Kaggle House Price Challenge
Team Least Squares

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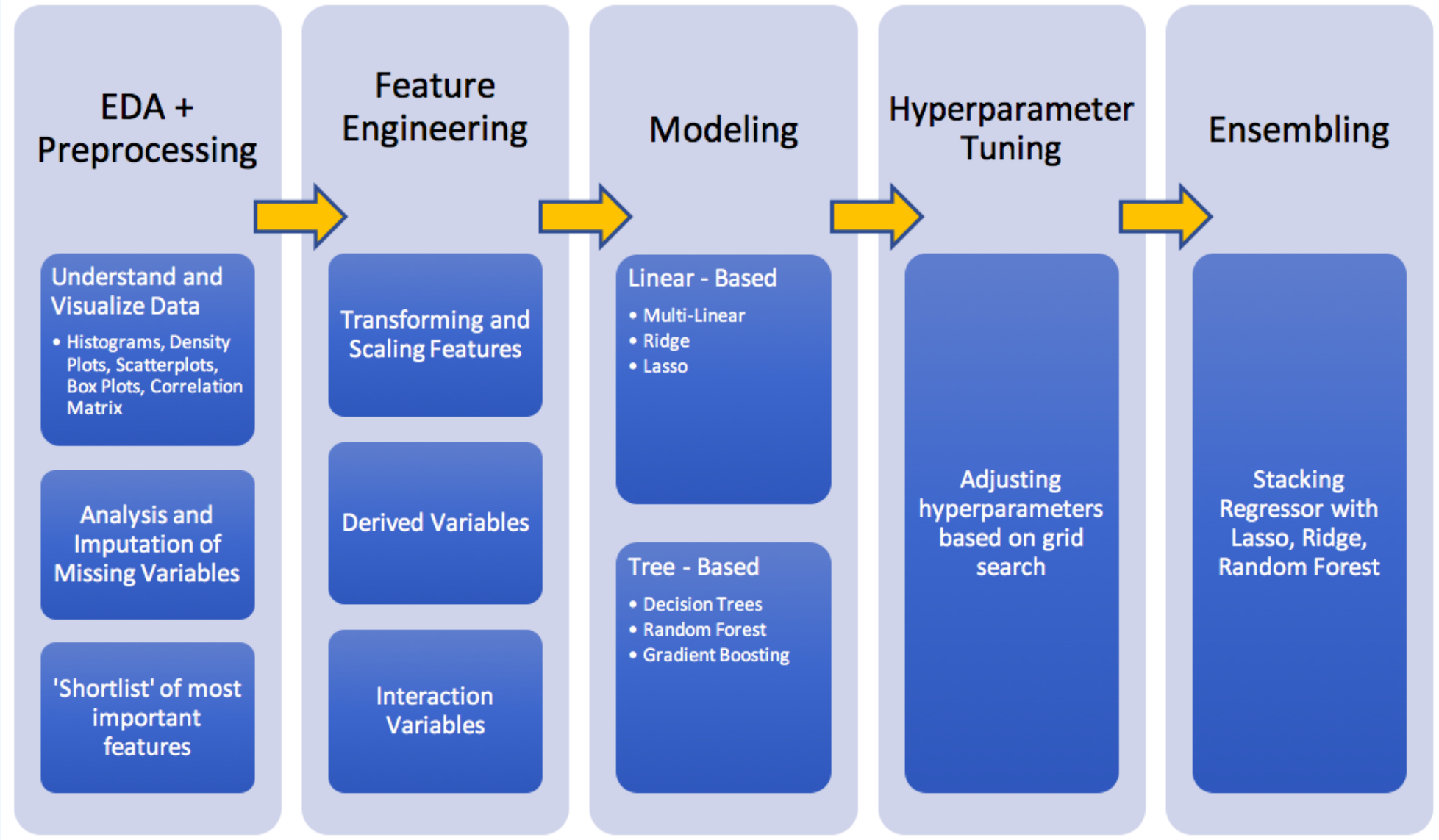
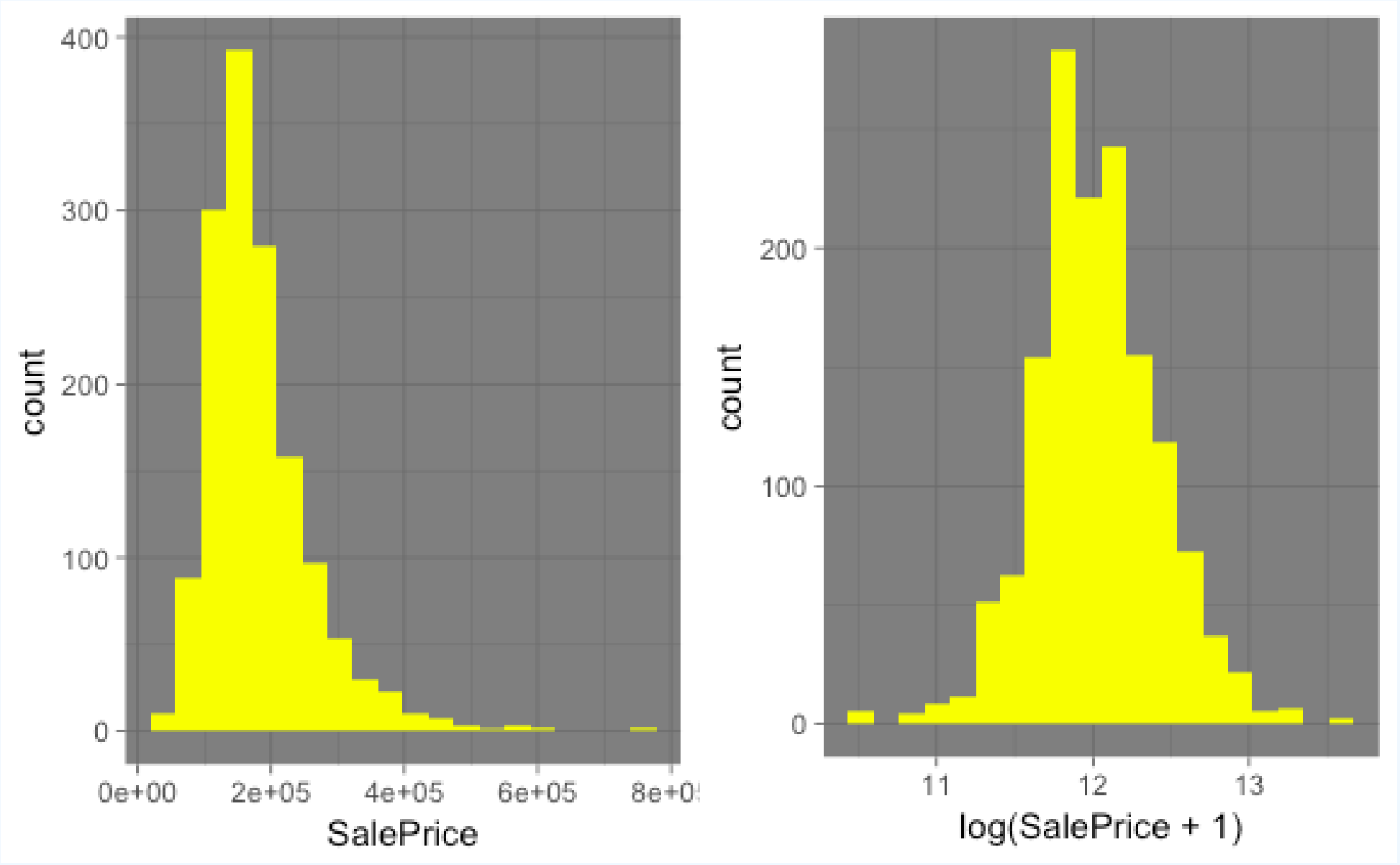
Workflow

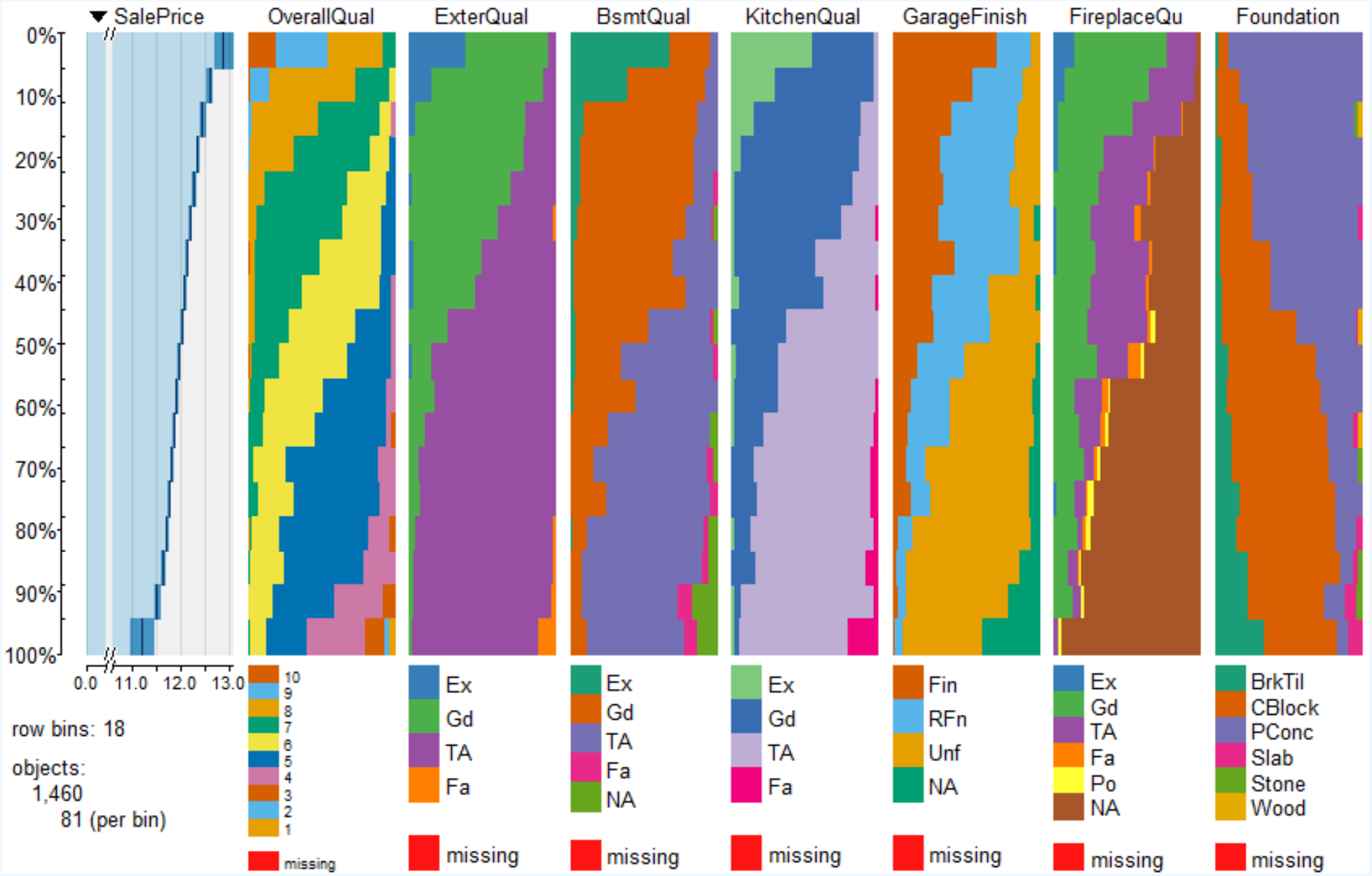

EDA + Preprocessing
Understand and Visualize Data
• Histograms, Density Plots, Scatterplots, Box Plots, Correlation Matrix
Analysis and Imputation of Missing Variables
'Shortlist' of most important features
Feature Engineering
Transforming and Scaling Features
Derived Variables
Interaction Variables
Modeling
Linear - Based
• Multi-Linear
• Ridge
• Lasso
Tree - Based
• Decision Trees
• Random Forest
• Gradient Boosting
Hyperparameter Tuning
Adjusting hyperparameters based on grid search
Ensembling
Stacking Regressor with Lasso, Ridge, Random Forest

