MIDS W207

Final Project

Kaggle - House Prices Advanced Regression

Fall 2021

Parham Motameni (pmotameni@berkeley.edu)
Radia Wahab (radiawahab@berkeley.edu)
Jun Qian (junqian@berkeley.edu)

Instructor: Uri Schonfeld

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Introduction

Description of Data and Data Source

The Ames Housing dataset was compiled by **Dean De Cock**, with 79 explanatory variables describing (almost) every aspect of residential homes in Ames, Iowa.

This data set (https://www.kaggle.com/c/house-prices-advanced-regression-techniques) is being used for this project to demonstrate the use of various Machine Learning techniques, to be able to have the algorithm perform the difficult task of deciding what the house price should be.

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Model Exploration

Full Workflow

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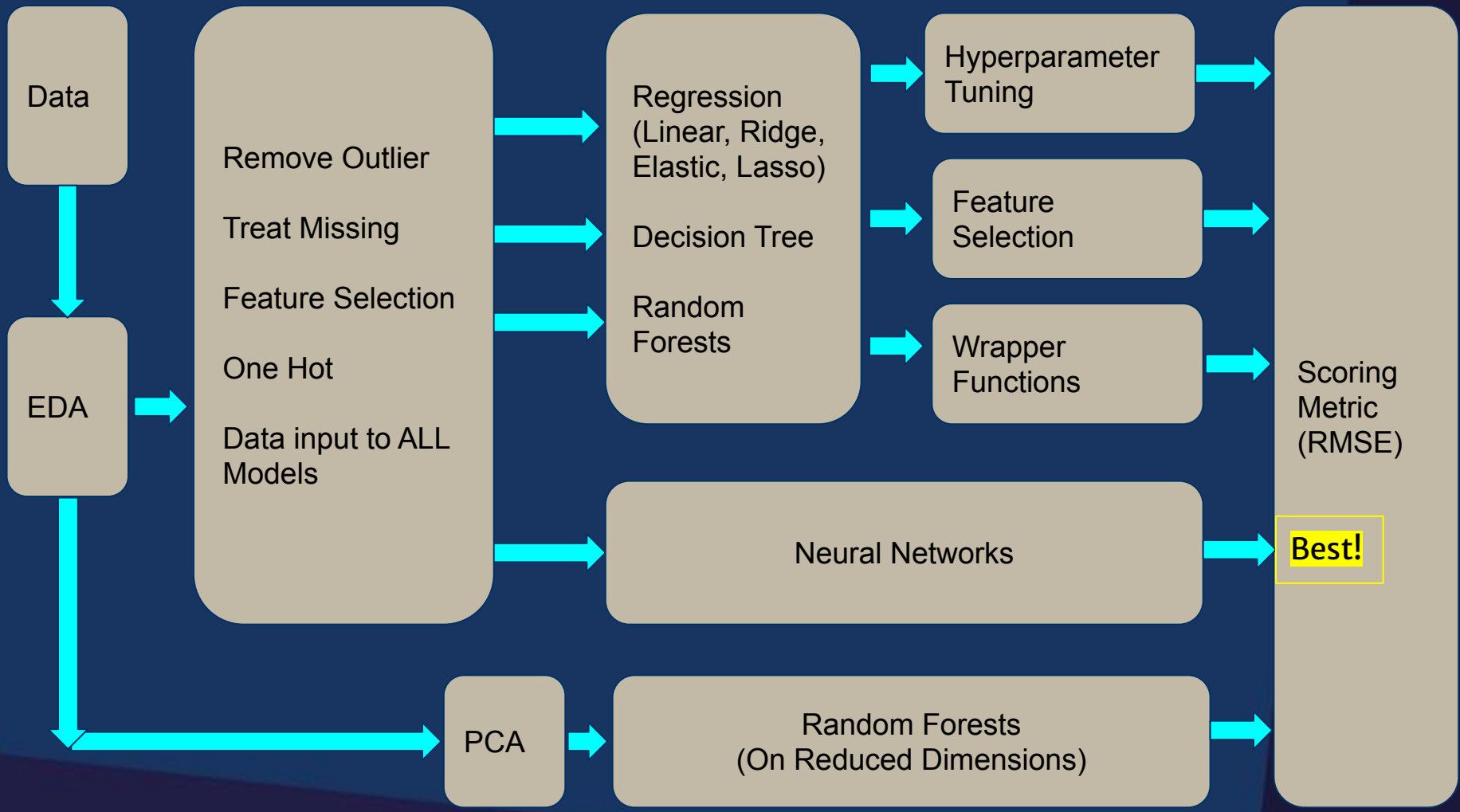
Model Exploration



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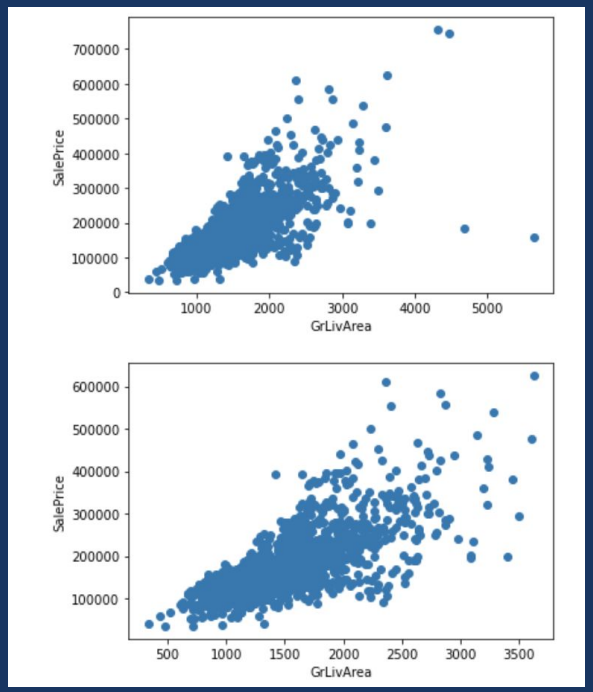
Exploratory Data Analysis



1. Data_Description.txt
2. The paper where the original data was published
3. Reviewing House Price Websites for Subject Matter

Ames, Iowa: Alternative to the Boston Housing Data as an End of Semester Regression Project

Dean De Cock
Truman State University

Journal of Statistics Education Volume 19, Number 3(2011),
www.amstat.org/publications/jse/v19n3/decock.pdf

Potential Pitfalls (Outliers): Although all known errors were corrected in the data, no observations have been removed due to unusual values and all final residential sales from the initial data set are included in the data presented with this article. There are five observations that an instructor may wish to remove from the data set before giving it to students (a plot of SALE PRICE versus GR LIV AREA will quickly indicate these points). Three of them are true outliers (Partial Sales that likely don't represent actual market values) and two of them are simply unusual sales (very large houses priced relatively appropriately). I would recommend removing any houses with more than 4000 square feet from the data set (which eliminates these five unusual observations) before assigning it to students.

