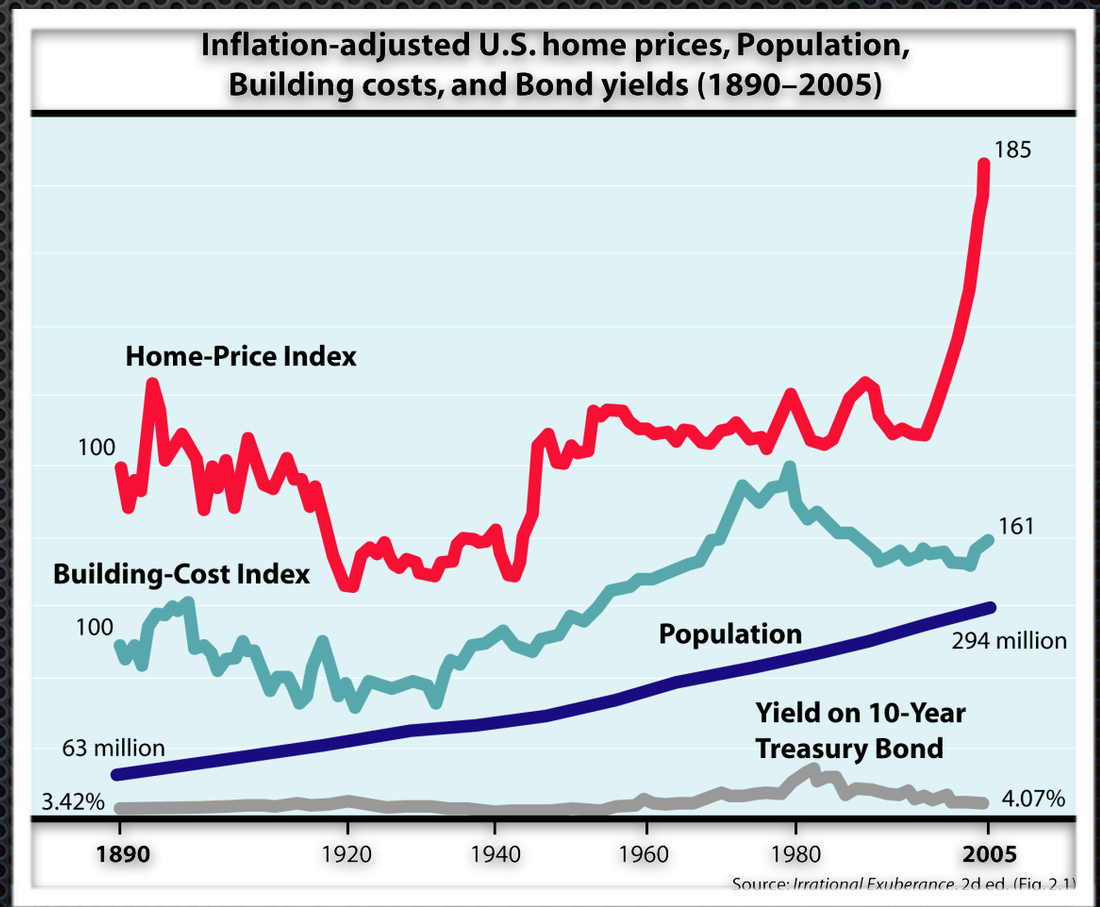
Predicting Sales Prices for the Kaggle Ames, Iowa Housing Dataset

Team Proxima Centauri - Wenchang, Kenny, James, Danny

Brief Overview of Data Set

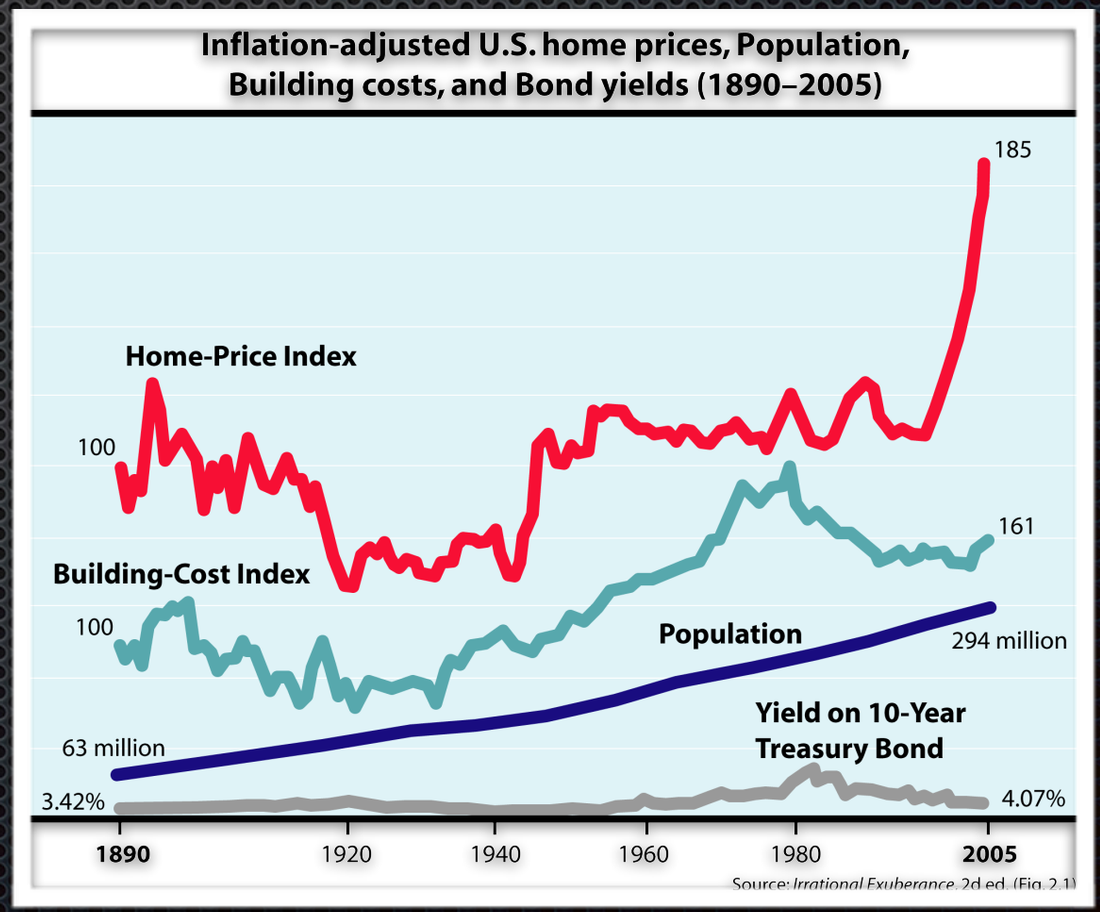
- 80 variables tied to price of home sales in Ames, Iowa between 2006-2010
- Initially obtained from Ames City Assessor's Office with 113 variables that described 3970 property sales -> cleaned and collated by Dean De Cock {Journal of Statistics Ed., **19**, (3) 2011}
- Reduced to 80 predictors:
  - 20 continuous variables {total dwelling sq. footage etc}
  - 14 discrete variables {number of bathrooms, kitchens}
  - 46 categorical variables - 23 nominal/23 ordinal {street pavement, neighborhood}

The US Housing Bubble



The US Housing Bubble

- What was going on between 2006-2010 in our country?
- Will there be a noticeable effect?



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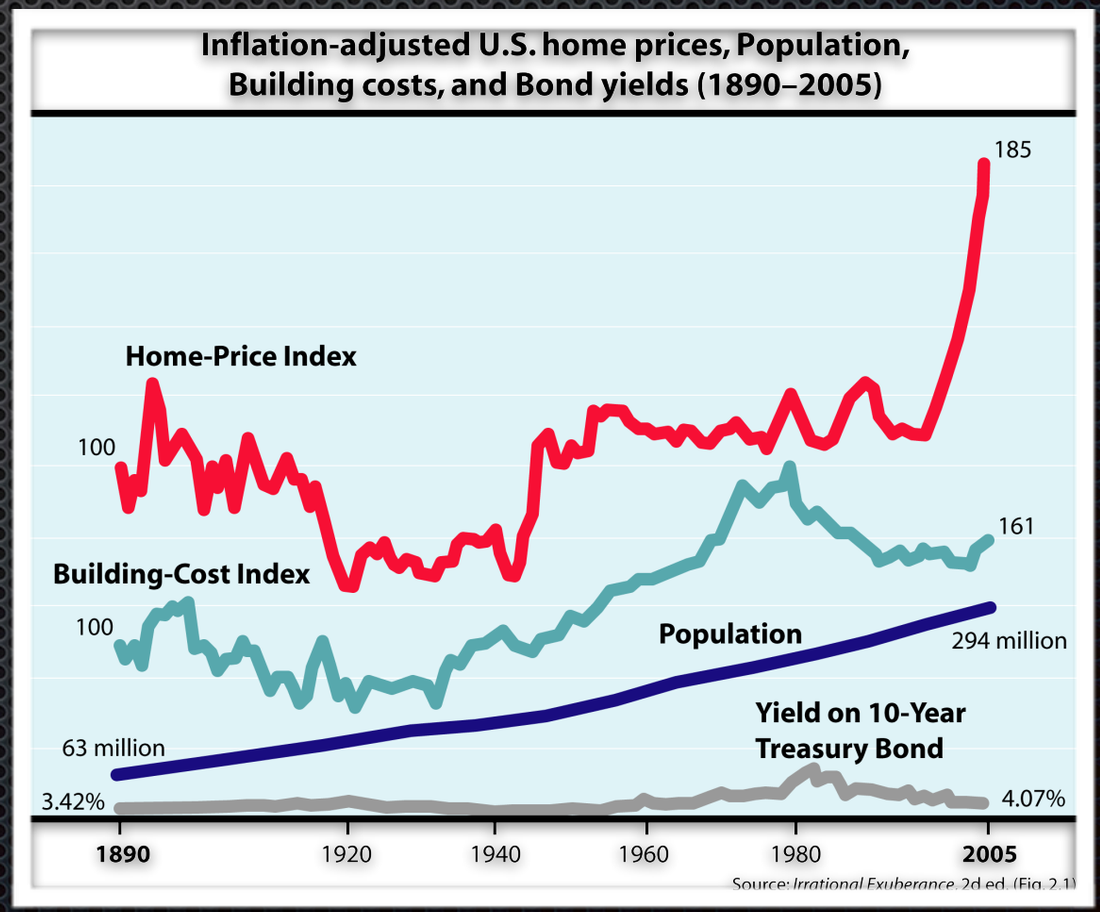

