Problem Statement -Part 2

Question 1

What is the optimal value of alpha for ridge and lasso regression? What will be the changes in the model if you choose double the value of alpha for both ridge and lasso? What will be the most important predictor variables after the change is implemented?

1. The optimal value of alpha for ridge and lasso regression

   Ridge Alpha 1

   lasso Alpha 10

Ridge Regression

```
#Change the alpha value from 1 to 2
alpha = 3
ridge2 = Ridge(alpha=alpha)
ridge2.fit(X_train1, y_train)
```

Ridge(alpha=3)

```
# Lets calculate some metrics such as R2 score, RSS and RMSE
y_pred_train = ridge2.predict(X_train1)
y_pred_test = ridge2.predict(X_test1)

metric2 = []
r2_train_lr = r2_score(y_train, y_pred_train)
print(r2_train_lr)
metric2.append(r2_train_lr)
```

```
r2_test_lr = r2_score(y_test, y_pred_test)
print(r2_test_lr)
metric2.append(r2_test_lr)

rss1_lr = np.sum(np.square(y_train - y_pred_train))
print(rss1_lr)
metric2.append(rss1_lr)

rss2_lr = np.sum(np.square(y_test - y_pred_test))
print(rss2_lr)
metric2.append(rss2_lr)

mse_train_lr = mean_squared_error(y_train, y_pred_train)
print(mse_train_lr)
metric2.append(mse_train_lr**0.5)

mse_test_lr = mean_squared_error(y_test, y_pred_test)
print(mse_test_lr)
metric2.append(mse_test_lr**0.5)

#Alpha 1
#R2score(train) 0.884340040460635
#R2score(test)  0.869613280468847
```

**0.8797315810932456 0.8710282148272899 607995142958.1411
320928407278.46216 680845624.8131479 729382743.8146868**

2. R2score on training data has decreased but it has increased on testing data

Lasso

```
#Changed alpha 10 to 20
alpha =20
lasso20 = Lasso(alpha=alpha)
lasso20.fit(X_train1, y_train)
```

Lasso(alpha=20)

```python
# Lets calculate some metrics such as R2 score, RSS and RMSE
y_pred_train = lasso20.predict(X_train1)
y_pred_test = lasso20.predict(X_test1)

metric3 = []
r2_train_lr = r2_score(y_train, y_pred_train)
print(r2_train_lr)
metric3.append(r2_train_lr)

r2_test_lr = r2_score(y_test, y_pred_test)
print(r2_test_lr)
metric3.append(r2_test_lr)

rss1_lr = np.sum(np.square(y_train - y_pred_train))
print(rss1_lr)
metric3.append(rss1_lr)

rss2_lr = np.sum(np.square(y_test - y_pred_test))
print(rss2_lr)
metric3.append(rss2_lr)

mse_train_lr = mean_squared_error(y_train, y_pred_train)
print(mse_train_lr)
metric3.append(mse_train_lr**0.5)

mse_test_lr = mean_squared_error(y_test, y_pred_test)
print(mse_test_lr)
metric3.append(mse_test_lr**0.5)

#R2score at alpha-10
#0.8859222400899005
#0.8646666084570094
```

**0.8854019697956436 0.8670105921065014 579329522996.7144
330925704432.26794 648745266.5136778 752103873.7096999**

R2score of training data has decrease and it has increase on testing data

```
#important predictor variables
betas = pd.DataFrame(index=X_train1.columns)
betas.rows = X_train1.columns
betas['Ridge2'] = ridge2.coef_
betas['Ridge'] = ridge.coef_
betas['Lasso'] = lasso.coef_
betas['Lasso20'] = lasso20.coef_
pd.set_option('display.max_rows', None)
betas.head(68)
```

o/p

Ridge2RidgeLassoLasso20LotArea52892.41850259778.43193963955.06421063617.887669OverallQual106429.293471115599.252408119957.483345121719.072148OverallCond30969.11966435638.74539837354.98181236948.765235YearBuilt53872.88493254545.69231453864.33290653764.548095BsmtFinSF153388.96469251586.6574105021 6.53970150458.153814TotalBsmtSF71811.34855276674.75426478348.09973578209.3335021stFlrSF70196.44340073061.0860638832.8988638244.9581412ndFlrSF33666.88817037149.8793460.0000000.000000GrLivArea83295.30950687839.676484163982.920640162804.680303BedroomAbvGr-38094.981167-52962.603870-62831.358381-61134.170375TotRmsAbvGrd54102.65247852937.95245651280.02369650757.774874Street_Pave34001.15305749959.41242663045.46082559515.001052LandSlope_Sev-17857.132747-27846.862924-37188.510825-29661.614776Condition2_PosN-3031.699352-11908.785655-21920.323877-11645.855795RoofStyle_Shed5474.38381611641.73110217801.4526201966.058339RoofMatl_Metal8130.06899418201.04992932845.68407316580.031007Exterior1st_Stone-17057.383837-37132.047065-69633.615929-59674.587283Exterior2nd_CBlock-15569.072249-32941.699298-60463.906721-49678.514531ExterQual_Gd-49400.503457-54900.543840-58459.152105-57016.336034ExterQual_TA-59179.903853-62317.508218-64902.622534-63508.829030BsmtCond_Po-4343.870481-2488.0397880.000000-0.000000KitchenQual_TA-7060.140437-5437.664855-4495.491440-4450.468043Functional_Maj2-10968.231950-23574.925049-40743.007254-31654.783158SaleType_CWD-16897.367011-27224.575631-35460.118834-30830.830798SaleType_Con13636.66073121036.19375925659.75573921222.403113

- LotArea---------------Lot size in square feet
- OverallQual---------Rates the overall material and finish of the house
- OverallCond--------Rates the overall condition of the house
- YearBuilt-------------Original construction date
- BsmtFinSF1--------Type 1 finished square feet
- TotalBsmtSF------- Total square feet of basement area
- GrLivArea-----------Above grade (ground) living area square feet
- TotRmsAbvGrd----Total rooms above grade (does not include bathrooms)
- Street_Pave--------Pave road access to property
- RoofMatl_Metal----Roof material_Metal

Predictors are same but the coefficent of these predictor has changed

Question 2
You have determined the optimal value of lambda for ridge and lasso regression during the assignment. Now, which one will you choose to apply and why?

