Predicting Home Prices in Los Angeles

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Design

Client: Urban housing markets were particularly disrupted by the Covid pandemic. For investors, this presents an opportunity to capitalize in a new market environment. Redfin wants to understand the LA housing market so that it invest in properties.

Objective: Explore whether the sale price of a home can be modeled against other housing/geographic features.

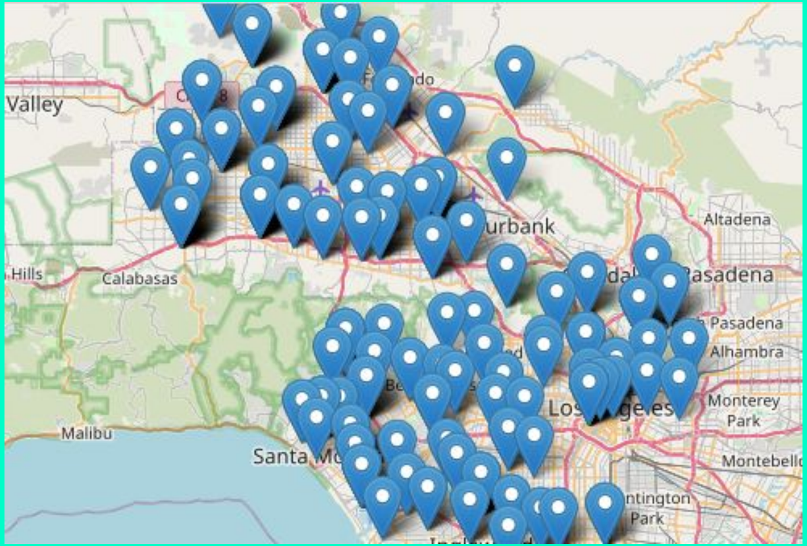
Goal: Produce a regression model that can best interpret a relationship for sale price and a model that can best predict home sale price in Los Angeles.

Data

Data on houses sold in the previous three weeks was scraped from **Zillow** and geographic socio-economic data was scraped from **City-Data.com** by zip code. Each row represents a unique home and address for a ‘Recently Sold’ property in the Los Angeles area.

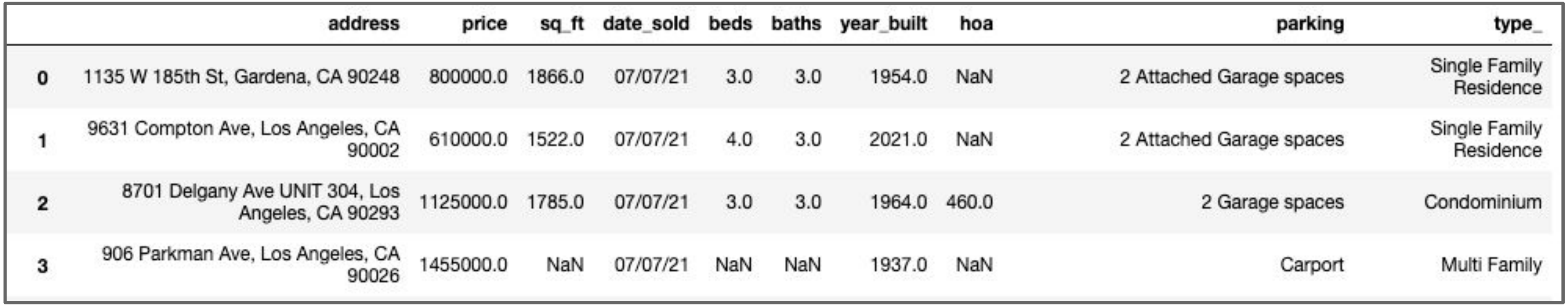
Of 600+ home sales scraped, 288 were used in our final analysis.

- BeautifulSoup & Selenium
- Numpy & Pandas
- Scikit-learn & Statsmodels
- Matplotlib & Seaborn
- Folium, Geopandas & Geopy