EDA

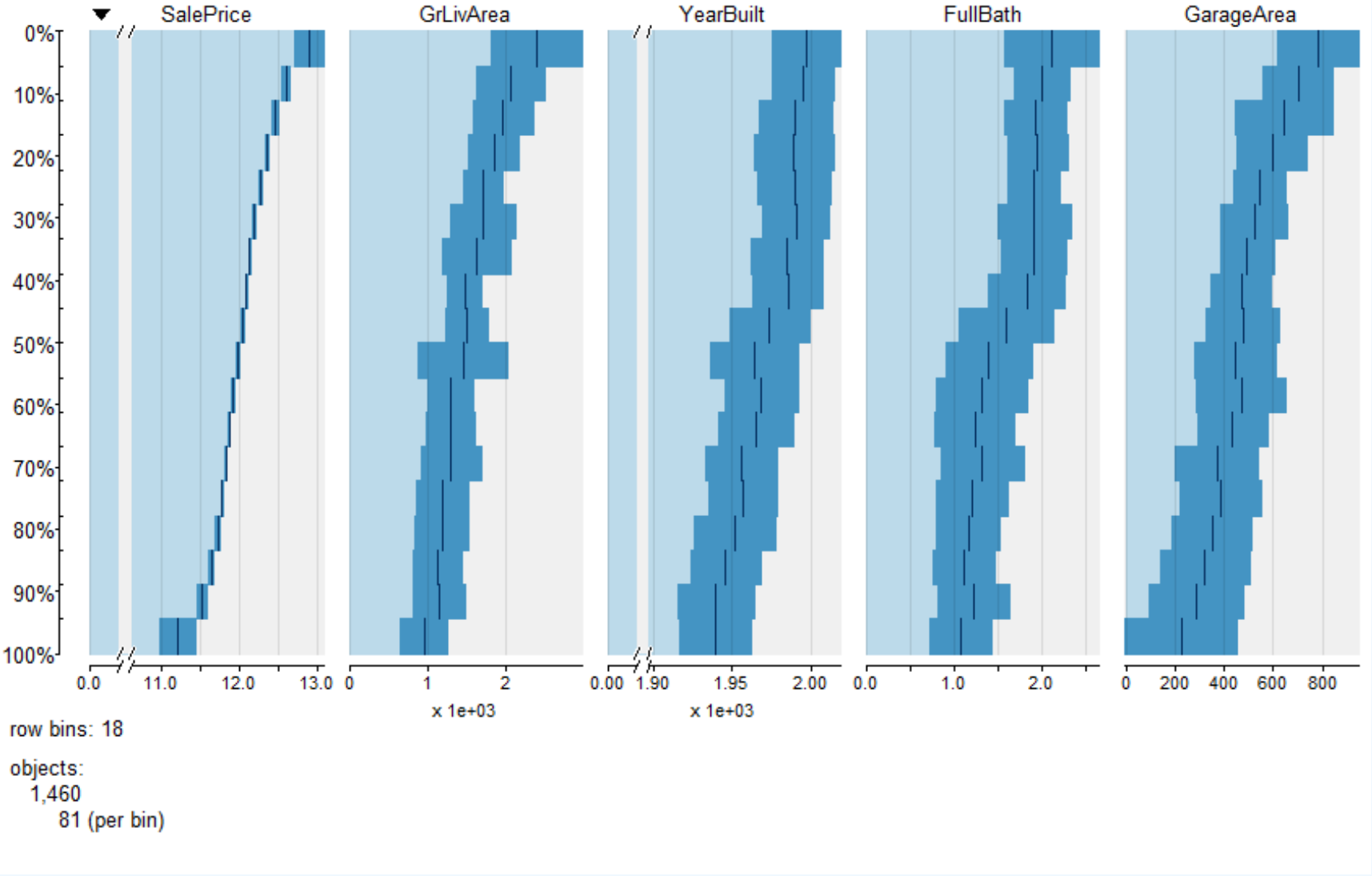
EDA - Sale Price Histogram



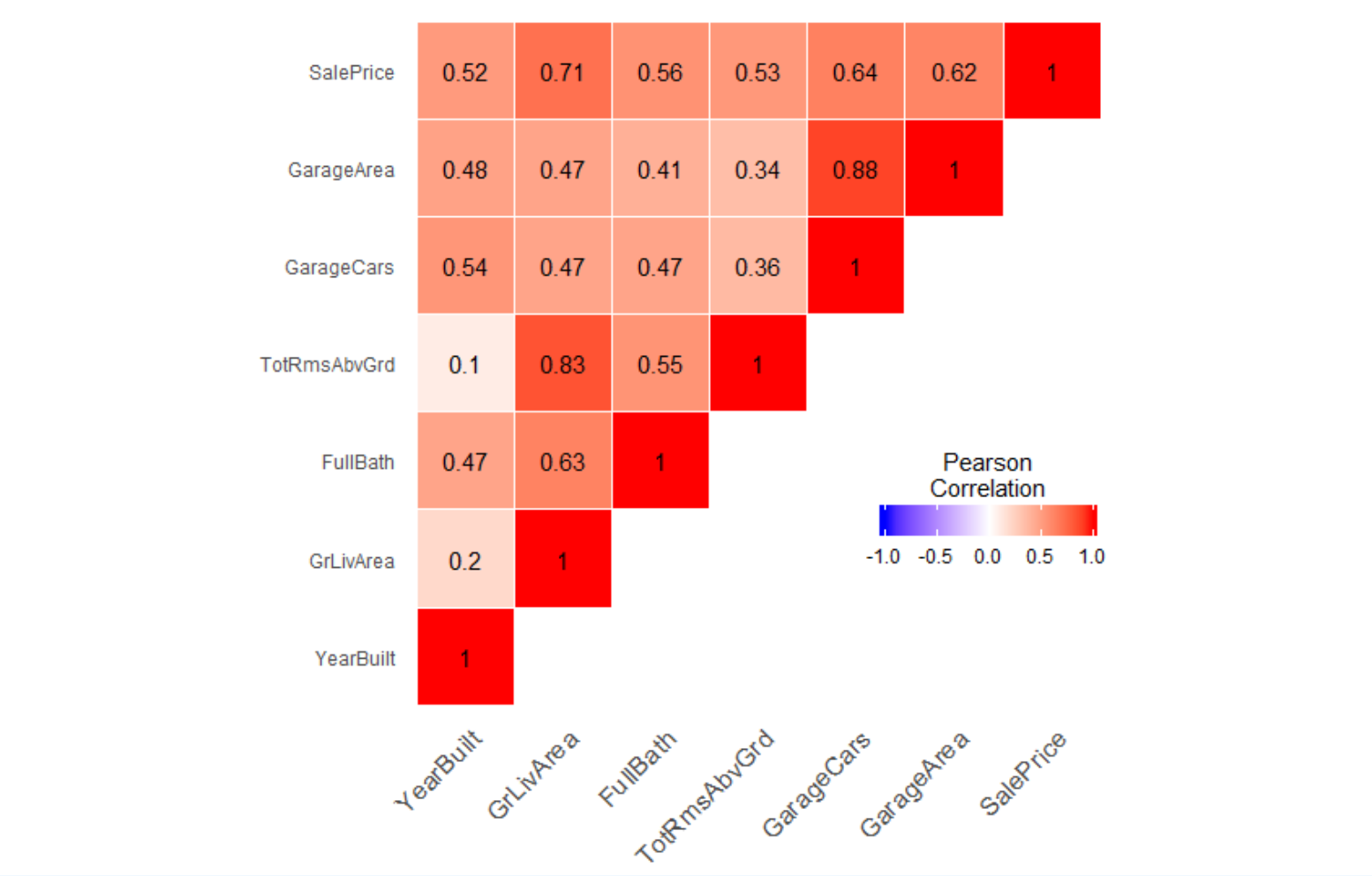
EDA - Categorical Vars



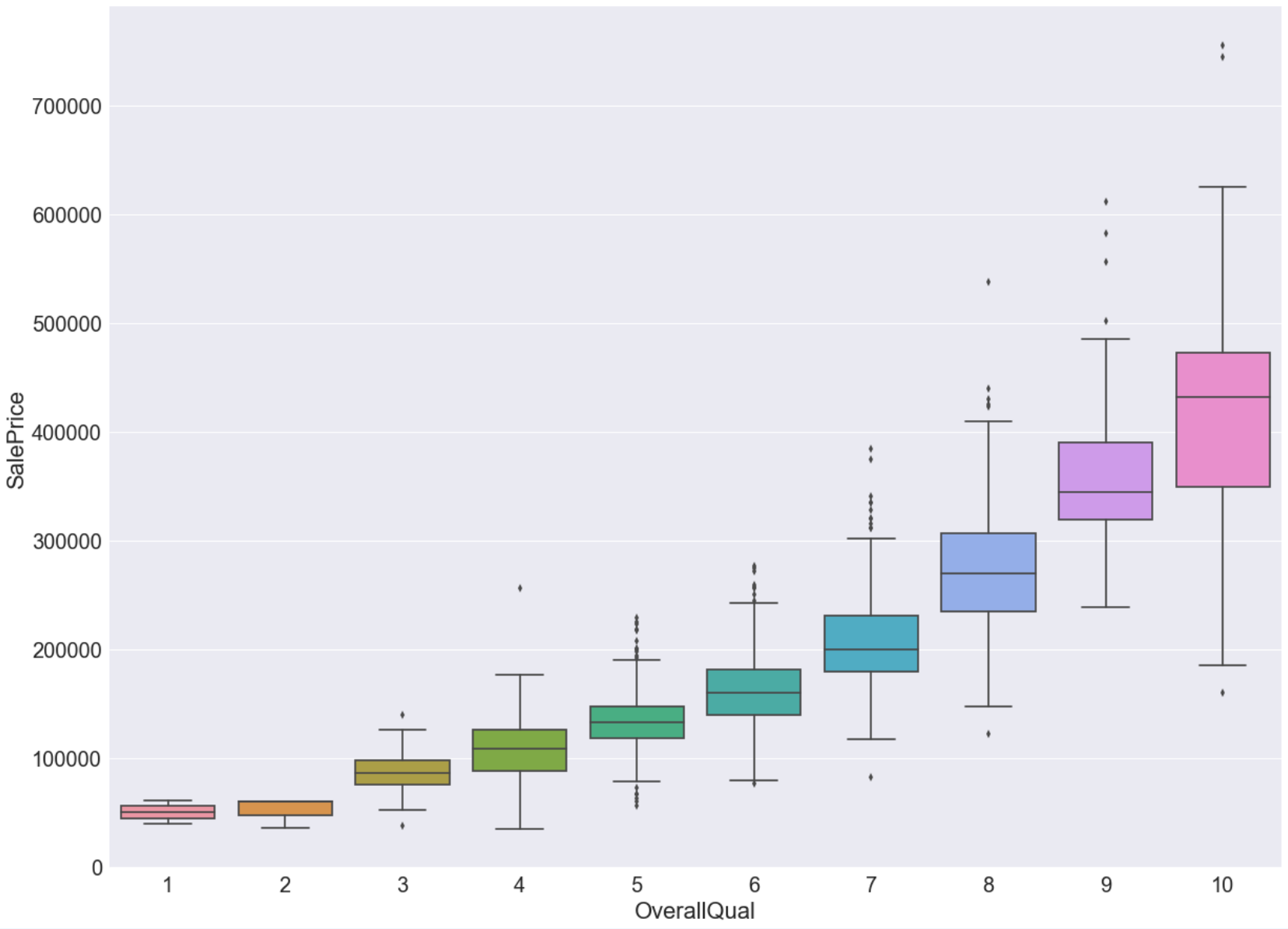
EDA - Continuous Vars



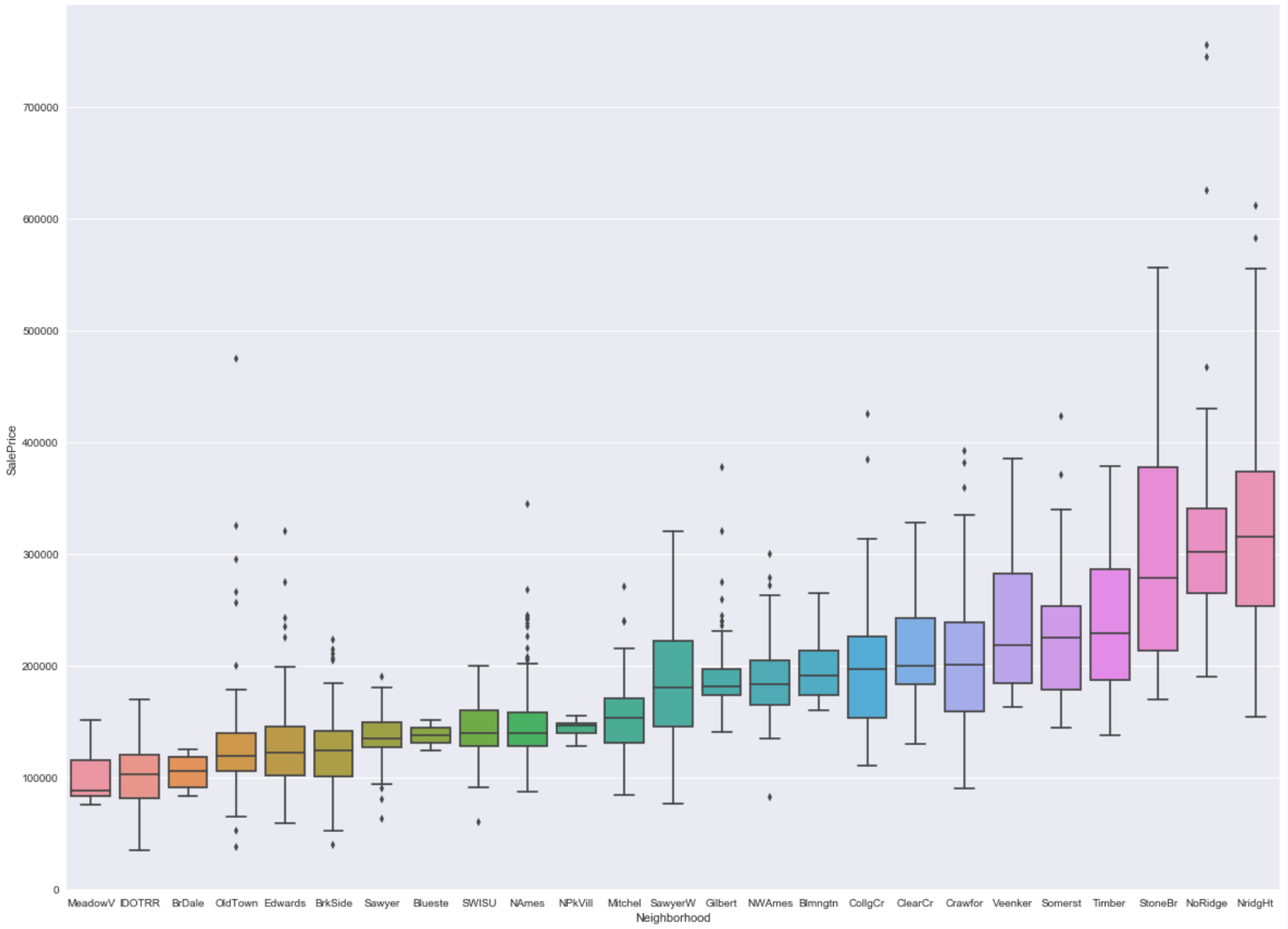
EDA – Correlation Plots



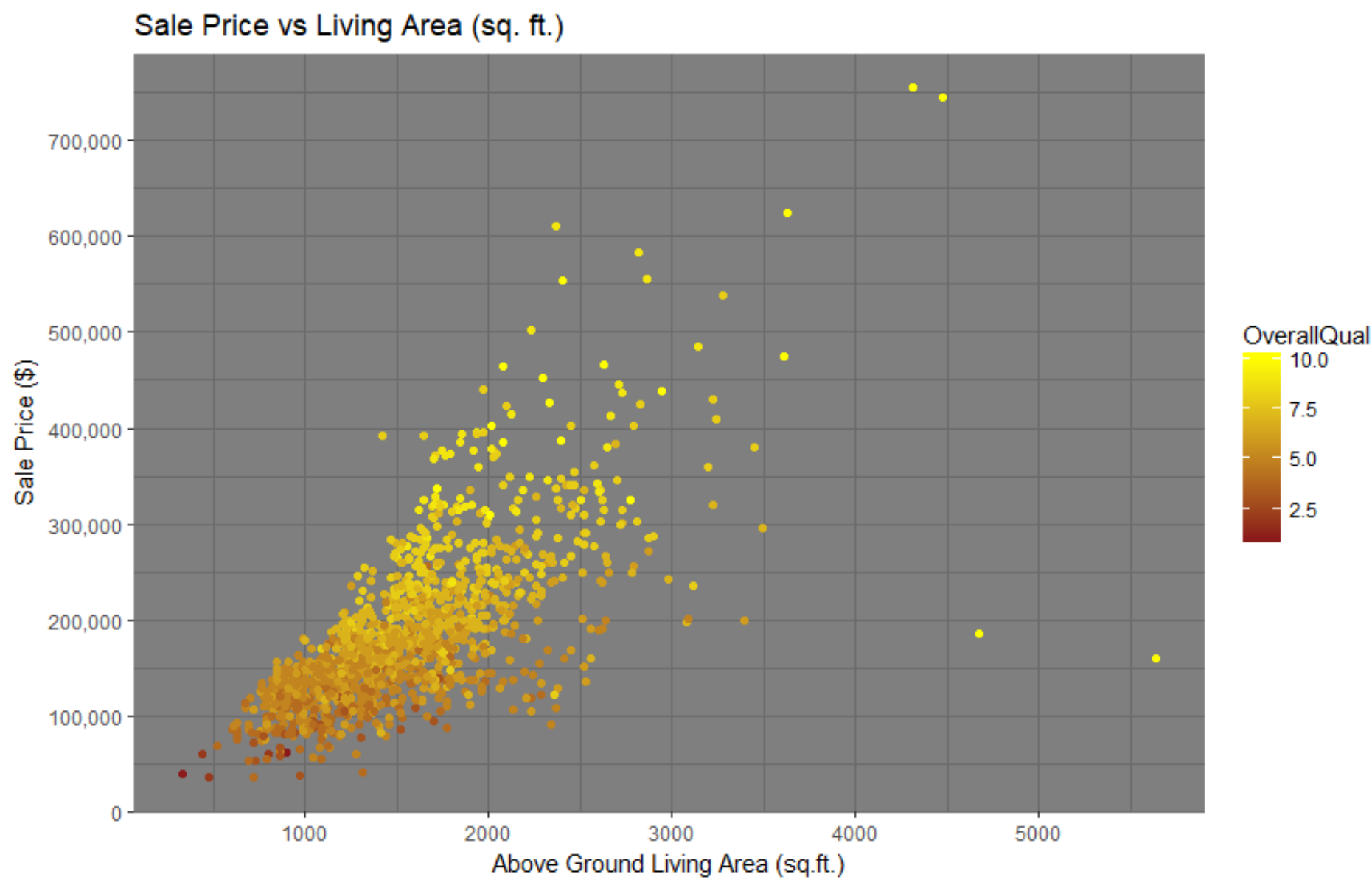