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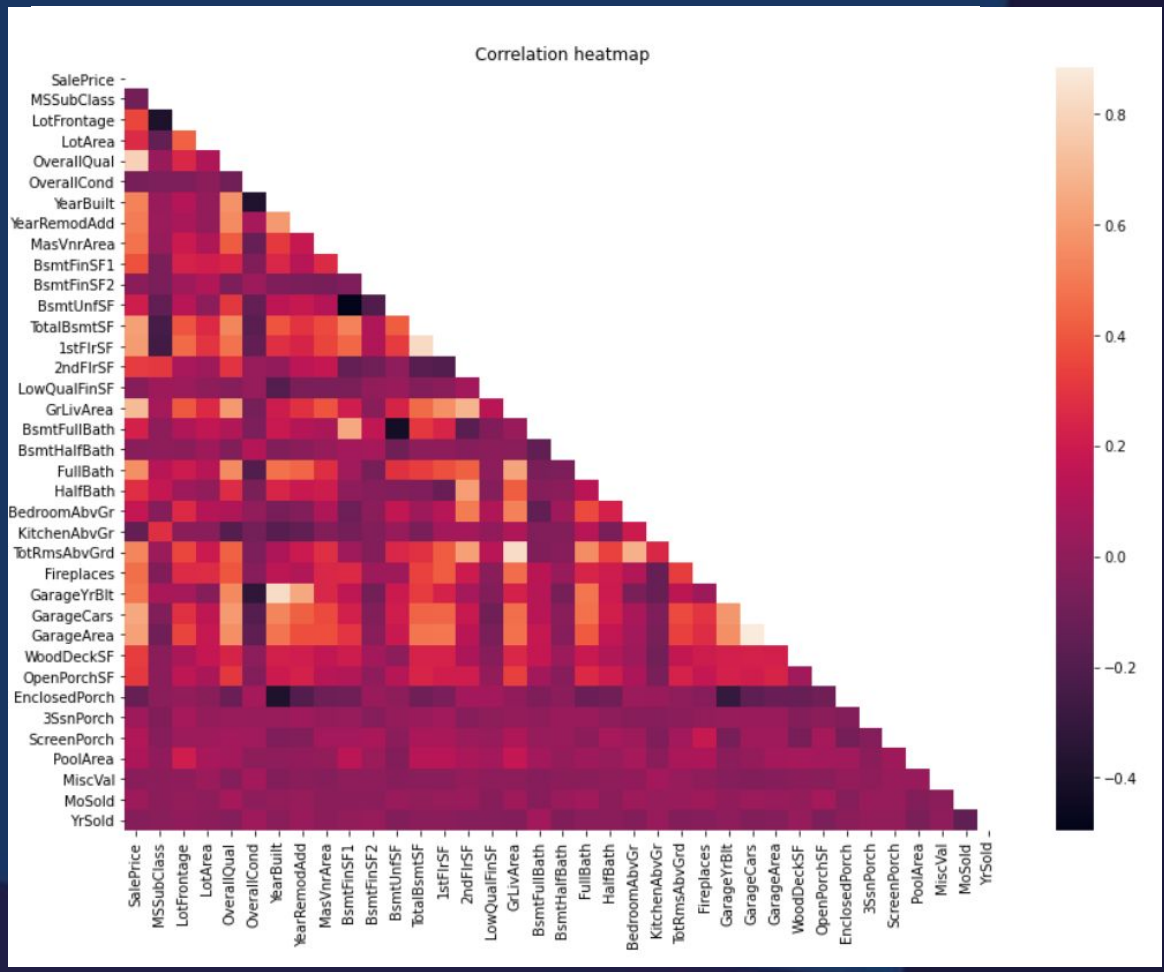
Exploratory Data Analysis

Numerical Variables

- Distribution Analysis
- Correlation Analysis



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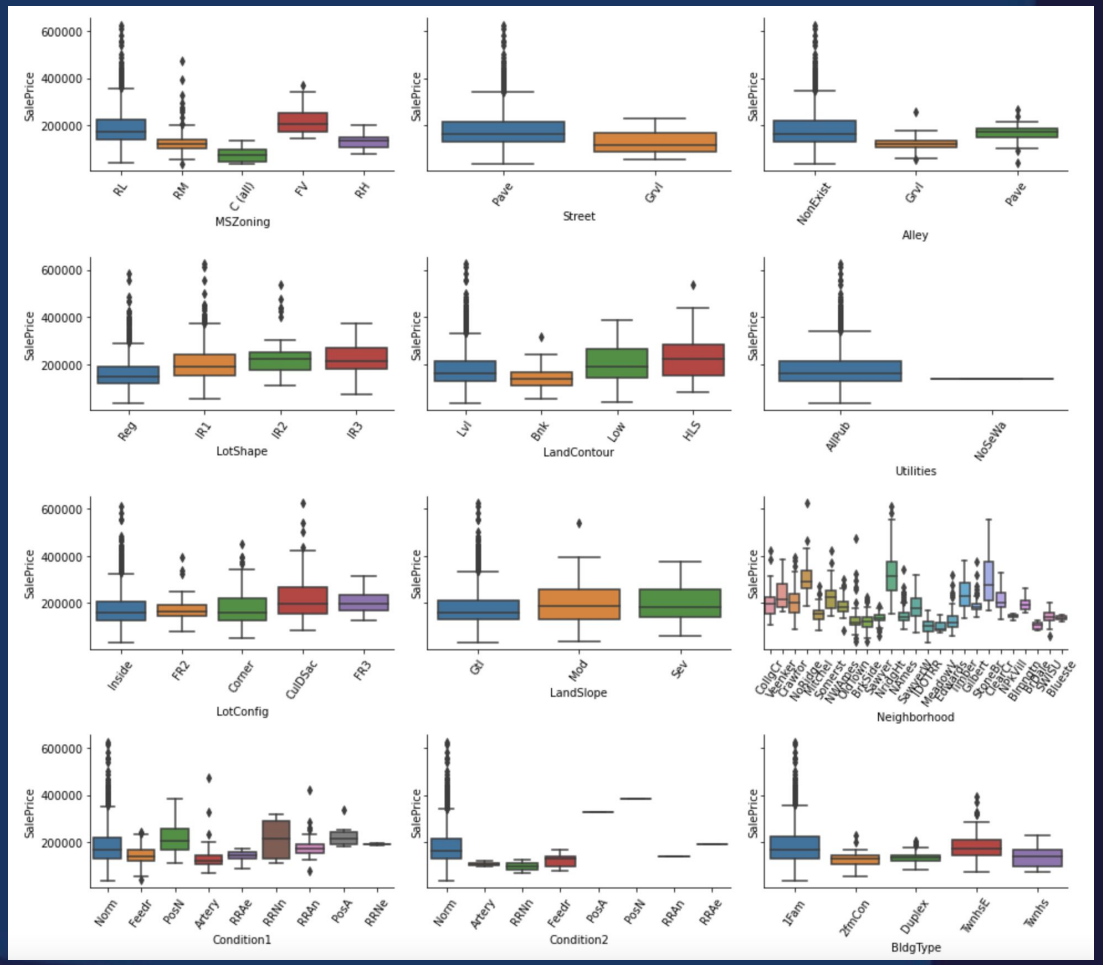
Exploratory Data Analysis