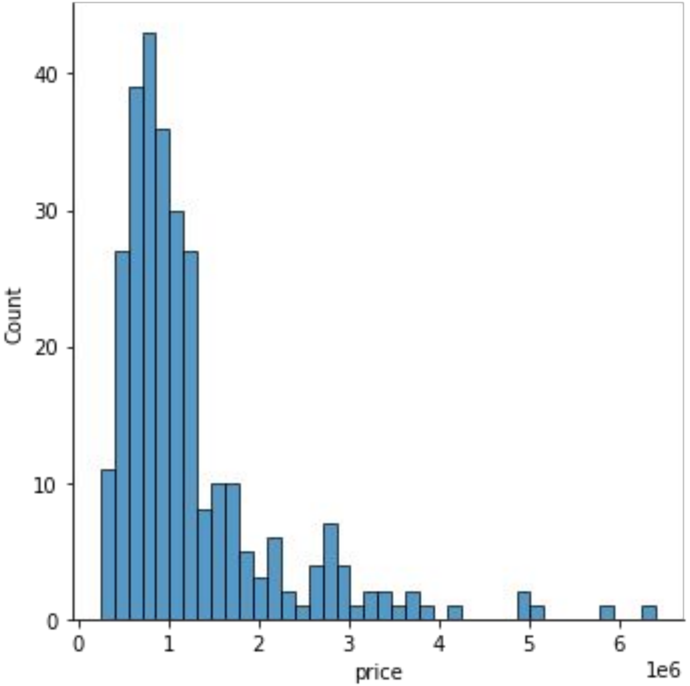
Data Cleaning & EDA

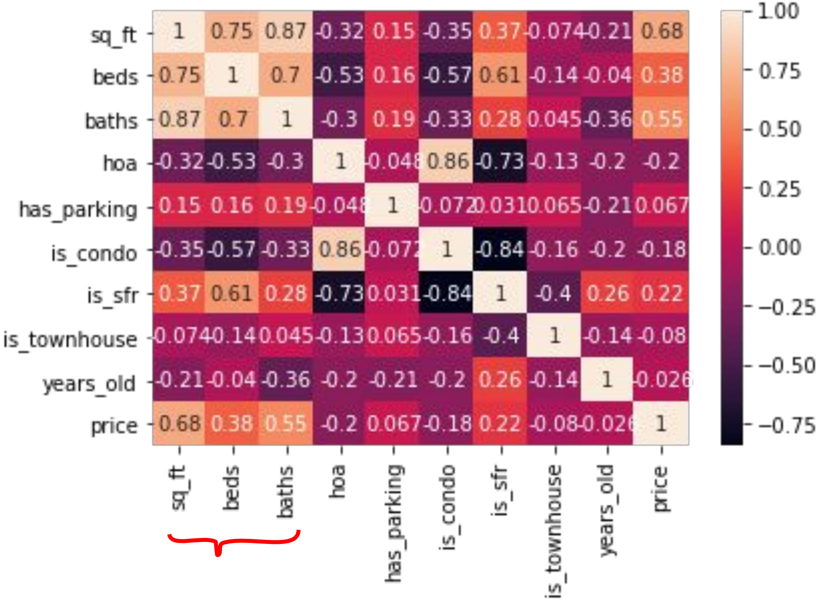
- Delete duplicates and drop rows with null *‘prices’, ‘addresses’*
- Binarize categorical data
  - New columns include *‘has_parking’, ‘is_condo’, ‘is_sfr’, ‘is_townhouse’*
- Restrict sold listings to prior three weeks
- Impute missing *‘hoa’ (0)* and *‘beds’* (0, indicates studio)



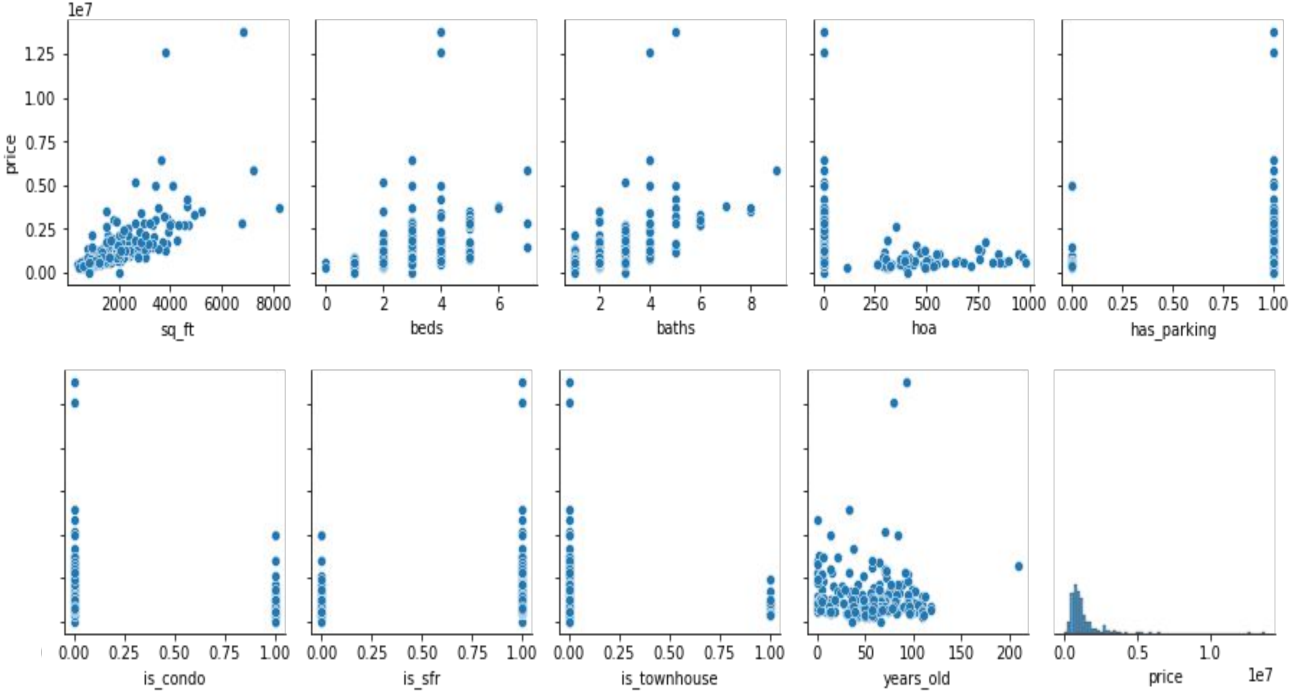
	address	price	sq_ft	date_sold	beds	baths	year_built	hoa	parking	type_
0	1135 W 185th St, Gardena, CA 90248	800000.0	1866.0	07/07/21	3.0	3.0	1954.0	NaN	2 Attached Garage spaces	Single Family Residence
1	9631 Compton Ave, Los Angeles, CA 90002	610000.0	1522.0	07/07/21	4.0	3.0	2021.0	NaN	2 Attached Garage spaces	Single Family Residence
2	8701 Delgany Ave UNIT 304, Los Angeles, CA 90293	1125000.0	1785.0	07/07/21	3.0	3.0	1964.0	460.0	2 Garage spaces	Condominium
3	906 Parkman Ave, Los Angeles, CA 90026	1455000.0	NaN	07/07/21	NaN	NaN	1937.0	NaN	Carport	Multi Family