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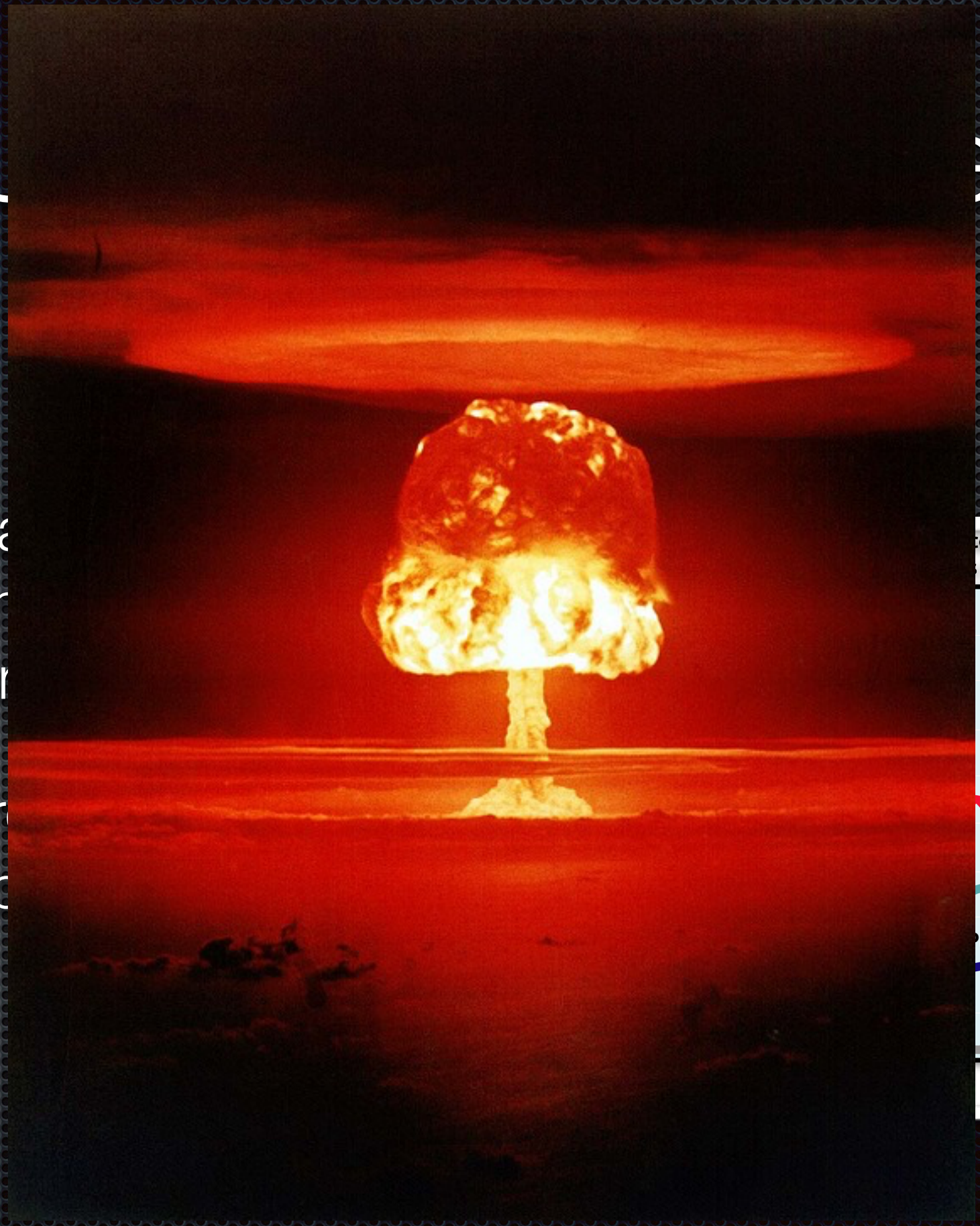
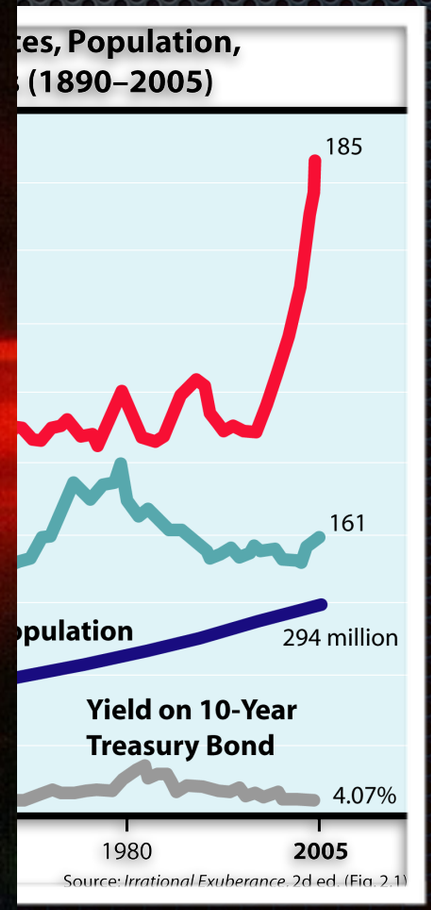




Considerations Involving Home Prices

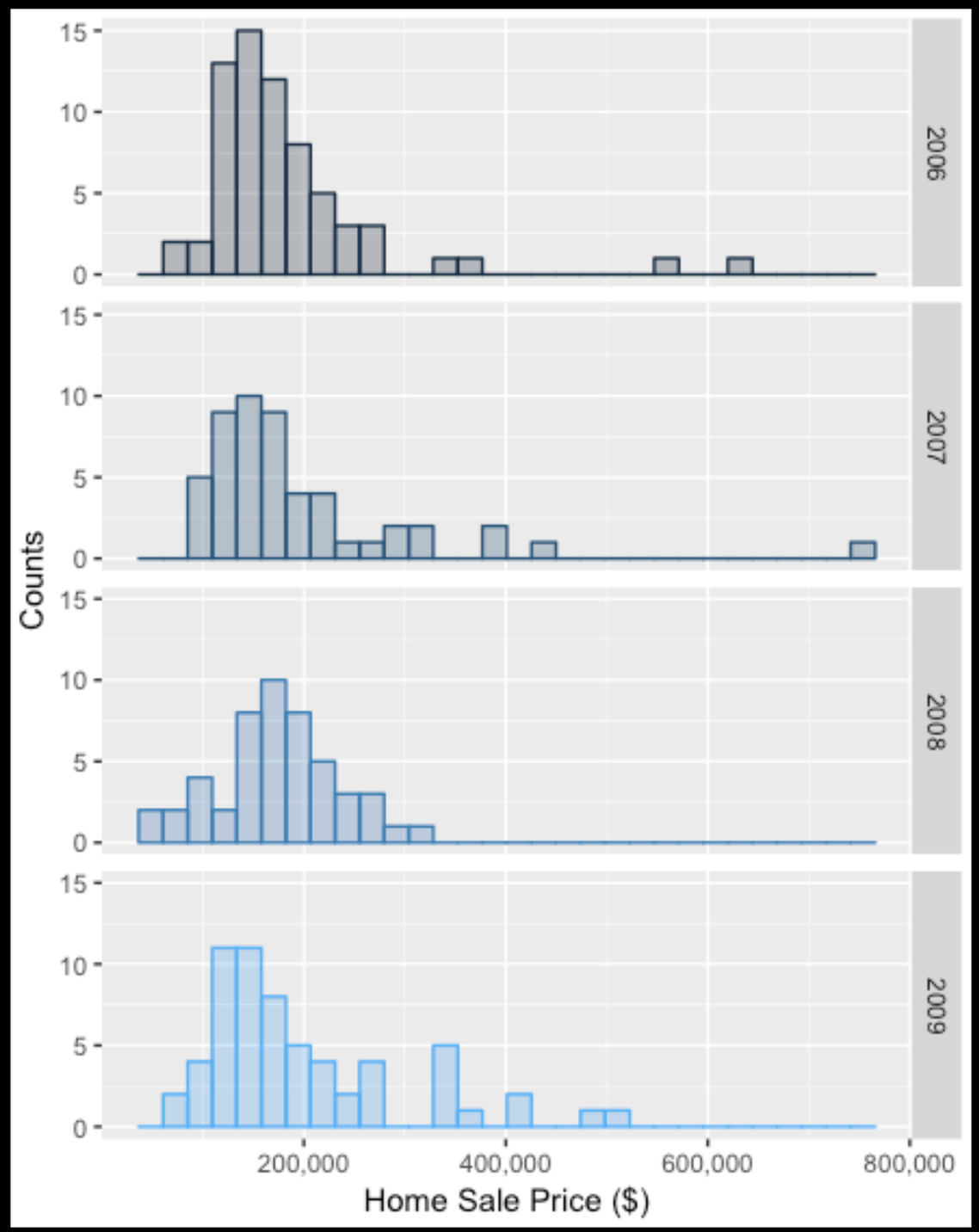
How did monthly home sales vary during the timespan represented in dataset?

https://plot.ly/~dbubb/13/

Buyer's market in Spring, Seller's in Fall

Kruskall-Wallis (~Anova): p=0.97, df=3, χ^2 = 0.24345

Levene(~Barlett's): p=0.97, df=3, F = 1.325



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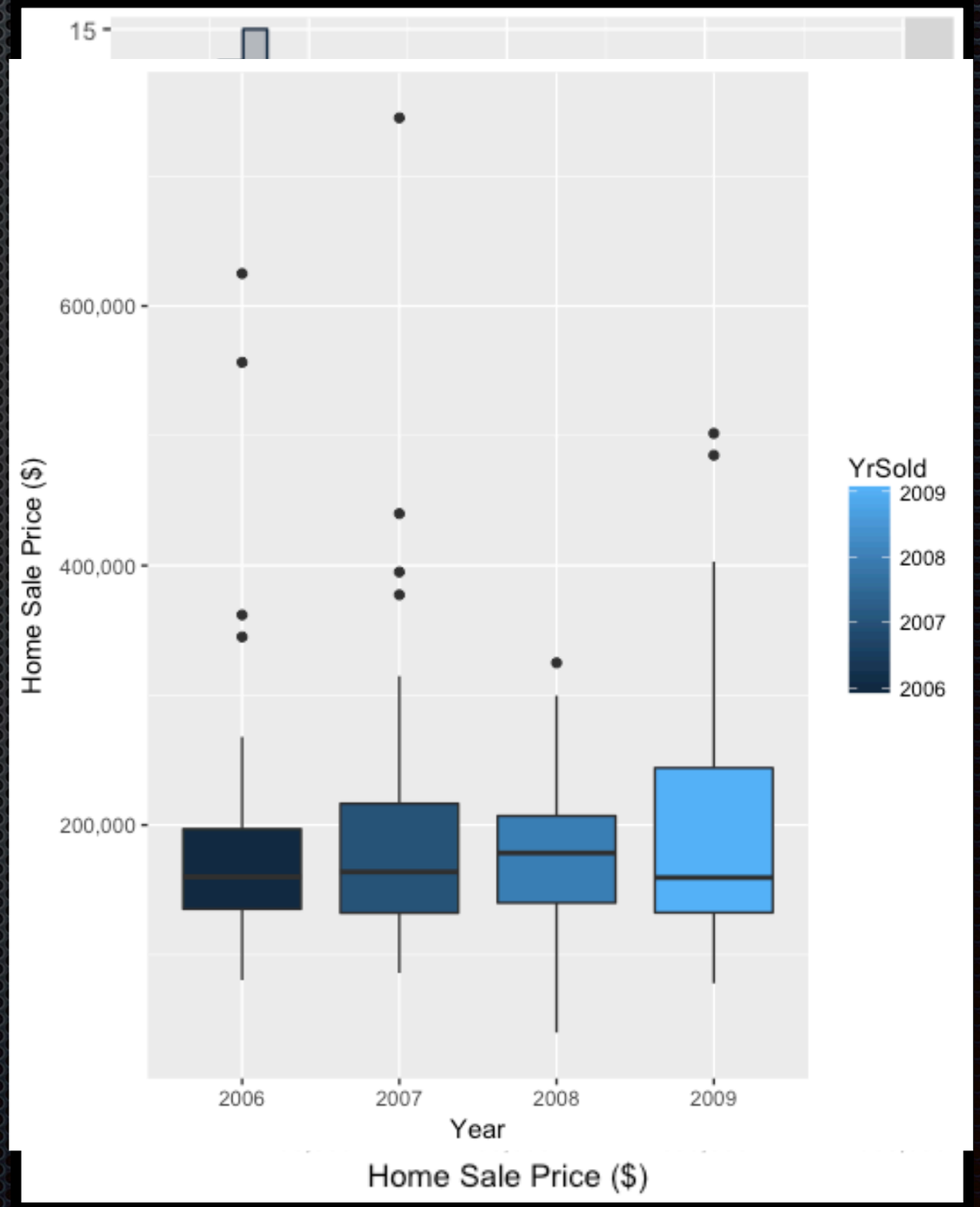
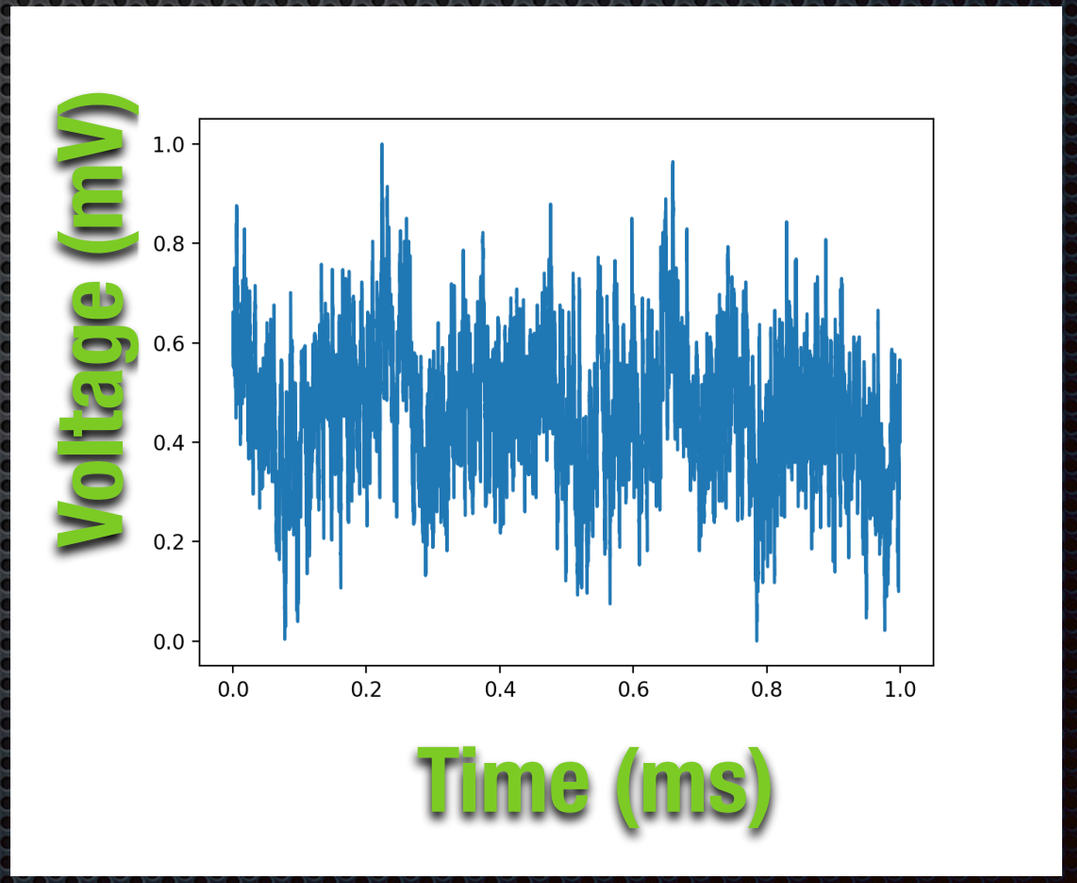


