Data preparation, exploration, visualization

For this assignment, I wanted to build on top of the EDA I did for the housing data set in assignment 2. In line 67, I created a correlation matrix to once again see which variables highly correlate to another. In lines 71, 22 and 23, I converted qualitative data such as “has central air” to a binary standard and other categorical values such as “sale type” to a numeric scale. I then in line 24 created another correlation to see if the numeric conversions changed the correlation between variables. Overall, I decided to use every variable in the training set for my modeling methods and found that using all the variables would most likely create a higher accuracy.

Review research design and modeling methods

The 5 types of models I wanted to use are the linear regression, gradient boost, elastic net, ridge regression, lasso, linear regression and decision tree. In assignment 2, I explored the linear regression and lasso regression but I wanted to utilize these new ML technique to see if I could gain a higher accuracy for this predictive model. For all 5 of these models, I used a mean squared error as well as a salesprice for outcome variable. In line 35, I split the data into a training set and a test set and from lines 36-53 I conducted all five models using all the variables, I used a residual plot to evaluate the accuracy of the test set and training set score. I also used all the variables in my modeling methods, meaning that I had used 27 features for each model. I then tested the variance for each model using the mean squared error and then in line 62, I organized the techniques by accuracy.

Review results, evaluate models

I found that the most accurate result was the gradient boost model, followed by the elastic net, ridge, lasso, linear and then the decision tree. I was initially expecting that the linear regression would provide the most accurate results, however I was surprised when I saw the gradient boost was the most accurate of them all. In line 77, I exported my results to a file and submitted it onto Kaggle.

Implementation and programming as evidenced by Kaggle submission scores

My Kaggle username is Ankita Avadhani, with a score of 0.11843 and a ranking so far of 220 (getting better!)

Exposition, problem description, and management recommendations

If I were to address the management issue of what model to use to predict the sale price home based on certain features, I would recommend using a Gradient Boost model utilizing 27 of the features of the current data given. However, the most important explanatory variables still come from the quantitative aspects of the house meaning, LotSize, BasementSize and overall quality. However, I wanted to be able to include all the variables in this modeling assignment by converting the qualitative numbers to the quantitative values that we can utilize (for example, a binary classification of whether or not the house has an AC or a Pool). Once I was able to convert these explanatory variables into usable variables for my models, I believe my accuracy increased. From assignment 2, where I just analyzed the Lasso regression as well as linear regression, I only utilized 5 explanatory variables in my models. This caused my accuracy to be 70% for the linear regression and 40% for my lasso regression. I wanted to change the way I approached modeling again however, because I wanted to see how accurate I could make my models utilizing the given variables and data.

	Model	RMSE	Score
5	GradientBoost	27040.561603	87.518960
3	ElasticNet	32702.080706	81.745491
1	Ridge	33087.178311	81.313032
2	Lasso	33101.723515	81.296599
0	Linear	33101.896616	81.296403
4	Decision Tree	41136.679707	71.114636

In [63]:

```
import pandas as pd
import math
from math import sqrt
import numpy as np
import pandas_profiling
from pandas_profiling import ProfileReport as pp
import random
np.random.seed(42)

import matplotlib.pyplot as plt
import seaborn as sns
import IPython
from IPython.display import display
from scipy.stats import skew

%matplotlib inline

import sklearn
from sklearn import linear_model
from sklearn.model_selection import cross_val_score, train_test_split, cross_val_pr
edict
from sklearn.linear_model import LinearRegression, RidgeCV, LassoCV, ElasticNetCV
from sklearn.linear_model import LinearRegression, Ridge, Lasso, ElasticNet
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import mean_squared_error, r2_score, make_scorer

pd.set_option('display.float_format', lambda x: '%3f' %x)


from sklearn.utils import resample
from sklearn.decomposition import PCA
from scipy import misc
from scipy import stats as st
from sklearn.model_selection import KFold, GridSearchCV
```

In [64]:

```
housing_train = pd.read_csv("train (1).csv")
housing_test = pd.read_csv("test (1).csv")
```

In [65]:

```
housing_train.SalePrice.describe()
```

Out[65]:

```
count      1460.000000
mean     180921.195890
std       79442.502883
min       34900.000000
25%      129975.000000
50%      163000.000000
75%      214000.000000
max      755000.000000
Name: SalePrice, dtype: float64
```

In [66]:

```
def corr_chart(df_corr):
    corr=df_corr.corr()
    #screen top half to get a triangle
    top = np.zeros_like(corr, dtype=np.bool)
    top[np.triu_indices_from(top)] = True
    fig=plt.figure()
    fig, ax = plt.subplots(figsize=(100,100))
    sns.heatmap(corr, mask=top, cmap='coolwarm',
        center = 0, square=True,
        linewidths=.5, cbar_kws={'shrink':.5},
        annot = True, annot_kws={'size': 9}, fmt = '.3f')
    plt.xticks(rotation=45) # rotate variable labels on columns (x axis)
    plt.yticks(rotation=0) # use horizontal variable labels on rows (y axis)
    plt.title('Correlation Heat Map')
```

