Real Estate Price Prediction

with MLS and Redfin Data

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Harvard CS209b Data Science Final Project

AGENDA

- Problem Statement & Motivation
- Data Description
- Exploratory Data Analysis
- Approach
- Results
- Conclusions
- Future Work

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To accurately predict real estate prices / DOM ...

- Curate historical real estate transaction data with an emphasis on property images
- Develop feature extraction methods and identify the key factors
- Build predictive models for sold price and number of days on market (DOM)

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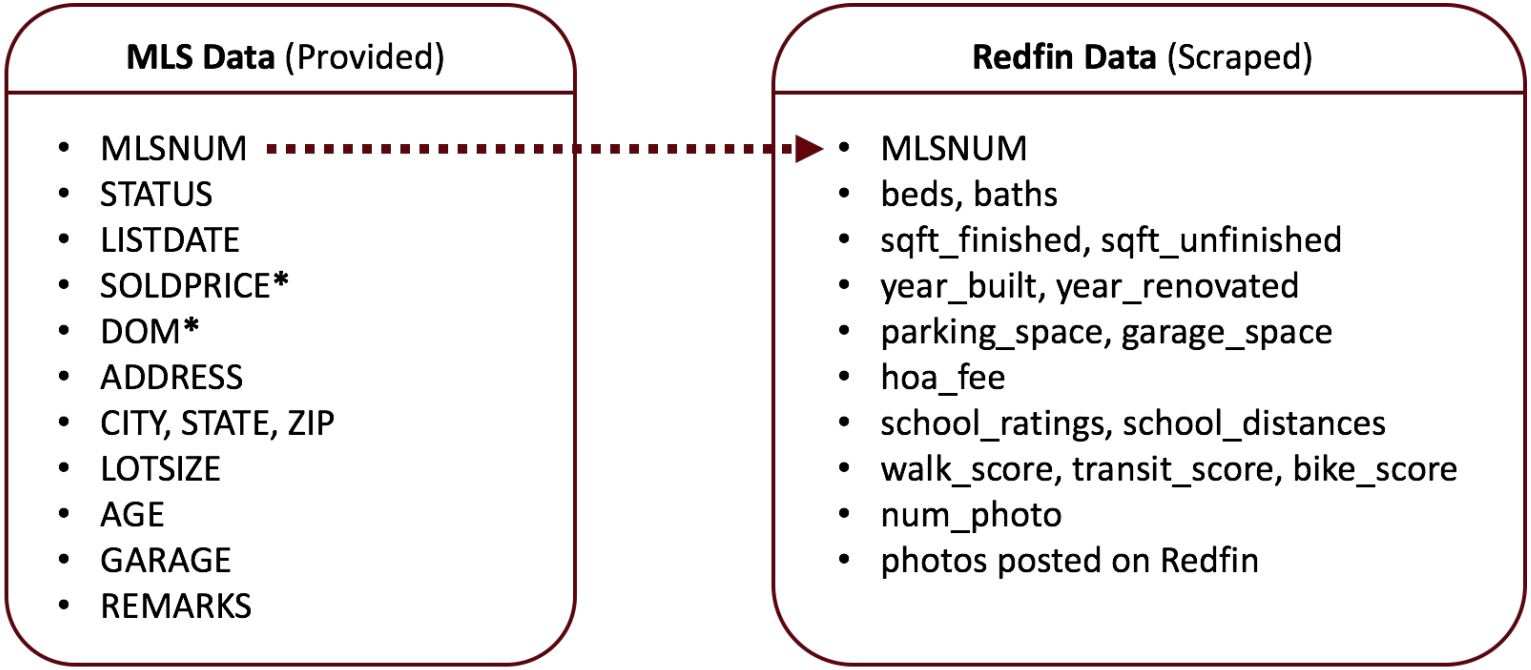
Data Description