Answer:

The r2_score of lasso is slightly higher than lasso for the test dataset so we will choose lasso regression to solve this problem

Question 3
After building the model, you realised that the five most important predictor variables in the lasso model are not available in the incoming data. You will now have to create another model excluding the five most important predictor variables. Which are the five most important predictor variables now?

X_train1

O/P

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	LotArea	OverallQual	OverallCond	YearBuilt	BsmtFinSF1	TotalBsmtSF	1stFlrSF	2ndFlrSF	GrLivArea	BedroomAbvGr	TotRmsAbvGrd	Street_Pave	LandSlope_Sev	Condition2_PosN	RoofStyle_Shed	RoofMatl_Metal	Exterior1st_r2nd	Exterior2nd	ExterQual_Gd	ExterQual_TA	BsmtCond_BlOck	KitchenQual_Po	Functional_Maj2	SaleType_CWD	SaleType_Con
11	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0

index												binary indicators
08	187723	555556	500	932836	000000	288210	170380	460519	407813	500000	444444	
745	0.213431	0.777778	1.000	0.753731	0.262797	0.356207	0.252911	0.955928	0.753286	0.666667	0.888889	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
134	0.208004	0.555556	0.500	0.910448	0.000000	0.285714	0.158661	0.424581	0.377486	0.500000	0.444444	1 0 0 0 0 0 0 0 0 1 0 1 0 0 0
512	0.217344	0.444444	0.500	0.619403	0.238117	0.269495	0.139738	0.000000	0.129424	0.500000	0.222222	1 0 0 0 0 0 0 0 0 1 0 1 0 0 0
43	0.220201	0.444444	0.625	0.746269	0.127971	0.292576	0.166667	0.000000	0.154365	0.500000	0.222222	1 0 0 0 0 0 0 0 0 1 0 1 0 0 0
33	0.258819	0.444444	0.500	0.626866	0.465265	0.436057	0.443959	0.000000	0.411190	0.666667	0.333333	1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0

	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14
269	0.183553	0.555556	0.7500	0.753731	0.343236	0.356519	0.230349	0.000000	0.213347	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
789	0.306036	0.555556	0.875	0.679104	0.259598	0.259513	0.180495	0.689634	0.541625	0.833333	0.666667	1	0	0	0	0	0	0	0	1	0	0	0	0	0
1038	0.001200	0.333333	0.625	0.708955	0.000000	0.170306	0.115721	0.338920	0.291203	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
151	0.354195	0.777778	0.500	0.985075	0.639854	0.533375	0.447598	0.000000	0.414560	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0
344	0.031449	0.444444	0.250	0.753731	0.058958	0.167187	0.020378	0.357542	0.213010	0.500000	0.111111	1	0	0	0	0	0	0	0	1	0	1	0	0	0
1218	0.135651	0.333333	0.500	0.537313	0.000000	0.000000	0.069869	0.148976	0.145602	0.333333	0.000000	1	0	0	0	0	0	0	0	1	0	1	0	0	0

	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11															
1040	0.332315	0.444444	0.375	0.611940	0.076782	0.353712	0.481441	0.000000	0.445905	0.500000	0.555556	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
688	0.188466	0.777778	0.625	0.985075	0.431901	0.442608	0.341703	0.000000	0.316481	0.333333	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1289	0.273473	0.777778	0.5000	0.977612	0.000000	0.338428	0.232897	0.527623	0.502191	0.500000	0.555556	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1459	0.241252	0.444444	0.625	0.671642	0.379342	0.391765	0.282387	0.000000	0.261544	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0
1448	0.293525	0.333333	0.750	0.261194	0.000000	0.174672	0.114993	0.341403	0.291877	0.333333	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
733	0.243052	0.444444	0.625	0.641791	0.271481	0.269495	0.241630	0.000000	0.223795	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0

3	0.230198	0.666667	0.500	0.298507	0.098720	0.235808	0.175036	0.469274	0.416919	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
123	0.182839	0.555556	0.500	0.880597	0.137112	0.373986	0.261645	0.000000	0.242332	0.333333	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
812	0.206261	0.444444	0.500	0.574627	0.000000	0.168434	0.205240	0.000000	0.190091	0.333333	0.111111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1258	0.231255	0.666667	0.500	0.970149	0.299360	0.266999	0.249636	0.000000	0.231210	0.333333	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
929	0.328915	0.666667	0.500	0.910448	0.000000	0.300686	0.186681	0.771570	0.591844	0.666667	0.555556	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
1348	0.420035	0.666667	0.500	0.917910	0.659506	0.462258	0.368996	0.000000	0.341759	0.500000	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0

	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
692	0.705162	0.666667	0.5000	0.850746	0.441042	0.377417	0.275837	0.795158	0.687226	0.666667	0.666667	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1014	0.290582	0.555556	0.5000	0.544776	0.153755	0.337492	0.219068	0.000000	0.228999	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	
412	0.083179	0.666667	0.5000	1.000000	0.264168	0.458515	0.363173	0.000000	0.336367	0.333333	0.444444	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1425	0.263646	0.555556	0.625	0.626866	0.000000	0.390518	0.280932	0.000000	0.260195	0.500000	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
497	0.217915	0.666667	0.625	0.373134	0.150366	0.320025	0.233767	0.426143	0.451665	0.666667	0.555556	1	0	0	0	0	0	0	0	1	0	1	0	0	0	
603	0.048302	0.666667	0.5000	0.962687	0.000000	0.187164	0.042643	0.372469	0.246669	0.333333	0.111111	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0

index	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	i1	i2	i3	i4	i5	i6	i7	i8	i9	i10	i11	i12	i13	i14	i15
3488	0.027336	0.666667	0.5000	0.955224	0.261883	0.238303	0.103348	0.535071	0.386249	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
481	0.295781	0.888889	0.5000	0.955224	0.716179	0.558952	0.477438	0.000000	0.442198	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
484	0.179011	0.444444	0.7500	0.649254	0.268739	0.311603	0.188865	0.000000	0.174924	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
1184	0.960953	0.444444	0.3750	0.665616	0.559907	0.429031	0.399780	0.000000	0.366849	0.500000	0.222222	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
353	0.200777	0.555556	0.8750	0.395522	0.000000	0.194635	0.087336	0.000000	0.080890	0.333333	0.222222	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
1415	0.061241	0.666667	0.5000	0.985055	0.451514	0.432384	0.396208	0.000000	0.367037	0.166667	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0