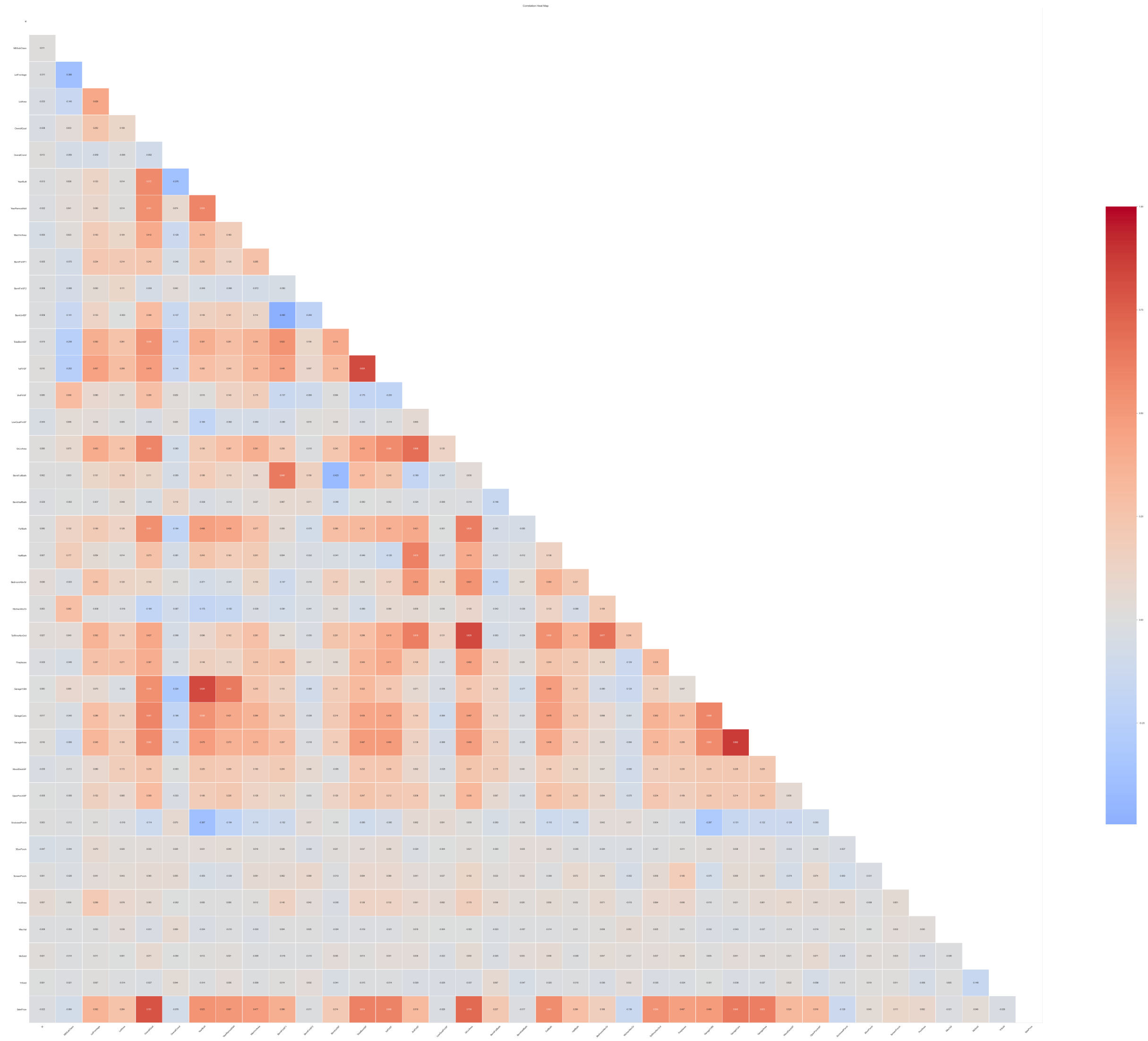
In [ ]:

```

```

In [67]:

```
corr_chart(df_corr = housing_train)
```

<Figure size 432x288 with 0 Axes>



In [68]:

```
housing_train.hist(bins=40,figsize=(30,20));
plt.show()
```

In [69]:

```
# x data and y data
delcolumns=['MSSubClass','MSZoning','Utilities','HouseStyle','Alley','OverallCond',
'Neighborhood','BsmtFinSF2','LowQualFinSF',
            'RoofStyle','RoofMatl','Exterior1st','KitchenAbvGr','GarageType','Garag
eFinish',
                                        'Exterior2nd','MasVnrType','ExterQual','Ext
erCond','Foundation',
                                        'BsmtQual','BsmtCond','BsmtFinType1',
                                        'BsmtFinType2','Electrical', 'Heating','Hea
tingQC',
                                        'BsmtHalfBath','FireplaceQu',
                                        'GarageQual','GarageCond','PavedDrive',
                                        'MiscFeature','LotFrontage','GarageYrBlt',
'MasVnrArea','PoolQC',
            'EnclosedPorch','MiscVal','YrSold','KitchenQual','Fence', 'Functional',
            'MoSold','3SsnPorch','PoolArea','Street','LandContour','LotConfig','Con
dition2','BsmtExposure','LandSlope', 'BldgType'
                                       ]
train_data=housing_train.drop(columns=delcolumns)
```

In [70]:

```
test_data=housing_test.drop(columns=delcolumns)
```

In [71]:

```
# Convert Condition to numeric
convert_condition={'Artery':0,'Feedr':1,'Norm':3,'RRNn':4,'RRAn':5,'PosN':6,'PosA':
7,'RRNe':8,'RRAe':9}
temp_df=train_data['Condition1'].map(convert_condition)
train_data['Condition1']=temp_df

temp_df=test_data['Condition1'].map(convert_condition)
test_data['Condition1']=temp_df
```

In [72]:

```
w
convert_to_binary={'N':0,'Y':1}
temp_df=train_data['CentralAir'].map(convert_to_binary)
train_data['CentralAir']=temp_df

temp_df=test_data['CentralAir'].map(convert_to_binary)
test_data['CentralAir']=temp_df
```

In [73]:

```
convert_salecondition={'Normal':0,'Abnorml':1,'AdjLand':2,'Alloca':3,'Family':4,'Pa
rtial':5}
temp_df=train_data['SaleCondition'].map(convert_salecondition)
train_data['SaleCondition']=temp_df

temp_df=test_data['SaleCondition'].map(convert_salecondition)
test_data['SaleCondition']=temp_df
```