Hurst exponent

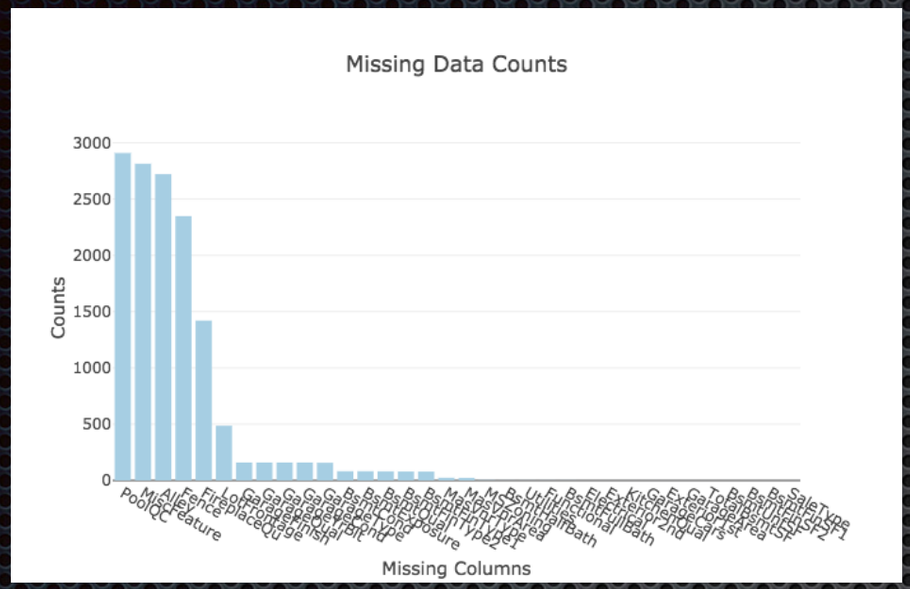
$$D_f = -\lim_{\epsilon \to 0} \frac{ln(N(\epsilon))}{ln(\epsilon)}$$

- H = 2 - D_f = 0.536 - ~ Brownian Motion
  - 0 < H < 0.5 - mean-reverting, anti-persistent
  - 0.5 < H < 1- persistent $\Longrightarrow$ increases tend to follow increases, same for decreases…



Good discussion here re: S&P 500

Data Cleaning, Feature Eng.



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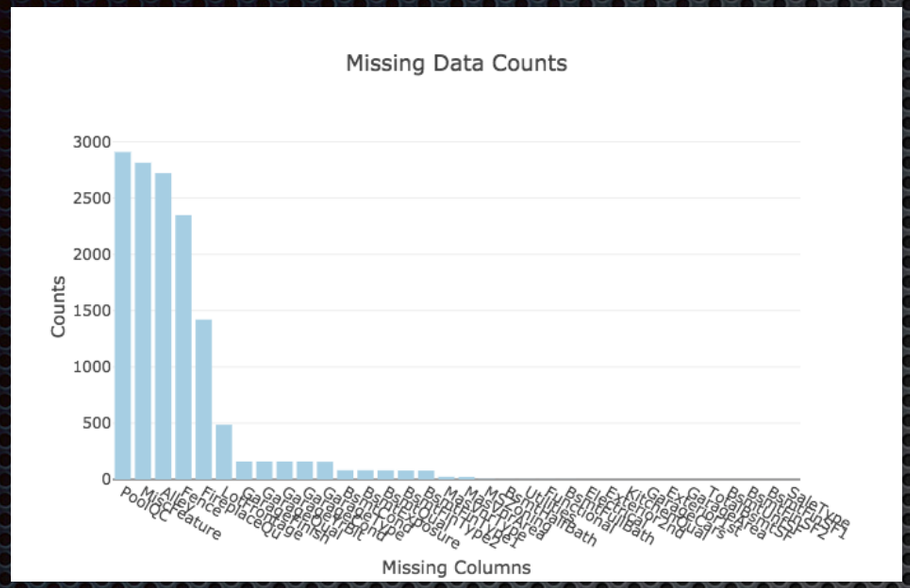
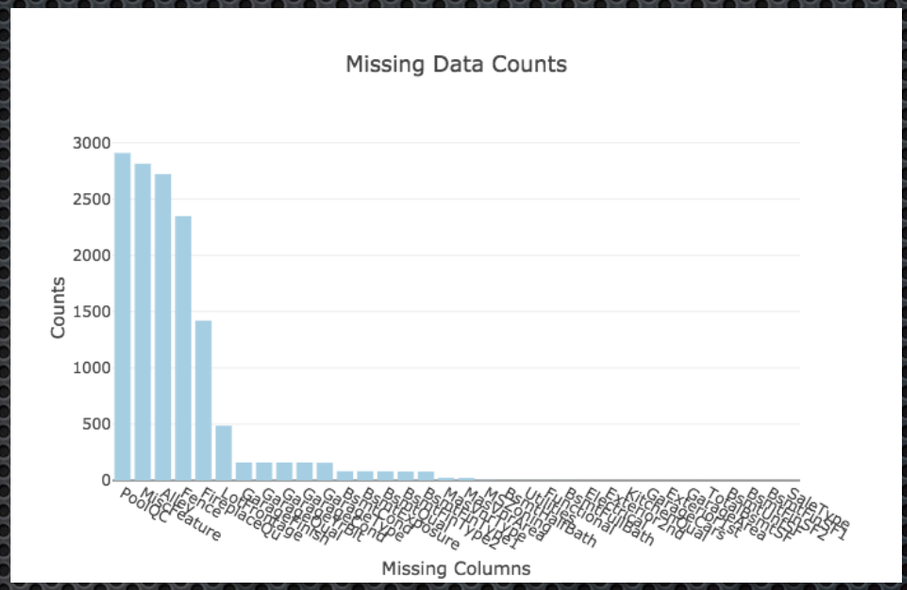
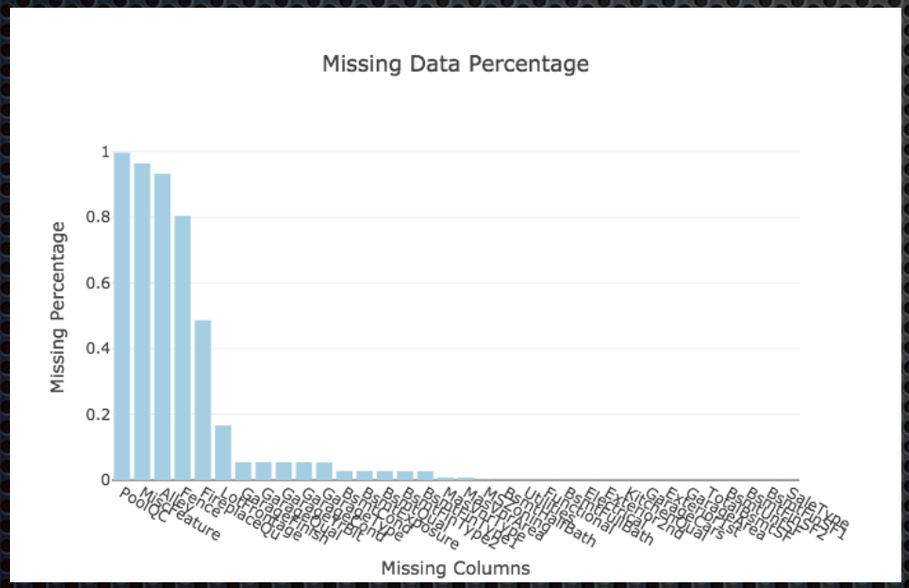


- Missingess
- Imputation
- Added features
- Normalization

Data Cleaning, Feature Eng.





- Normalization

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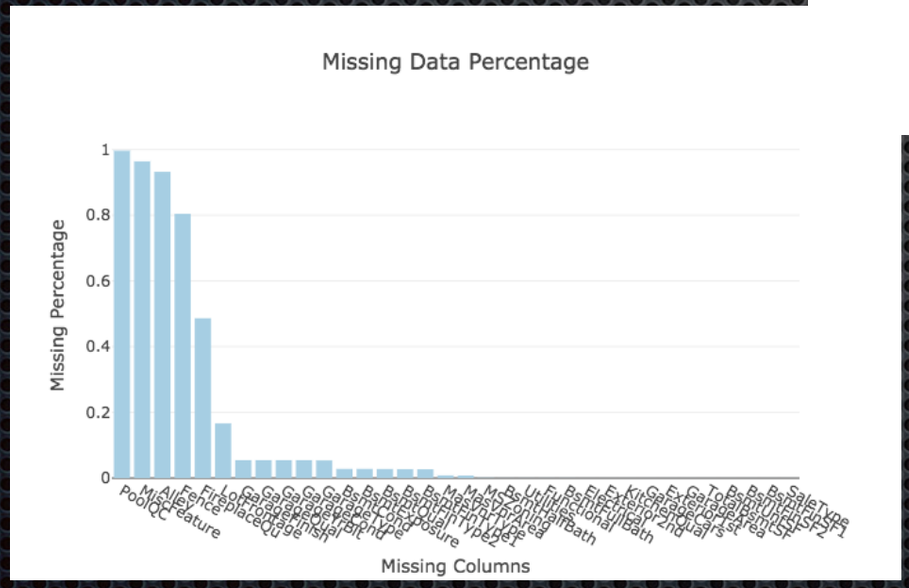