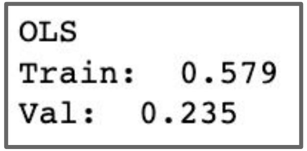
Baseline Model





Baseline Model

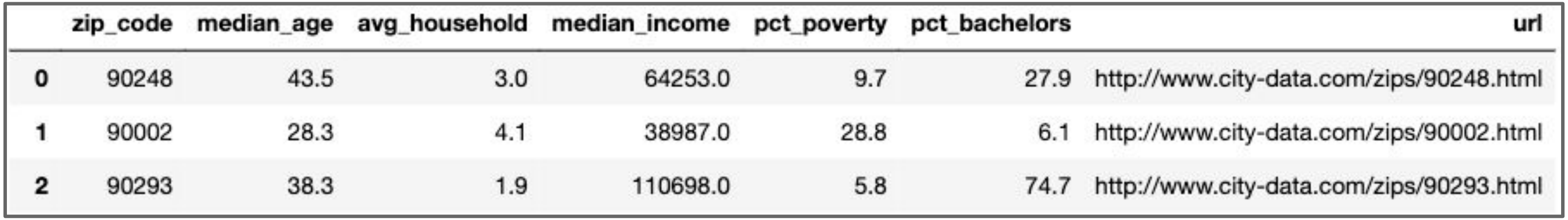




```
OLS
Train:   0.579
Val:  0.235
```

Import Geographic Data

- Scrape socio-economic data by Zip Code
  - *'median_resident_age'*
  - *'avg_household_size'*
  - *'avg_household_income'*
  - *'pct_poverty'*
  - *'pct_bachelors'*
- Merge datasets on zip_code



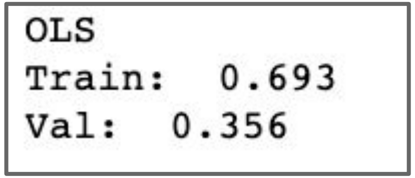
	zip_code	median_age	avg_household	median_income	pct_poverty	pct_bachelors	url
0	90248	43.5	3.0	64253.0	9.7	27.9	http://www.city-data.com/zips/90248.html
1	90002	28.3	4.1	38987.0	28.8	6.1	http://www.city-data.com/zips/90002.html
2	90293	38.3	1.9	110698.0	5.8	74.7	http://www.city-data.com/zips/90293.html

Feature Selection

Drop features with high multicollinearity and low correlation.

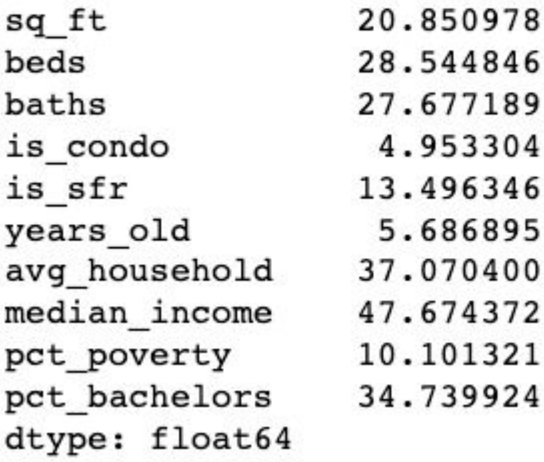
- *‘hoa’*
- *‘median_age’*
- *‘has_parking’*
- *‘is_townhouse’*

Improvement on baseline:

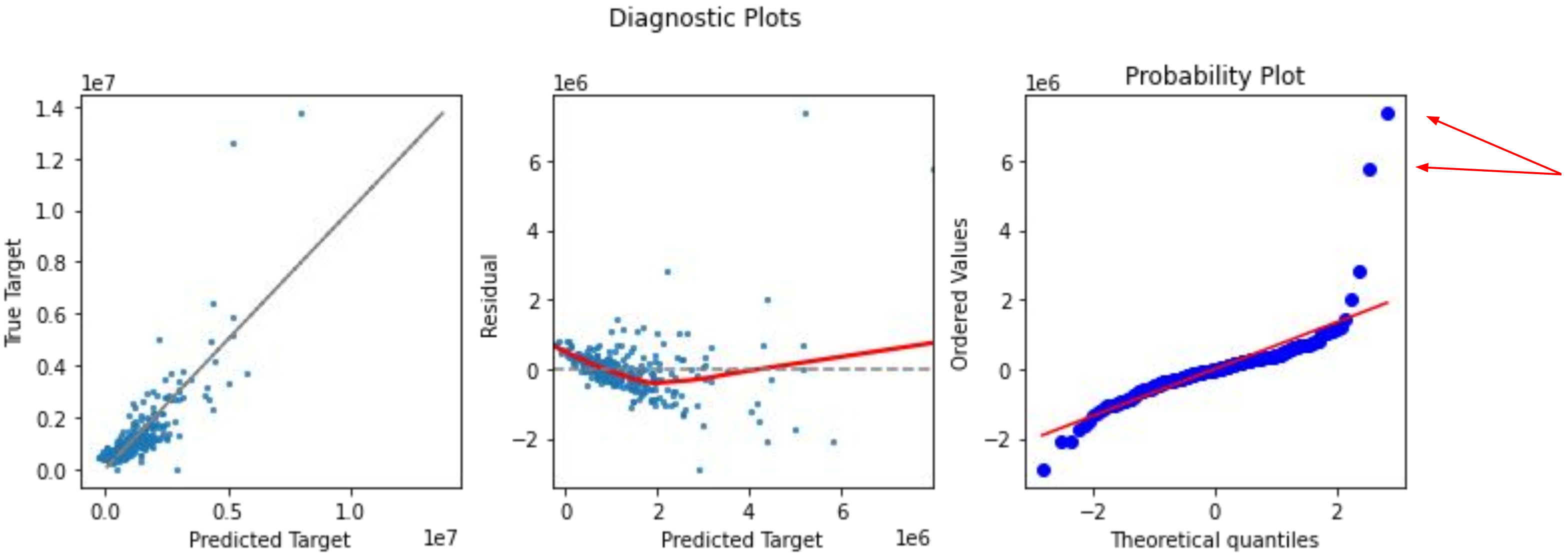


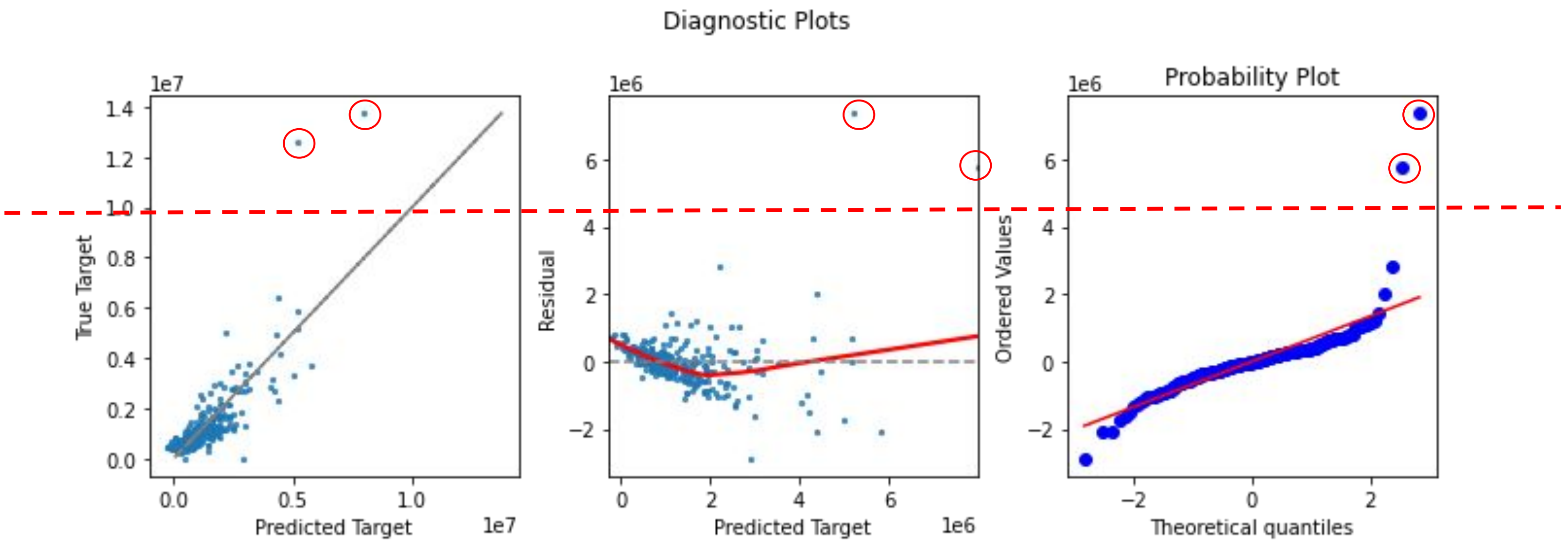
```
OLS
Train:  0.693
Val:  0.356
```

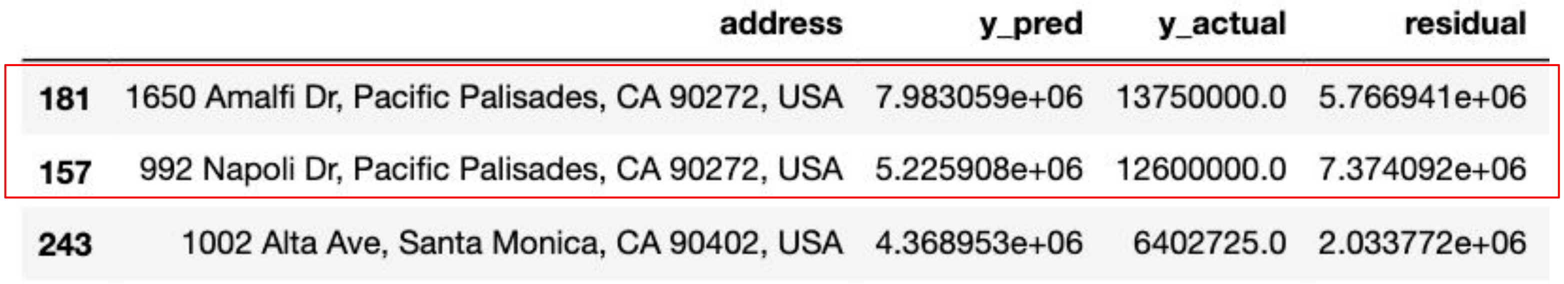
Variance Inflation Factor



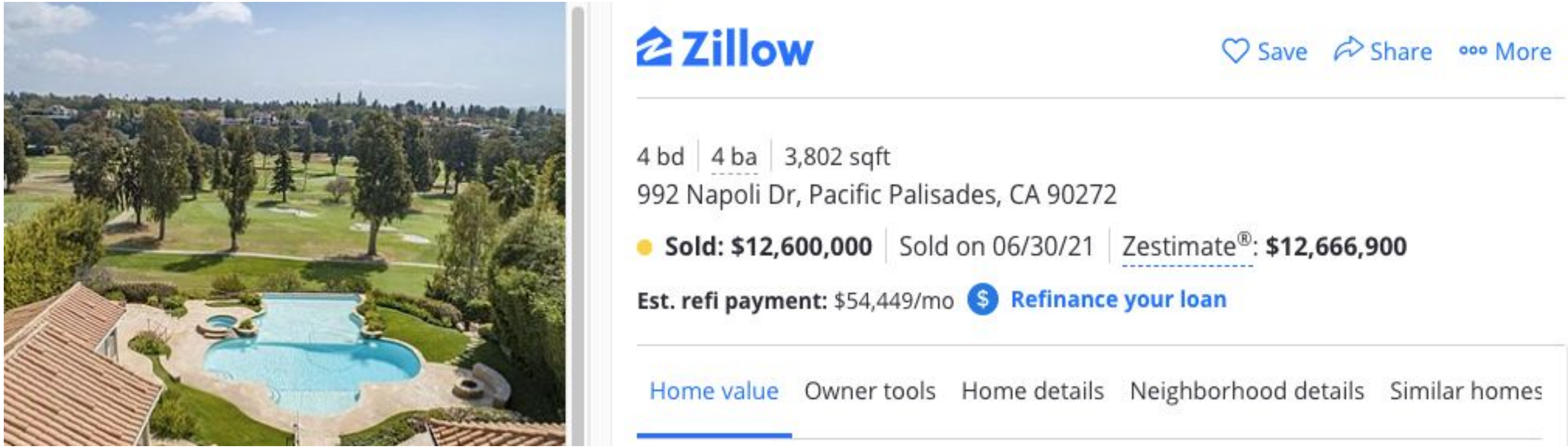
```
sq_ft              20.850978
beds               28.544846
baths              27.677189
is_condo            4.953304
is_sfr             13.496346
years_old           5.686895
avg_household      37.070400
median_income      47.674372
pct_poverty        10.101321
pct_bachelors      34.739924
dtype: float64
```


Diagnostic Plots
1e7
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
True Target
0.0
0.5
1.0
Predicted Target
1e7
1e6
6
4
2
0
−2
Residual
0
2
4
6
Predicted Target
1e6
Probability Plot
1e6
6
4
2
0
−2
Ordered Values
−2
0
2
Theoretical quantiles





	address	y_pred	y_actual	residual
181	1650 Amalfi Dr, Pacific Palisades, CA 90272, USA	7.983059e+06	13750000.0	5.766941e+06
157	992 Napoli Dr, Pacific Palisades, CA 90272, USA	5.225908e+06	12600000.0	7.374092e+06
243	1002 Alta Ave, Santa Monica, CA 90402, USA	4.368953e+06	6402725.0	2.033772e+06