In [74]:

```
convert_lotshape={'Reg':0,'IR1':1,'IR2':2,'IR3':3}
temp_df=train_data['LotShape'].map(convert_lotshape)
train_data['LotShape']=temp_df

temp_df=test_data['LotShape'].map(convert_lotshape)
test_data['LotShape']=temp_df
```

In [22]:

```
# Convert SaleType to numeric
convert_saletype={'WD':0,'CWD':1,'VWD':2,'New':3,'COD':4,'Con':5,'ConLw':6,'ConLI':
7,'ConLD':8,'Oth':9}
temp_df=train_data['SaleType'].map(convert_saletype)
train_data['SaleType']=temp_df

temp_df=test_data['SaleType'].map(convert_saletype)
test_data['SaleType']=temp_df
```

In [23]:

```
train_data.fillna(0,inplace=True)
test_data.fillna(0,inplace=True)
```

In [24]:

```
corr_data=train_data.corr()
corr_data
```

Out[24]:

	Id	LotArea	LotShape	Condition1	OverallQual	YearBuilt	YearRemodA
Id	1.000000	-0.033226	-0.024071	-0.018247	-0.028365	-0.012713	-0.0219
LotArea	-0.033226	1.000000	0.315484	0.032573	0.105806	0.014228	0.0137
LotShape	-0.024071	0.315484	1.000000	0.096835	0.198994	0.229365	0.1754
Condition1	-0.018247	0.032573	0.096835	1.000000	0.109307	0.198147	0.1559
OverallQual	-0.028365	0.105806	0.198994	0.109307	1.000000	0.572323	0.5506
YearBuilt	-0.012713	0.014228	0.229365	0.198147	0.572323	1.000000	0.5928
YearRemodAdd	-0.021998	0.013788	0.175488	0.155936	0.550684	0.592855	1.0000
BsmtFinSF1	-0.005024	0.214103	0.157718	0.060744	0.239666	0.249503	0.1284
BsmtUnfSF	-0.007940	-0.002618	0.014179	0.021346	0.308159	0.149040	0.1811
TotalBsmtSF	-0.015415	0.260833	0.200469	0.085029	0.537808	0.391452	0.2910
CentralAir	0.009821	0.049755	0.099138	0.038493	0.272038	0.381831	0.2988
1stFlrSF	0.010496	0.299475	0.189251	0.096499	0.476224	0.281986	0.2403
2ndFlrSF	0.005590	0.050986	0.089380	-0.012598	0.295493	0.010308	0.1400
GrLivArea	0.008273	0.263116	0.212741	0.053928	0.593007	0.199010	0.2873
BsmtFullBath	0.002289	0.158155	0.064638	0.038696	0.111098	0.187599	0.1194
FullBath	0.005587	0.126031	0.184213	0.104931	0.550600	0.468271	0.4390
HalfBath	0.006784	0.014259	0.116576	0.069078	0.273458	0.242656	0.1833
BedroomAbvGr	0.037719	0.119690	0.060028	0.005432	0.101676	-0.070651	-0.0405
TotRmsAbvGrd	0.027239	0.190015	0.137148	0.041608	0.427452	0.095589	0.1917
Fireplaces	-0.019772	0.271364	0.202019	0.022800	0.396765	0.147716	0.1125
GarageCars	0.016570	0.154871	0.194984	0.110557	0.600671	0.537850	0.4206
GarageArea	0.017634	0.180403	0.173472	0.089003	0.562022	0.478954	0.3716
WoodDeckSF	-0.029643	0.171698	0.161717	0.059400	0.238923	0.224880	0.2057
OpenPorchSF	-0.000477	0.084774	0.093135	0.081863	0.308819	0.188686	0.2262
ScreenPorch	0.001330	0.043160	0.065182	0.018132	0.064886	-0.050364	-0.0387
SaleType	-0.028774	-0.004436	0.008355	0.025398	0.134304	0.160709	0.1090
SaleCondition	-0.021060	0.013773	0.027139	0.022991	0.269625	0.290899	0.2610
SalePrice	-0.021917	0.263843	0.267759	0.113916	0.790982	0.522897	0.5071

28 rows × 28 columns

In [34]:

```
train_x=train_data.copy()
train_x.drop(columns=['SalePrice'], inplace=True)
train_y=train_data[['SalePrice']]
```

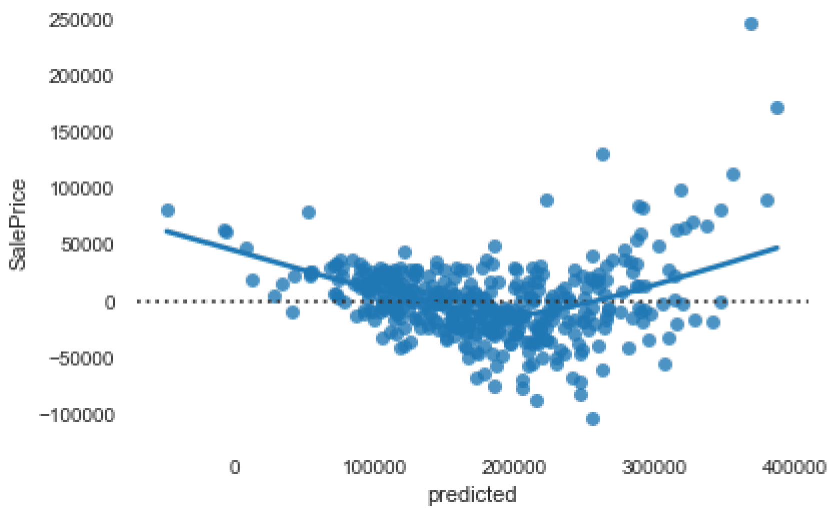
In [35]:

```
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import train_test_split
# split data using test_train_split
lin_x_train,lin_x_test,lin_y_train,lin_y_test=train_test_split(train_x,train_y,test
_size=.3,random_state=10)
```