* : response variable

Exploratory Data Analysis I - Response Variable

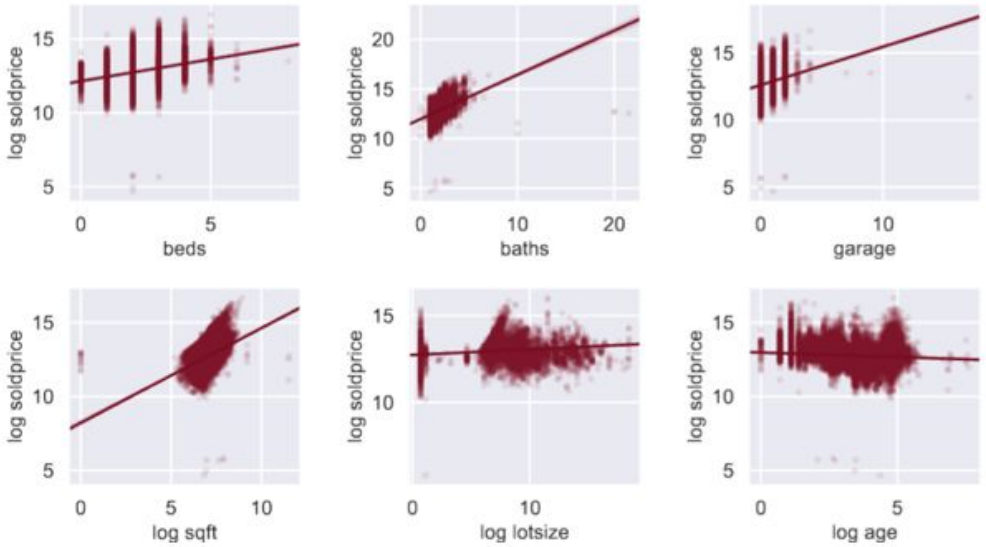
Sold-Price is very right skewed
Single log-transformation makes it more symmetrical

Response: Log(sold-price)

Exploratory Data Analysis II - Selected MLS Predictors

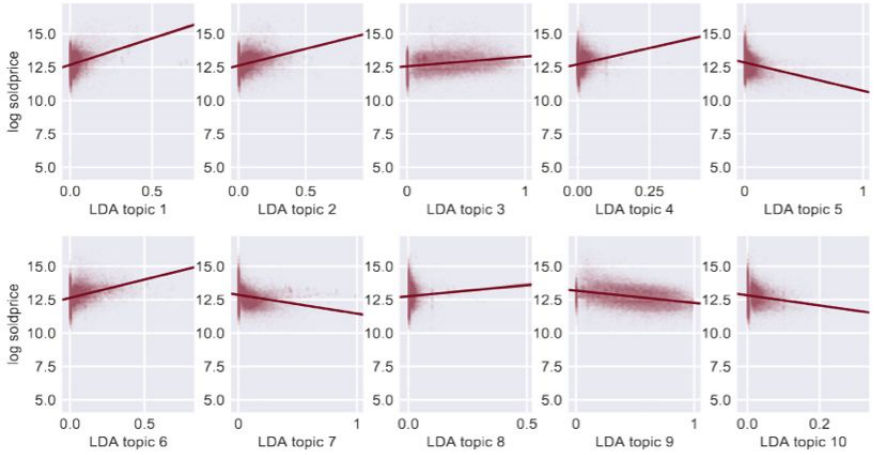
- Beds, baths, number of parking spaces, square footage and lot size positively correlate with the response
- Property age negatively correlates with the response