Categorical Variables



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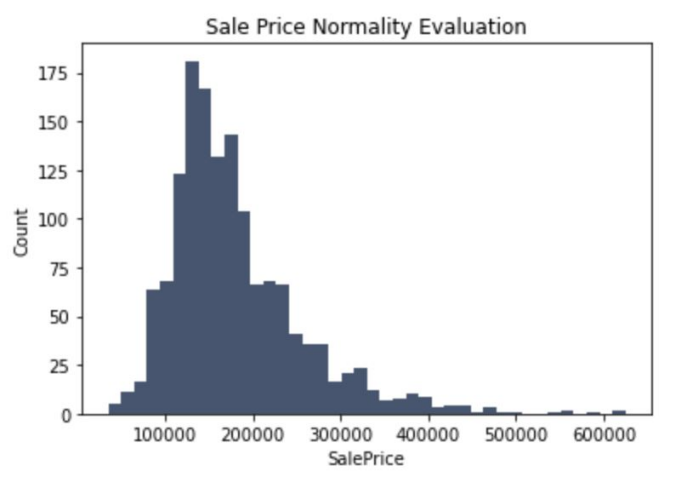
Exploratory Data Analysis

1. Normality of Target Variable
2. Check for Missing Values
3. All our EDA fed into the next steps of Data preparation



	Missing Values	Percentage Missing
PoolQC	1451	99.656593
MiscFeature	1402	96.291209
Alley	1365	93.750000
Fence	1176	80.769231
FireplaceQu	690	47.390110
LotFrontage	259	17.788462
GarageYrBlt	81	5.563187
GarageQual	81	5.563187
GarageFinish	81	5.563187
GarageType	81	5.563187
GarageCond	81	5.563187
BsmtExposure	38	2.609890
BsmtFinType2	38	2.609890
BsmtFinType1	37	2.541209
BsmtCond	37	2.541209
BsmtQual	37	2.541209
MasVnrArea	8	0.549451
MasVnrType	8	0.549451
Electrical	1	0.068681

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Regression and Hyperparameter Tuning

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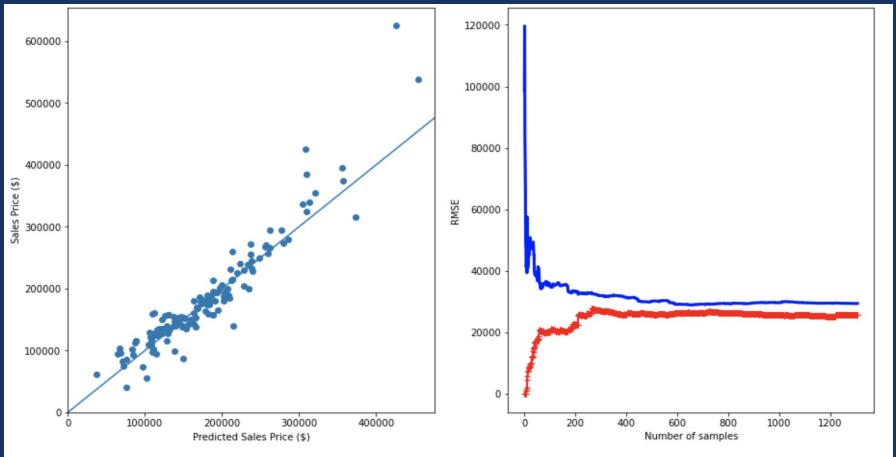
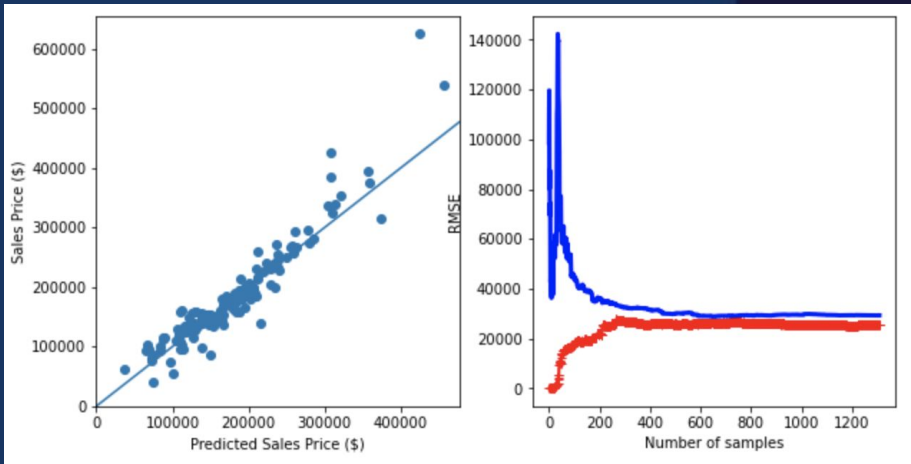
Hyperparameter Tuning