10000	0.248936	0.222222	0.250	0.574627	0.000000	0.000000	0.168850	0.000000	0.156387	0.333333	0.111111	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5	0.360593	0.444444	0.500	0.880597	0.334552	0.248284	0.114993	0.351335	0.297270	0.166667	0.222222	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	
112	0.242052	0.666667	0.500	0.985075	0.449726	0.394261	0.291849	0.877716	0.746882	0.666667	0.777778	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
465	0.045160	0.666667	0.500	0.962687	0.000000	0.428883	0.339884	0.000000	0.314796	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
859	0.272444	0.555556	0.750	0.694030	0.282907	0.328759	0.375546	0.708886	0.732727	0.666667	0.666667	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
687	0.103231	0.666667	0.500	0.962687	0.109232	0.171865	0.025837	0.342024	0.209639	0.333333	0.111111	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	

	0	1	2	3	4	5	6	7	8	9	10															
1254	0.155389	0.666667	0.500	0.955224	0.000000	0.232689	0.101876	0.556162	0.396360	0.500000	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
783	0.217373	0.444444	0.625	0.768657	0.501371	0.342171	0.229258	0.000000	0.212336	0.166667	0.111111	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
464	0.198206	0.444444	0.500	0.768657	0.281536	0.324392	0.203785	0.000000	0.188743	0.500000	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
1102	0.157360	0.444444	0.750	0.634328	0.268739	0.315034	0.237991	0.000000	0.220425	0.333333	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
1192	0.231626	0.444444	0.875	0.373134	0.000000	0.218964	0.131732	0.391061	0.334344	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
677	0.215116	0.444444	0.875	0.365672	0.000000	0.239551	0.113537	0.000000	0.105157	0.333333	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0

1193	0.085949	0.555556	0.500	0.925373	0.403565	0.381784	0.270742	0.000000	0.250758	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0
841	0.255620	0.444444	0.875	0.216418	0.000000	0.202745	0.173945	0.360646	0.356926	0.500000	0.555556	1	0	0	0	0	0	0	0	1	0	0	0	0	0
252	0.196378	0.555556	0.500	0.962687	0.000000	0.248908	0.115721	0.522657	0.390967	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0
622	0.159188	0.444444	0.625	0.761194	0.255941	0.305777	0.181951	0.000000	0.168520	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
711	0.206261	0.333333	0.750	0.186567	0.000000	0.267935	0.137918	0.198014	0.235254	0.333333	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0
861	0.289468	0.444444	0.375	0.671642	0.384369	0.324080	0.203421	0.000000	0.188406	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0

idx	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15	b16
604	0.323117	0.666667	0.500	0.947761	0.421389	0.466091	0.368996	0.000000	0.341759	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
73	0.248765	0.444444	0.750	0.589552	0.146252	0.338740	0.220524	0.004240	0.204247	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0		
926	0.300151	0.777778	0.5000	0.955224	0.000000	0.368372	0.274381	0.707635	0.638355	0.666667	0.777778	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
75	0.002999	0.333333	0.5000	0.731343	0.211152	0.144105	0.016739	0.286778	0.171217	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0		
1327	0.145934	0.444444	1.0000	0.798507	0.292962	0.254523	0.122271	0.000000	0.113246	0.500000	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
234	0.181668	0.555556	0.5000	0.947761	0.285649	0.268247	0.138282	0.682806	0.498820	0.666667	0.555556	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14
14	0.269331	0.555556	0.5000	0.634338	0.335009	0.390830	0.281295	0.000000	0.260533	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0
686	0.248965	0.666667	0.625	0.985075	0.000000	0.272614	0.143377	0.550590	0.431749	0.500000	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0
882	0.232654	0.555556	0.5000	0.873134	0.000000	0.252027	0.119360	0.487275	0.375126	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0
331	0.190951	0.444444	0.625	0.619403	0.386654	0.329382	0.209607	0.000000	0.194135	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
624	0.254477	0.555556	0.5000	0.723881	0.112888	0.228322	0.193595	0.482930	0.441523	0.666667	0.555556	1	0	0	0	0	0	0	0	1	0	1	0	0	0
578	0.060356	0.666667	0.5000	0.985075	0.000000	0.214910	0.081150	0.427685	0.307381	0.333333	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0

Index																										
1033	0.189494	0.666667	0.500	0.947761	0.450640	0.515908	0.427220	0.000000	0.395686	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1312	0.230826	0.777778	0.500	0.858209	0.220293	0.453213	0.354076	0.842334	0.785305	0.666667	0.666667	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1087	0.259448	0.777778	0.500	0.970149	0.000000	0.337492	0.219068	0.540658	0.496461	0.500000	0.666667	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1392	0.181296	0.444444	0.500	0.686567	0.351463	0.269495	0.152838	0.000000	0.141557	0.500000	0.333333	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
1337	0.107038	0.333333	0.375	0.492537	0.000000	0.216157	0.077511	0.000000	0.071790	0.333333	0.111111	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1383	0.168196	0.444444	0.750	0.320896	0.000000	0.254523	0.340611	0.000000	0.315470	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Index																									
577	0.293810	0.444444	0.625	0.679104	0.149909	0.363669	0.305677	0.000000	0.283114	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
1313	0.379417	0.888889	0.500	0.925373	0.000000	0.434498	0.342795	0.730602	0.714189	0.666667	0.777778	1	0	0	0	0	0	0	1	0	0	0	0	0	0
1413	0.271444	0.777778	0.500	0.970049	0.446169	0.575072	0.496161	0.000000	0.459724	0.333333	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0
1363	0.200177	0.555556	0.500	0.977612	0.000000	0.192140	0.049491	0.494103	0.314122	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	0	0	0	0
10001	0.111657	0.444444	0.625	0.335821	0.000000	0.215533	0.076783	0.000000	0.071116	0.333333	0.111111	1	0	0	0	0	0	0	0	1	0	0	0	0	0
302	0.348853	0.666667	0.500	0.940099	0.000000	0.480661	0.386699	0.000000	0.357600	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0