Log Sold-Price vs. Selected MLS Predictors

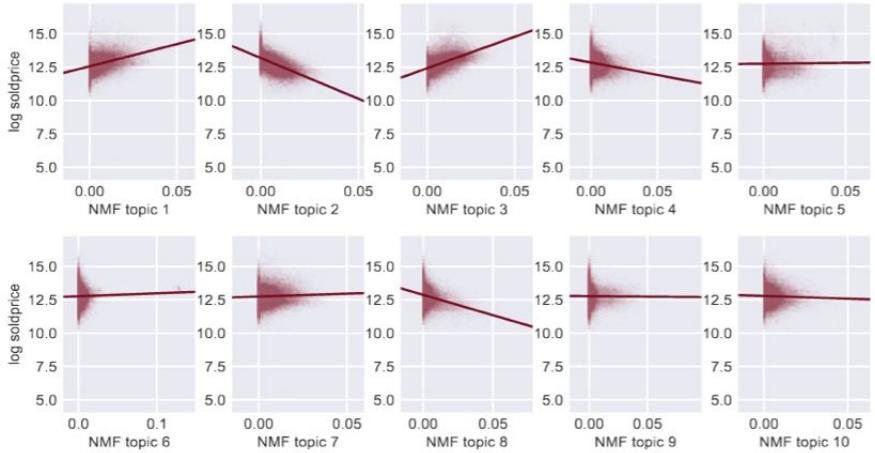


Exploratory Data Analysis III - MLS Remarks Topics

LDA topics

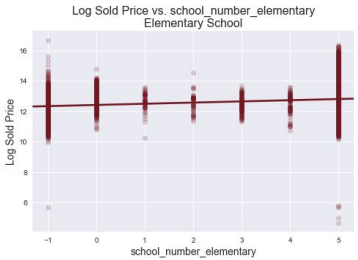
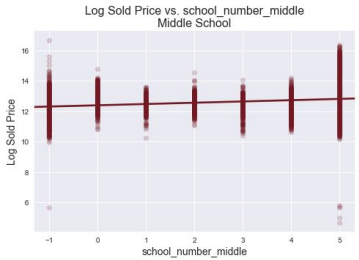
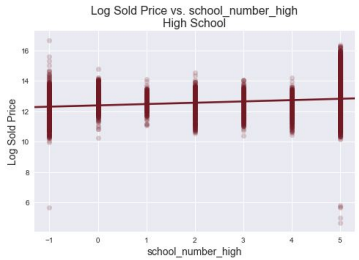
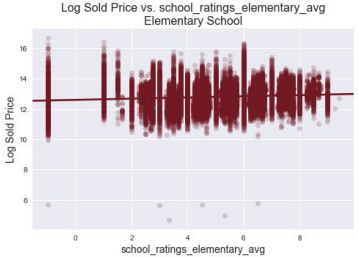
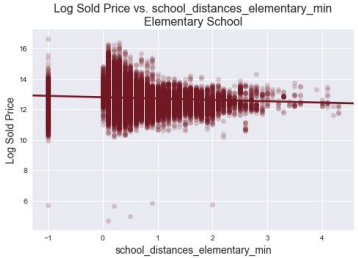
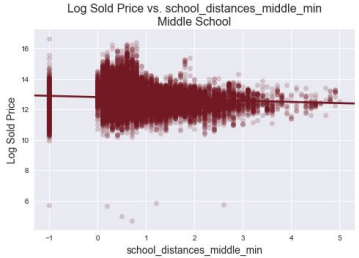
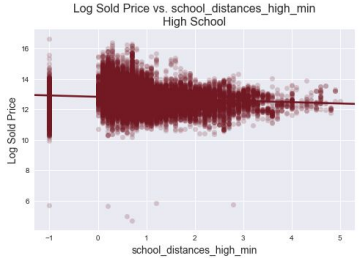


NMF topics



- Features extracted from remarks appear to have strong correlation with the response variable

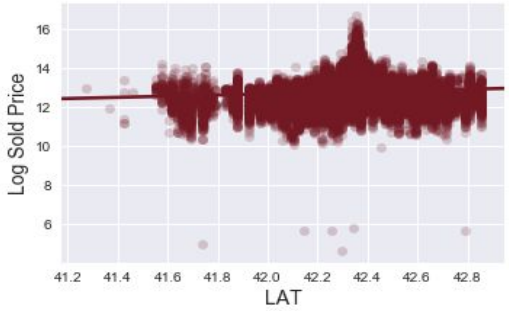
Exploratory Data Analysis IV - Educational Resources

	Elementary School	Middle School	High School
Number of Schools			
Avg School Rating			
Min Distance to School			

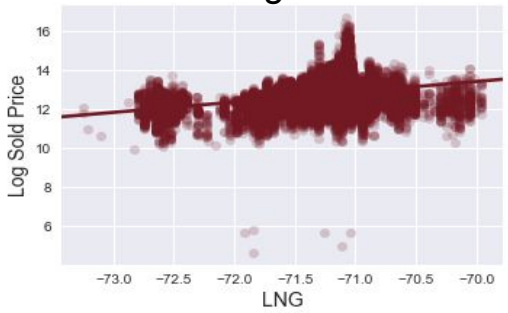
Exploratory Data Analysis V - Geographic Location