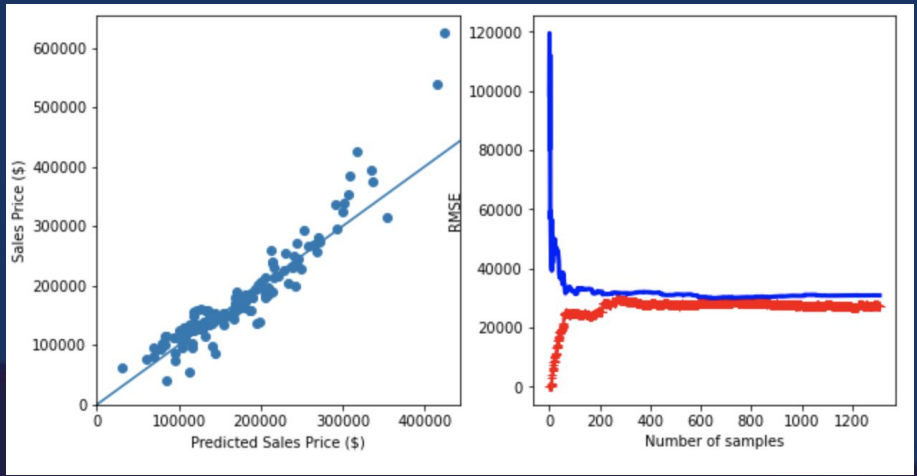
Ridge Regression



Lasso Regression



Elastic Net Regression



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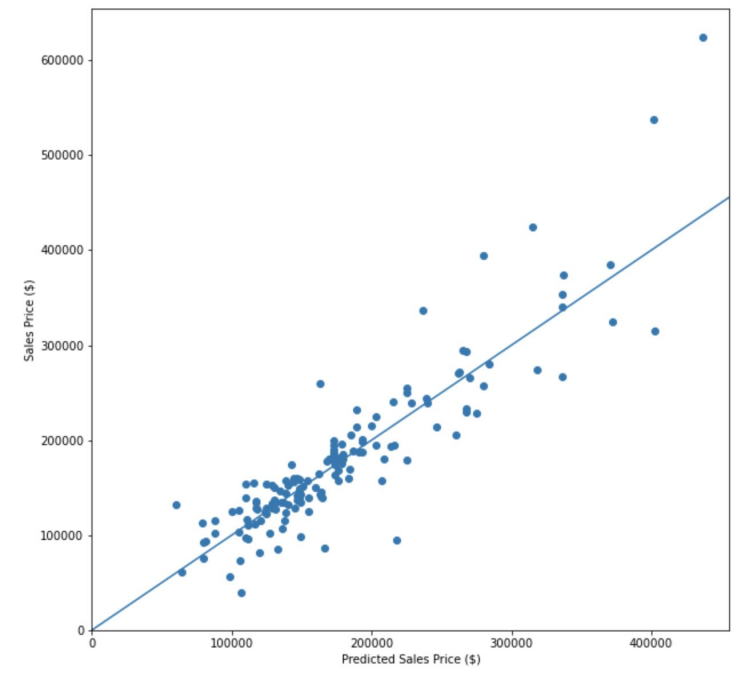
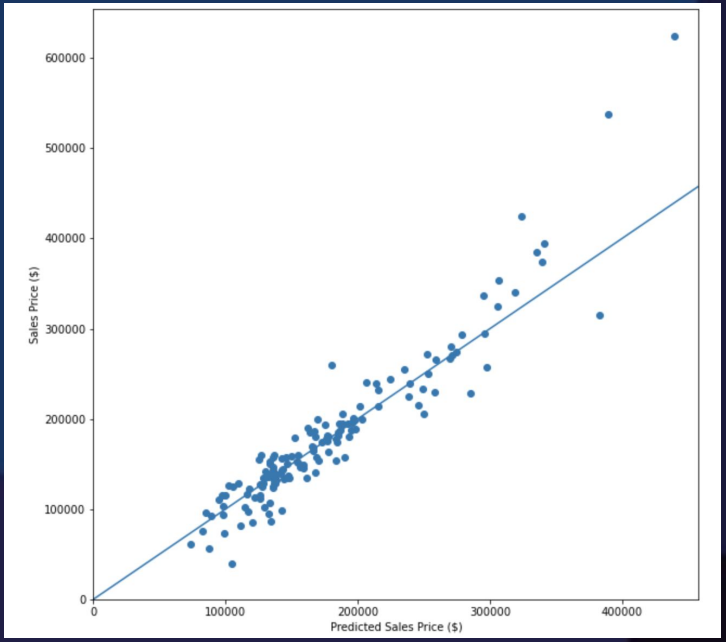
Hyperparameter Tuning

Decision Tree



Random Forest Regression



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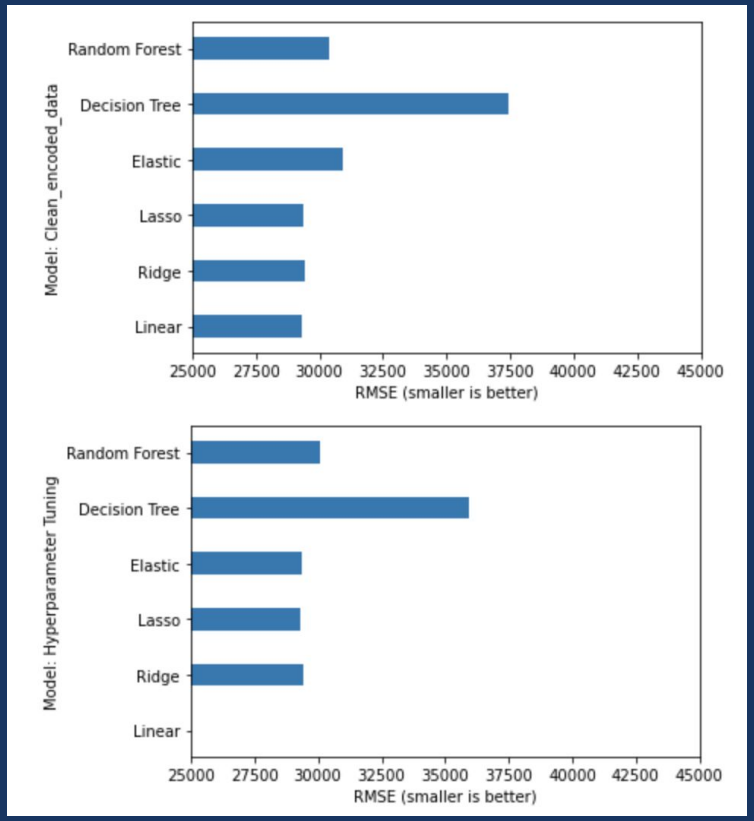
Overall Score



	Regressor	Baseline	Hyperparameter_tuning
0	Linear	29325.596202	0.000000
1	Ridge	29406.413053	29409.794982
2	Lasso	29340.796981	29325.822247
3	Elastic	30925.944372	29340.796981
4	Decision Tree	37407.315384	35942.875202
5	Random Forest	30394.642472	30210.036331

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Feature Selection

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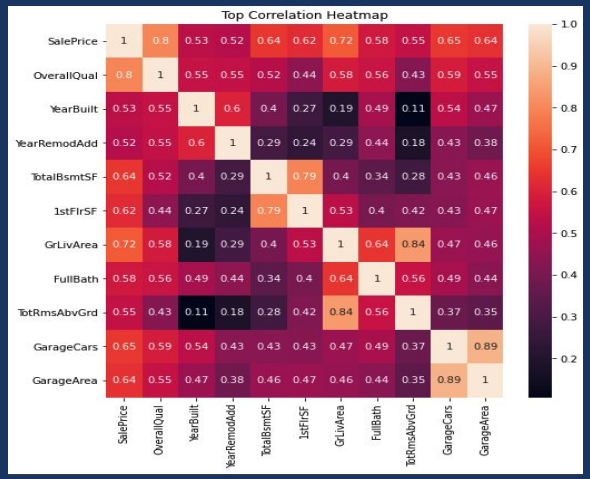
Feature Selection|

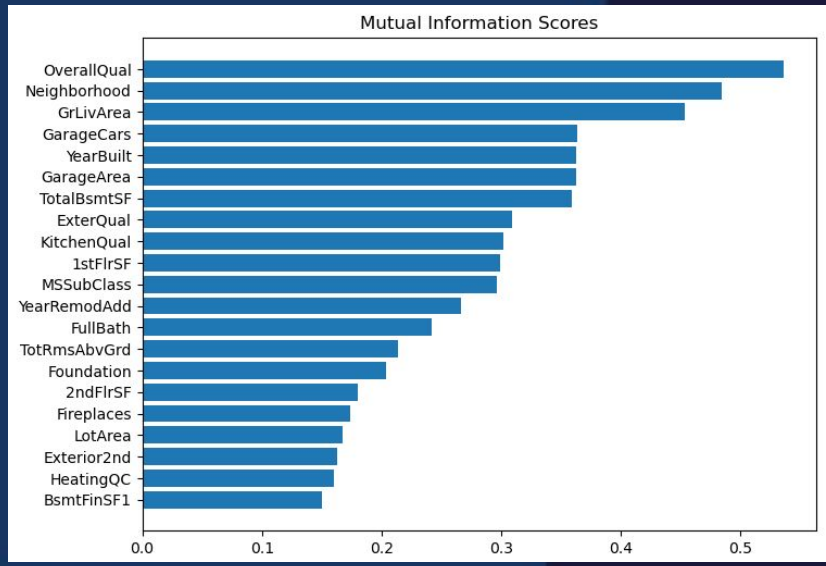
1. Filtered Method

- Correlation (corr>0.5)
- Mutual Information (mi score > 0.15)




```
21 features are selected

'GarageCars', 'FullBath', 'OverallQual',
'Exterior2nd', 'MSSubClass', 'LotArea',
'Neighborhood', 'ExterQual', 'HeatingQC',
'TotRmsAbvGrd', 'KitchenQual', 'Fireplaces',
'YearRemodAdd', '1stFlrSF', 'TotalBsmtSF',
'YearBuilt', 'GrLivArea', 'Foundation',
'2ndFlrSF', 'GarageArea', 'BsmtFinSF1'
```