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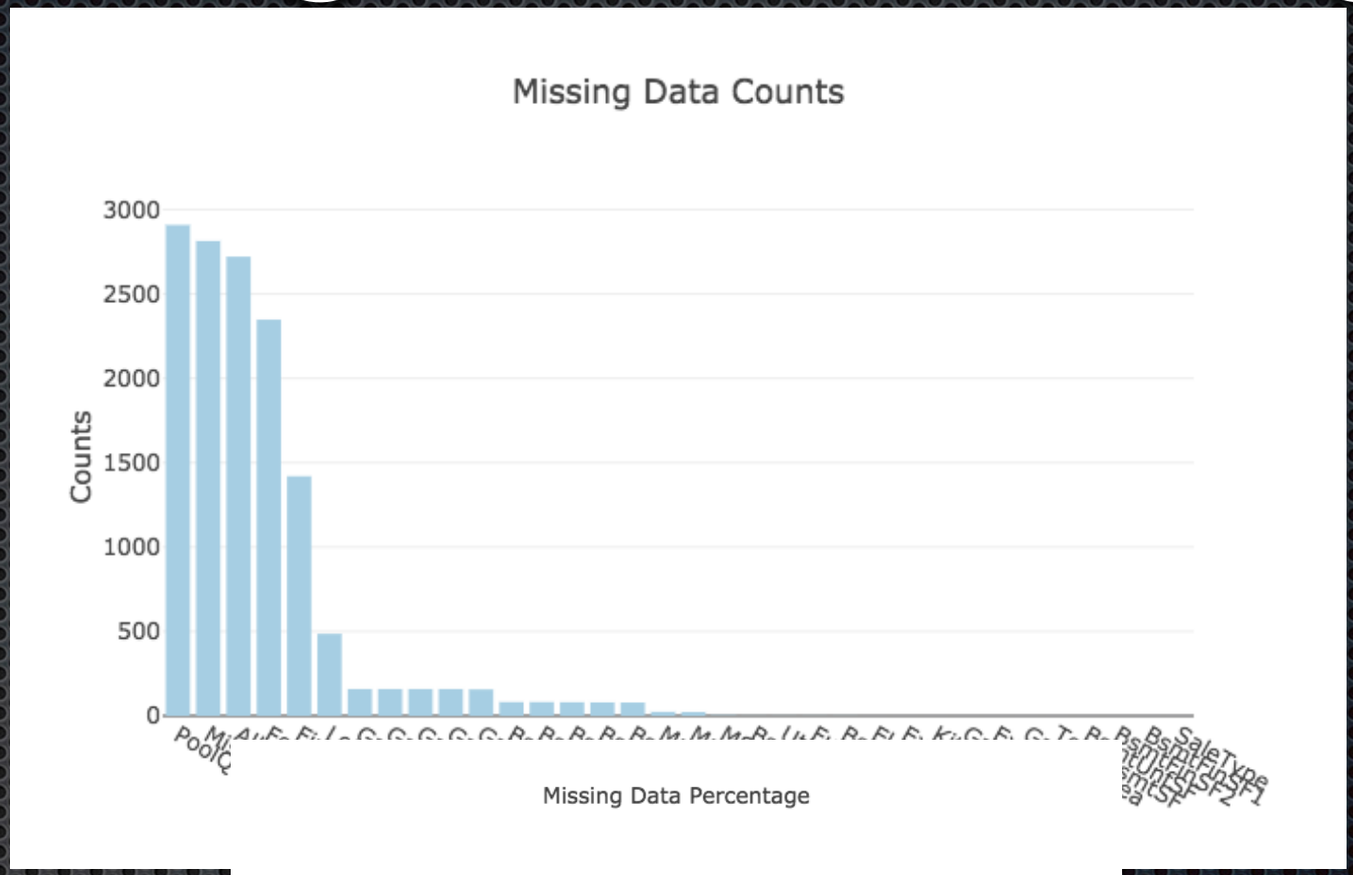

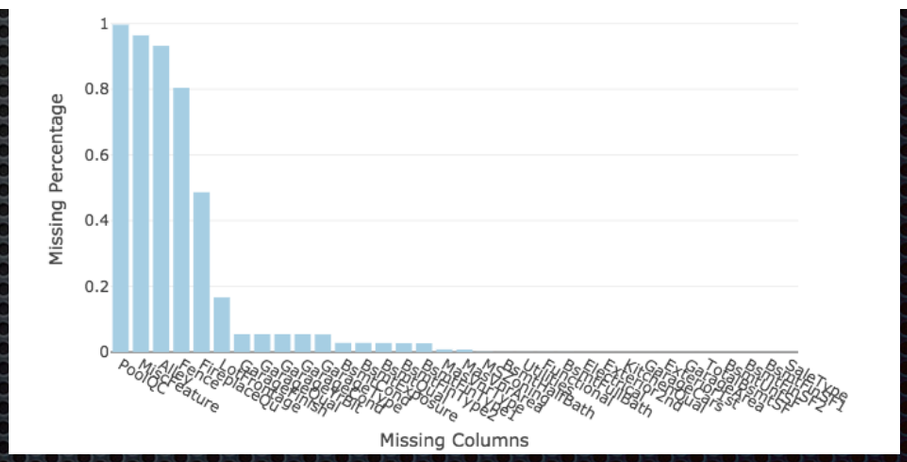

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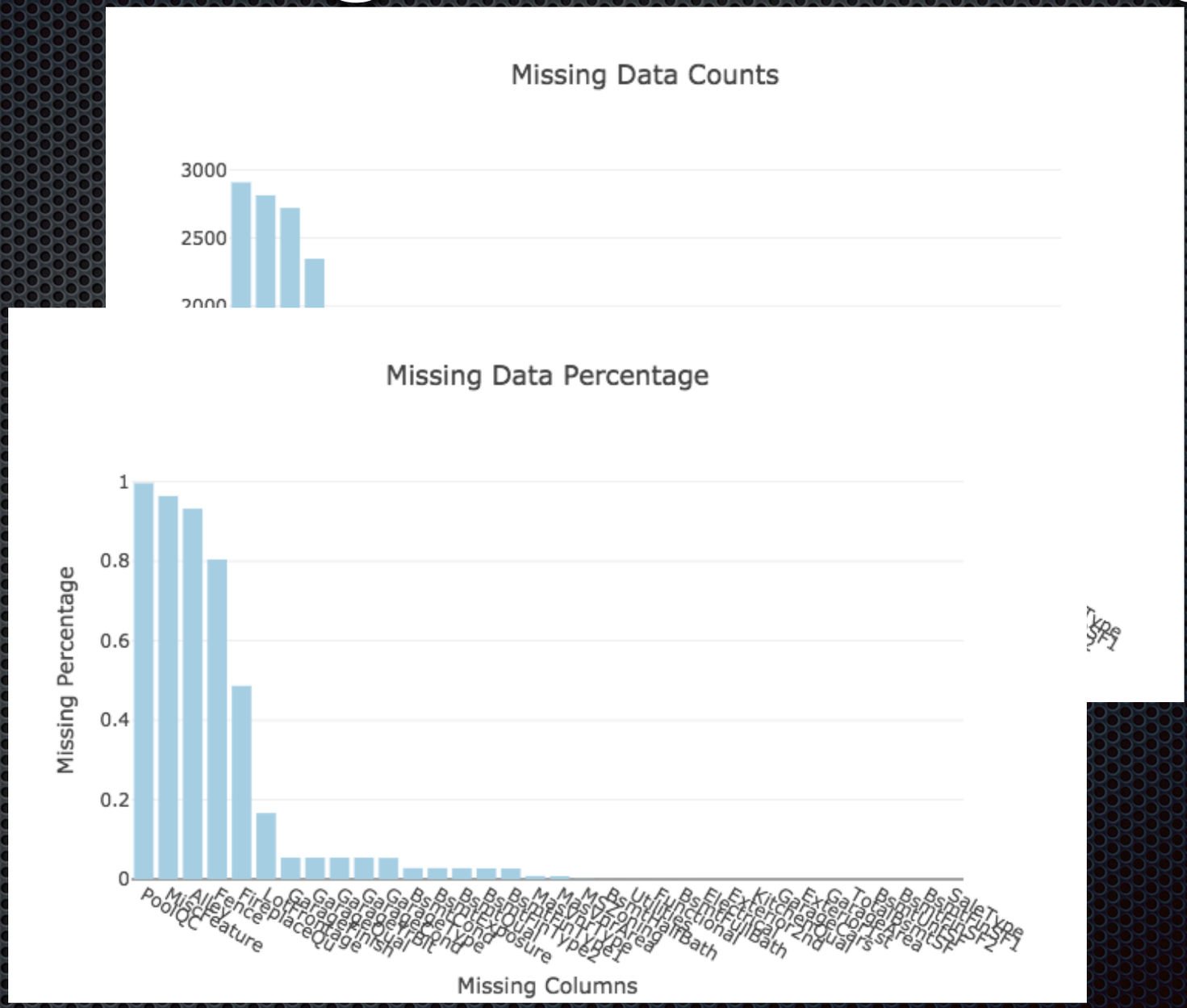