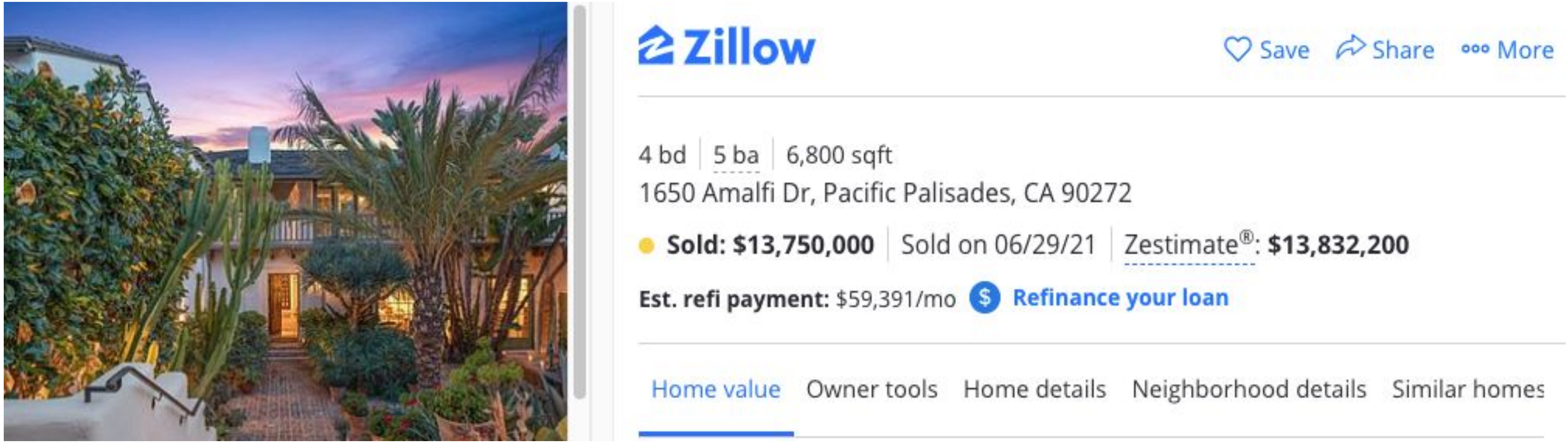


4 bd | 4 ba | 3,802 sqft

992 Napoli Dr, Pacific Palisades, CA 90272

● **Sold: $12,600,000** | Sold on 06/30/21 | Zestimate®: **$12,666,900**

Est. refi payment: $54,449/mo **Refinance your loan**

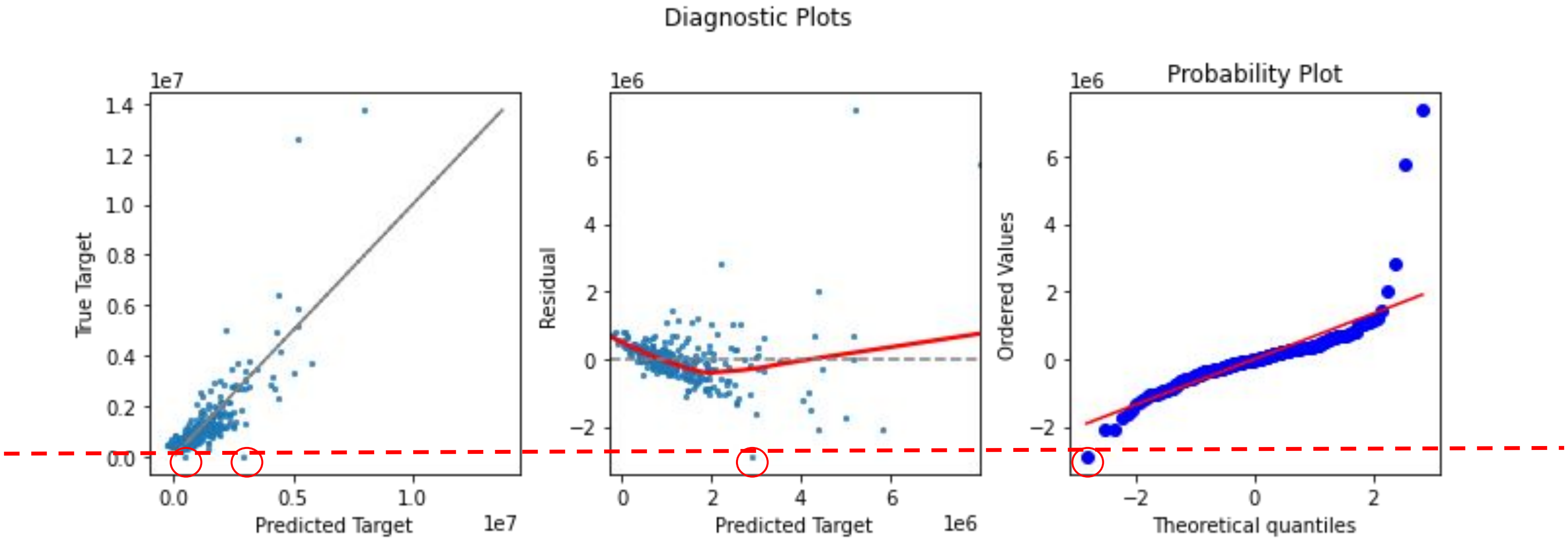


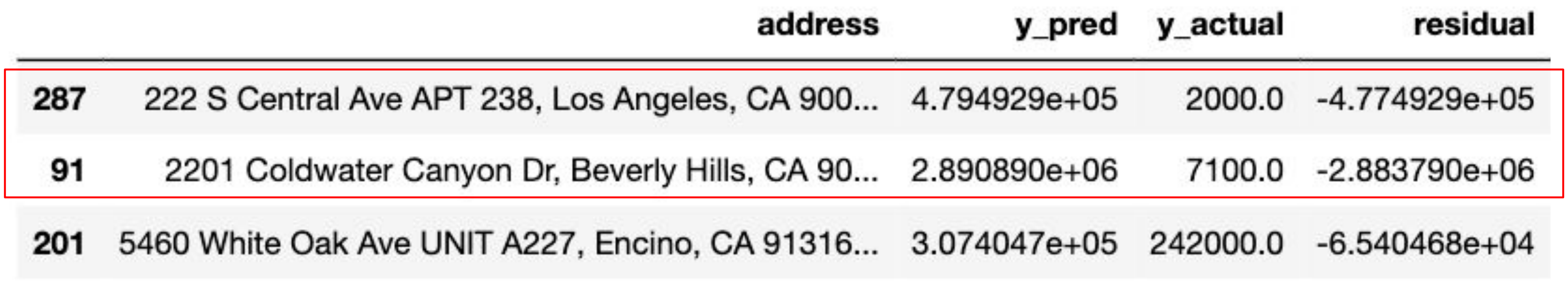
4 bd | 5 ba | 6,800 sqft

1650 Amalfi Dr, Pacific Palisades, CA 90272

● **Sold: $13,750,000** | Sold on 06/29/21 | Zestimate®: **$13,832,200**

Est. refi payment: $59,391/mo **Refinance your loan**