EDA - OverallQual



EDA - Neighborhood



EDA - Scatterplot



Feature Engineering

Imputation

Categorical Variables

Fill NAs : Mode
- MSZoning
- Electrical
- KitchenQual
- SaleType

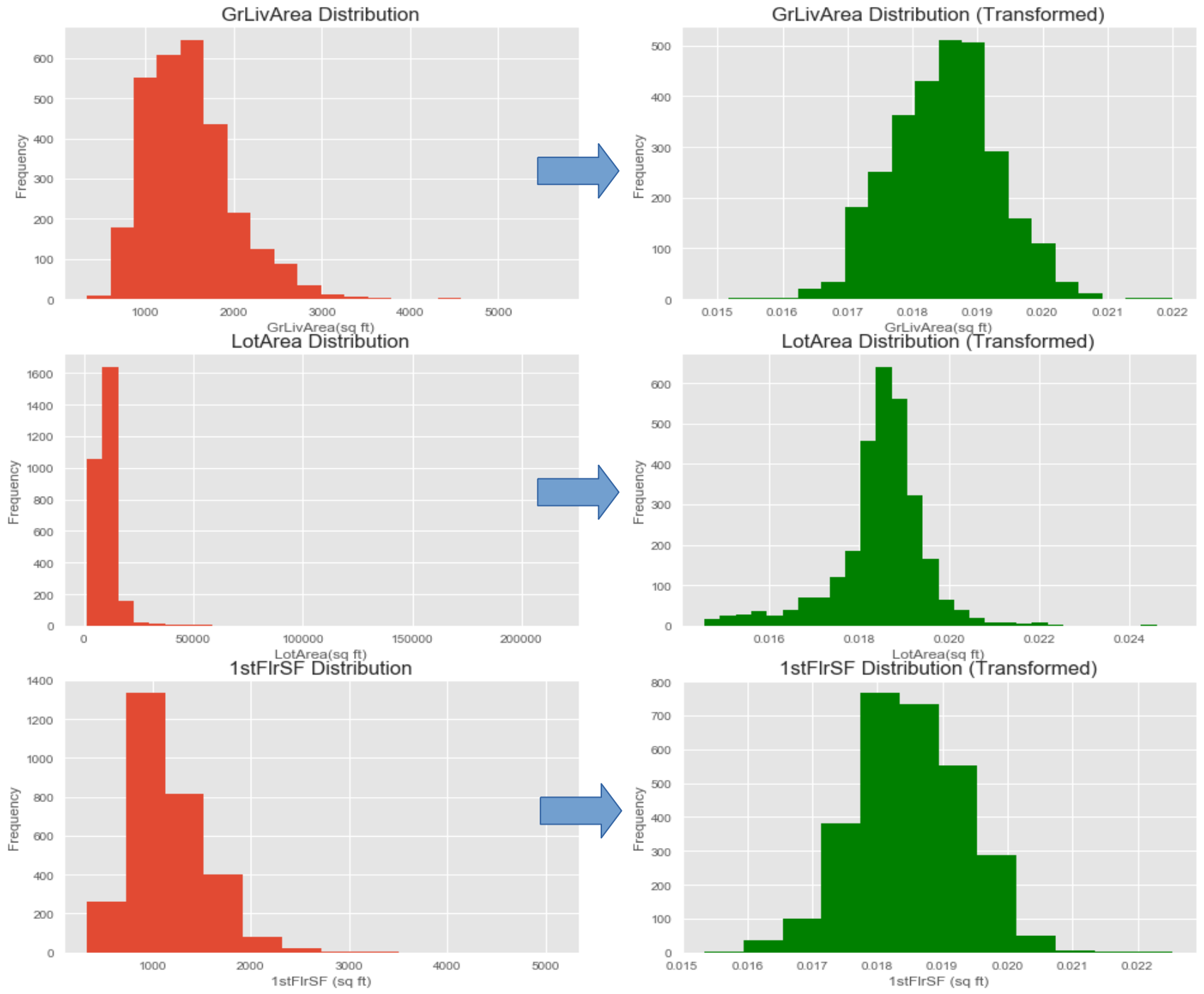
Fill NAs : None
- PoolQC
- MiscFeature
- Alley
- Fence
- BsmtQual
- BsmtCond