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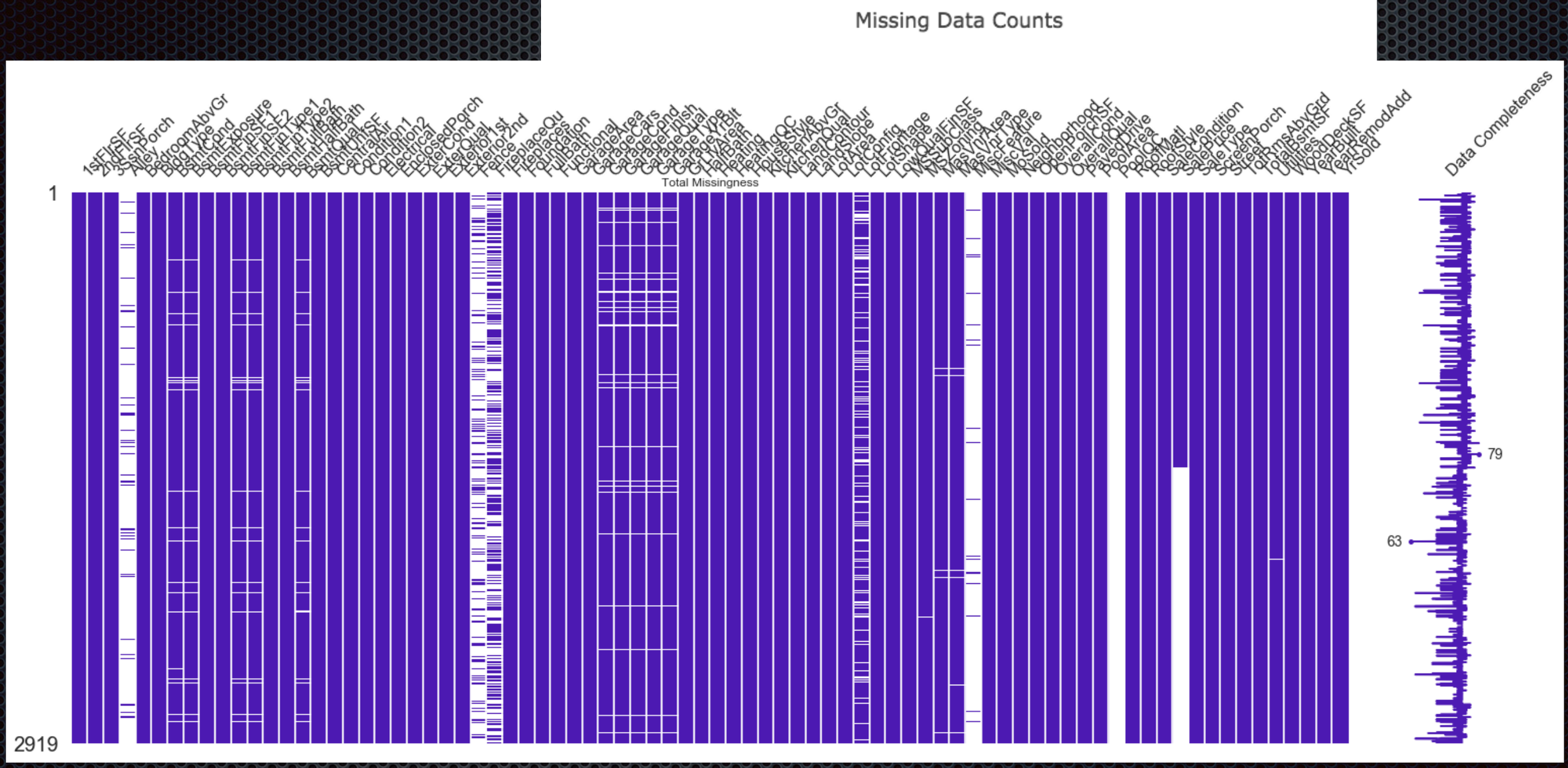
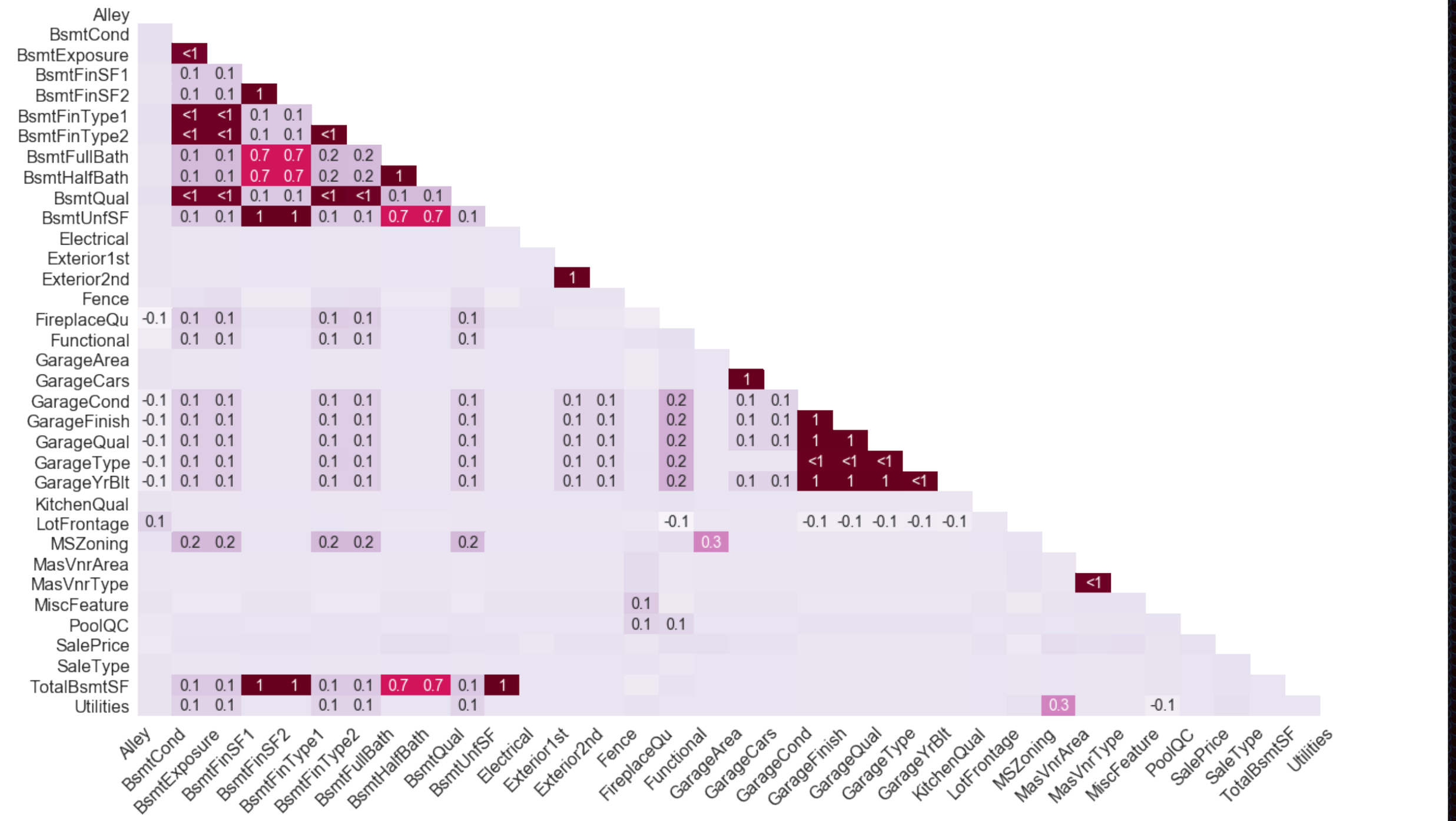
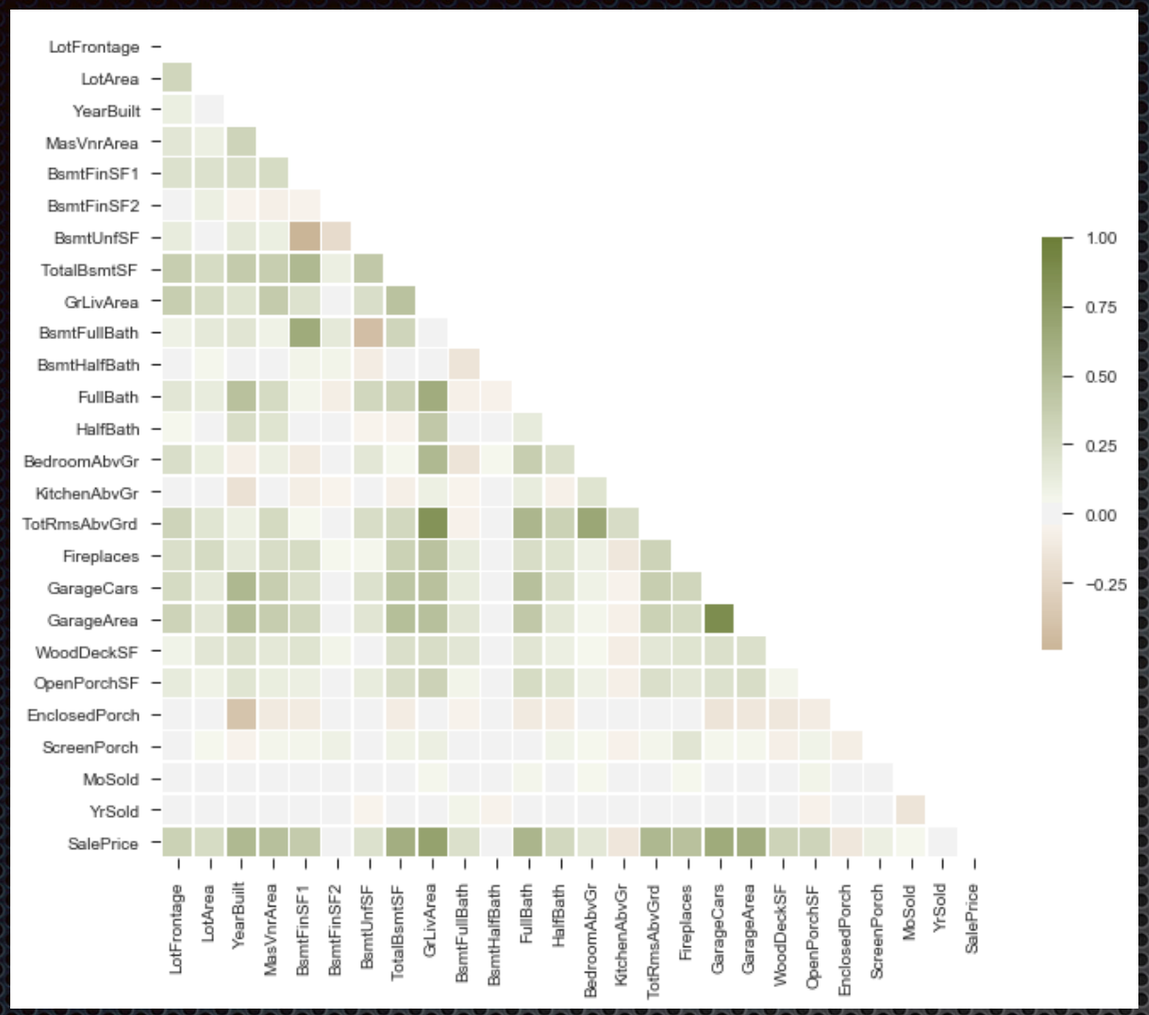


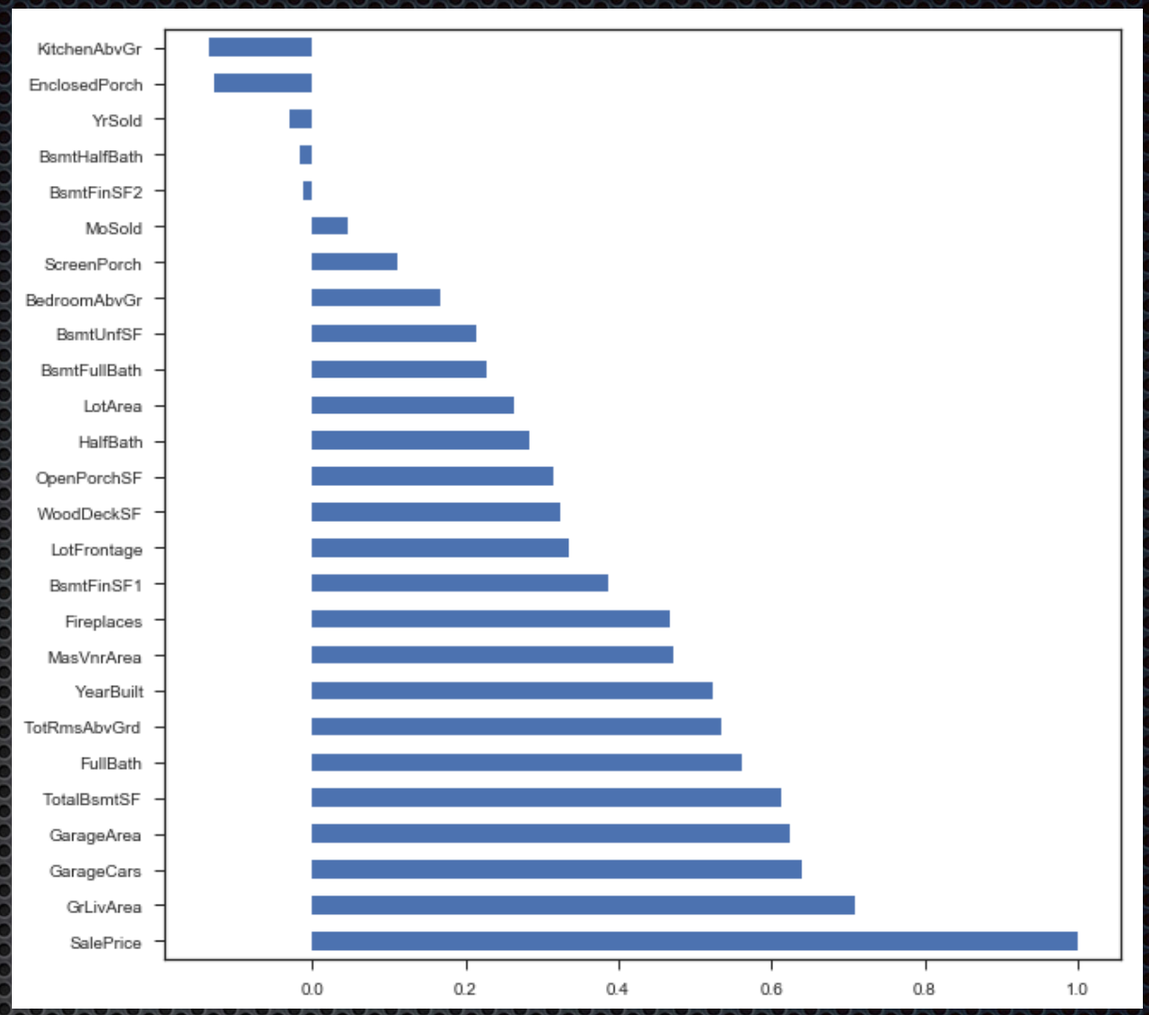


Correlated Missingness?