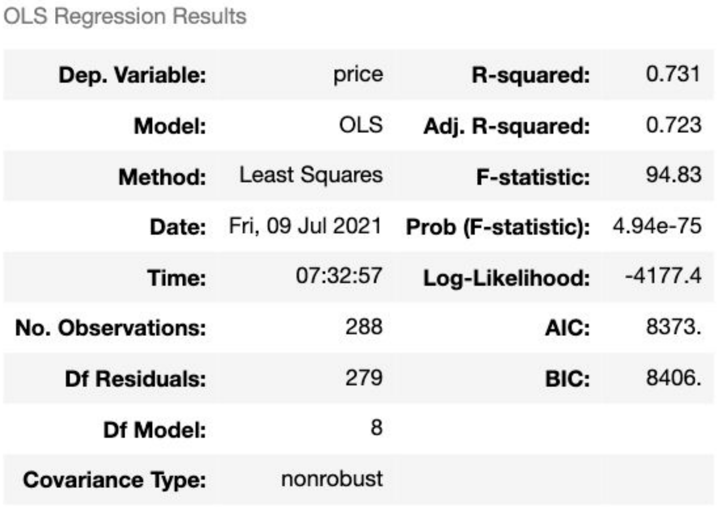


	address	y_pred	y_actual	residual
287	222 S Central Ave APT 238, Los Angeles, CA 900...	4.794929e+05	2000.0	-4.774929e+05
91	2201 Coldwater Canyon Dr, Beverly Hills, CA 90...	2.890890e+06	7100.0	-2.883790e+06
201	5460 White Oak Ave UNIT A227, Encino, CA 91316...	3.074047e+05	242000.0	-6.540468e+04

Improving on Baseline Model

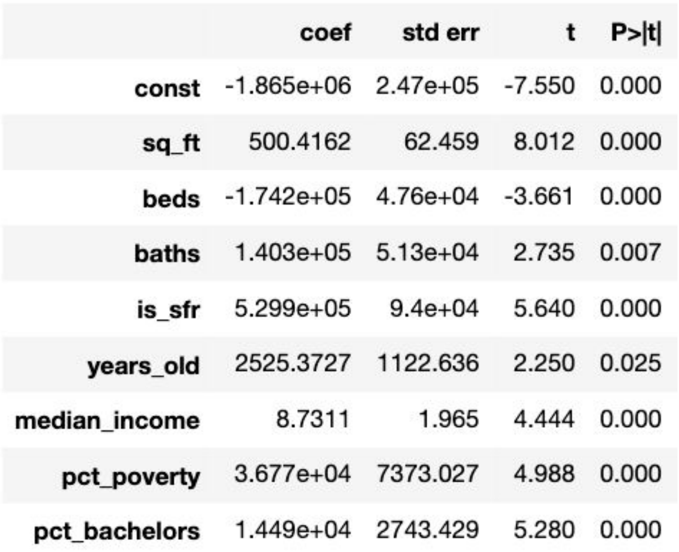
Drop homes with sale prices above $10 million or below $10,000.