Numerical Variables

Fill NAs : Median
- LotFrontage
- (Neighborhood Median)

Fill NAs : 0
- BsmtFullBath
- GarageCars
- GarageArea
- MasVnrArea

Feature Scaling & Skewness



Linear Models

- Multiple Linear Regression
  - Explored Initial shortlist of 20 Features
  - Narrowed list to 5 features
  - Performed Regression
- Ridge/Lasso
  - Explored Interaction of Features
  - Expanded Shortlist with Interaction Features

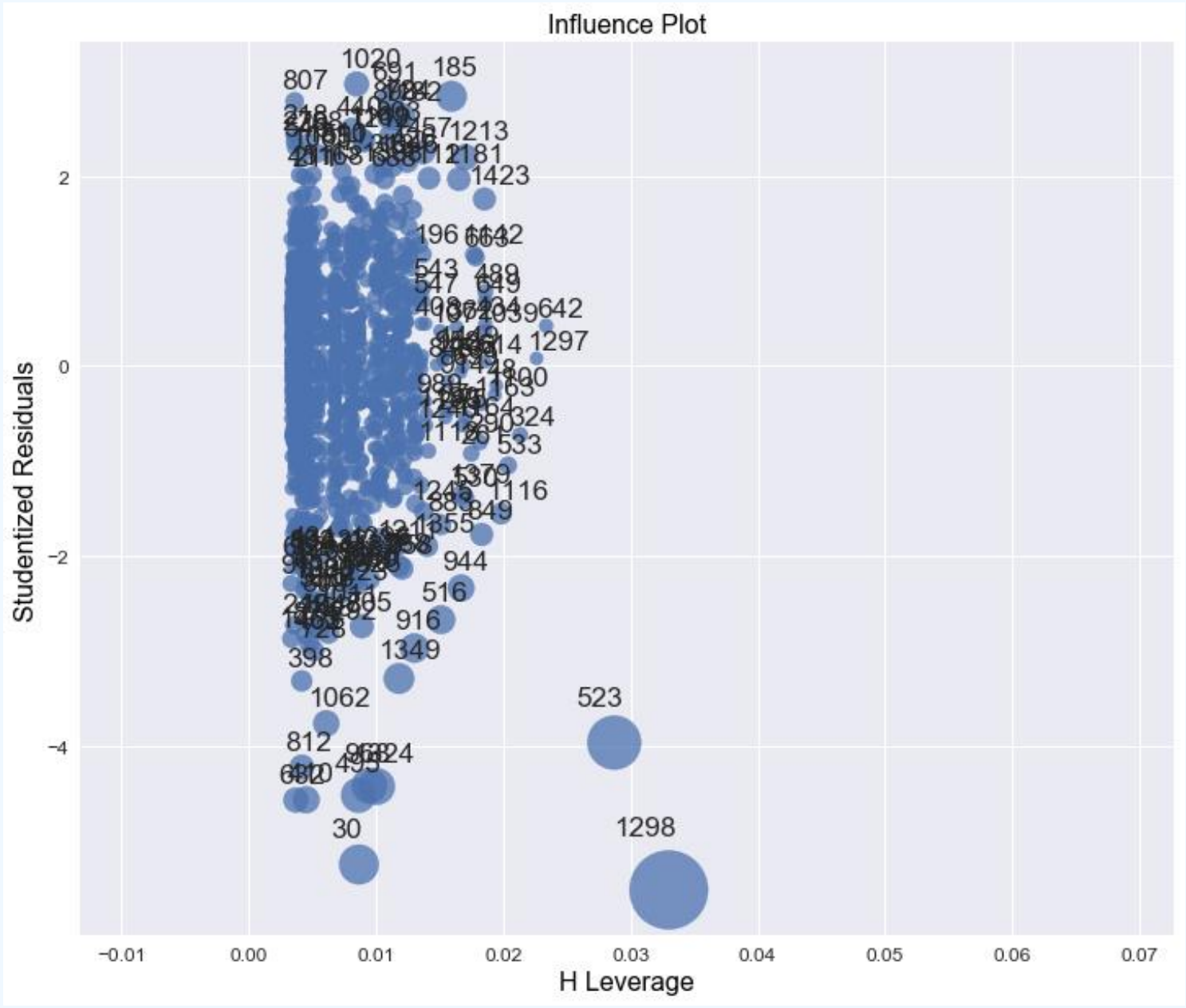
Multiple Linear Regression

Shortlist of 20 Features

(Red ones used in Initial Regression)

Location	Style	Condition	Size	Other
Neighborhood	HouseStyle	OverallQual	GrLivArea	SaleCondition
MSZoning	Foundation	OverallCond	1stFlrSF, 2ndFlrSF	SaleType
	GarageFinish	YrBuilt	FullBath	
	Paved Drive	ExterQual	TotRms	
		BsmtQual	GarageCars	
			GarageArea	

Multiple Linear Regression



Multiple Linear Regression

	R^2 (Training Set)	**RMSE (Training Set)**
With Influential Points	0.800	0.178
Without Influential Points	0.807	0.176

Feature Engineering

Derived Features

- TotalSF = TotalBsmtSF + GrLivArea

- HighQualFinishedSF
- = TotalSF - LowQualFinSF

- TotalBaths
  = Full Baths + BsmtFullBath +
  0.5 * (Half Baths + BsmtHalfBath)

Interaction Features

Examples of Numeric Interactions:

- TotalBaths * Total Square Footage
- OverallQual (as int) * Total Square Footage

Examples of Categorical Interactions:

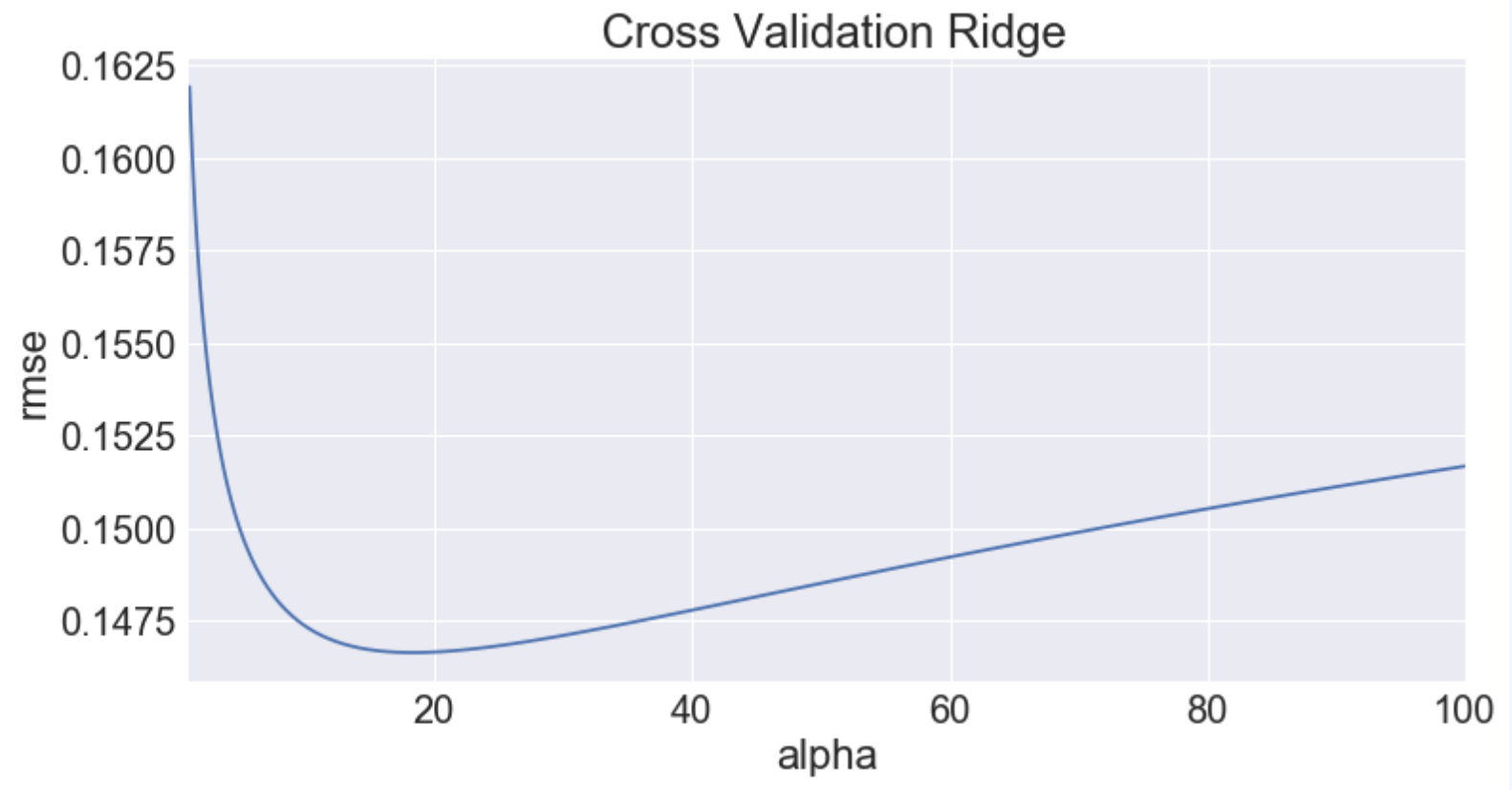
- OverallQual + OverallCond
- Neighborhood + OverallQual + OverallCond

RIDGE/LASSO PROCESS

- Split training data 80%/20%
- Used grid search to tune hyperparameter
  - 5-fold cross-validation for each parameter value
- Tested against remaining 20%
- Trained against entire 100% of training set