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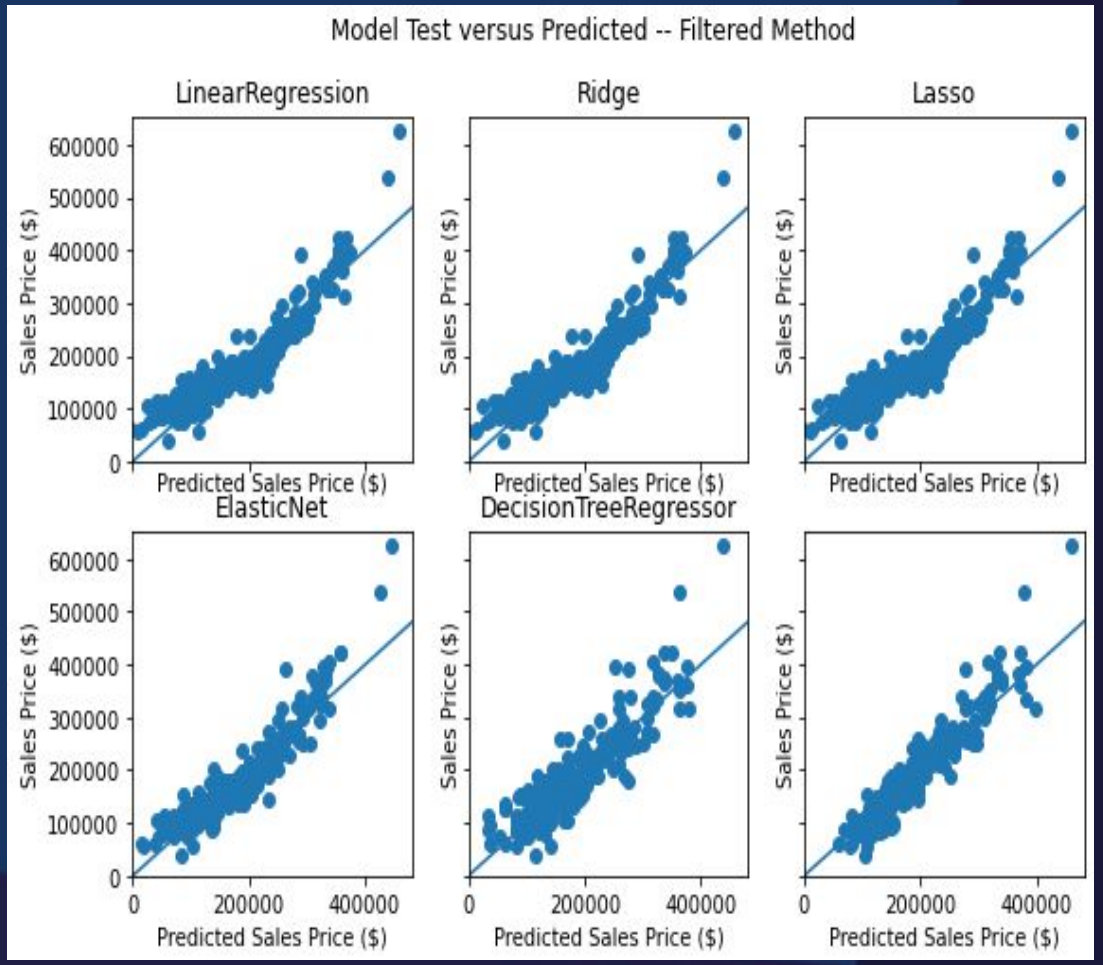
Feature Selection|

Filtered Method - Results

	RMSE
LinearRegression	31542.3456
Ridge	31516.065
Lasso	31538.9221
ElasticNet	29546.5483
DecisionTreeRegressor	36009.2444
RandomForestRegressor	27720.2856



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Feature Selection|

Wrapper Method

- A recursive feature elimination process using sklearn RFE function, threshold=35

- Some of the top features selected.
- Liner, Ridge, Lasso share relatively similar features
- Decision Tree based have difference selections

OriginalFeatures	Linear	Ridge	Lasso	ElasticNet
OverallCon	1	1	1	1
ExterQual	1	1	1	1
LandSlope	1	1	1	5
SaleType	1	1	1	6
SaleCondit	1	1	1	8
Condition1	1	1	1	12
BedroomAt	1	1	1	14
Street	1	1	1	
Utilities	1	1	1	
CentralAir	1	1	1	
PavedDrive	1	1	1	
BsmtHalfBa	1	1	2	
HeatingQC	1	1	4	1
RoofMatl	1	4	1	1
KitchenAbv	1	7	7	1
HalfBath	1	12	16	1
MasVnrTyp	1	16	13	1
GarageCar	1	17	27	1
BldgType	1		1	1
HouseStyle	1			1
ExterCond	1			
BsmtFullBa	3	21	22	1
OverallQua	4	1	6	1
MSZoning	5	3	10	1
Heating	6	5	5	1
RoofStyle	7	1	3	1
Foundation	8	1	1	1
LotConfig	10	8	1	24
FullBath	14	1	1	13
Fireplaces	18	29	20	16
KitchenQua	20	1	1	21
Electrical	21	1	1	

Original Features	Decision Tree	Random Forest
SaleType	1	1
BedroomAt	1	1
CentralAir	1	1
HeatingQC	1	
MasVnrTyp	1	
GarageCar	1	1
Fireplaces	1	12
KitchenQua	1	1
Functional	1	
YrSold	1	9
Neighborhc	1	1
LotArea	1	1
BsmtUnfSF	1	1
TotalBsmtS	1	1
1stFlrSF	1	21
GrLivArea	1	1
WoodDeck	1	1
OpenPorch	1	1
SaleCondit	2	20
HalfBath	3	
RoofStyle	4	1
BsmtFinSF	6	1
OverallCon	7	28
MSZoning	8	1
TotRmsAbv	12	17
YearBuilt	13	5
Exterior1st	15	15
2ndFlrSF	16	1
ExterCond	17	
YearRemoc	18	10
OverallQua	19	14
GarageArea	21	13