	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11															
630	0.214488	0.444444	0.625	0.037313	0.000000	0.198378	0.221616	0.410304	0.428042	0.500000	0.555556	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
397	0.174212	0.444444	0.500	0.649254	0.246801	0.269495	0.144105	0.581006	0.448938	0.666667	0.555556	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
2	0.278757	0.666667	0.500	0.940299	0.222121	0.286962	0.160116	0.537554	0.440175	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
6	0.245451	0.777778	0.500	0.962687	0.625686	0.525889	0.441776	0.000000	0.409168	0.500000	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
345	0.141221	0.555556	0.500	0.477612	0.000000	0.303182	0.179039	0.375543	0.369734	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
821	0.128795	0.333333	0.375	0.582090	0.000000	0.291953	0.165939	0.000000	0.153691	0.333333	0.111111	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0

	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11														
1439	0.288297	0.666667	0.625	0.776119	0.143967	0.168122	0.203785	0.425202	0.419616	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
238	0.301037	0.777778	0.5000	0.985075	0.000000	0.528384	0.441776	0.000000	0.409168	0.500000	0.444444	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1021	0.168957	0.666667	0.5000	0.977612	0.312614	0.373986	0.269287	0.000000	0.249410	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0
30	0.200206	0.333333	0.375	0.335821	0.000000	0.202433	0.061499	0.484643	0.282109	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
10199	0.043475	0.666667	0.5000	0.970149	0.007313	0.424828	0.373362	0.000000	0.345804	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0
10744	0.201805	0.666667	0.5000	0.977612	0.000000	0.386775	0.276575	0.000000	0.256151	0.333333	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0

1309	0.161730	0.555556	0.500	0.865672	0.548446	0.398628	0.296215	0.000000	0.274351	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
660	0.311149	0.666667	0.750	0.753731	0.000000	0.247349	0.240902	0.492241	0.490394	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
1125	0.255449	0.333333	0.500	0.597015	0.000000	0.313475	0.191048	0.000000	0.176946	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
742	0.198777	0.666667	0.500	0.932836	0.000000	0.420774	0.316230	0.000000	0.292888	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
284	0.186266	0.555556	0.500	0.873134	0.196527	0.491266	0.398472	0.000000	0.369060	0.333333	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
28	0.423605	0.444444	0.625	0.611940	0.583638	0.462882	0.407569	0.000000	0.377486	0.333333	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0

370	0.189380	0.555556	0.5000	0.932836	0.000000	0.297255	0.172121	0.441346	0.399056	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0
54	0.161187	0.444444	0.5000	0.597015	0.175503	0.119775	0.320235	0.000000	0.296596	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
118	0.310920	0.666667	0.5000	0.858209	0.671846	0.521834	0.443595	0.945376	0.924166	0.833333	0.888889	1	0	0	0	0	0	0	0	1	0	0	0	0	0
1103	0.211917	0.555556	0.625	0.626866	0.299360	0.204304	0.259825	0.000000	0.240647	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
62	0.141421	0.777778	0.5000	0.977612	0.010969	0.427324	0.323872	0.000000	0.299966	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0
1290	0.360507	0.444444	0.7500	0.664179	0.463437	0.359326	0.244541	0.000000	0.226491	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0

236	0.208004	0.666667	0.500	0.962687	0.010968	0.441044	0.339884	0.000000	0.314796	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
133	0.153161	0.777778	0.500	0.940299	0.459324	0.395197	0.296943	0.000000	0.275025	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
760	0.217344	0.555556	0.625	0.626866	0.279707	0.269495	0.139738	0.000000	0.129424	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
646	0.163072	0.444444	0.500	0.559701	0.000000	0.000000	0.206696	0.000000	0.191439	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
81	0.085949	0.555556	0.500	0.917910	0.548903	0.385839	0.311863	0.000000	0.288844	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
1215	0.160045	0.444444	0.500	0.679104	0.082267	0.278852	0.150655	0.000000	0.139535	0.500000	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0

970	0.265903	0.333333	0.375	0.552239	0.000000	0.224579	0.087336	0.292986	0.239973	0.666667	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
50	0.353566	0.555556	0.625	0.910448	0.083181	0.247661	0.114265	0.419615	0.333670	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
1293	0.247051	0.666667	0.5000	0.753731	0.088665	0.259513	0.128093	0.516446	0.399057	0.666667	0.555556	1	0	0	0	0	0	0	0	1	0	1	0	0	0
573	0.242109	0.666667	0.5000	0.932836	0.000000	0.119775	0.106987	0.407200	0.320189	0.500000	0.555556	1	0	0	0	0	0	0	0	1	0	1	0	0	0
11366	0.231626	0.555556	0.5000	0.559701	0.127971	0.321896	0.200873	0.136561	0.260195	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
979	0.209232	0.444444	0.625	0.656716	0.297532	0.349657	0.233261	0.000000	0.216043	0.500000	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0

	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11															
1085	0.216459	0.555556	0.6255	0.873134	0.341408	0.291953	0.187773	0.000000	0.173913	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
584	0.132223	0.333333	0.750	0.447761	0.000000	0.275733	0.185226	0.362508	0.368386	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
510	0.373275	0.444444	0.750	0.567164	0.297075	0.314110	0.321325	0.000000	0.297607	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0
715	0.247051	0.555556	0.5000	0.738806	0.000000	0.331878	0.316594	0.000000	0.293225	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
1247	0.309549	0.555556	0.5000	0.753731	0.246344	0.315658	0.201601	0.000000	0.186721	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
681	0.085949	0.444444	0.5000	0.425373	0.083181	0.247349	0.133916	0.417132	0.350522	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0