In [36]:

```
lin_test=test_data.copy()
lin_test_res=test_data[['Id']]


#Linear Regression
lin_reg=LinearRegression(fit_intercept=True).fit(lin_x_train,lin_y_train)

lin_score=lin_reg.score(lin_x_test,lin_y_test)

print('Number of features used:',np.sum(lin_reg.coef_ !=0))
print('Training set score:', lin_reg.score(lin_x_train,lin_y_train))
print('Testing set score:',lin_reg.score(lin_x_test,lin_y_test))

lin_y_test['predicted']=lin_reg.predict(lin_x_test)

sns.residplot(lin_y_test['predicted'],lin_y_test['SalePrice'],lowess=True)
lin_np=np.sqrt(mean_squared_error(lin_y_test['SalePrice'],lin_y_test['predicted']))

lin_test_res['SalePrice']=lin_reg.predict(lin_test)
```

```
Number of features used: 27
Training set score: 0.7887849834489229
Testing set score: 0.8129640324858132

/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:14: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:19: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```



In [47]:

```
grad_test=test_data.copy()
grad_test_res=test_data[['Id']]

# split data using test_train_split
grad_x_train,grad_x_test,grad_y_train,grad_y_test=train_test_split(train_x,train_y,
test_size=.3,random_state=10)

from sklearn.ensemble import GradientBoostingRegressor
gbrt = GradientBoostingRegressor(max_depth=2, n_estimators=120, random_state=42)
gbrt.fit(grad_x_train,grad_y_train)

errors = [mean_squared_error(grad_y_test, y_pred)
          for y_pred in gbrt.staged_predict(grad_x_test)]
bst_n_estimators = np.argmin(errors)

gbrt_best = GradientBoostingRegressor(max_depth=2,n_estimators=bst_n_estimators, ra
ndom_state=42)
gbrt_best.fit(grad_x_train,grad_y_train)
```

```
/Users/avadhani/anaconda3/lib/python3.7/site-packages/sklearn/utils/val
idation.py:73: DataConversionWarning: A column-vector y was passed when
a 1d array was expected. Please change the shape of y to (n_samples, ),
for example using ravel().
  return f(**kwargs)
/Users/avadhani/anaconda3/lib/python3.7/site-packages/sklearn/utils/val
idation.py:73: DataConversionWarning: A column-vector y was passed when
a 1d array was expected. Please change the shape of y to (n_samples, ),
for example using ravel().
  return f(**kwargs)
```

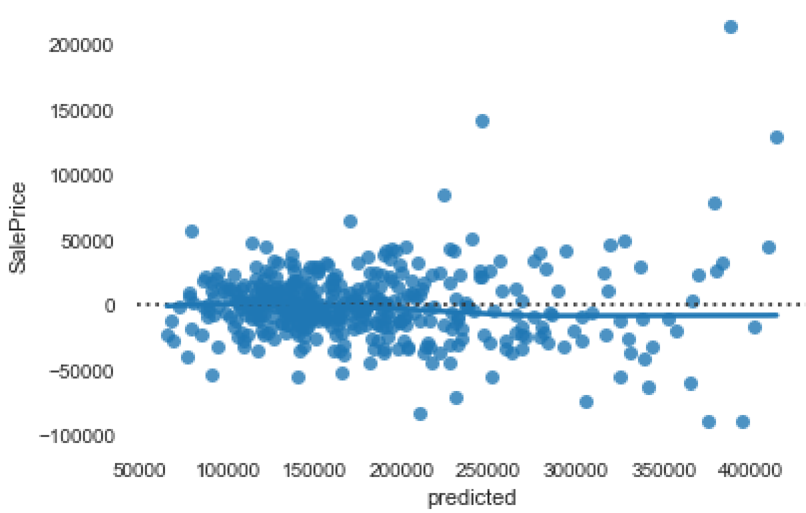
Out[47]:

```
GradientBoostingRegressor(max_depth=2, n_estimators=119, random_state=4
2)
```

In [48]:

```
grad_score=gbrt_best.score(grad_x_test,grad_y_test)
print("Training set score: {:.2f}".format(gbrt_best.score(grad_x_train,grad_y_train
)))
print("Test set score: {:.2f}".format(gbrt_best.score(grad_x_test,grad_y_test)))
#print("Number of features used: {}".format(np.sum(gbrt_best.coef_ !=0)))


grad_y_test['predicted']= gbrt_best.predict(grad_x_test)
# Plot the residuals after fitting a linear model
sns.residplot(grad_y_test['predicted'], grad_y_test['SalePrice'], lowess=True)


grad_np=np.sqrt(mean_squared_error(grad_y_test['SalePrice'],grad_y_test['predicted'
]))

grad_test_res['SalePrice']=gbrt_best.predict(grad_test)
```

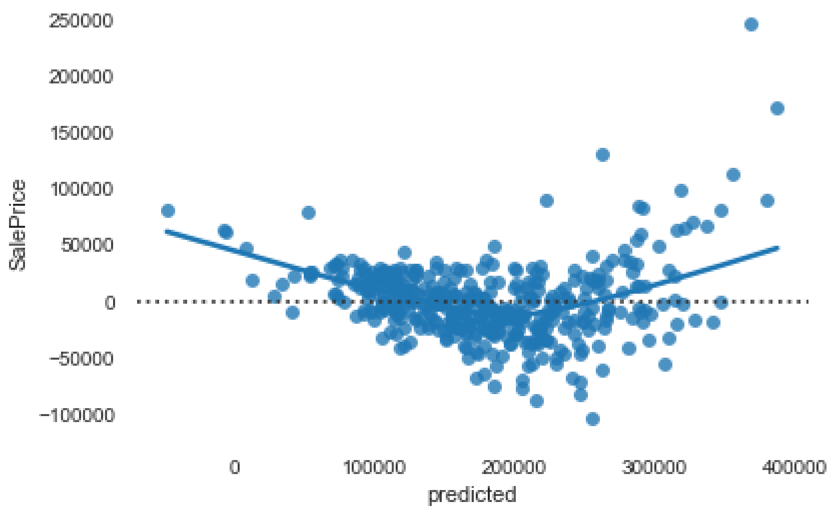
```
Training set score: 0.95
Test set score: 0.88

