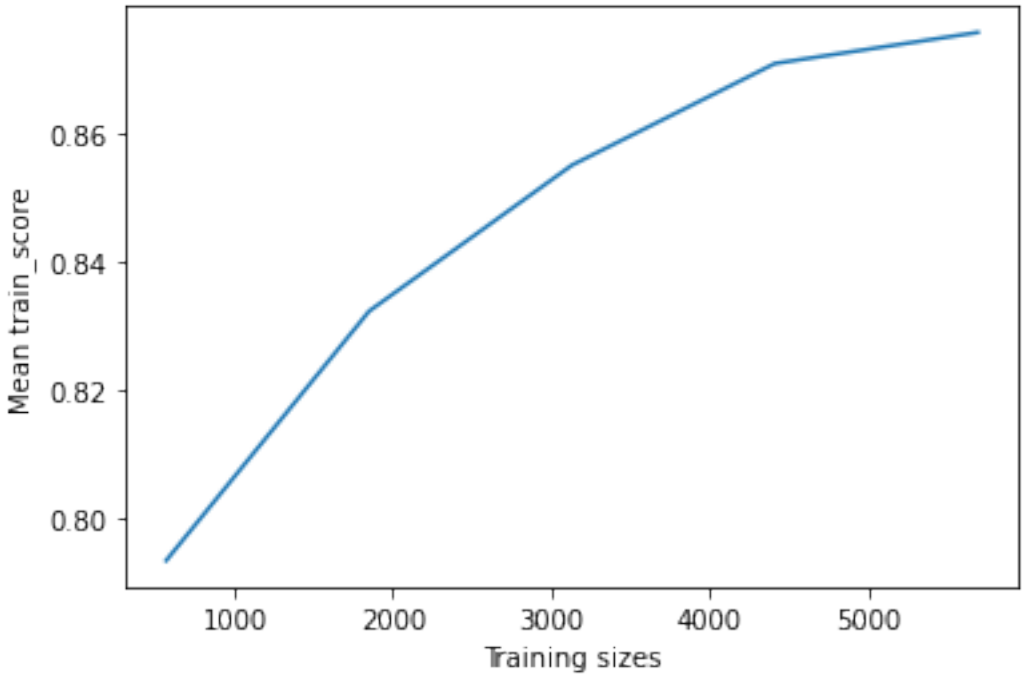


[49]:
```
# K Nearest Neighbor
```

[50]:
```
from sklearn.neighbors import KNeighborsRegressor
neigh = KNeighborsRegressor(n_neighbors=3)
neigh.fit(X_train, y_train)
neigh.score(X_test, y_test)
```

[50]: 0.7937267071315093

[51]:
```
train_sizes, train_scores, test_scores, fit_times, _ = learning_curve(neigh,␣
 ↪X_test, y_test, cv=30, return_times=True)
plt.plot(train_sizes, np.mean(train_scores, axis=1))
plt.xlabel('Training sizes')
plt.ylabel('Mean train_score')
plt.show()
```

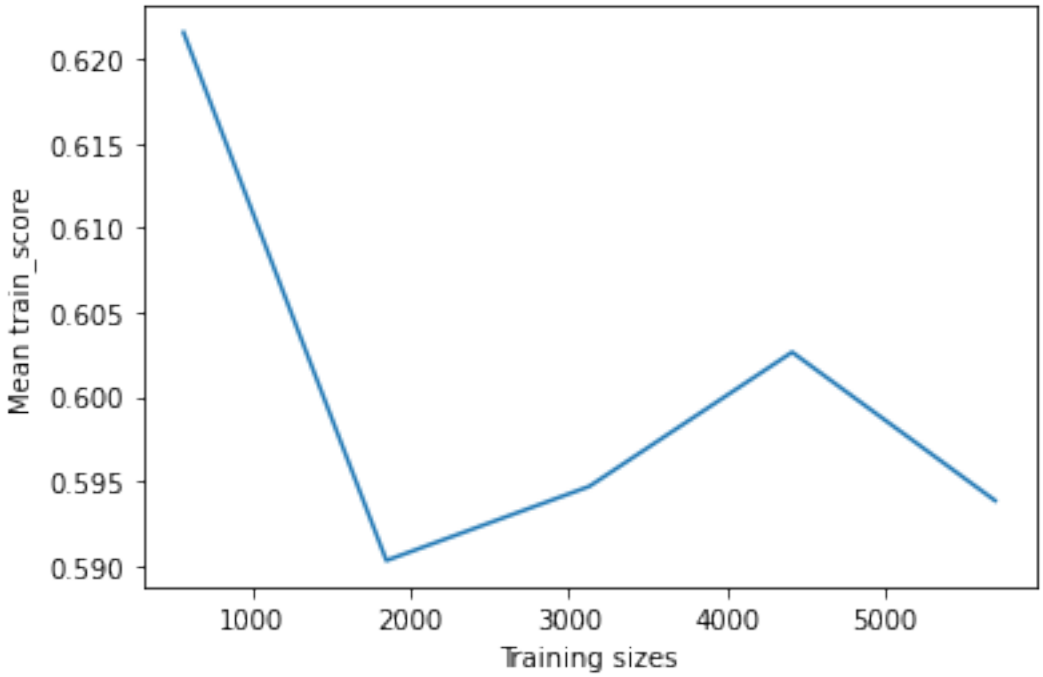


[52]:
```
# Linear Regression
```

[53]:
```
from sklearn.linear_model import LinearRegression
reg = LinearRegression().fit(X_train, y_train)
reg.score(X_test, y_test)
```

[53]: 0.5890383006435393

[54]:
```
train_sizes, train_scores, test_scores, fit_times, _ = learning_curve(reg,␣
 ↪X_test, y_test, cv=30, return_times=True)
plt.plot(train_sizes, np.mean(train_scores, axis=1))
plt.xlabel('Training sizes')
plt.ylabel('Mean train_score')
plt.show()
```


0.620
0.615
0.610
0.605
0.600
0.595
0.590
Mean train_score
1000
2000
3000
4000
5000
Training sizes