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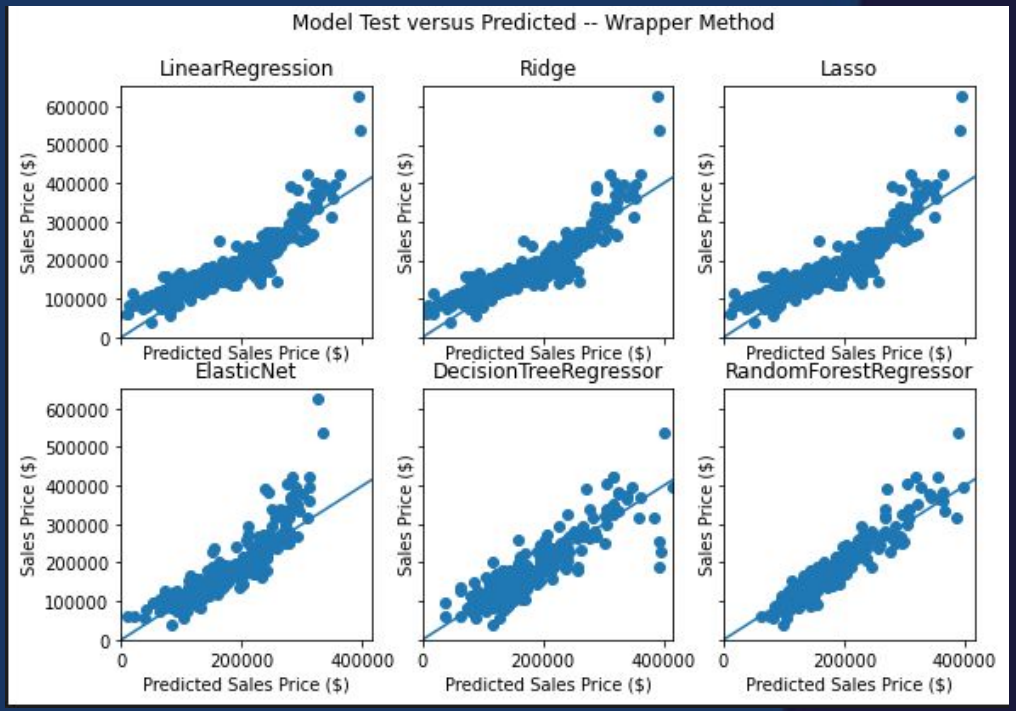
Feature Selection|

Wrapper Method - Results

	RMSE
LinearRegression	38633.08
Ridge	39027.536
Lasso	38558.299
ElasticNet	41114.857
DecisionTreeRegressor	38439.478
RandomForestRegressor	28009.02



Neural Network

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Neural Net | Architecture and Implementation

Considering the size of data and nature of the problem, a tiny tower architecture designed for this regression problem.

- Sequential
- 2 Hidden Layers
- Relu Activation Functions

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense (Dense)               (None, 128)               14592