/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  import sys
/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:14: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```



In [49]:

```
lasso_test=test_data.copy()
lasso_test_res=test_data[['Id']]

from sklearn.linear_model import Lasso
lasso_train_x, lasso_test_x,lasso_train_y,lasso_test_y=train_test_split(train_x,tra
in_y, test_size=.3,random_state=10)
lasso_model = Lasso(alpha=.1, max_iter = 10000,fit_intercept=True,tol=0.01).fit(las
so_train_x,lasso_train_y)
print("Number of features used: {}".format(np.sum(lasso_model.coef_ !=0)))
print("Training set score:" ,lasso_model.score(lasso_train_x,lasso_train_y))
lasso_score=lasso_model.score(lasso_test_x,lasso_test_y)
print("Test set score:" ,lasso_score)
lasso_test_y['predicted']=lasso_model.predict(lasso_test_x)
sns.residplot(lasso_test_y['predicted'],lasso_test_y['SalePrice'],lowess=True)

lasso_np=np.sqrt(mean_squared_error(lasso_test_y['SalePrice'],lasso_test_y['predict
ed']))

lasso_test_res['SalePrice']=lasso_model.predict(lasso_test)
```

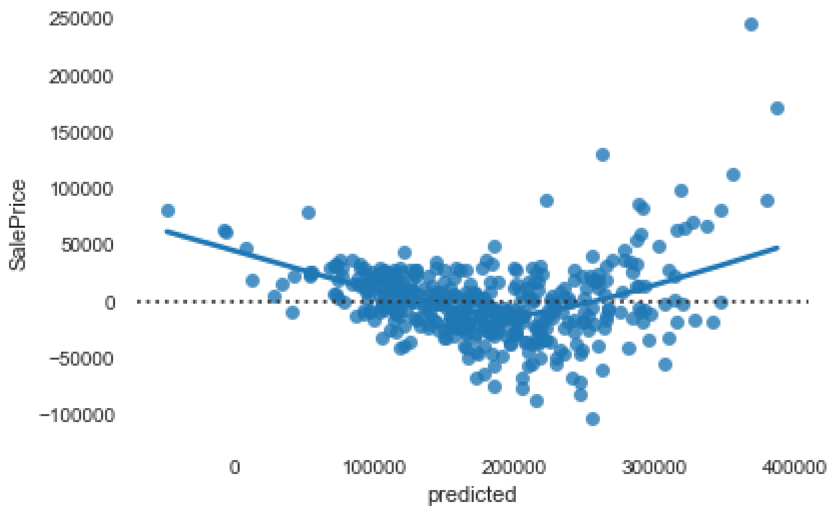
```
Number of features used: 27
Training set score: 0.7887849833262455
Test set score: 0.8129659886345015

/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:11: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  # This is added back by InteractiveShellApp.init_path()
/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:16: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  app.launch_new_instance()
```



In [50]:

```
#ridge regression
ridge_test=test_data.copy()
ridge_test_res=test_data[['Id']]

from sklearn.linear_model import Ridge
ridge_train_x, ridge_test_x,ridge_train_y,ridge_test_y=train_test_split(train_x,tra
in_y, test_size=.3,random_state=10)
ridge_model = Ridge(alpha=1, solver="cholesky",fit_intercept=True).fit(ridge_train_
x,ridge_train_y)
print("Number of features used: {}".format(np.sum(ridge_model.coef_ !=0)))
print("Training set score:" ,ridge_model.score(ridge_train_x,ridge_train_y))
ridge_score=ridge_model.score(ridge_test_x,ridge_test_y)
print("Test set score:" ,ridge_score)
ridge_test_y['predicted']=ridge_model.predict(ridge_test_x)
sns.residplot(ridge_test_y['predicted'],ridge_test_y['SalePrice'],lowess=True)
ridge_np=np.sqrt(mean_squared_error(ridge_test_y['SalePrice'],ridge_test_y['predict
ed']))

ridge_test_res['SalePrice']=ridge_model.predict(ridge_test)
```

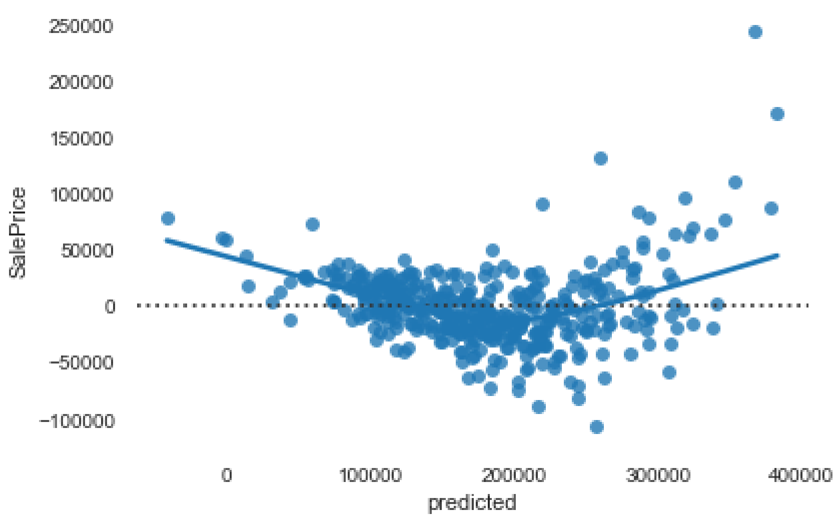
```
Number of features used: 27
Training set score: 0.788784416550699
Test set score: 0.8131303214712008

/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:12: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  if sys.path[0] == '':
/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:16: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  app.launch_new_instance()
```