67	0.262047	0.666667	0.500	0.955224	0.462980	0.453213	0.363537	0.000000	0.336704	0.500000	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
104	0.179011	0.666667	0.375	0.417910	0.102377	0.324392	0.271470	0.367474	0.450961	0.666667	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
878	0.293953	0.444444	0.750	0.641791	0.410878	0.345914	0.245633	0.000000	0.227503	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
217	0.240367	0.333333	0.375	0.373134	0.000000	0.213974	0.120087	0.321539	0.285811	0.500000	0.555556	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
309	0.310977	0.888889	0.500	0.955224	0.582267	0.591391	0.532751	0.000000	0.493428	0.500000	0.555556	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
394	0.246879	0.444444	0.625	0.485075	0.000000	0.229258	0.092795	0.185599	0.186721	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11															
568	0.309520	0.777778	0.875	0.805970	0.658592	0.466625	0.369723	0.394786	0.556791	0.166667	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
798	0.343540	0.888889	0.500	0.992537	0.000000	0.600749	0.540757	0.728740	0.896528	0.666667	0.888889	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
674	0.220201	0.555556	0.625	0.671642	0.407678	0.354336	0.238719	0.000000	0.221099	0.500000	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	
205	0.295924	0.666667	0.5000	0.858209	0.000000	0.444167	0.350073	0.000000	0.324233	0.500000	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	
122	0.227741	0.555556	0.750	0.619403	0.260512	0.336868	0.218341	0.000000	0.202224	0.500000	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	
966	0.231626	0.444444	0.750	0.485075	0.195612	0.227074	0.180495	0.206083	0.279070	0.333333	0.444444	1	0	0	0	0	0	0	1	0	0	1	0	0	0	

1012	0.259962	0.555556	0.750	0.358209	0.000000	0.187773	0.152838	0.373681	0.344456	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
227	0.010797	0.555556	0.625	0.708955	0.146709	0.150655	0.001092	0.312849	0.170880	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
1166	0.256620	0.777778	0.500	0.992537	0.000000	0.528384	0.441776	0.000000	0.409168	0.500000	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1106	0.253249	0.666667	0.500	0.858209	0.337294	0.283843	0.350073	0.000000	0.324233	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
597	0.069439	0.666667	0.500	0.977612	0.000000	0.392389	0.335517	0.000000	0.310752	0.333333	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
874	0.120798	0.444444	0.625	0.492537	0.000000	0.210855	0.071325	0.282433	0.219414	0.500000	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0

784	0.137365	0.555556	0.625	0.291045	0.000000	0.231441	0.395342	0.460583	0.338389	0.500000	0.666667	1	0	0	0	0	0	0	0	1	0	1	0	0	0
747	0.291611	0.666667	0.750	0.037313	0.000000	0.386775	0.305677	0.819367	0.728008	0.666667	0.555556	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
1324	0.242652	0.777778	0.5000	0.977612	0.000000	0.559888	0.478530	0.000000	0.443209	0.333333	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
206	0.347968	0.444444	0.5000	0.649254	0.000000	0.355583	0.442504	0.000000	0.409842	0.500000	0.555556	1	0	0	0	0	0	0	0	1	0	1	0	0	0
152	0.380245	0.555556	0.5000	0.716418	0.190128	0.257330	0.224527	0.556196	0.509943	0.666667	0.555556	1	0	0	0	0	0	0	0	1	0	1	0	0	0
853	0.302894	0.555556	0.625	0.664179	0.257770	0.351128	0.351164	0.000000	0.325244	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0

	0	1	2	3	4	5	6	7	8	9	10														
90	0.163072	0.333333	0.500	0.559701	0.000000	0.000000	0.203785	0.000000	0.188743	0.333333	0.111111	1	0	0	0	0	0	0	0	1	0	1	0	0	0
1188	0.212631	0.666667	0.500	0.947761	0.000000	0.259201	0.127279	0.514587	0.397708	0.500000	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0
1080	0.272758	0.555556	0.750	0.716418	0.299817	0.392389	0.283115	0.000000	0.262218	0.500000	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0
593	0.084093	0.555556	0.500	0.955224	0.313071	0.264504	0.133916	0.000000	0.124031	0.166667	0.111111	1	0	0	0	0	0	0	1	0	0	0	0	0	0
900	0.167071	0.333333	0.625	0.716418	0.147163	0.267623	0.137555	0.000000	0.127401	0.333333	0.111111	1	0	0	0	0	0	0	0	1	0	1	0	0	0
527	0.384387	0.888889	0.500	0.992537	0.607861	0.452901	0.362445	0.767846	0.752612	0.500000	0.888889	1	0	0	0	0	0	0	0	0	0	0	0	0	0

	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11															
183	0.283784	0.666667	0.500	0.955224	0.000000	0.424828	0.320961	0.446927	0.539939	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
276	0.220086	0.666667	0.500	0.955224	0.000000	0.486588	0.393013	0.000000	0.364004	0.500000	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
340	0.362764	0.777778	0.500	0.947761	0.000000	0.301622	0.186681	0.567970	0.481294	0.666667	0.666667	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
10422	0.111114	0.555556	0.500	0.970149	0.411335	0.407361	0.300582	0.000000	0.278396	0.166667	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
10500	0.214288	0.666667	0.500	0.985075	0.000000	0.406114	0.299127	0.000000	0.277048	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
368	0.180211	0.444444	0.625	0.589552	0.246801	0.395658	0.286754	0.000000	0.265558	0.333333	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0

	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14
1109	0.293067	0.555556	0.625	0.761194	0.322212	0.575171	0.496360	0.000000	0.459724	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0
891	0.276872	0.555556	0.500	0.768657	0.103291	0.286338	0.159389	0.474860	0.405460	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0
825	0.380245	1.000000	0.500	0.985077	0.747715	0.648160	0.583697	0.000000	0.540613	0.333333	0.444444	1	0	1	0	0	0	0	0	0	0	0	0	0	0
1097	0.106298	0.777778	0.500	0.828358	0.000000	0.334997	0.221252	0.000000	0.204921	0.333333	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0
1034	0.137507	0.444444	0.750	0.470149	0.000000	0.286962	0.172489	0.000000	0.159757	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	0	0	0	0
935	0.123797	0.333333	0.500	0.380597	0.000000	0.187149	0.097162	0.000000	0.089990	0.166667	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0