Log Sold-Price vs. Latitude/Longitude

Latitude

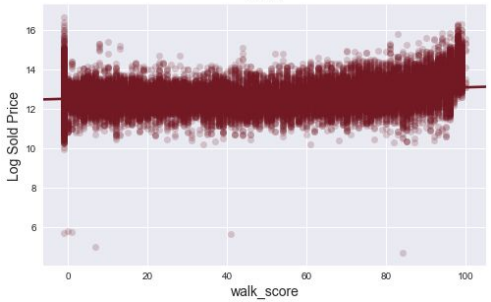


Longitude

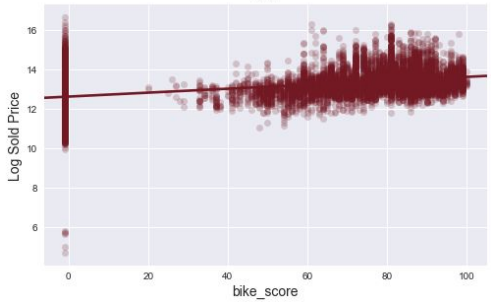


Log Sold-Price vs. Convenience Scores

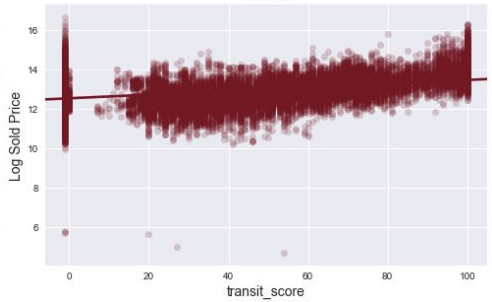
Walk score



Bike score



Transit score



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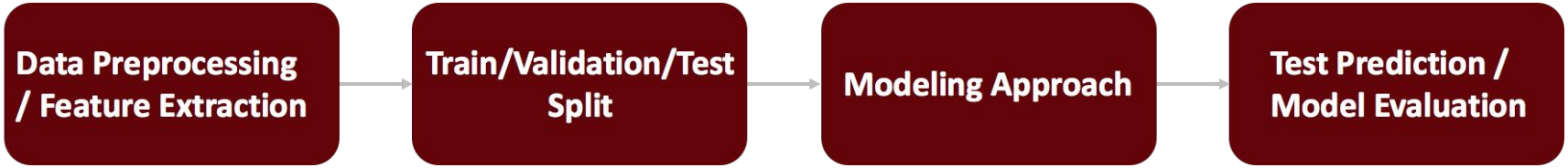
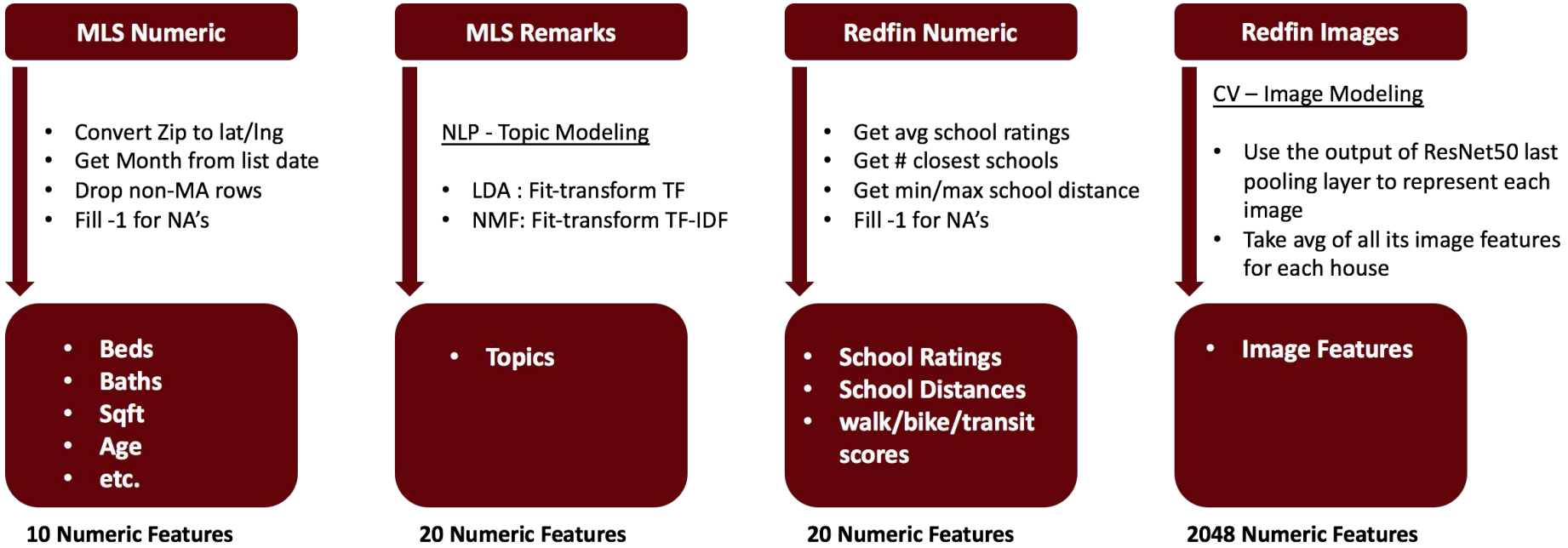
Approach Overview