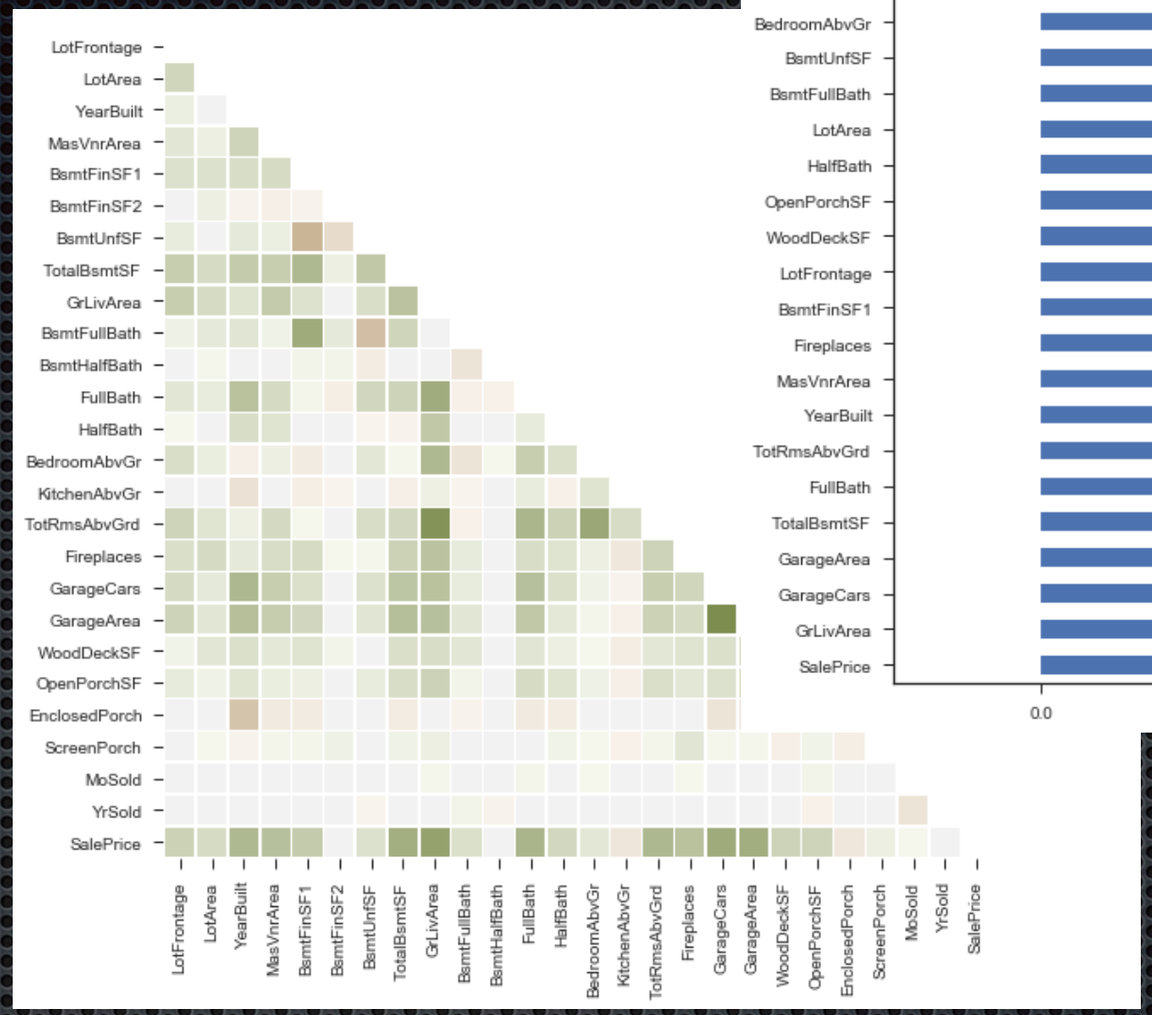
Skew and Dummifying

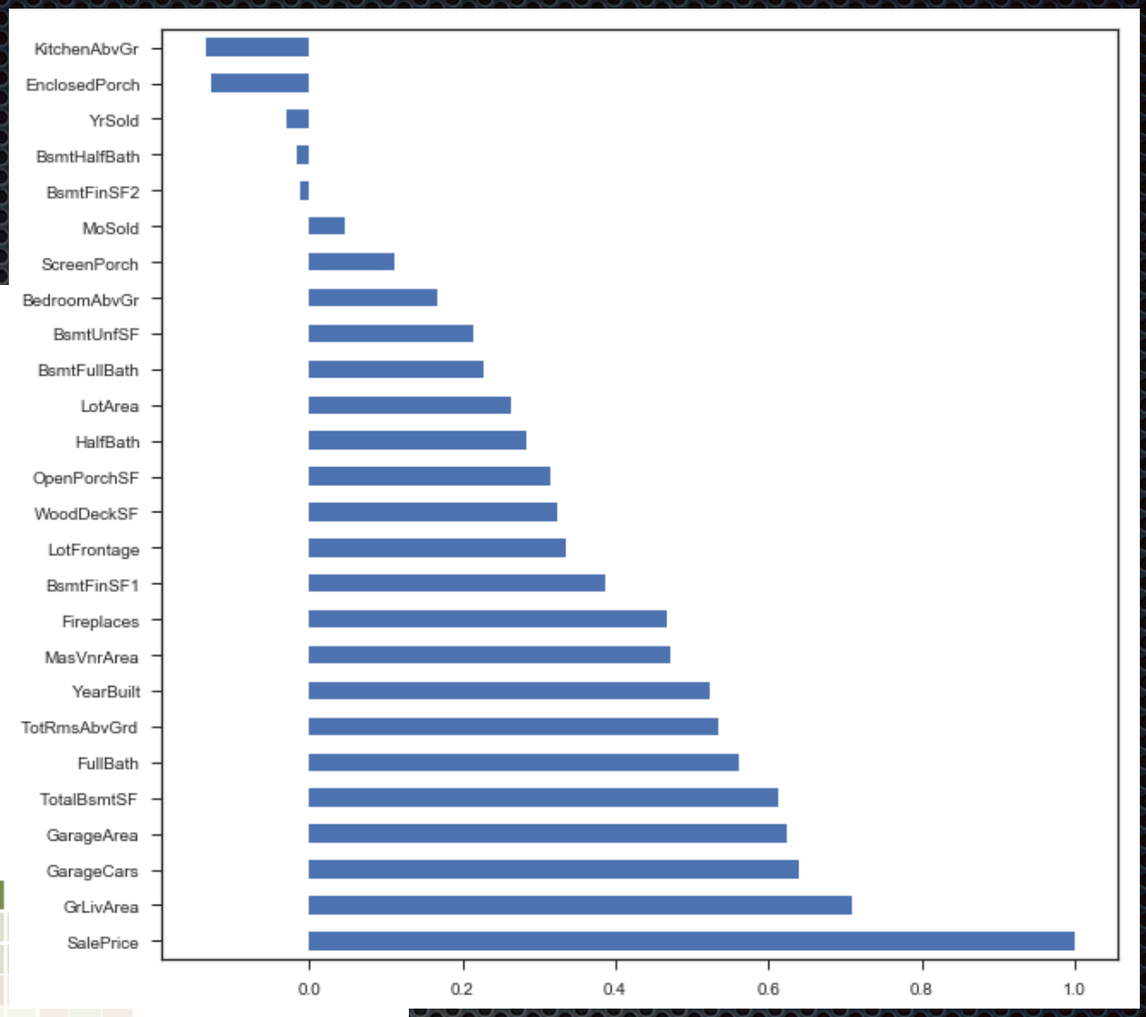
Sales Price info





Correlations





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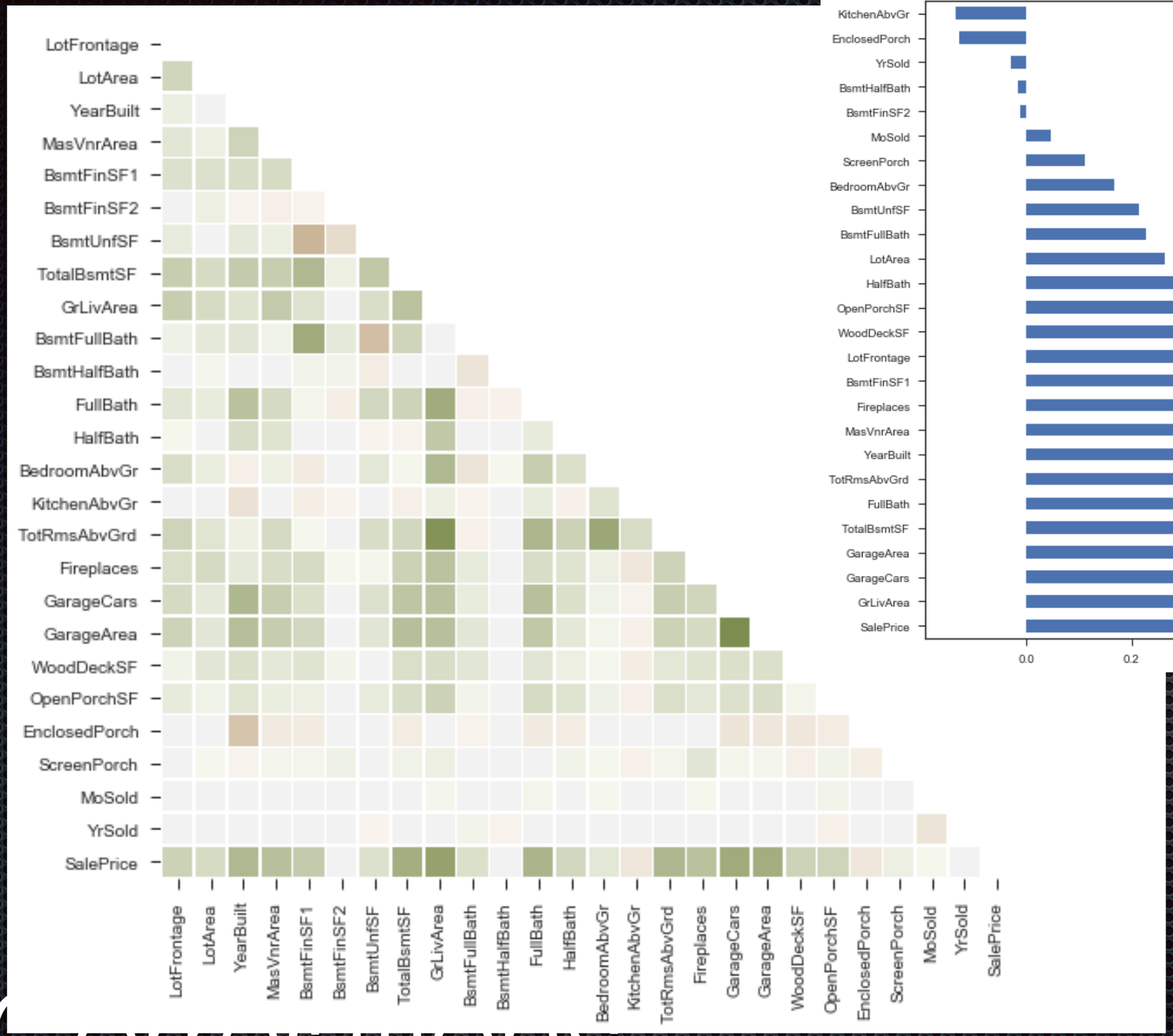