Index																										
1304	0.053472	0.666667	0.500	0.962687	0.000000	0.304429	0.180495	0.454376	0.413886	0.500000	0.444444	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1388	0.382787	0.888889	0.500	0.977612	0.603291	0.544609	0.460699	0.000000	0.426694	0.500000	0.444444	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1321	0.146705	0.222222	0.625	0.552239	0.000000	0.000000	0.087336	0.000000	0.080890	0.333333	0.111111	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
334	0.215687	0.555556	0.500	0.917910	0.378428	0.294136	0.168486	0.431409	0.390293	0.500000	0.444444	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
1454	0.171642	0.666667	0.500	0.962687	0.187384	0.380845	0.269651	0.000000	0.249747	0.333333	0.333333	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
425	0.053900	0.666667	0.875	0.529851	0.000000	0.203057	0.082606	0.423340	0.306370	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0

260	0.508584	0.555556	0.500	0.649254	0.307130	0.424828	0.328239	0.000000	0.304011	0.500000	0.333333	1	0	0	0	0	0	0	0	1	0	1	0	0	0
1107	0.621726	0.666667	0.500	0.977612	0.000000	0.270742	0.148108	0.703911	0.519380	0.500000	0.666667	1	0	0	0	0	0	0	1	0	0	0	0	0	0
972	0.182839	0.555556	0.500	0.776119	0.000000	0.286338	0.159389	0.000000	0.147624	0.333333	0.222222	1	0	0	0	0	0	0	0	1	0	1	0	0	0
338	0.361450	0.666667	0.750	0.813433	0.097349	0.376794	0.415211	0.000000	0.384564	0.500000	0.555556	1	0	0	0	0	0	0	1	0	0	0	0	0	0
1401	0.169214	0.555556	0.500	0.962687	0.346892	0.261697	0.139738	0.452514	0.375126	0.500000	0.555556	1	0	0	0	0	0	0	0	1	0	1	0	0	0
1187	0.313348	0.777778	0.500	0.888060	0.665448	0.506550	0.416303	0.000000	0.385575	0.333333	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
277	0.504070	0.333333	0.500	0.567164	0.054845	0.269495	0.130738	0.000000	0.129442	0.333333	0.111111	1	0	0	0	0	0	0	0	1	0	1	0	0	0
1036	0.325831	0.888889	0.500	0.985075	0.467093	0.505303	0.414847	0.000000	0.384226	0.333333	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0
1016	0.296838	0.666667	0.500	0.902985	0.315356	0.469120	0.372635	0.000000	0.345130	0.500000	0.333333	1	0	0	0	0	0	0	1	0	0	0	0	0	0
80	0.328744	0.555556	0.625	0.694030	0.204753	0.279476	0.255459	0.595903	0.560162	0.666667	0.555556	1	0	0	0	0	0	0	0	1	0	0	0	0	0
106	0.265903	0.333333	0.750	0.074627	0.000000	0.199938	0.206332	0.000000	0.191102	0.333333	0.333333	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
767	0.314691	0.555556	0.750	0.485075	0.301645	0.306613	0.183042	0.476102	0.428042	0.666667	0.444444	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0

idx	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10	n11	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
36	0.267588	0.444444	0.500	0.888060	0.000000	0.342171	0.224527	0.000000	0.207954	0.500000	0.333333	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
1049	0.274472	0.333333	0.750	0.529851	0.000000	0.000000	0.163755	0.000000	0.151668	0.333333	0.333333	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
491	0.228484	0.555556	0.750	0.492537	0.184186	0.251404	0.173945	0.384854	0.370071	0.500000	0.222222	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
487	0.307121	0.444444	0.625	0.716418	0.456124	0.462882	0.365357	0.000000	0.338389	0.500000	0.444444	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
1122	0.212374	0.333333	0.250	0.604478	0.000000	0.209607	0.174672	0.000000	0.161780	0.500000	0.222222	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
790	0.048302	0.666667	0.500	0.970149	0.007313	0.357143	0.241994	0.000000	0.224132	0.333333	0.222222	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0

index	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	one-hot columns
1382	0.163072	0.666667	0.750	0.335821	0	0.185901	0.188501	0.474240	0.432086	0.666667	0.555556	1 0 0 0 0 0 0 0 1 0 0 0 0 0 0
86	0.297638	0.555556	0.500	0.970149	0	0.213356	0.074262	0.543764	0.364000	0.500000	0.333333	1 0 0 0 0 0 0 0 1 0 0 0 0 0 0
95	0.236339	0.555556	0.875	0.880597	0.141682	0.212102	0.072780	0.490379	0.333670	0.500000	0.333333	1 0 0 0 0 0 0 0 0 0 0 1 0 0 0
744	0.111514	0.777778	0.500	0.880597	0.335009	0.417031	0.311863	0	0.288844	0.333333	0.222222	1 0 0 0 0 0 0 1

y_train

1108	181000
745	299800
1134	169000
512	129900
43	130250
33	165500
269	148000
789	187500
1038	97000
151	372402
344	85000
1218	80500

1040	155000
688	392000
1289	281000
1459	147500
1448	112000
733	131400
3	140000
123	153900
812	55993
1258	190000
929	222000
1348	215000
692	335000
1014	119200
412	222000
1425	142000
497	184000
603	151000
348	154000
481	374000
484	132500
1184	186700
353	105900
1415	175900
1000	82000
5	143000
112	383970
465	178740
859	250000
687	148800
1254	165400
783	165500
464	124000
1102	135000
1192	125000
677	109500
1193	165000
841	157500
252	173000
622	135000
711	102776
861	131500
604	221000
73	144900
926	285000
75	91000
1327	130500
234	216500
14	157000
686	227875

882	178000
331	139000
624	165150
578	146000
1033	230000
1312	302000
1087	252000
1392	123000
1337	52500
1383	112000
577	164500
1313	333168
1413	257000
1363	156932
1001	86000
302	205000
630	124000
397	169500
2	223500
6	307000
345	140200
821	93000
1439	197000
238	318000
1021	194000
30	40000
1019	213490
1074	194000
1309	179200
660	197900
1125	115000
742	179000
284	179200
28	207500
370	172400
54	130000
118	320000
1103	159500
62	202500
1290	180500
236	185500
133	220000
760	127500
646	98300
81	153500
1215	125000
970	135000
50	177000
1293	162900
573	170000