Ridge Regression

Best Alpha = 18.7



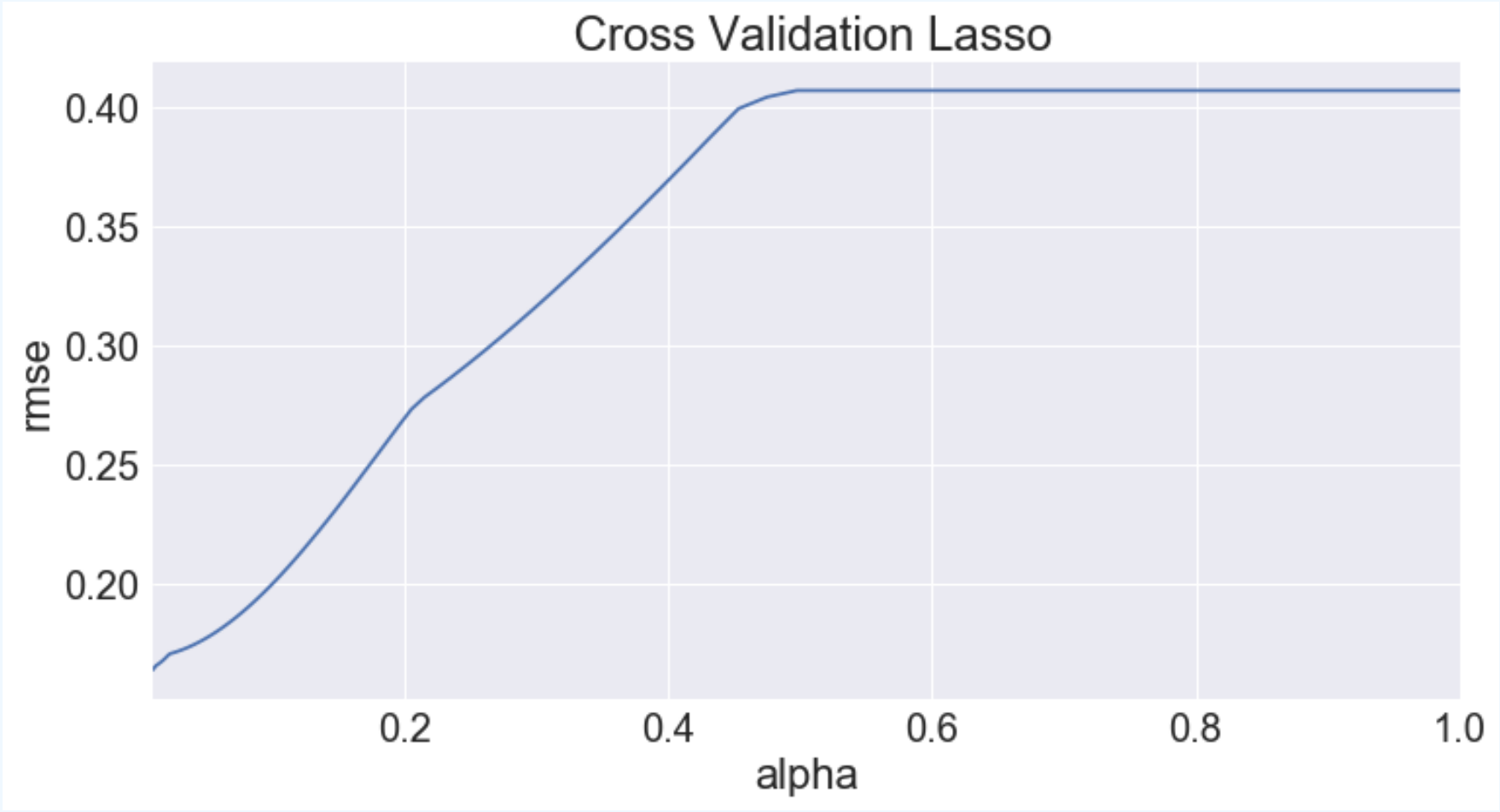
Ridge Regression

	R^2	**RMSE**
SUB-TRAINING SET (80%)	0.938	0.100
TEST SET (20%	0.913	0.111
TOTAL TRAINING SET (100%)	0.933	0.099

Ridge Regression

Top Features	Coefficient Value
OverallCond_3	-0.066691
Neighborhood + OverallQual + OverallCond_Edwards10+5	-0.066562
MSSubClass_160	-0.051320
Neighborhood_Edwards	-0.048231
Neighborhood + OverallQual + OverallCond_IDOTRR4+4	-0.048116
Neighborhood_Crawfor	0.048117
CentralAir_Y	0.049257
MSZoning_RL	0.053233
OverallQual	0.057236
Functional_Typ	0.057430

Lasso Regression



Lasso Regression

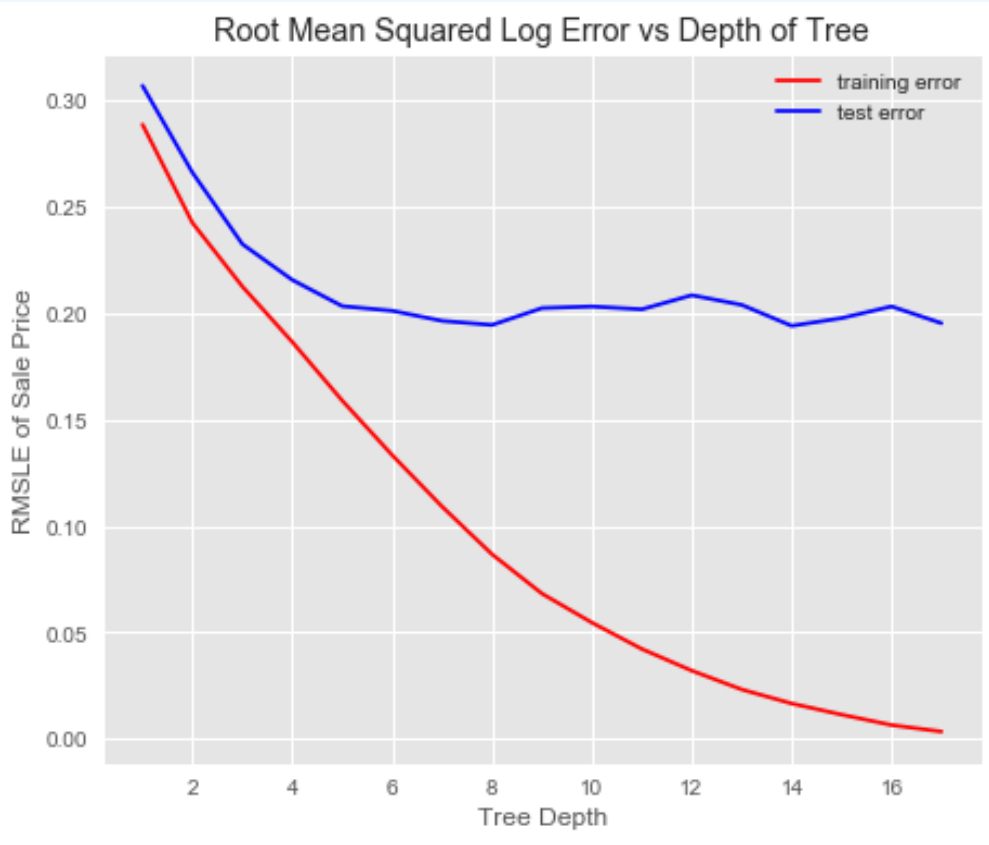
	R^2 (Training Set)	**RMSE (Training Set)**
SUB-TRAINING SET (80%)	0.839	0.163
TEST SET (20%)	0.838	0.137
TOTAL TRAINING SET (100%)	0.843	0.159

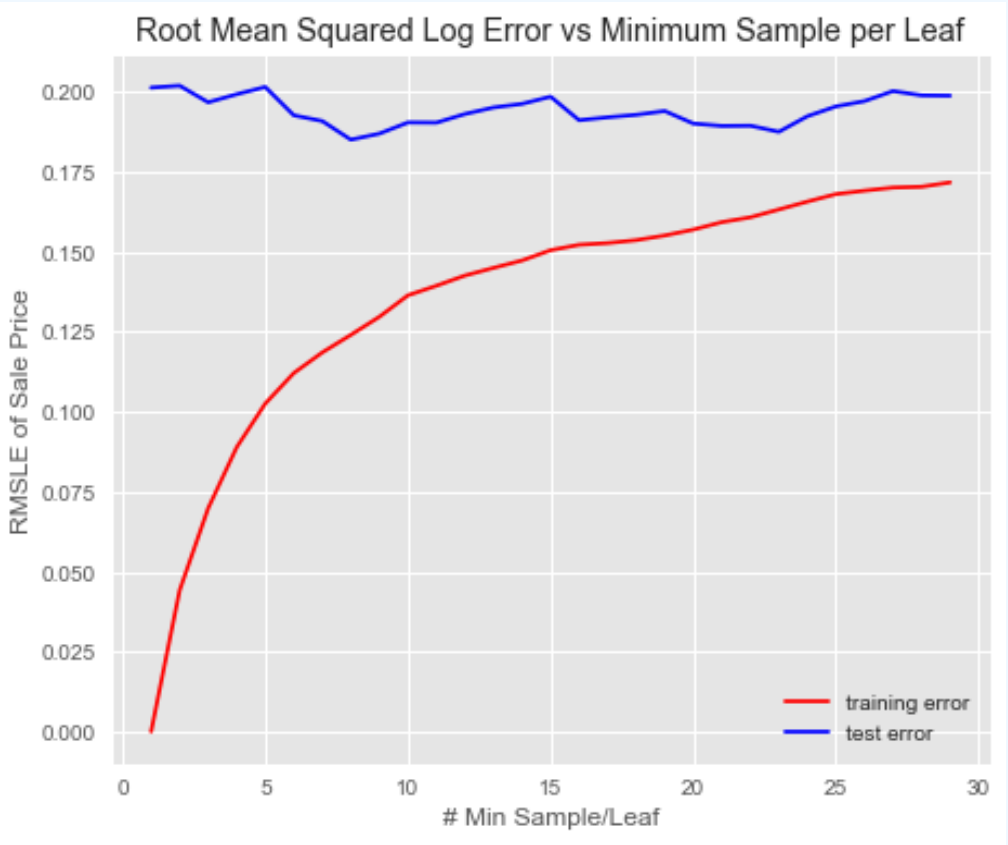
Lasso Regression

Top Features	Coefficient Value
Neighborhood_IDOTRR	-0.106394
Neighborhood_OldTown	-0.098231
OverallQual + OverallCond _5+3	-0.088836
Neighborhood_MeadowV	-0.075524
BsmtQual + BsmtCond_Ta+FA	-0.072136
Heating + HeatingQC_GasA+Ex	0.066236
Neighborhood_Crawford	0.068795
TotalFinishedSF	0.075379
OverallQual	0.098205
SaleType+SaleCondtion_New+Partial	0.128627