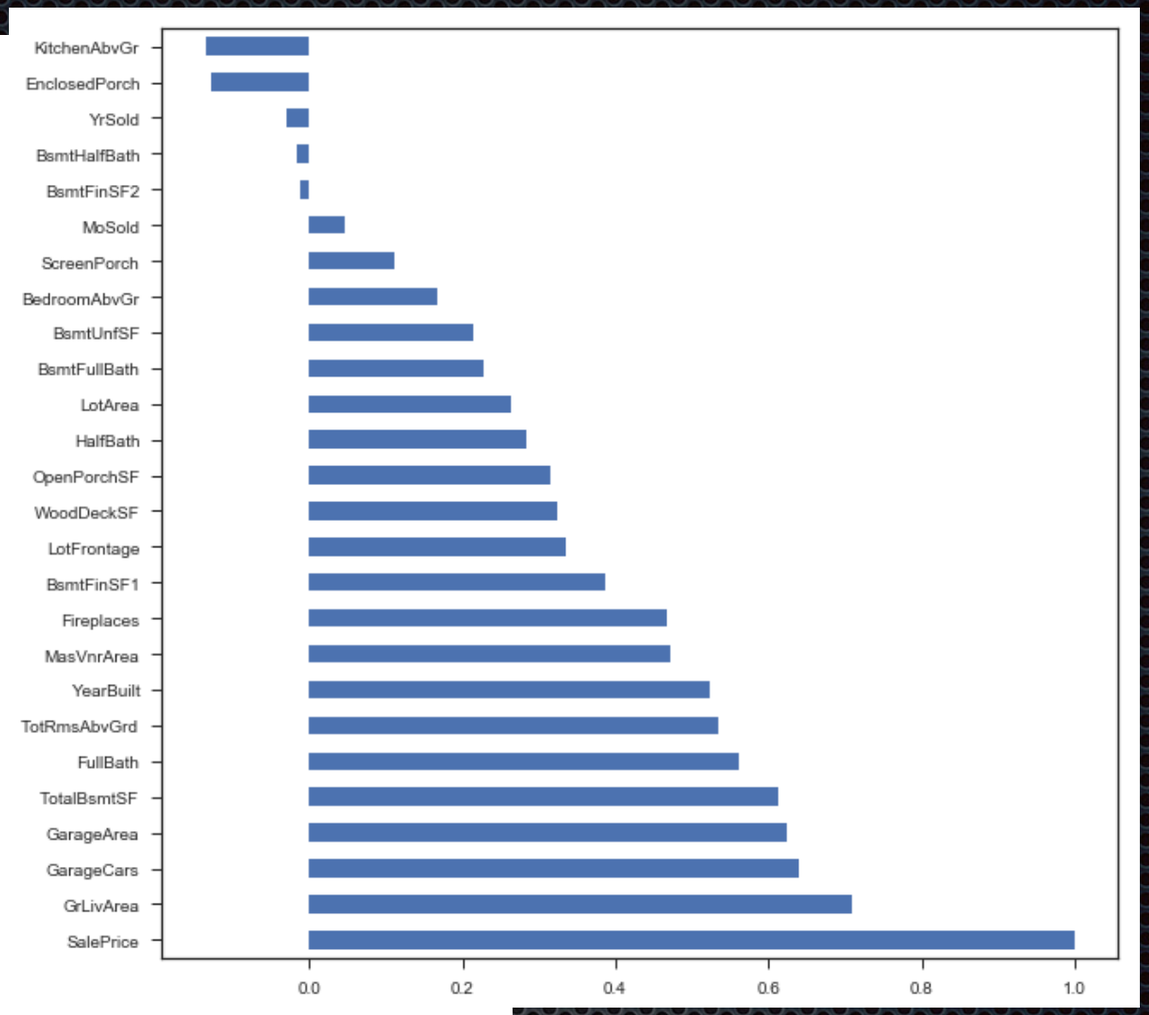

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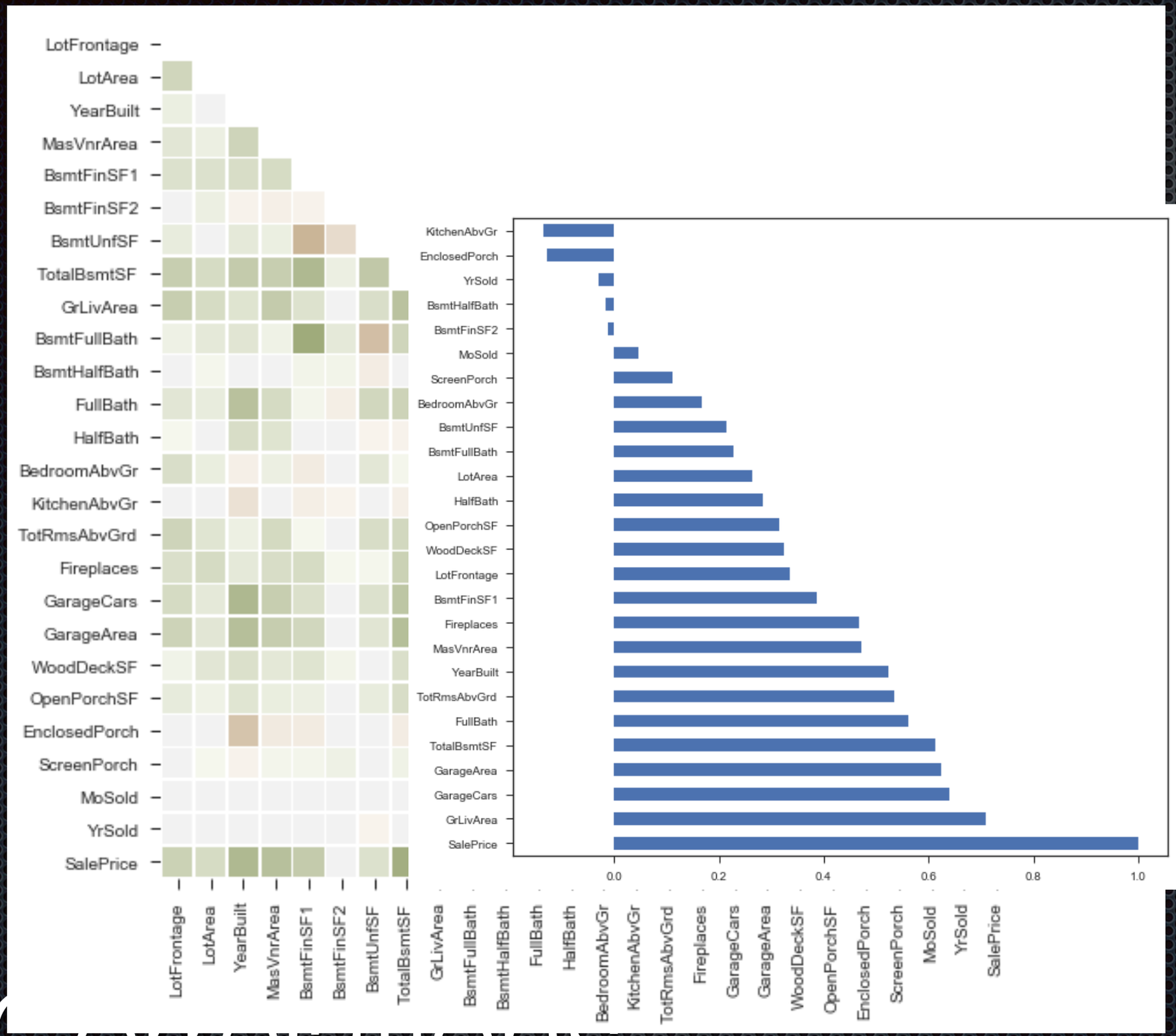

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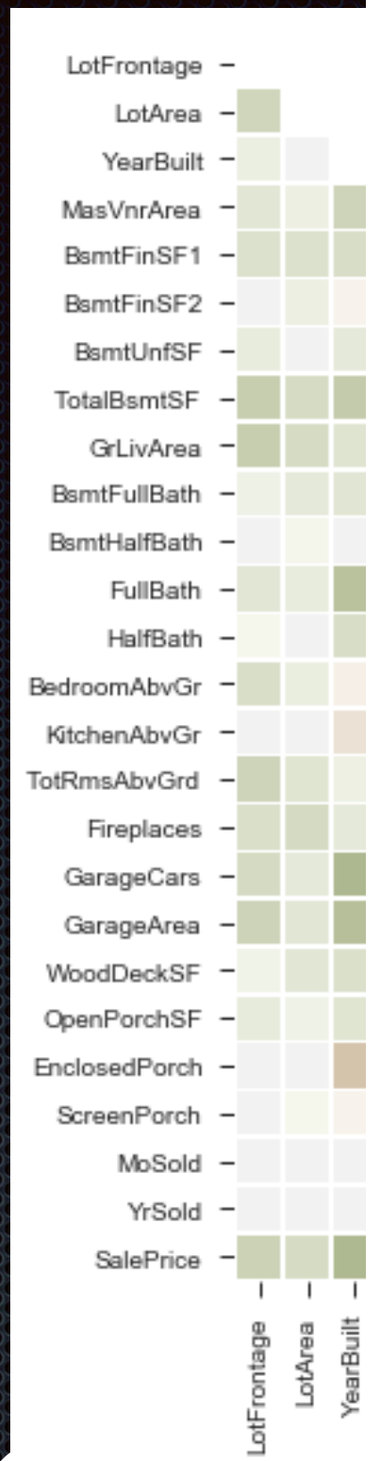