 dense_1 (Dense)             (None, 64)                8256

 dense_2 (Dense)             (None, 1)                 65

=================================================================
Total params: 22,913
Trainable params: 22,913
Non-trainable params: 0
_________________________________________________________________
```

- TensorFlow
- Keras
- Optimizer: Adam
- Loss: MSE
- Metrics: RMSE
- 1000 Epochs
- Call backs
  - Save
  - Early Stopping
- Save, resume

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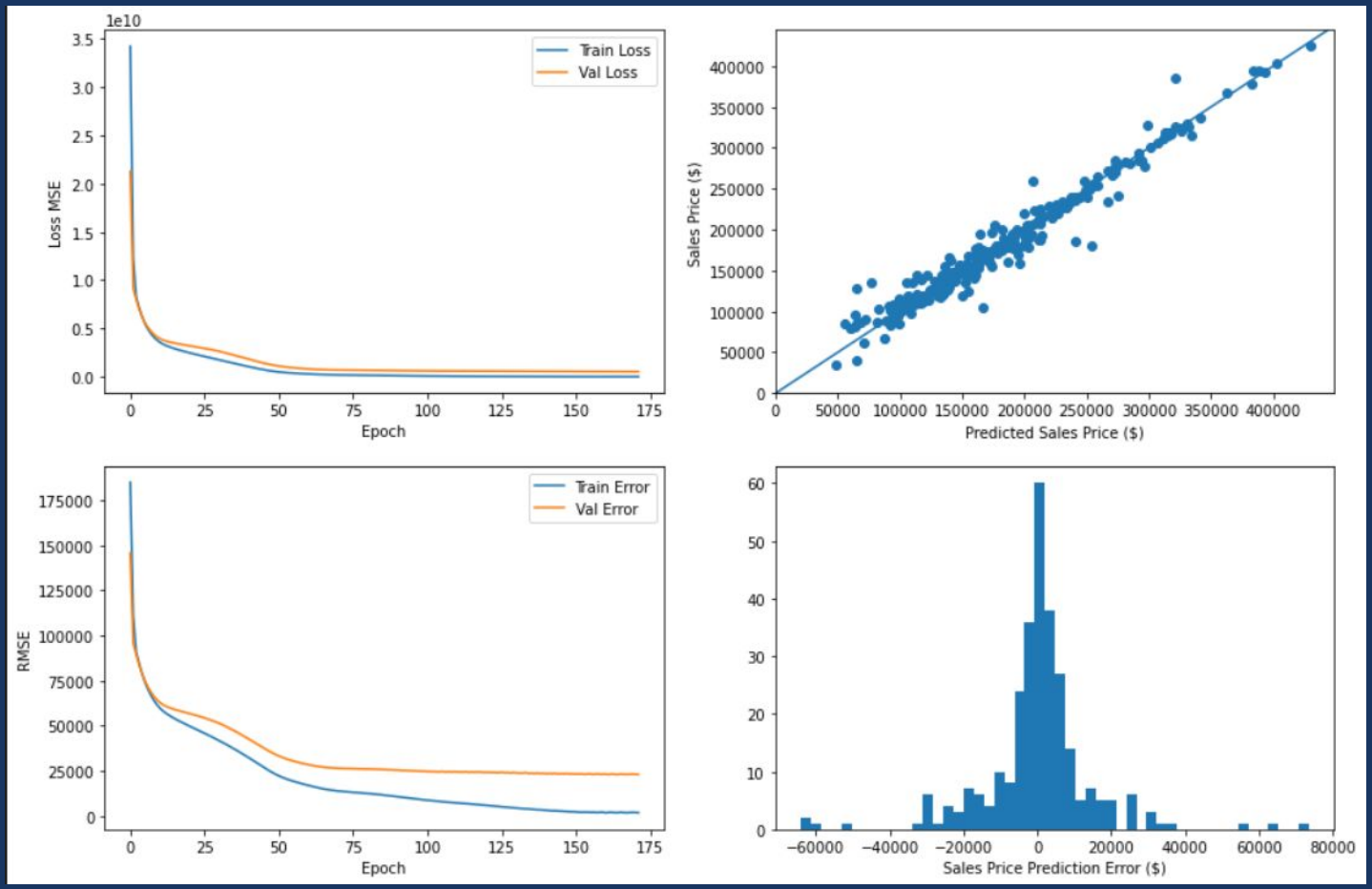
Neural Net | Result



RMSE for test: 16309.35

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Modules

- Regressors
  - Base Regressor
  - Decision Tree
  - Elastic Net
  - Lasso
  - Linear
  - Neural Net
  - Random Forest
  - Ridge
- Helpers
  - DataLoader
  - BaseRegressorPlot
- Configurations
  - num epochs
  - resume_nn
  - enable cache
  - log level
  - saved model file
  - data path
  - sections to skip

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Notebook Organization

Notebook 1:

- Project Overview
- EDA
- Missing Values
- Distribution of Nominal and categorical variables

Notebook 2:

- Regression and Hyperparameter Tuning