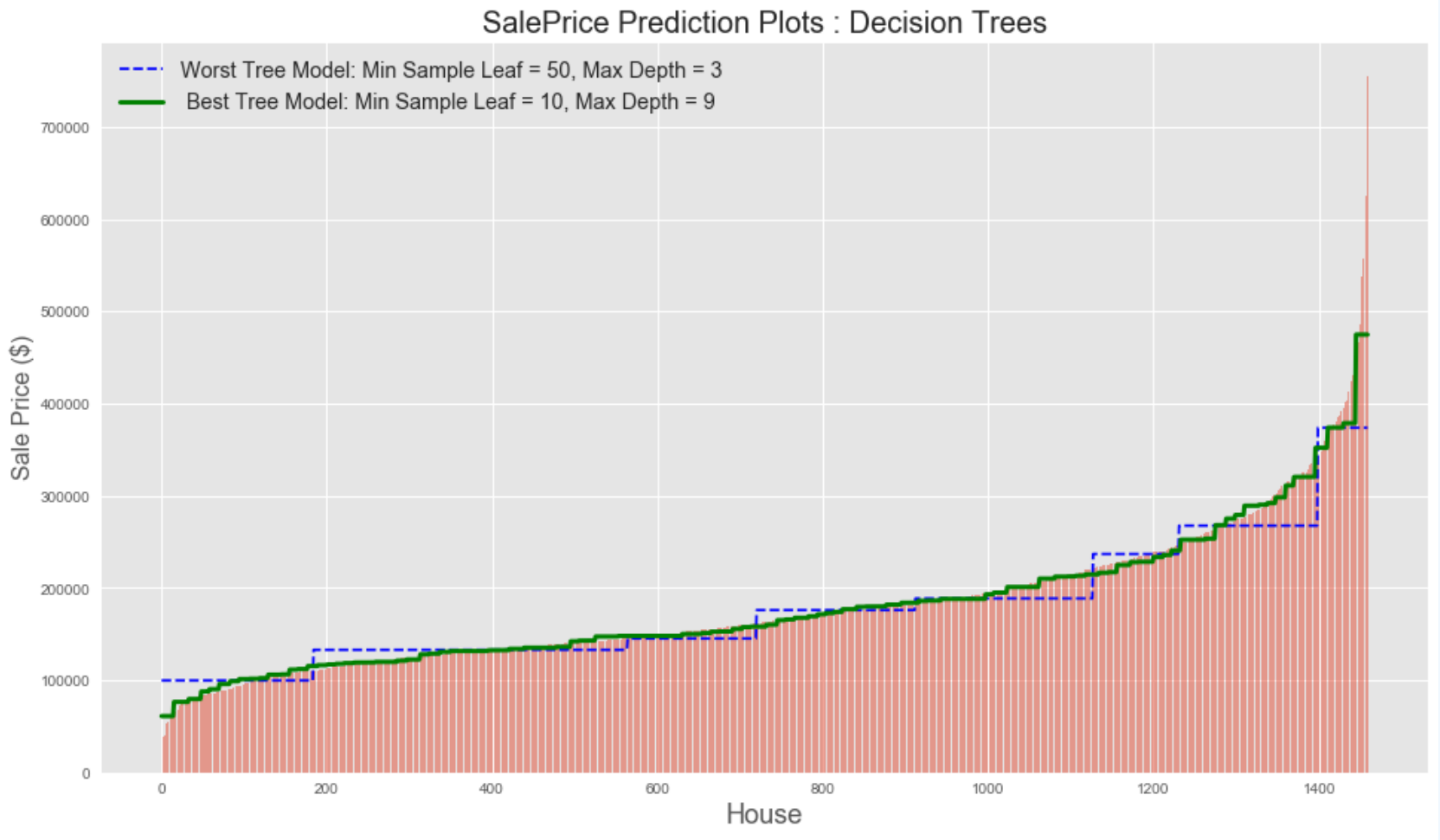
Tree Based Models

Decision Trees

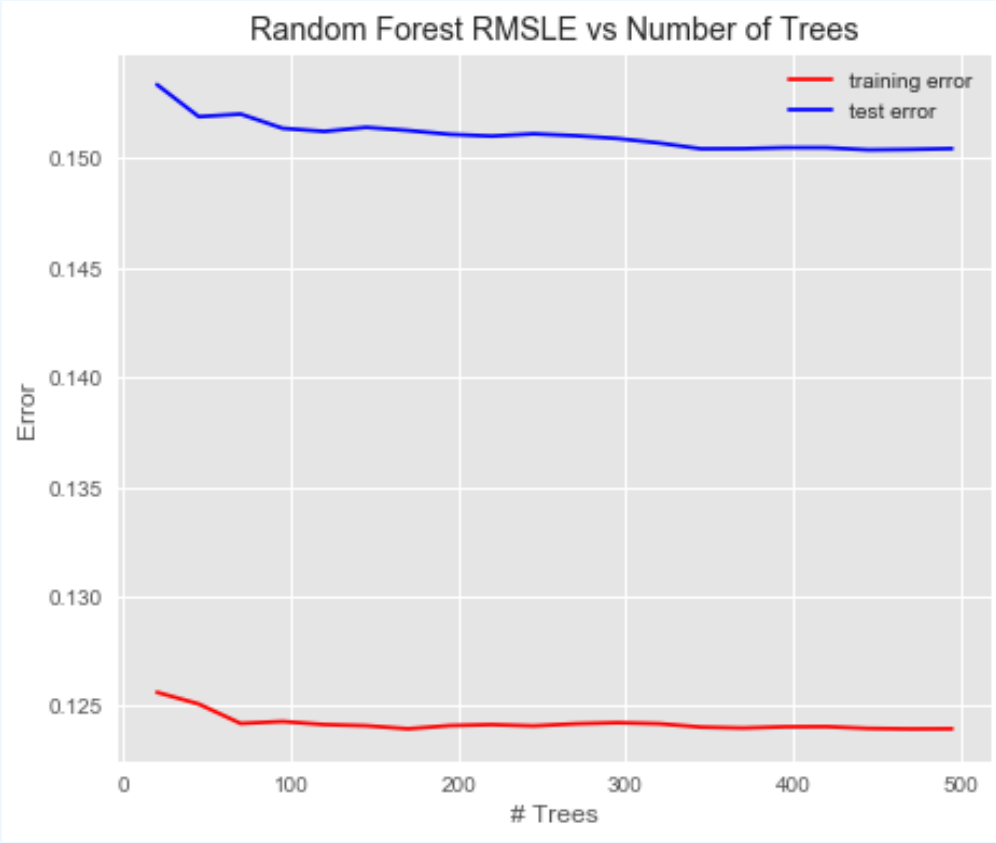


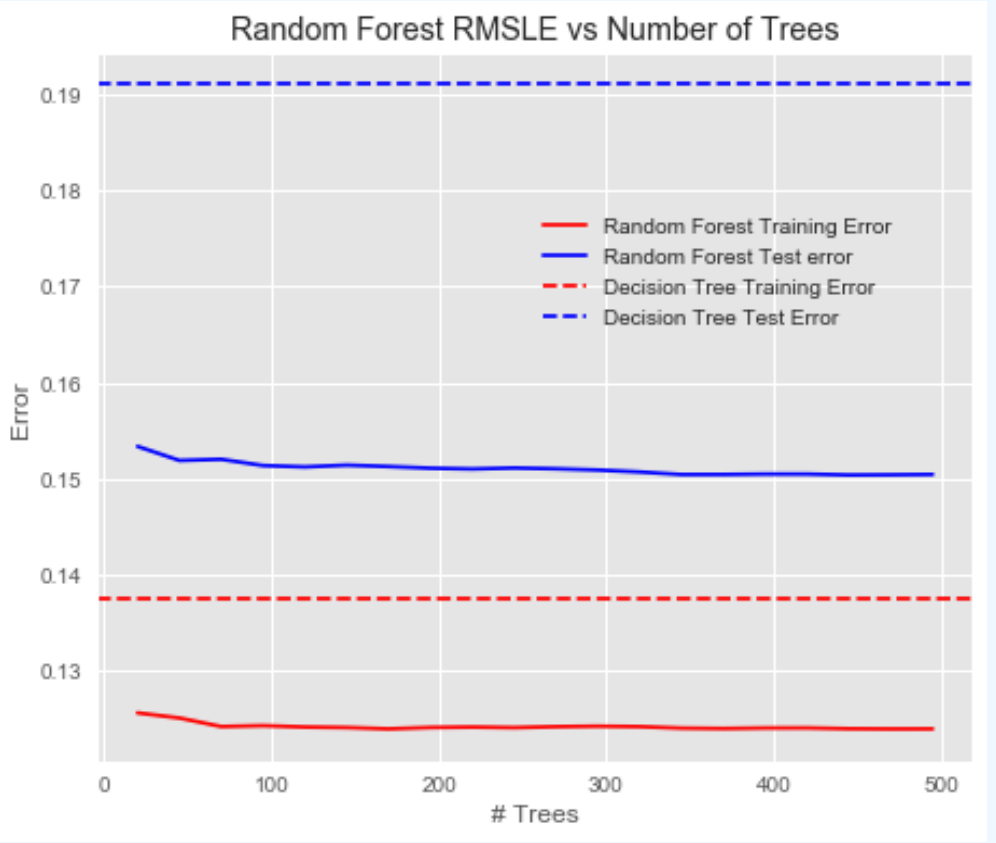


Decision Trees

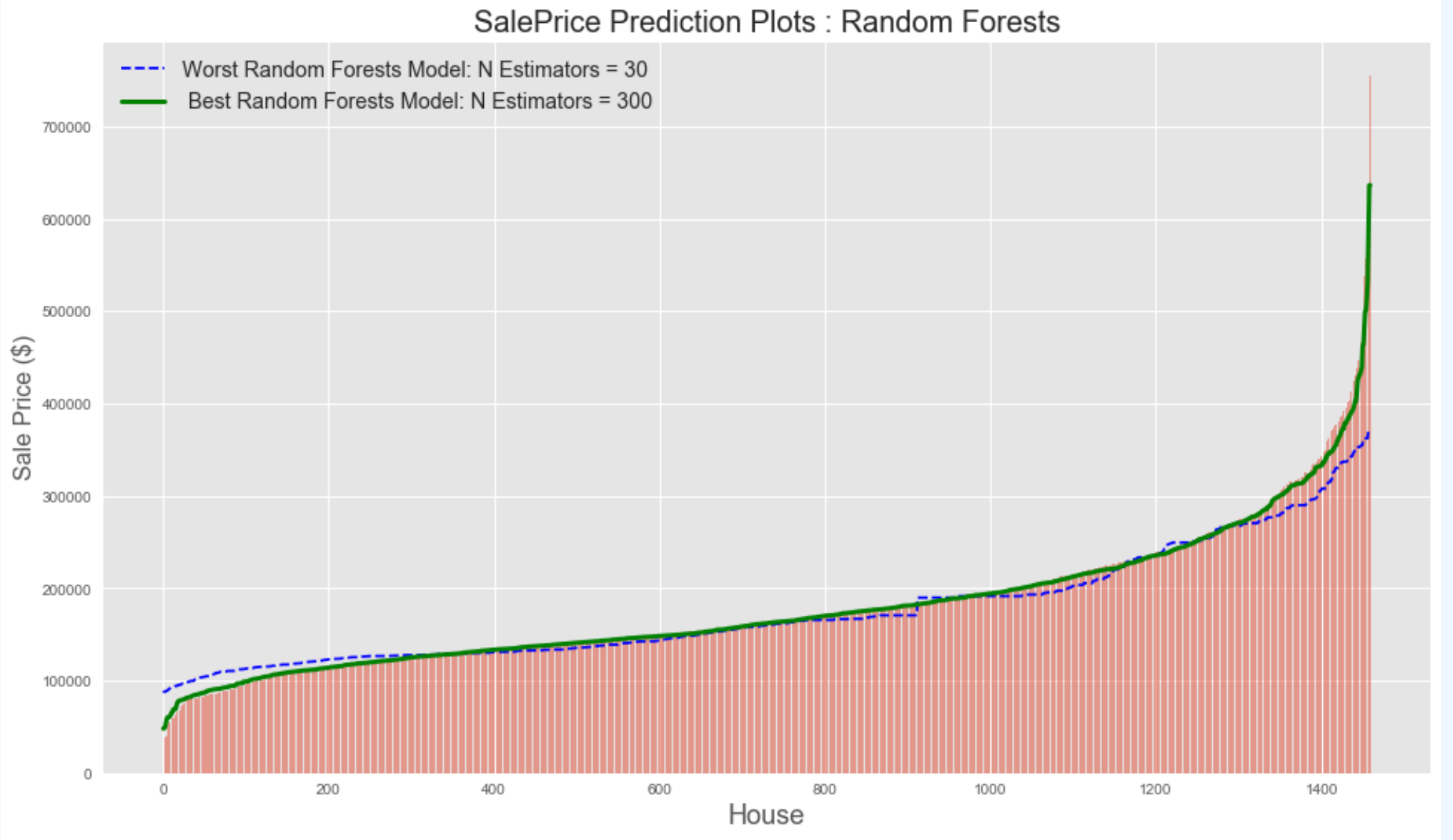


Random Forest

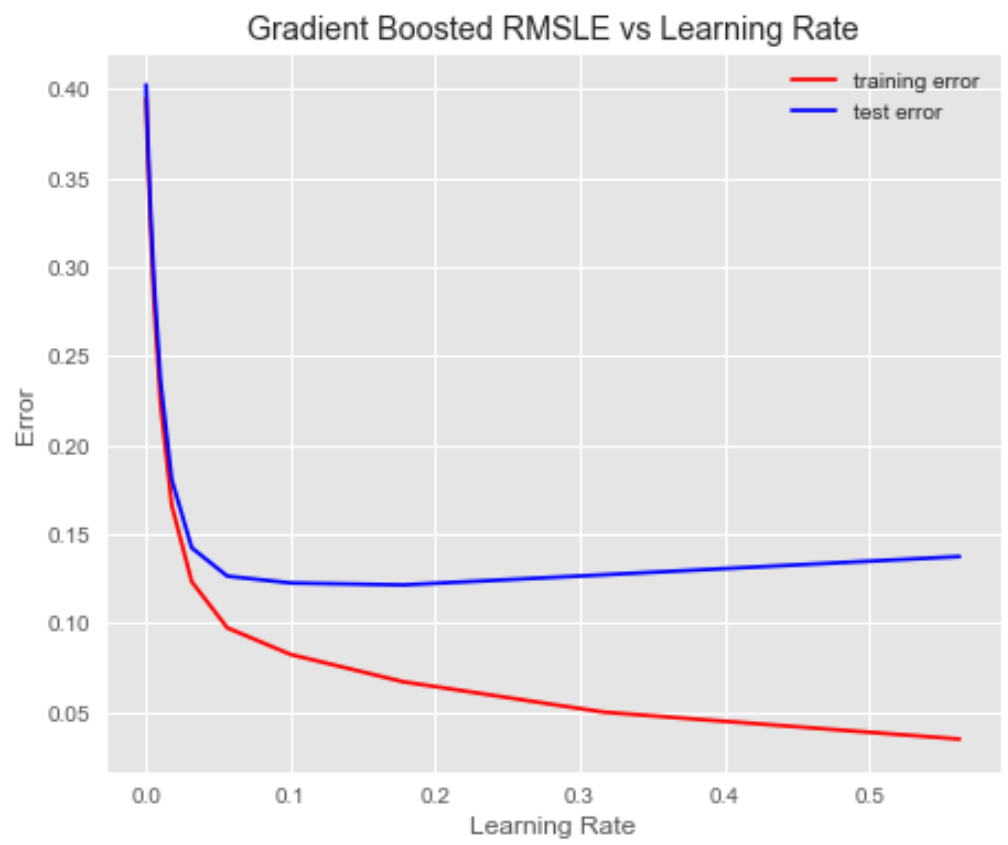


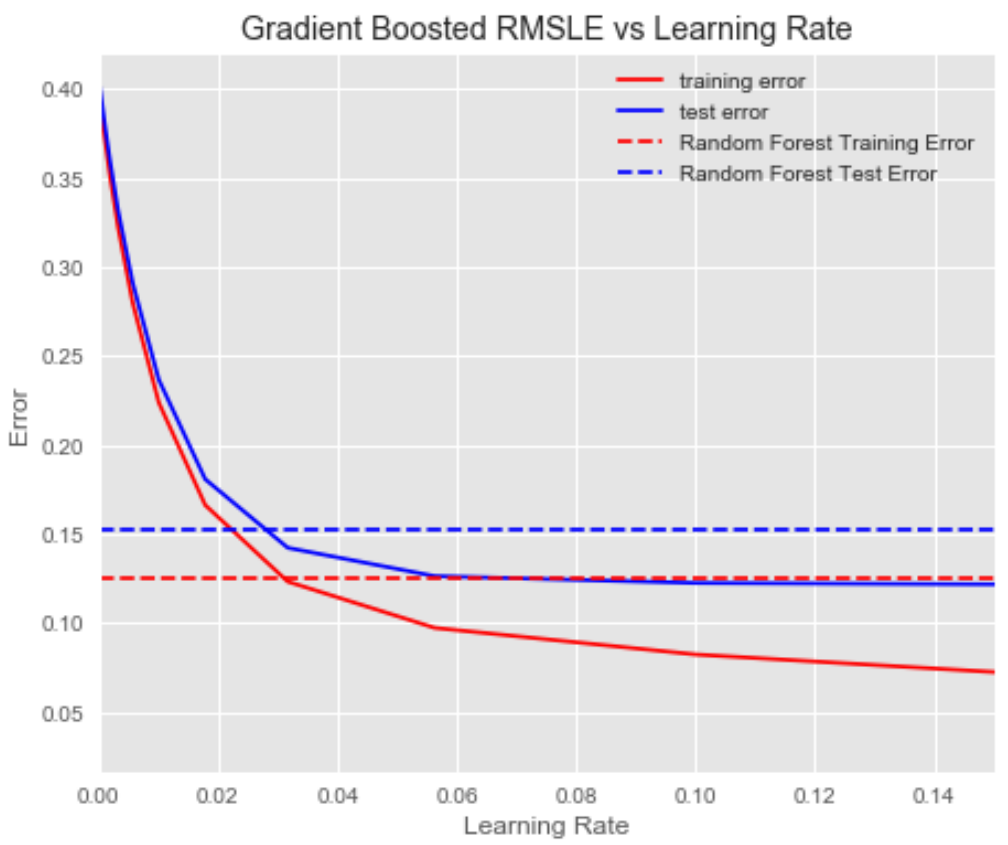


Random Forests

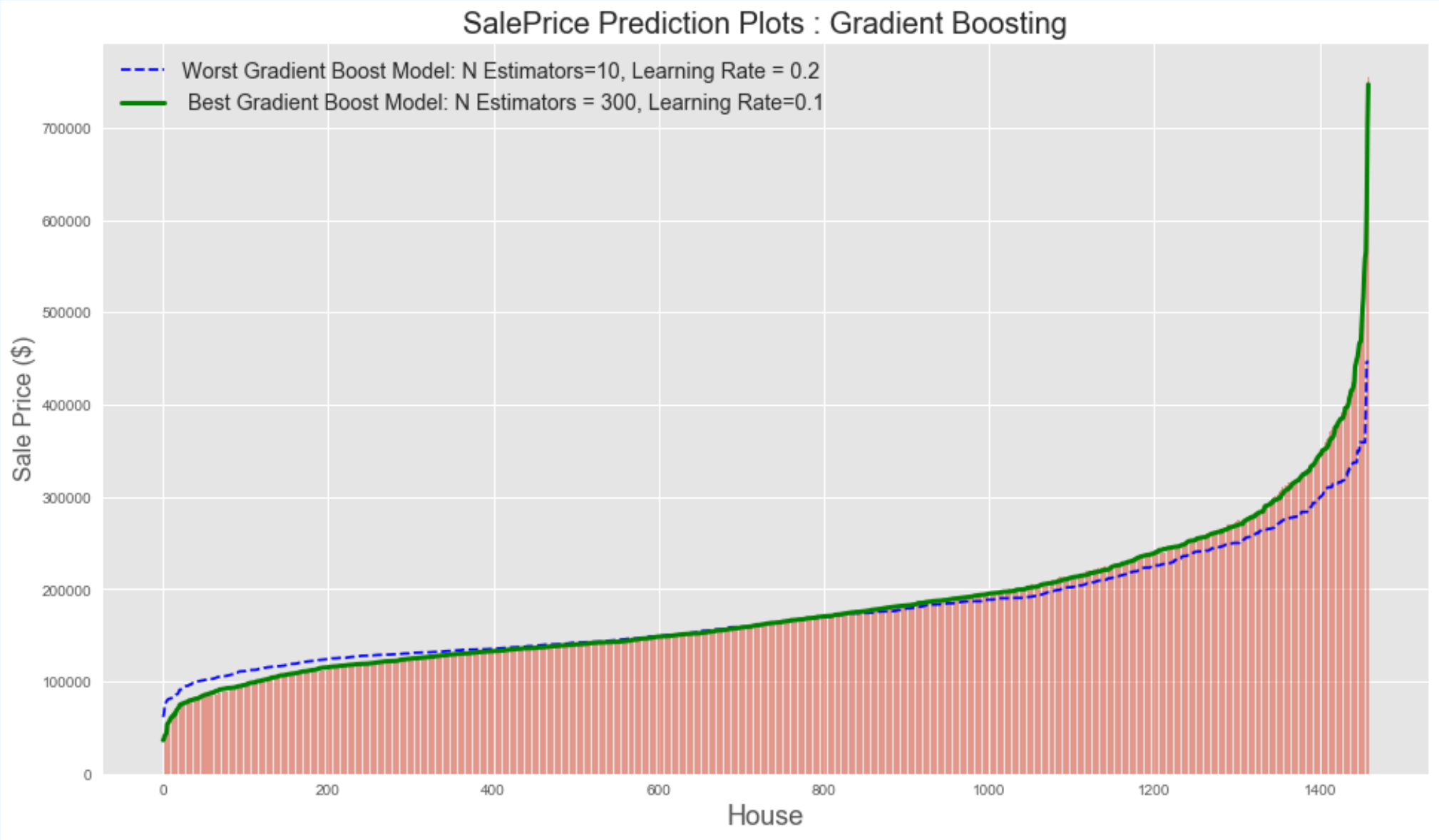


Gradient Boosting

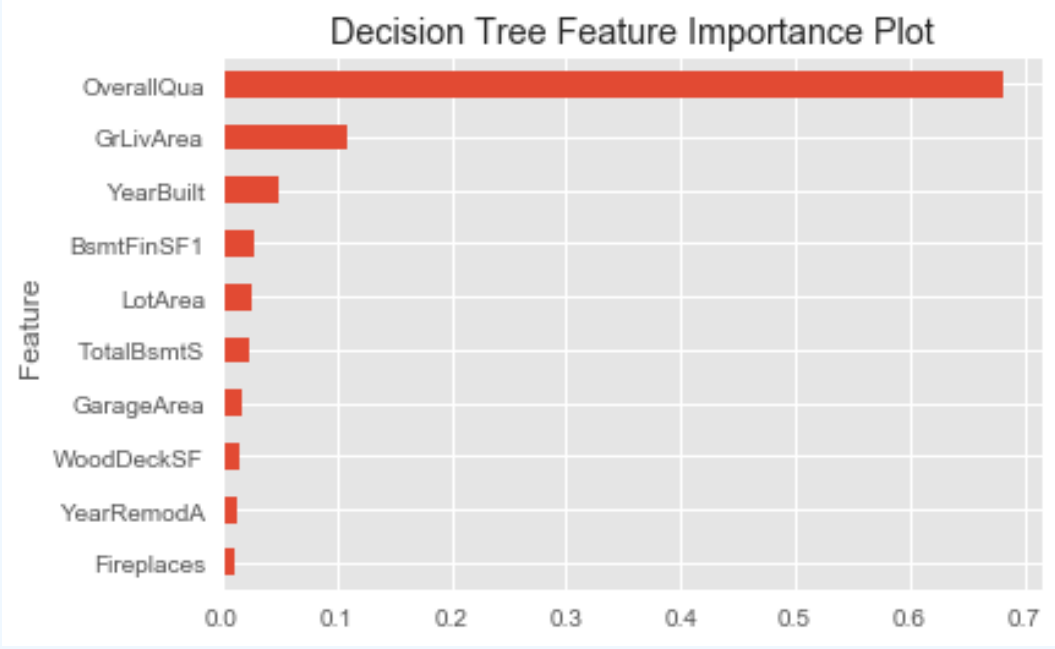


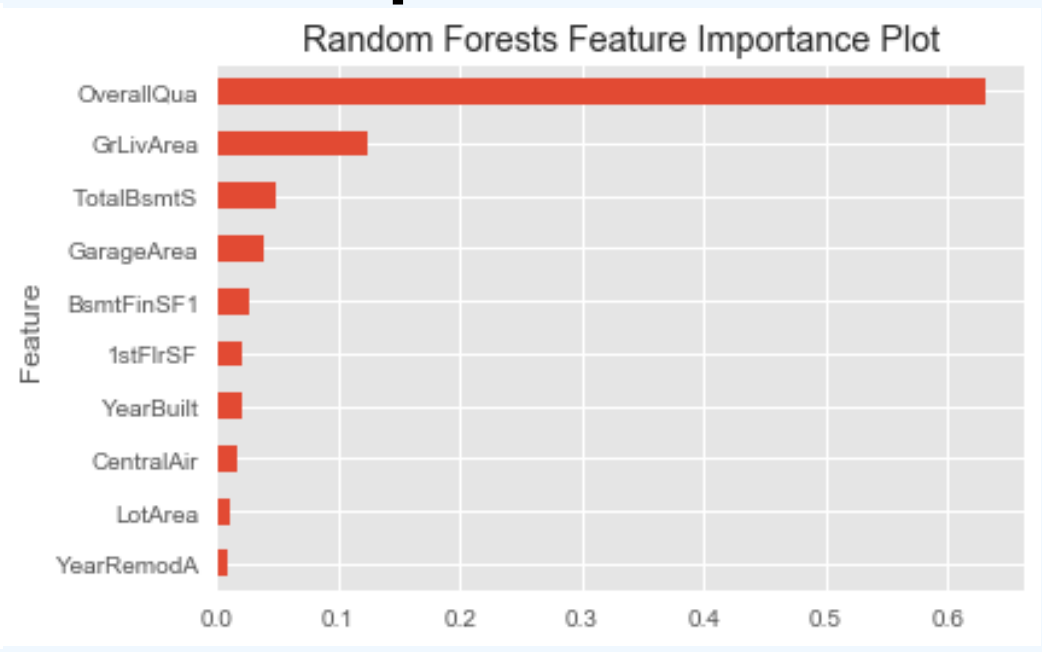


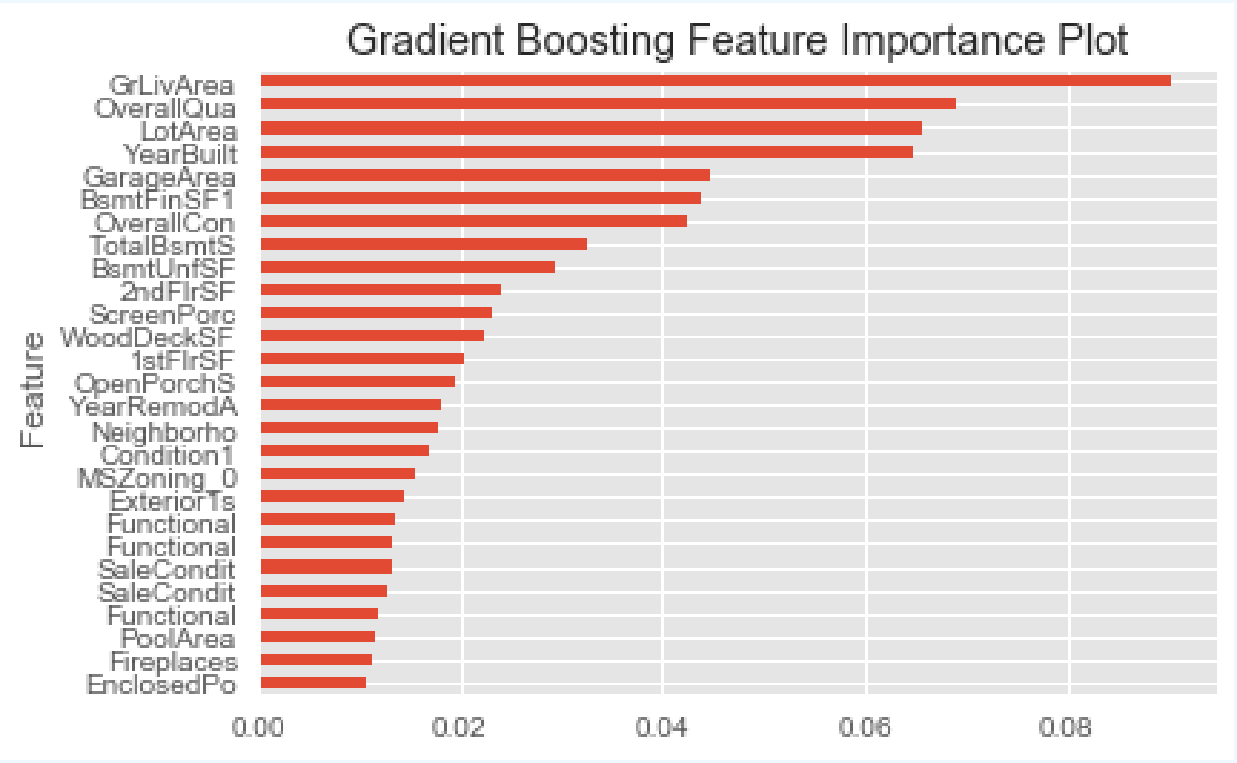
Gradient Boosting



Tree Based Variable Importance







Tree Based Models
CV Grid Search

	Hyper Parameters		RMSLE		