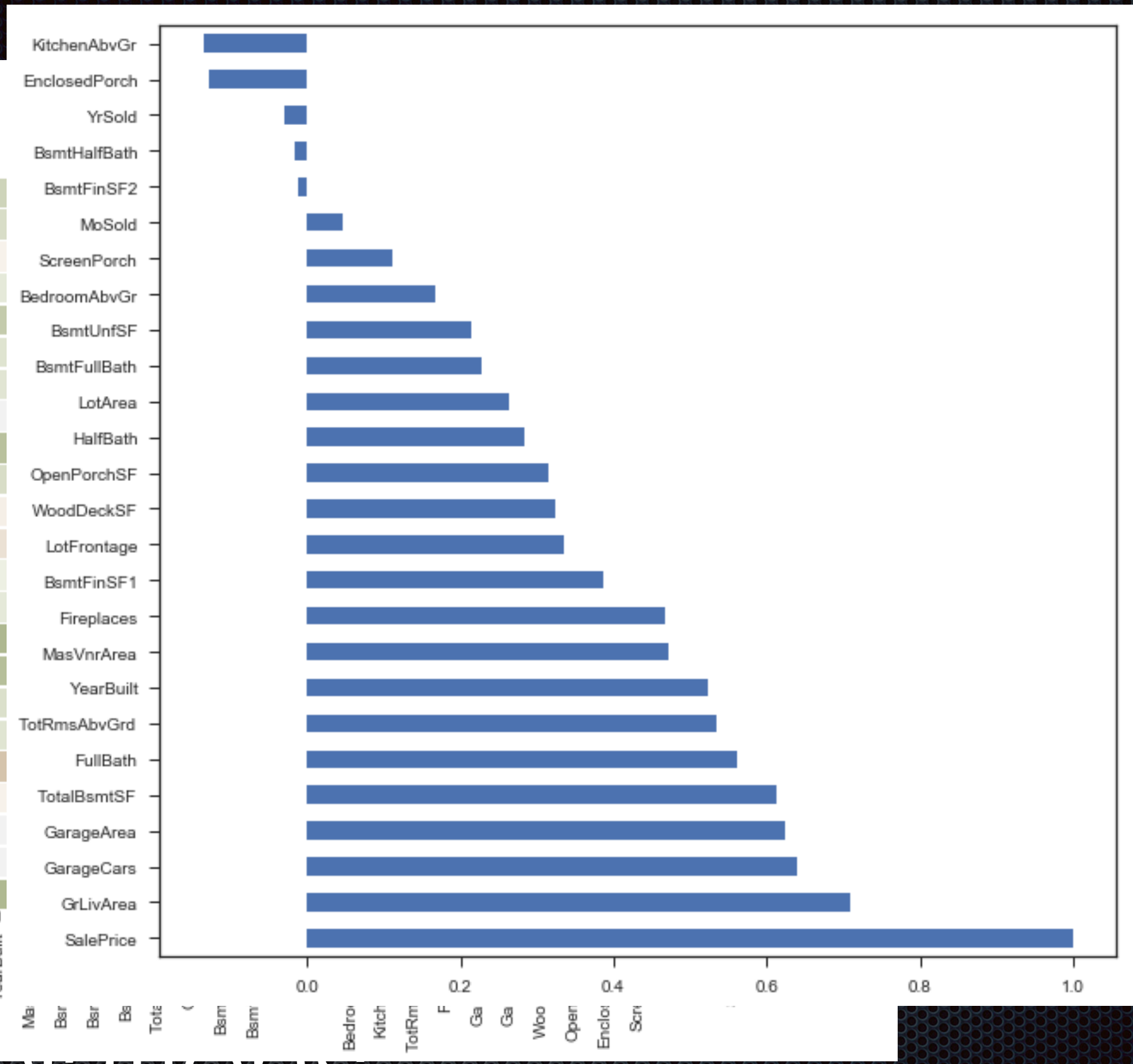

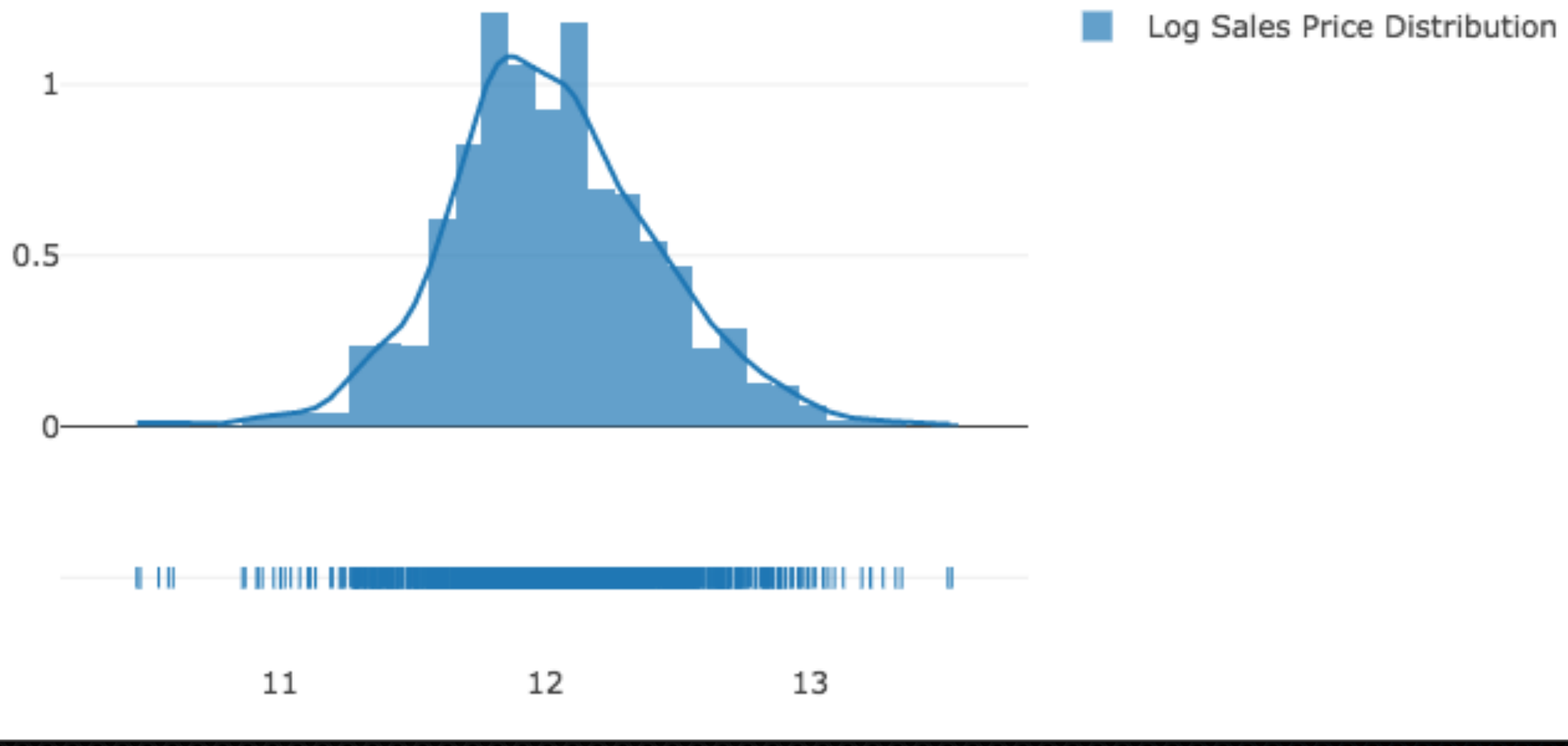

Normalizing Sales Price Distribution

Models Chosen

- Regularized
  - Ridge
  - Lasso
- PCA - MLR
- Random Fo
- XGBoost

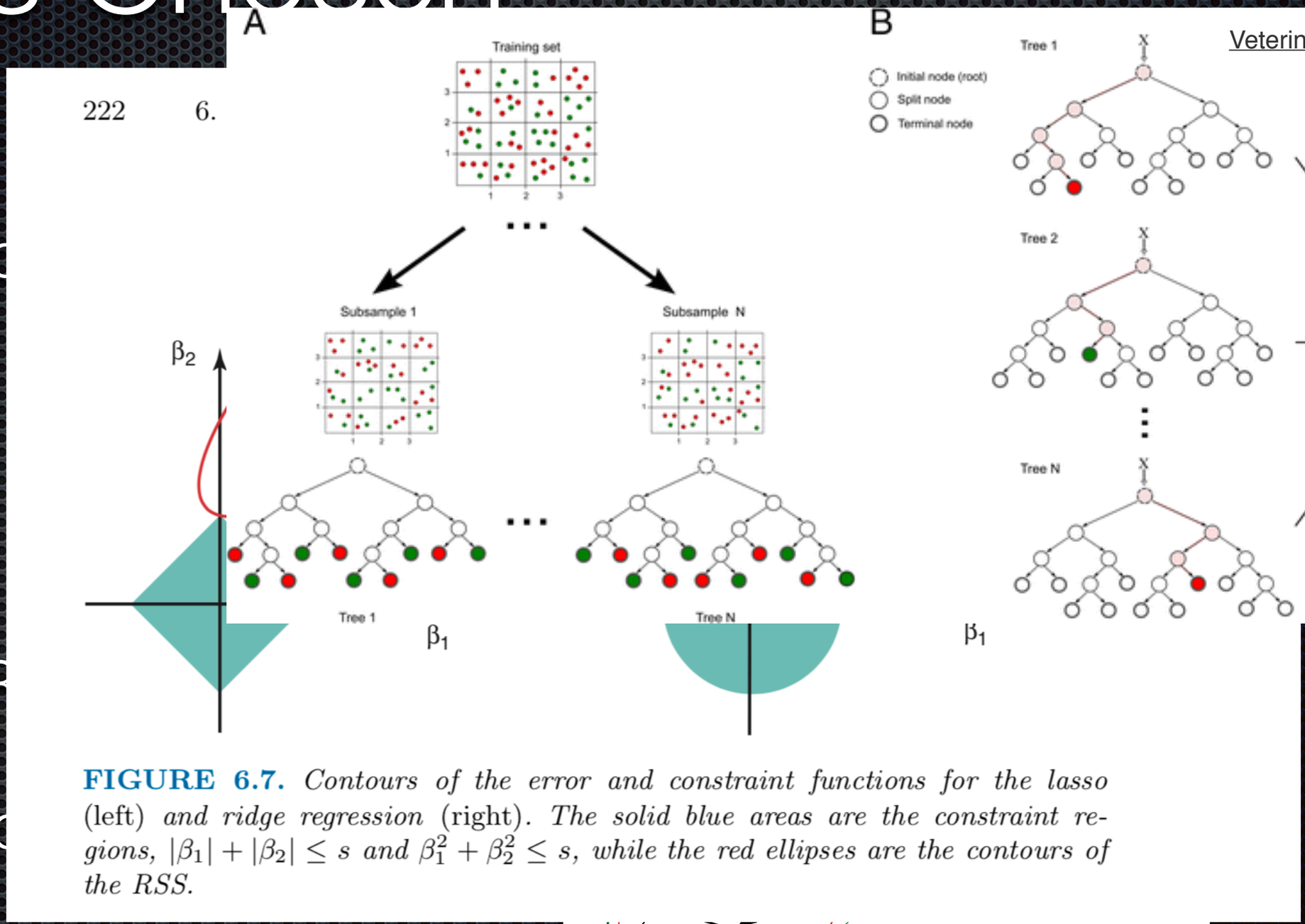

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FIGURE 6.7. *Contours of the error and constraint functions for the lasso* (left) *and ridge regression* (right). *The solid blue areas are the constraint regions,* $|\beta_1| + |\beta_2| \leq s$ *and* $\beta_1^2 + \beta_2^2 \leq s$, *while the red ellipses are the contours of the RSS.*

Veterinary

Journey Through The Woods

- Decision Tree
- Tuned Decision Tree
- Bagged Tree
- Random Forest
- Tuned Random Forest
- Stochastic Gradient Boost

Bagged Tree

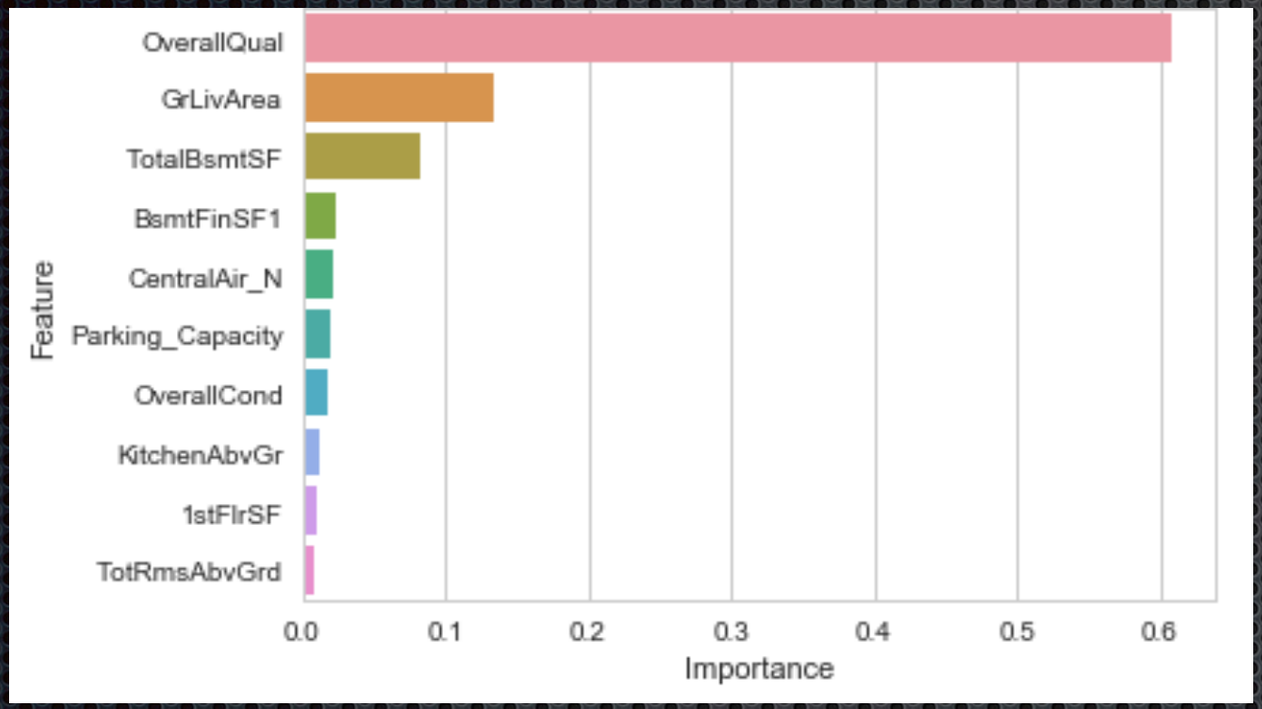
- **Parameters**
  - **Trees: 500**
  - **Max Samples: 783 (2/3rds of training set)**
- **R2**
  - **Training: 97%**
  - **Test: 87%**
- **RMSE**
  - **Training: .0745**
  - **Test: .1394**

First Attempt - Random Forest

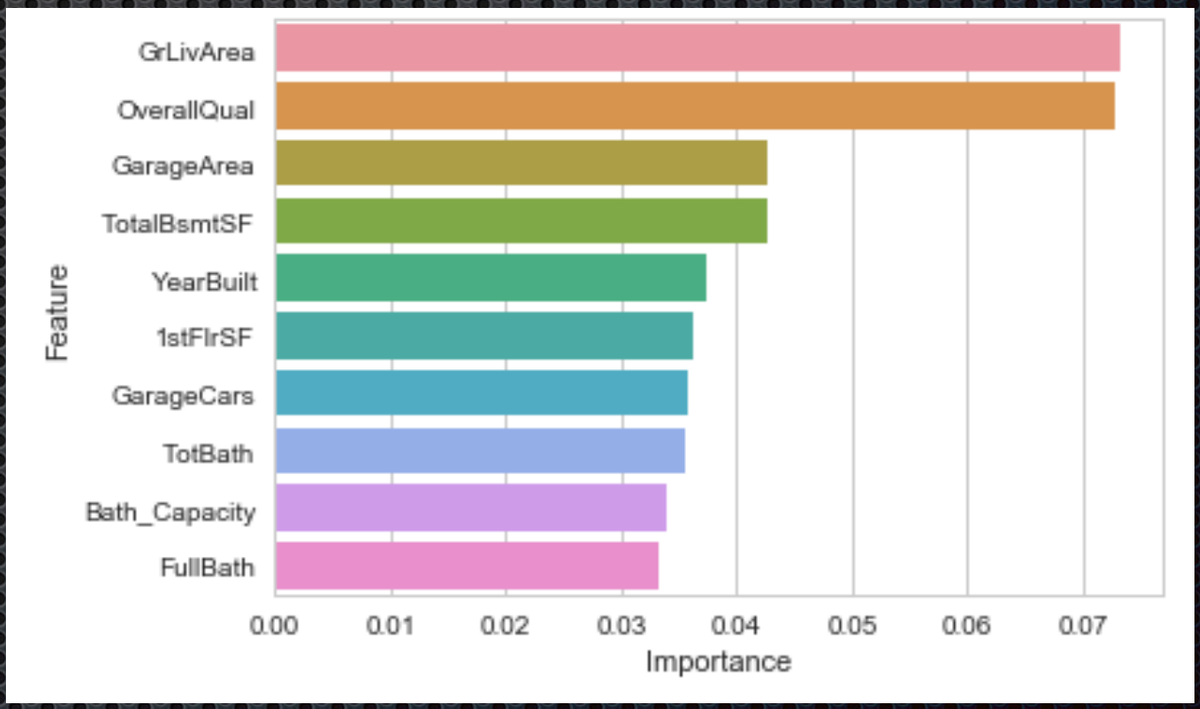
- **Parameters**
- **Trees: 500**
- **Max features: 17 (~ sqrt # of predictors)**
- **R2**
- **Training: 98%**
- **Test: 87%**
- **RMSE**
- **Training: .0538**
- **Test: .1397**

Feature Importance in Trees

Correlated (Bagged) Tree



Non-Correlated Random Forest



Next: On to Stochastic Gradient Boosting

Tuning with GridSearchCV

- **Best Parameters**
- **Max Features: 500**
- **Max Features: 36**
- **R2**
- **Training: 98%**
- **Test: 88%**
- **RMSE**
- **Training: .0526**
- **Test: .1361**

THOUGHTS: Again, not much changed for the Training and Test R^2 . What's going on?

Introducing Stochastic Gradient Boosting

- **Parameters**
- **Learning Rate: 0.1**
- **Subsample = 2/3**
- **R2**
- **Training: 96%**
- **Test: 92%**
- **RMSE**
- **Training: .0835**
- **Test: .1125**

Utilizing Tuned Stochastic Boosting

- **Best Parameters**
- Trees: 800
- Learning Rate: 0.04
- Subsample = 2/3
- **R2**
- Training: 99%
- Test: 93%
- **RMSE**
- Training: .0454
- Test: .1036

- Parameters
  - Learning Rate: 0.1
  - Subsample = 2/3
- R^2
  - Training: 96%
  - Test: 92%
  - RMSE
  - Training: .0835
  - Test: .1125