Notebook 3: Neural Networks

Notebook 4: Features and Wrapper Functions

Notebook 5: PCA and Random Forest on Reduced Dimensions

Notebook 6: Conclusion and Further-work

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PCA (Failed Attempt)

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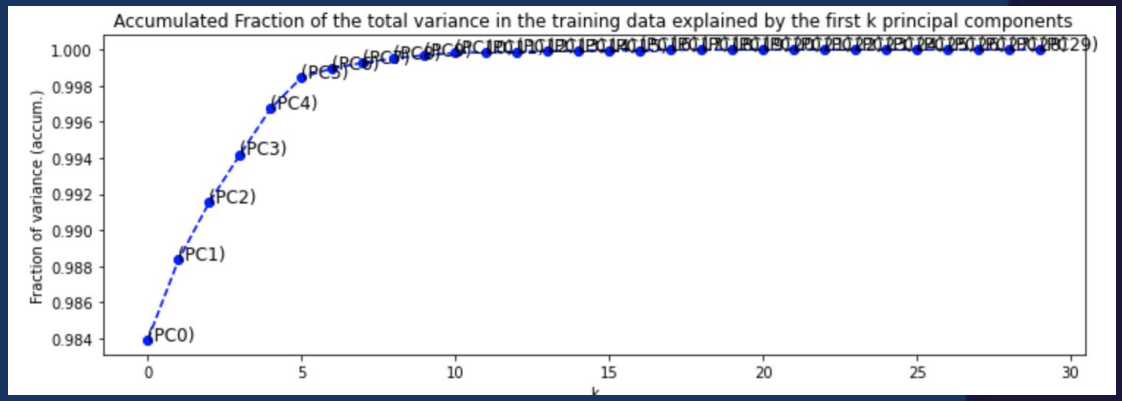
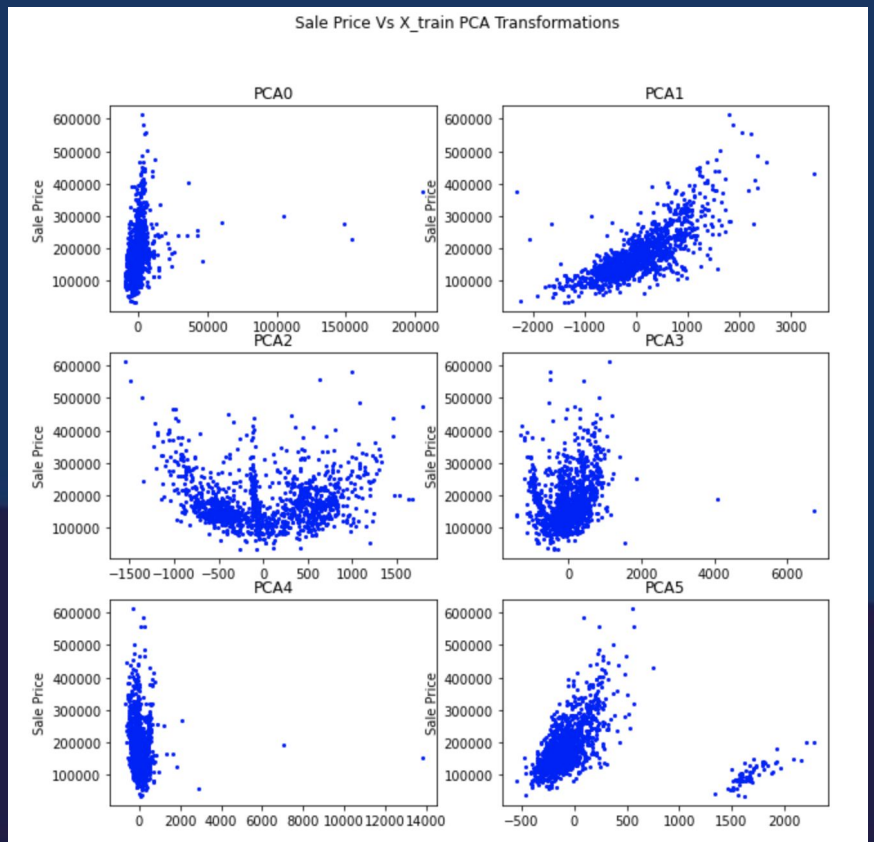
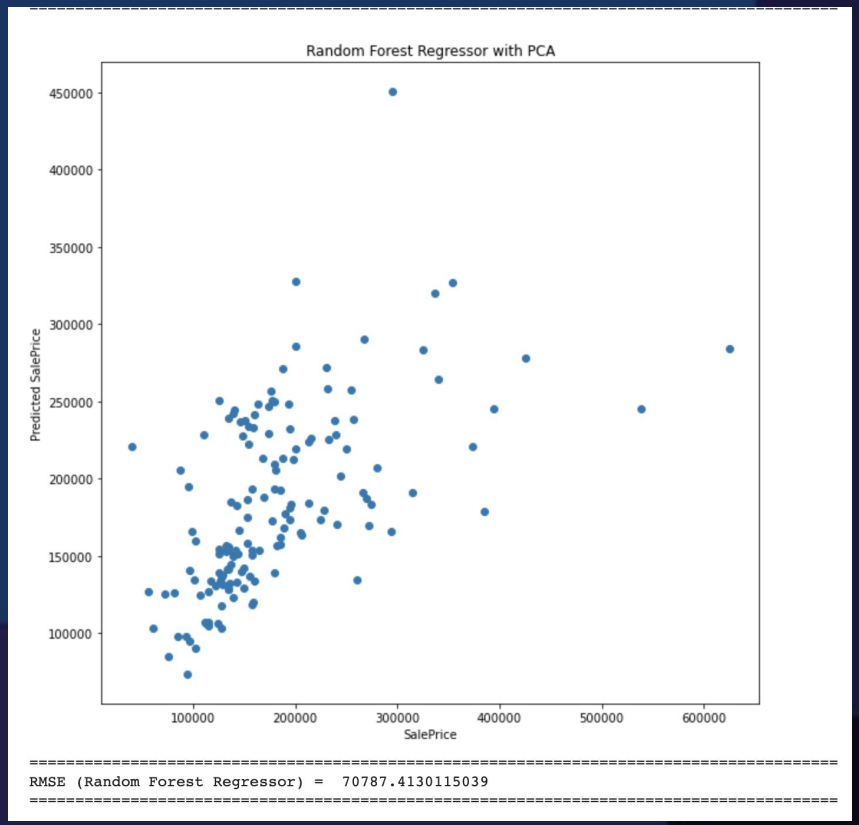
PCA

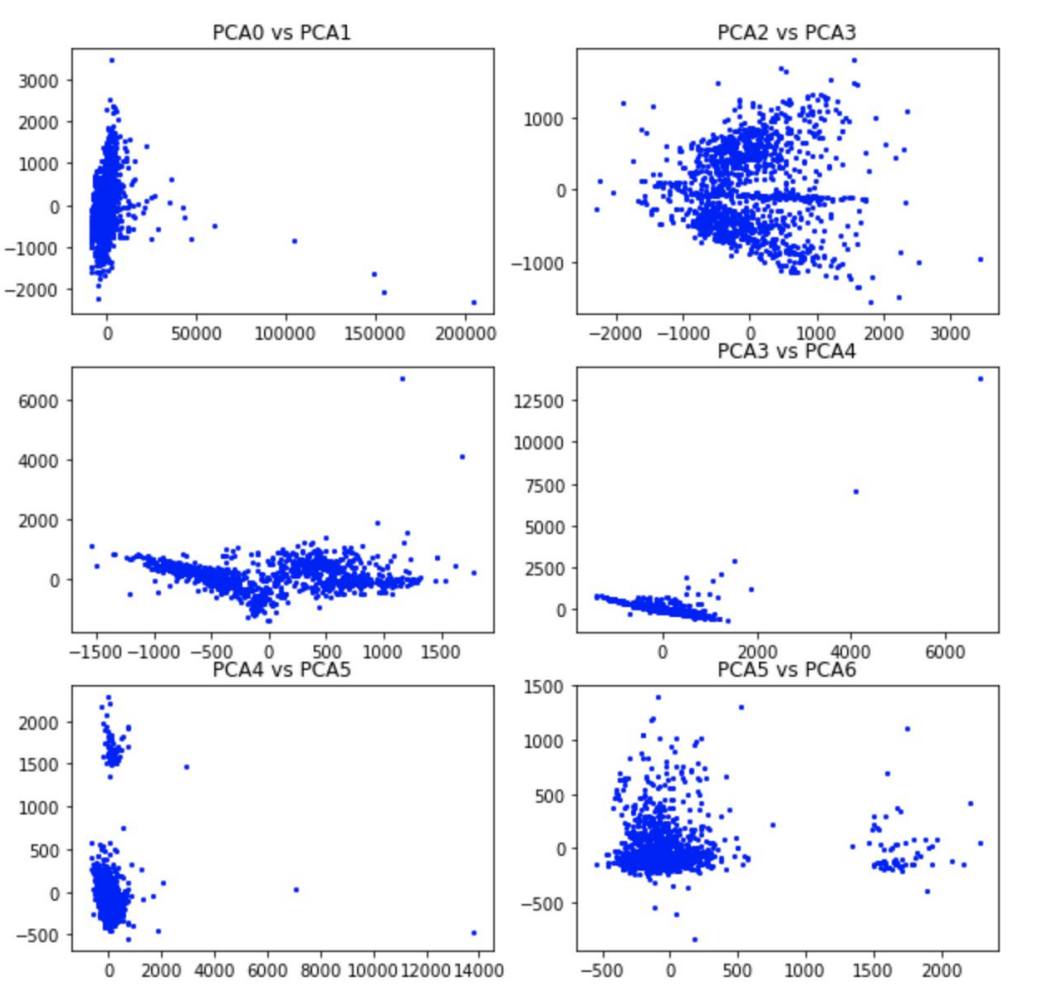
Numerical Variables

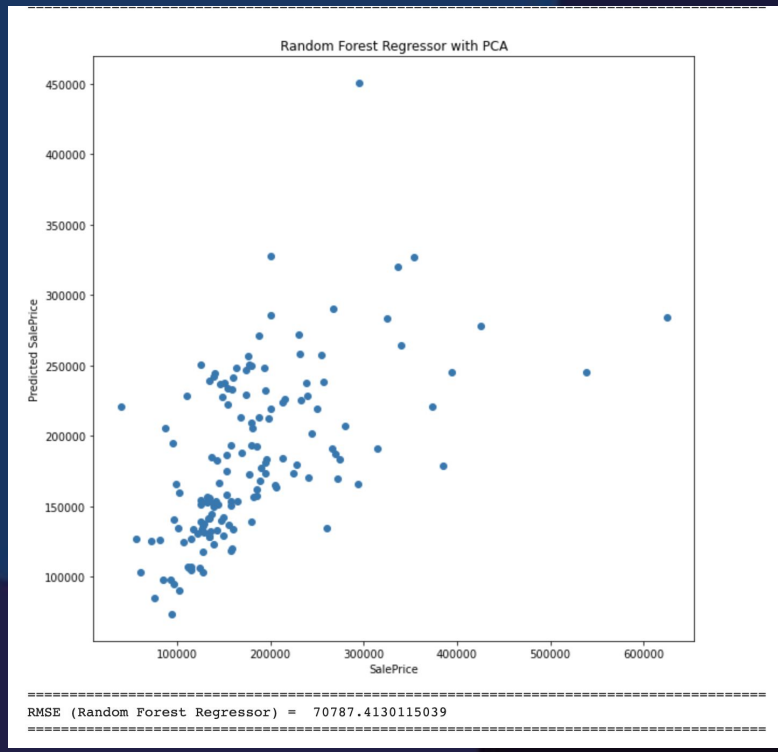






PCA





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Thanks!

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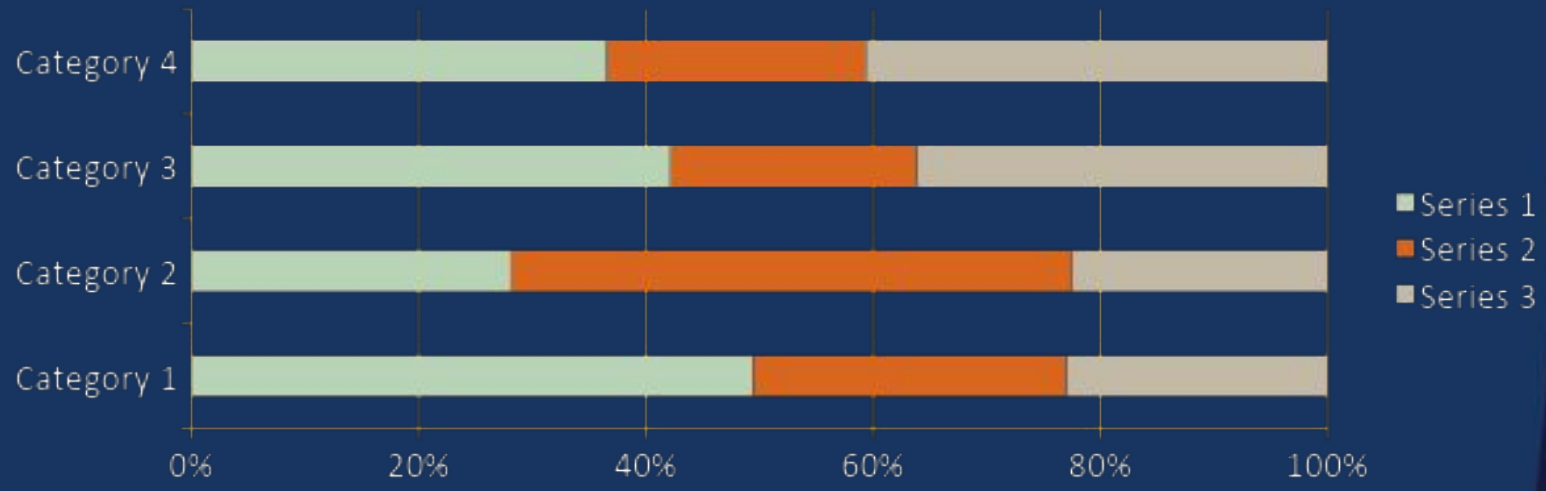

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35	55000	89056	4359	0349
435	3245	23243	25567	123
56	7	45	09867	456
345	768	0980	43138	2389
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Cor	Et vel	Wquis	Autem	Nulla

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Header Georgia 42 pt

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  - Add your secondary bullet point here
    - Add your tertiary bullet point here

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