In [53]:

```
es_test=test_data.copy()
es_test_res=test_data[['Id']]

from sklearn.linear_model import ElasticNet
es_train_x, es_test_x,es_train_y,es_test_y=train_test_split(train_x,train_y, test_s
ize=.3,random_state=10)
es_model = ElasticNet(random_state=1, alpha=0.1,fit_intercept=True,tol=0.01).fit(es
_train_x,es_train_y)
print("Number of features used: {}".format(np.sum(es_model.coef_ !=0)))
print("Training set score:" ,es_model.score(es_train_x,es_train_y))
es_score=es_model.score(es_test_x,es_test_y)
print("Test set score:" ,es_score)
es_test_y['predicted']=es_model.predict(es_test_x)
sns.residplot(es_test_y['predicted'],es_test_y['SalePrice'],lowess=True)
es_np=np.sqrt(mean_squared_error(es_test_y['SalePrice'],es_test_y['predicted']))

es_test_res['SalePrice']=es_model.predict(es_test)
```

```
/Users/avadhani/anaconda3/lib/python3.7/site-packages/sklearn/linear_mo
del/_coordinate_descent.py:531: ConvergenceWarning: Objective did not c
onverge. You might want to increase the number of iterations. Duality g
ap: 671258869385.2974, tolerance: 66374050967.45818
  positive)
/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:11: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  # This is added back by InteractiveShellApp.init_path()
/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:15: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  from ipykernel import kernelapp as app

Number of features used: 27
Training set score: 0.7880790115300065
Test set score: 0.8174549139372843
```



In [56]:

```
des_tree=test_data.copy()
des_tree_res=test_data[['Id']]

# split data using test_train_split
des_x_train,des_x_test,des_y_train,des_y_test=train_test_split(train_x,train_y,test
_size=.3,random_state=10)

#Decision tree
from sklearn.tree import DecisionTreeRegressor  # machine learning tree

tree_model_maker = DecisionTreeRegressor(random_state = 9999, max_depth = 5)


# fit regression tree using model 1 training/test split
tree_model_fit = tree_model_maker.fit(des_x_train, des_y_train)

#print("Number of features used: {}".format(np.sum(tree_model_maker.coef_ !=0)))

tree_score=tree_model_maker.score(des_x_test,des_y_test)

des_y_train['predicted'] = tree_model_fit.predict(des_x_train)
full_tree_train_result = round(np.power(des_y_train['SalePrice'].corr(des_y_train[
'predicted']),2),3)
print('\nFull Tree Proportion of Training Set Variance Accounted for: ',full_tree_t
rain_result)

# compute the proportion of response variance for test data

des_y_test['predicted'] = tree_model_fit.predict(des_x_test)
full_tree_train_result = round(np.power(des_y_test['SalePrice'].corr(des_y_test['pr
edicted']),2),3)
print('\nFull Tree Proportion of Training Set Variance Accounted for: ',full_tree_t
rain_result)

tree_np=np.sqrt(mean_squared_error(des_y_test['SalePrice'],des_y_test['predicted'
]))


des_tree_res['SalePrice']=tree_model_maker.predict(des_tree)
```

```
Full Tree Proportion of Training Set Variance Accounted for:  0.873

Full Tree Proportion of Training Set Variance Accounted for:  0.713

/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:20: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:26: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
/Users/avadhani/anaconda3/lib/python3.7/site-packages/ipykernel_launche
r.py:33: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

In [62]:

```
data={'Model':['Linear','Ridge','Lasso','ElasticNet','Decision Tree','GradientBoos
t'],
      'RMSE':[lin_np,ridge_np,lasso_np,es_np,tree_np,grad_np],
      'Score':[round(lin_score*100,30),round(ridge_score*100,30),
               round(lasso_score*100,30),round(es_score*100,30),
               round(tree_score*100,30),
               round(grad_score*100,30)
              ]
     }
result=pd.DataFrame(data,columns=['Model','RMSE','Score'])
result.sort_values(by='RMSE')
```

Out[62]:

	Model	RMSE	Score
5	GradientBoost	27040.561603	87.518960
3	ElasticNet	32702.080706	81.745491
1	Ridge	33087.178311	81.313032
2	Lasso	33101.723515	81.296599
0	Linear	33101.896616	81.296403
4	Decision Tree	41136.679707	71.114636

In [77]:

```
result.to_csv("submission.csv")
```

In [ ]:

```

```

submission

Id	SalePrice
1461	120836.64818814676
1462	160942.77326224043
1463	184873.13385510867
1464	194758.0024079365
1465	193284.76680408217
1466	172112.49789589652
1467	176406.69460978877
1468	162456.52475293228
1469	182490.81017712774
1470	122818.12608462932
1471	196528.59613622967
1472	94169.55381847931
1473	94258.51487861751
1474	147670.28366322152
1475	112607.72328148005
1476	381447.6943090885
1477	251927.0426714853
1478	285128.8545021899
1479	280870.91167147073
1480	518688.9539986728
1481	316499.22428498295
1482	204981.7067835306
1483	178630.18949332973
1484	164210.72767673328
1485	182144.3530275173
1486	195121.15256743127
1487	345249.8938972267
1488	231244.41394081106
1489	199342.45159414748

1490	236974.31739543067
1491	194457.7881052933
1492	91655.11782999629
1493	174494.1513090954
1494	294947.9582547871
1495	284042.4246968649
1496	239012.54540375536
1497	178614.6867253717
1498	164348.62117456656
1499	158819.58054959914
1500	155694.4611816735
1501	176559.50472496313
1502	142104.89055519336
1503	294628.9079861114
1504	240206.06324593
1505	228171.7498333699
1506	185991.24306553518
1507	255567.36266964642
1508	196230.27348264135
1509	158679.03842631617
1510	144849.35060152764
1511	151798.17502245464
1512	171035.0117112518
1513	143381.98701848838
1514	157023.82408884808
1515	203284.3324512461
1516	149967.4925592457
1517	161372.6611499341
1518	129063.07333491408
1519	217328.67507461802
1520	132499.02912354565
1521	136117.47872963717

1522	172806.005554176
1523	112931.11300154263
1524	125656.461373078
1525	122691.88952110097
1526	112580.011208591
1527	102018.25337583879
1528	132764.2470536191
1529	149038.52176680643
1530	173780.6940118463
1531	103494.444826792
1532	95705.47811664142
1533	147532.49464035616
1534	124282.20416264288
1535	150577.90216550467
1536	107016.40182378245
1537	57191.61634576515
1538	147814.9125245537
1539	197203.82794514744
1540	94375.04627220715
1541	142560.569530372
1542	143588.47597438697
1543	197799.0109074269
1544	82500.92337354738
1545	109730.26103896994
1546	133336.02024545742
1547	135604.09359696467
1548	137274.44651577438
1549	115906.14198258953
1550	135764.06880454437
1551	109621.30584111776
1552	139043.82324854896
1553	154553.14818785936

1554	113204.26226151263
1555	163570.56697123472
1556	85585.35606765846
1557	110174.33715043533
1558	99995.48741631283
1559	67592.65314289894
1560	130086.89808220865
1561	137640.24072296018
1562	130136.24384873349
1563	119880.18008262648
1564	161491.78920061045
1565	147936.79165959702
1566	233497.90855360826
1567	74685.05014612534
1568	232075.85591156944
1569	132185.2685169939
1570	133894.95365244232
1571	120103.56909307072
1572	145790.44061083178
1573	246761.70623305245
1574	115570.78441060711
1575	221502.81526649487
1576	248987.31226058205
1577	185731.49493435194
1578	142386.9909435073
1579	146065.27931105258
1580	192405.3121087636
1581	152715.40914172615
1582	124366.48831744274
1583	308383.0815132928
1584	223806.15474038376
1585	139399.9177770101

1586	67154.5752918953
1587	99852.81532068273
1588	148773.5851411884
1589	100748.92969431632
1590	135122.4614569348
1591	94385.29500707067
1592	118702.81828903248
1593	126004.00608916325
1594	130108.69598930067
1595	107789.5571181866
1596	234892.3542841479
1597	194705.7351880877
1598	216297.68926935387
1599	163676.99912822995
1600	163364.34488229535
1601	62976.688699262464
1602	114787.99069889865
1603	76692.85964096163
1604	261591.90298338025
1605	240675.07453202913
1606	169459.05104549925
1607	170423.71979568826
1608	215362.89869792067
1609	185561.0680405894
1610	150956.9409309456
1611	139867.0946046081
1612	169282.71219105204
1613	166515.00520630123
1614	122271.87344975665
1615	87351.02595141699
1616	74441.16561855526
1617	92130.97794976964

1618	127419.45442833762
1619	139454.2493155578
1620	151135.40048837272
1621	140401.5626239054
1622	141856.31888598402
1623	260339.13247485537
1624	214299.6379042953
1625	119565.19994944813
1626	163352.39973019378
1627	192981.20729533606
1628	270984.0065973604
1629	176333.3160811252
1630	367512.43441668525
1631	221969.01903641177
1632	240024.62398113823
1633	168240.8126941375
1634	187191.47369696238
1635	175543.12862517993
1636	154235.57913730794
1637	201648.58955300495
1638	180824.4569744159
1639	183564.2775046416
1640	253590.12195444579
1641	176944.20822987854
1642	235493.6078895029
1643	216434.95980806812
1644	231799.88872747179
1645	202565.34202727623
1646	158315.9670644639
1647	156338.23706136507
1648	131817.69502295347
1649	140347.13834405039

1650	112630.29626729521
1651	121685.75687306505
1652	95944.66503129344
1653	97964.87508069725
1654	145221.34607838577
1655	140007.02605512776
1656	142185.71995387992
1657	149285.70328056172
1658	142865.86906468132
1659	118593.35465592484
1660	158884.44815628638
1661	459563.6287461878
1662	396768.6495041878
1663	393125.64746865875
1664	519710.9398469794
1665	308915.4725325517
1666	323489.0995796826
1667	385650.7714964621
1668	339915.3029906076
1669	297814.51252013823
1670	352251.71884313616
1671	260813.80920615344
1672	468020.8775898179
1673	288128.84174544853
1674	241550.54251223593
1675	195891.80086071033
1676	194998.45206811832
1677	221267.2880053418
1678	493688.9622833114
1679	388178.311992224
1680	353289.36581017217
1681	247966.25428127887

1682	299654.96327959094
1683	182009.95828128862
1684	171562.16491012037
1685	172030.30817194394
1686	166483.99748392473
1687	167377.81441235528
1688	189639.2682543897
1689	194235.48567851828
1690	194437.29520352595
1691	180689.45724207786
1692	261422.49007007806
1693	166174.86342839067