Models	**Type**	**Values**	**Training**	**Test**	**Kaggle**
Decision Trees	Max Depth	9	0.1374	0.1910	0.1882
	Min Sample Splits	10			
Random Forests	Min Sample Leaf	2	0.0771	0.1358	0.1465
	N Estimators	300			
Gradient Boosting	Min Sample Splits	50	0.0746	0.1184	0.1245
	Learning Rate	0.06			
	N Estimators	300			

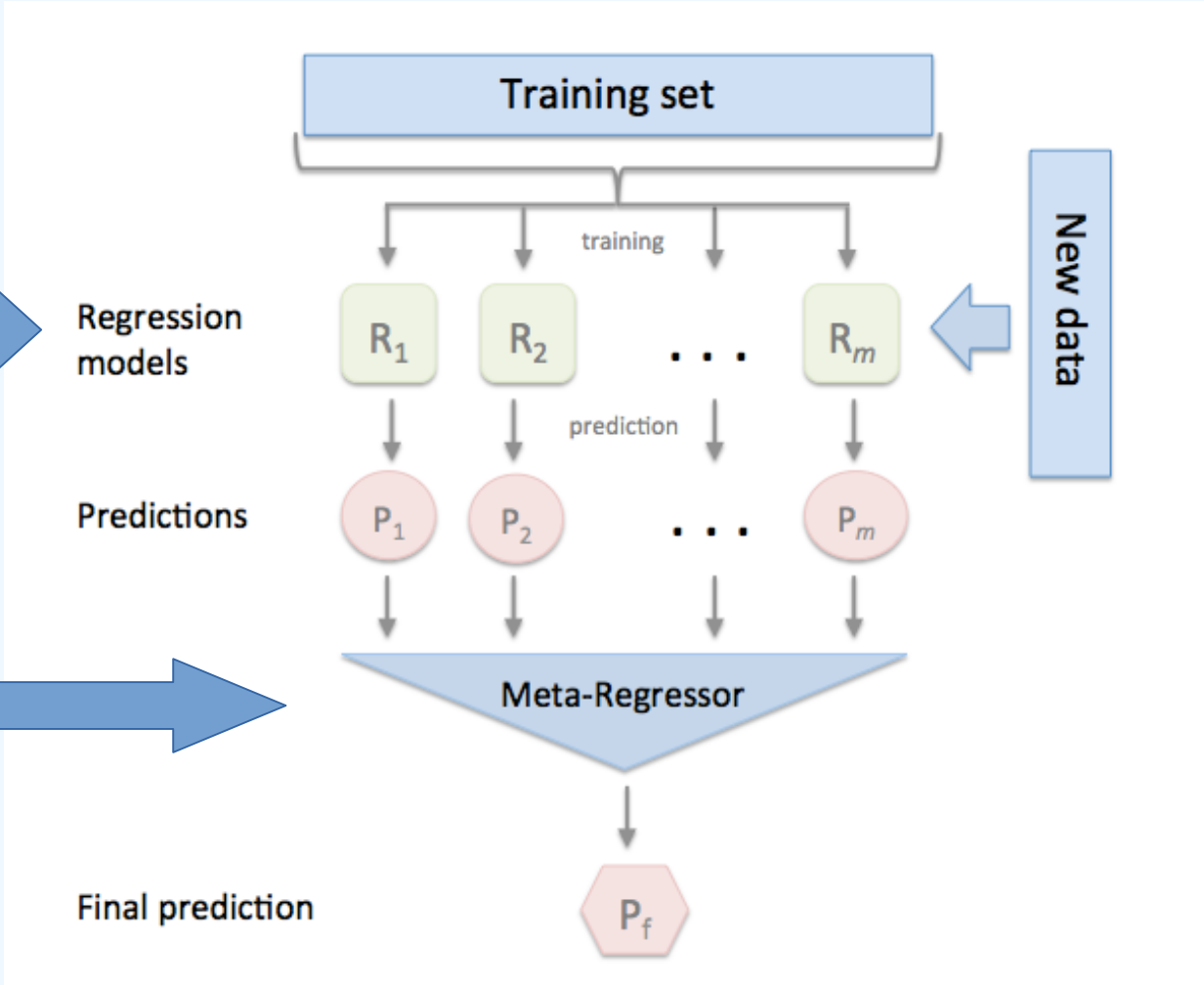
Ensemble Model
Stacking Regressor

Ridge Regression

Lasso Regression

Random Forests

Lasso
Meta Regressor



[Package MLXTEND]

Ensemble Model Results

				RMSLE	
	Models	**Meta-Regressor**	**Alphas**	**Test**	**Kaggle**
Ensemble 1	Lasso Regression Ridge Regression Random Forest	Lasso	0.001	0.0656	0.1492
Ensemble 2	Lasso Regression Ridge Regression	Lasso	0.0001	0.0949	0.1251

Models Results

		RMSLE		
	Models	**Training**	**Test**	**Kaggle**
Linear Based	Multi-Linear	0.1787	0.1641	0.1788
	Ridge Regression	0.1000	0.1110	0.1290
	Lasso Regression	0.1630	0.1370	0.1414
Tree Based	Decision Trees	0.1374	0.1910	0.1882
	Random Forests	0.0771	0.1358	0.1465
	Gradient Boosting	0.0746	0.1184	0.1245
Ensemble	Ensemble 1	0.0010	0.0656	0.1492
	Ensemble 2	0.0001	0.0949	0.1251

Conclusion

- Vital Steps
  - Feature Engineering
    - Surprising results with respect to most important features based on coefficients
  - Hyperparameters Tuning
- Model Performance:
  1. Ridge Regression
  2. Lasso Regression (within ensembling process)