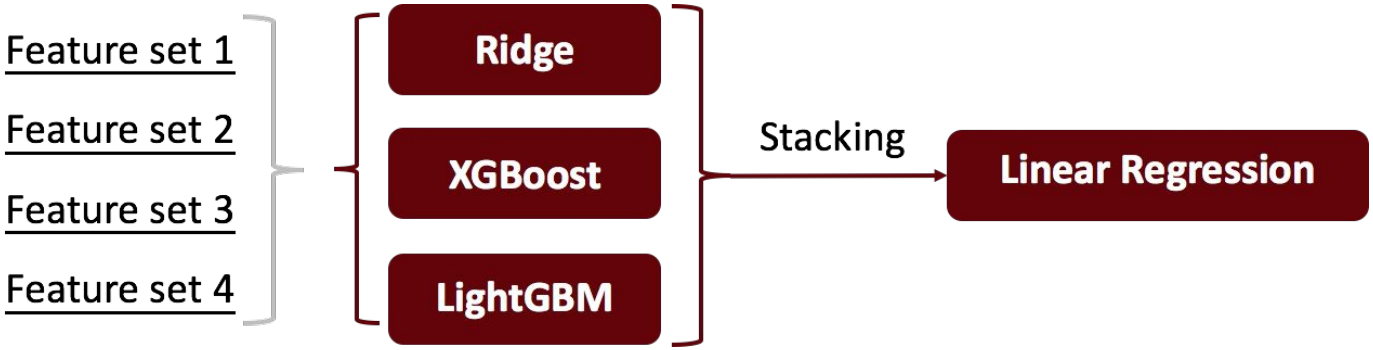
Data Preprocessing / Feature Extraction



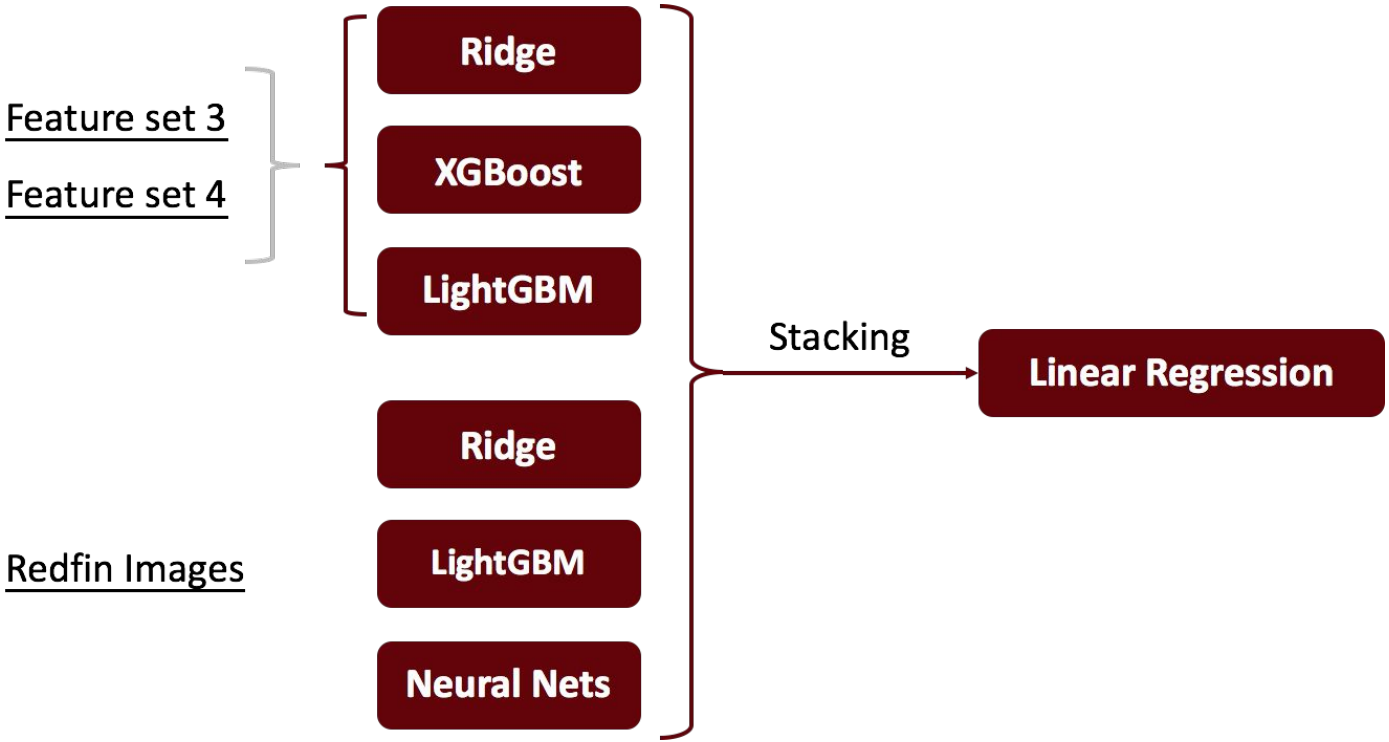
Feature Sets

Type	Source	Feature Set					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
Non-image	MLS numerical	X	X	X	X	X	X
	MLS remarks		X		X		X
	Redfin numerical			X	X	X	X
Image	Redfin images					X	X
Total # of features		10	30	30	50	2078	2098

Modeling Approach I



Modeling Approach II



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Results

	Condo: Price R^2 (Ensemble Model)			
		Training	Validation	Test
Feature set 1	MLS	0.977	0.936	0.884
Feature set 2	MLS + Remarks	0.990	0.942	0.899
Feature set 3	MLS + Redfin	0.987	0.947	0.893
Feature set 4	MLS + Redfin + Remarks	0.989	0.947	0.907
Feature set 5	MLS + Redfin + Images	0.988	0.949	0.898
Feature set 6	MLS + Redfin + Remarks + Images	0.990	0.948	0.911

	Multi-family: Price R^2 (Ensemble Model)			
		Training	Validation	Test
Feature set 1	MLS	0.903	0.782	0.718
Feature set 2	MLS + Remarks	0.956	0.841	0.801
Feature set 3	MLS + Redfin	0.930	0.807	0.736
Feature set 4	MLS + Redfin + Remarks	0.961	0.849	0.803
Feature set 5	MLS + Redfin + Images	0.947	0.777	0.724
Feature set 6	MLS + Redfin + Remarks + Images	0.967	0.837	0.800

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Conclusions

- Developed
  - topic feature extraction methods using NMF and LDA
  - a method to scrape property data and images from Redfin
  - a method to extract visual features from property images (the average 2048-dimensional ResNet final average pooling layer output)

- Found
  - that both transformed remark topic features and information from Redfin are useful features for predicting the sold price
  - that our current method of extracting images is likely sub-optimal

Future Work

- Curate more multi-family observations to reduce overfitting and improve model generalizability.
- Curate additional features from external sources to try to capture market temperature and the overall economy.
- Develop a better method of incorporating image features.