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979	139000
1085	147000
584	133000
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715	165000
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681	159434
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104	169500
878	148000
217	107000
309	360000
394	109000
568	316600
798	485000
674	140000
205	180500
122	136000
966	160000
1012	165000
227	106000
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1106	179900
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747	265979
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1080	145000
593	140000
900	110000
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276	201000
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891	172500
825	385000
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116	139000
665	230500
726	222000
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69	225000
310	165600
892	154500
264	73000
247	140000
161	412500
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648	155000
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730	236500
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1126	174000
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286	159000
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235	89500
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799	175000
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194	127000
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800	200000
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208	277000
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757	158900
120	180000
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620	67000
875	303477
1455	175000
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1109	280000
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963	239000
1223	137900
930	201000
650	205950
68	80000
301	267000
1183	120000
1371	165500
307	89500
1320	156500
759	290000
403	258000
1343	177000
40	160000
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1177	115000
723	135000
980	178400
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599	151000
1167	173000
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806	135500
214	161750
500	113000
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796	143500
460	263435
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1160	146000
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1029	118000
607	225000
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925	175000
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1104	106000
467	146500
755	172500
596	114504
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739	190000
754	156000
1287	190000
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1429	182900
177	172500
1366	193000
285	164700
1141	197500
369	162000
1372	274300
18	159000
564	268000
358	130000
839	130500

663	137500
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1197	144000
1007	88000
997	185000
245	241500
202	112000
1055	180000
111	180000
918	238000
826	109500
571	120000
832	237000
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801	109900
1212	113000
1353	410000
667	193500
1242	170000
374	219500
473	440000
1068	151400
240	262500
1004	181000
226	290000
1270	260000
1191	174000
105	250000
1093	146000
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1274	139000
314	178000
761	100000
96	214000
476	208900
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171	215000
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632	82500
489	86000
770	134900
211	186000
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1227	147000
975	165000
261	276000

535	107500
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611	148000
130	226000
695	176000
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999	206000
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860	189950
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117	155000
693	108480
404	168000
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902	180000
957	132000
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383	76000
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1089	197000
967	135000
845	171000
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4	250000
675	148500
623	168500

59	124900
291	135900
1308	147000
1331	132500
485	147000
1101	119500
1217	229456
856	147000
919	176500
1303	232000
756	212000
337	214000
375	61000
1297	140000
347	157500
166	190000
138	230000
1435	174000
626	139900
762	215200
725	120500
57	196500
1147	174500
794	194500
915	75000
515	402861
1069	135000
714	130500
436	116000
560	121500
354	140000
22	230000
749	98000
38	109000
994	337500
907	250000
1310	335000
445	127500
1015	227000
588	143000
827	189000
273	139000
858	152000
537	111250
172	239000
1058	335000
938	239799
682	173000
750	96500
621	240000

1390	235000
20	325300
141	260000
1022	87000
1078	155900
1432	64500
213	156000
1091	160000
1426	271000
662	110000
203	149000
333	207000
545	229000
1360	189000
1224	184000
1210	189000
566	325000
522	159000
175	243000
19	139000
598	217500
719	128500
1200	116050
1118	140000
1225	145000
1056	185850
1374	250000
312	119900
872	116000
250	76500
29	68500
479	89471
1420	179900
254	145000
41	170000
818	155000
1144	80000
514	96500
1248	129500
1434	160000
752	217000
1341	155000
697	123500
1263	180500
1221	134000
1325	55000
876	132250
178	501837
1053	144500
901	153000

1241	248328
968	37900
1006	163500
169	228000
1335	167900
558	175000
1226	214000
115	176000
641	226000
1294	115000
60	158000
168	183500
440	555000
230	148000
1380	58500
10	129500
1113	134500
1159	185000
496	430000
281	185000
988	195000
1277	197900
971	173000
1378	83000
680	143000
379	179000
1255	127500
290	233230
167	325624
517	265000
698	138500
1445	129000
1375	239000
602	220000
1023	191000
536	188000
1318	275000
162	220000
439	110000
1051	200141
1370	105000
720	275000
508	161000
209	145000
664	423000
159	320000
820	183000
1079	126000
220	204900
974	167500

308	82500
324	242000
1326	79000
437	119000
135	174000
225	112000
917	135000
274	124500
1419	223000
1373	466500
1261	128900
421	215000
939	244400
242	79000
699	196000
1	181500
124	181000
763	337000
1395	281213
1048	115000
1286	143000
1316	295493
483	164000
1243	465000
724	320000
1334	125000
351	190000
709	109900
776	221500
1070	135000
684	221000
689	194700
1424	144000
1346	262500
870	109500
704	213000
1111	205000
608	359100
746	236000
629	168500
1213	145000
1295	138500
574	139000
1158	235128
592	138000
1307	138000
817	271000
1351	171000
532	107500
107	115000

1119	133700
615	137500
811	144500
952	133900
982	159895
1137	94000
229	192500
429	175000
869	236000
961	272000
434	81000
837	100000
1339	128500
1127	259000
700	312500
668	168000
1057	248000
793	225000
748	260400
110	136900
880	157000
444	210000
551	112500
1172	171900
1155	218000
1024	287000
852	164000
223	97000
149	115000
1150	124000
44	141000
1116	184100
255	230000
414	228000
318	260000
459	110000
428	195400
647	155000
1271	185750
1190	168000
708	179540
1260	181000
569	135960
71	129500
16	149000
1291	119500
1164	194000
540	315000
415	181134
210	98000

834	139950
239	113000
865	148500
1178	154900
969	140000
371	134432
787	233000
326	324000
1115	318000
499	120000
893	165000
298	175000
1094	129000
224	386250
179	100000
797	110000
438	90350
768	216837
1236	175500
617	105500
1120	118400
1124	163900
1208	140000
228	125000
37	153000
847	133500
557	108000
1437	394617
103	198900
989	197000
616	183200
849	187000
268	120500
15	132000
349	437154
655	88000
424	139000
184	127000
923	193000
23	129900
707	254000
1262	161500
912	88000
1385	125500
614	75500
1423	274970
751	162000
1054	255000
212	252678
1073	159500

```
765     264132
559     234000
1185    104900
519     234000
944     137500
816     137000
280     228500
24      154000
503     289000
1296    155000
305     305900
1052    165000
1329    176500
422     113000
881     187500
377     340000
840     140000
145     130000
962     155000
1228    367294
98       83000
364     190000
1355    170000
511     202665
134     180000
1143     80000
1199    148000
1237    195000
1418    124000
949     197500
1233    142000
Name: SalePrice, dtype: int64
```

```
X_train1.columns
```