1694	181145.25866986162
1695	162432.065029031
1696	270457.904836825
1697	167228.24813308287
1698	357435.2464106193
1699	318621.2512570062
1700	254710.08644349725
1701	263760.4580554084
1702	247769.36479179063
1703	243891.37262199103
1704	277009.15983690374
1705	230989.92337403435
1706	438802.35371586605
1707	215909.31742399733
1708	206967.05711591482
1709	266468.78733956366
1710	216289.97261158732
1711	266666.8175245235
1712	259907.80759303298
1713	275931.1865170959

1714	223117.2937100082
1715	206804.18315041377
1716	182891.63937257655
1717	170290.03997851224
1718	134630.87137642535
1719	199501.83408456732
1720	236758.21263985313
1721	165052.46789749467
1722	125263.46696899708
1723	154488.53258528208
1724	210136.5269206205
1725	240010.1867703883
1726	184875.13010686397
1727	159094.71177442351
1728	175302.17158739304
1729	168327.80377470568
1730	155886.0197130488
1731	121396.22487211281
1732	127344.6378109873
1733	118037.33690305584
1734	122121.49166348536
1735	127659.17323309886
1736	111529.17499723252
1737	280662.6715878352
1738	237525.14675685868
1739	266171.0759884806
1740	227445.94015377603
1741	195085.05115324186
1742	174519.09995770227
1743	175440.5636487453
1744	310679.36549172725
1745	222384.412218421

1746	177294.7389255638
1747	212169.96362060437
1748	225615.57910260666
1749	148062.62789585078
1750	126038.7464350779
1751	249643.2177891669
1752	118532.8948398944
1753	149532.7510883439
1754	185953.31448310893
1755	167638.7162492225
1756	127434.04725423292
1757	122201.0597524411
1758	143026.80411099998
1759	163257.5322747114
1760	166212.2674853775
1761	144008.07740812065
1762	179489.88584798685
1763	172120.0144800203
1764	114538.8668231526
1765	168396.24872360472
1766	182098.27866464536
1767	224152.74499446154
1768	144670.9067628761
1769	170548.72363867296
1770	148617.88940814804
1771	124310.26363548054
1772	133810.36254816744
1773	126849.93408507603
1774	139422.87562601766
1775	139059.73329593992
1776	125111.51271590899
1777	115666.0755651742

1778	139378.5067348977
1779	117382.18938495655
1780	173363.86578683485
1781	130313.87833719165
1782	88590.30480468023
1783	143199.65803942122
1784	103922.5384223949
1785	123713.86102507742
1786	132009.45714961994
1787	162843.03097283078
1788	55658.96594338182
1789	94156.39914388905
1790	75670.33726094814
1791	180930.0994481076
1792	162774.17867558997
1793	125630.47025227323
1794	152032.21198232385
1795	133192.78454864683
1796	118317.73257744574
1797	113401.2024892309
1798	122494.06741117351
1799	109608.10735980734
1800	132004.23002465576
1801	129357.31190596995
1802	129546.05344929095
1803	146156.47898100596
1804	142693.35852185523
1805	135225.32747238406
1806	122442.80369279563
1807	127904.71850592457
1808	119152.31483890356
1809	123889.20901594633

1810	140474.51664092872
1811	100605.80950631136
1812	100290.16601073713
1813	122751.74195363995
1814	98267.11024376856
1815	52903.07514862192
1816	99530.98453745224
1817	109621.51068253964
1818	148721.49358147325
1819	120668.09164667418
1820	54537.09380220737
1821	112894.69885446671
1822	150463.74983733436
1823	46900.14821406295
1824	131161.77650298516
1825	131044.4041967179
1826	104458.24950392685
1827	100826.05315961399
1828	134707.13421783043
1829	116983.28350638616
1830	143282.4558427664
1831	142791.79335950644
1832	72909.3682996447
1833	141863.38852469024
1834	118206.25299126784
1835	121589.31131871534
1836	126341.70289298176
1837	89952.2206317079
1838	122118.83571756343
1839	94252.38778507466
1840	148474.27081215286
1841	137155.45448222585

1842	86428.7478107373
1843	127755.8924841136
1844	134086.271311681
1845	138651.52114762465
1846	156139.34799734468
1847	162707.78300653643
1848	53117.68402086589
1849	115650.98962210823
1850	117618.97599491317
1851	157284.07820462767
1852	123883.38679194805
1853	128973.11480631685
1854	171720.607880611
1855	150959.62863328602
1856	221879.85401167514
1857	155622.4867521339
1858	138232.6643679453
1859	117763.88550052776
1860	149845.15959519707
1861	117282.71694642368
1862	304385.3558357046
1863	282696.6871788736
1864	282777.52026391897
1865	333639.4650659029
1866	333519.90469433664
1867	229624.35753536143
1868	301381.5978507059
1869	204393.01236774106
1870	227039.56997246726
1871	247004.7593585877
1872	172370.71636468126
1873	238953.49991963909

1874	148087.56243804065
1875	199992.75185500557
1876	197037.77966827955
1877	210576.87224141447
1878	206553.4089277552
1879	128958.55306083483
1880	132872.49350921944
1881	246917.96159677443
1882	248863.0331601465
1883	188236.61191452865
1884	207568.98470222118
1885	234957.96041675576
1886	289592.26359628
1887	210943.55632959862
1888	271499.9360546469
1889	165468.5448836326
1890	119946.60498450897
1891	130073.95521112252
1892	98786.017970137
1893	132340.2111293729
1894	126584.88645345214
1895	133522.78309950288
1896	126484.12379621298
1897	111681.6856607406
1898	112215.7653770949
1899	156700.9404009163
1900	145070.03355132384
1901	173656.3473983059
1902	152467.81635556786
1903	210132.7866572285
1904	138917.36385767505
1905	196905.54293690668

1906	160288.61951429007
1907	205193.01263731078
1908	109455.04540106177
1909	132909.37806177585
1910	118752.26563093175
1911	221251.8327481307
1912	332498.8465177402
1913	145409.8015193522
1914	59383.61996620319
1915	321464.93403765105
1916	64598.84536123933
1917	247314.72743305212
1918	139155.02911654103
1919	174515.28262701828
1920	152652.3910777053
1921	414649.32794893684
1922	320089.7848219646
1923	229816.6106132259
1924	227020.50269108094
1925	195464.81974995014
1926	389002.12522668054
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