O/P

```
Index(['LotArea', 'OverallQual', 'OverallCond', 'YearBuilt', 'BsmtFinSF1',
       'TotalBsmtSF', '1stFlrSF', '2ndFlrSF', 'GrLivArea', 'BedroomAbvGr',
       'TotRmsAbvGrd', 'Street_Pave', 'LandSlope_Sev', 'Condition2_PosN',
       'RoofStyle_Shed', 'RoofMatl_Metal', 'Exterior1st_Stone', 'Exterior2nd_CBlock',
       'ExterQual_Gd', 'ExterQual_TA', 'BsmtCond_Po', 'KitchenQual_TA',
       'Functional_Maj2', 'SaleType_CWD', 'SaleType_Con'], dtype='object')
```

LotArea,OverallQual,YearBuilt,BsmtFinSF1,TotalBsmtSF are the top 5 important predictors.

Let's drop these columns

```
X_train2 =
X_train1.drop(['LotArea','OverallQual','YearBuilt','BsmtFinSF1','TotalBsmtSF'],axis=1)
X_test2 =
X_test1.drop(['LotArea','OverallQual','YearBuilt','BsmtFinSF1','TotalBsmtSF'],axis=1)

X_train2.head()
```

O/P

OverallCond1stFlrSF2ndFlrSFGrLivAreaBedroomAbvGrTotRmsAbvGrdStreet_PaveLandSlope_SevCondition2_Pos NRoofStyle_ShedRoofMatl_MetalExterior1st_StoneExterior2nd_CBlockExterQual_GdExterQual_TABsmtCond_PoKit chenQual_TAFunctional_Maj2SaleType_CWDSaleType_Con11080.5000.1703060.4605830.4078190.5000000.4444 44100000001010007451.0000.2529110.9559280.7532860.6666670.888889100000000000011340.5000.1586610.4 245810.3774860.5000000.4444441000000010100005120.5000.1397380.0000000.1294240.5000000.2222221000000 0101000430.6250.1666670.0000000.1543650.5000000.22222210000000101000

```
X_test2.head()
```

O/P

OverallCond1stFlrSF2ndFlrSFGrLivAreaBedroomAbvGrTotRmsAbvGrdStreet_PaveLandSlope_SevCondition2_Pos NRoofStyle_ShedRoofMatl_MetalExterior1st_StoneExterior2nd_CBlockExterQual_GdExterQual_TABsmtCond_PoKit chenQual_TAFunctional_Maj2SaleType_CWDSaleType_Con9900.500.3373360.6114210.6444220.50.44444410000 001000000011610.750.4221250.0000000.3909670.50.44444410000001000000013690.500.4323140.0000000.400404 0.50.55555610000001000003290.500.0422130.3699570.2399730.50.33333310000001010002620.750.2663760.0 000000.2467140.50.33333310000000101000

```
# Lasso

# alpha 10
alpha =10
lasso21 = Lasso(alpha=alpha)
lasso21.fit(X_train2, y_train)

Lasso(alpha=10)


# Lets calculate some metrics such as R2 score, RSS and RMSE
y_pred_train = lasso21.predict(X_train2)
```

```
y_pred_test = lasso21.predict(X_test2)

metric3 = []
r2_train_lr = r2_score(y_train, y_pred_train)
print(r2_train_lr)
metric3.append(r2_train_lr)

r2_test_lr = r2_score(y_test, y_pred_test)
print(r2_test_lr)
metric3.append(r2_test_lr)

rss1_lr = np.sum(np.square(y_train - y_pred_train))
print(rss1_lr)
metric3.append(rss1_lr)

rss2_lr = np.sum(np.square(y_test - y_pred_test))
print(rss2_lr)
metric3.append(rss2_lr)

mse_train_lr = mean_squared_error(y_train, y_pred_train)
print(mse_train_lr)
metric3.append(mse_train_lr**0.5)

mse_test_lr = mean_squared_error(y_test, y_pred_test)
print(mse_test_lr)
metric3.append(mse_test_lr**0.5)
#R2score at alpha-10
#0.8859222400899005
#0.8646666084570094
```

o/p

0.7988346707068132 0.758810320925813 1016954777102.8657 600167078819.8159
1138807141.2126155 1364016088.2268543

R2score of training and testing data has decreased

```
#important predictor variables
betas = pd.DataFrame(index=X_train2.columns)
betas.rows = X_train1.columns
```

```
betas['Lasso21'] = lasso21.coef_
pd.set_option('display.max_rows', None)
betas.head(68)
```

	Lasso21
OverallCond	7403.774043
1stFlrSF	163379.262938
2ndFlrSF	12227.759048
GrLivArea	186638.919740
BedroomAbvGr	-71218.036474
TotRmsAbvGrd	41610.305613
Street_Pave	101376.262107
LandSlope_Sev	-40205.679947
Condition2_PosN	0.000000
RoofStyle_Shed	53262.728685
RoofMatl_Metal	84219.173436
Exterior1st_Stone	-124162.644239
Exterior2nd_CBlock	-139534.253019
ExterQual_Gd	-77170.982079
ExterQual_TA	-108569.936019
BsmtCond_Po	-122646.594039

	Lasso21
KitchenQual_TA	-11135.858324
Functional_Maj2	-48462.215856
SaleType_CWD	-64725.438438
SaleType_Con	52937.625483

five most important predictor variables

- **11stFlrSF-----------First Floor square feet**
- **GrLivArea-----------Above grade (ground) living area square feet**
- **Street_Pave---------Pave road access to property**
- **RoofMatl_Metal------Roof material_Metal**
- **RoofStyle_Shed------Type of roof(Shed)**

Question 4
How can you make sure that a model is robust and generalisable? What are the implications of the same for the accuracy of the model and why?

Answer

The model should be generalized so that the test accuracy is not lesser than the training score. The model should be accurate for datasets other than the ones which were used during training. Too much importance should not given to the outliers so that the accuracy predicted by the model is high. To ensure that this is not the case, the outliers analysis needs to be done and only those which are relevant to the dataset need to be retained. Those outliers which it does not make sense to keep must be removed from the dataset. If the model is not robust, It cannot be trusted for predictive analysis.