Drop non-significant features: *‘avg_household’, ‘is_condo’.*

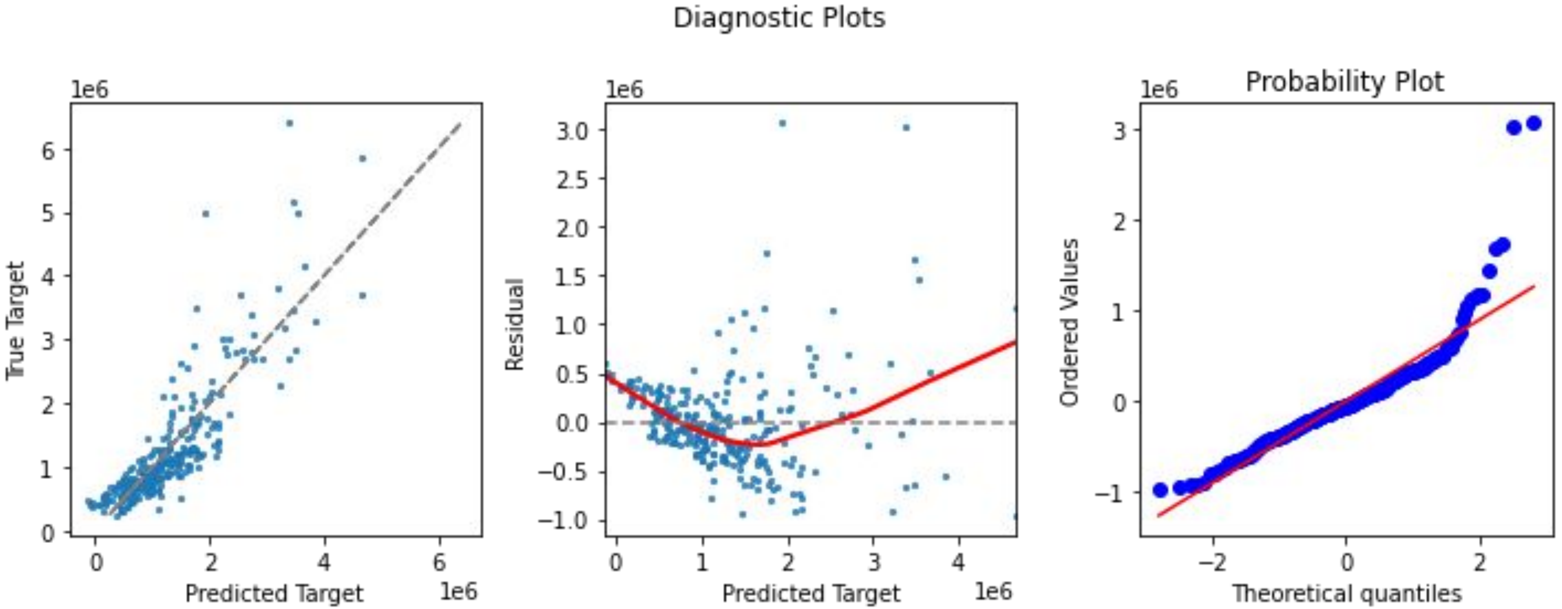


OLS Regression Results

Dep. Variable:	price	**R-squared:**	0.731
Model:	OLS	**Adj. R-squared:**	0.723
Method:	Least Squares	**F-statistic:**	94.83
Date:	Fri, 09 Jul 2021	**Prob (F-statistic):**	4.94e-75
Time:	07:32:57	**Log-Likelihood:**	-4177.4
No. Observations:	288	**AIC:**	8373.
Df Residuals:	279	**BIC:**	8406.
Df Model:	8		
Covariance Type:	nonrobust		



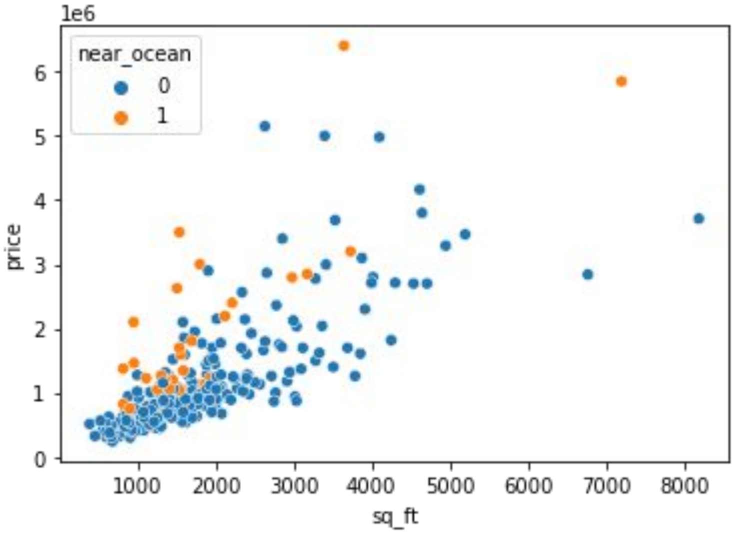
	coef	**std err**	**t**	**P>|t|**
const	-1.865e+06	2.47e+05	-7.550	0.000
sq_ft	500.4162	62.459	8.012	0.000
beds	-1.742e+05	4.76e+04	-3.661	0.000
baths	1.403e+05	5.13e+04	2.735	0.007
is_sfr	5.299e+05	9.4e+04	5.640	0.000
years_old	2525.3727	1122.636	2.250	0.025
median_income	8.7311	1.965	4.444	0.000
pct_poverty	3.677e+04	7373.027	4.988	0.000
pct_bachelors	1.449e+04	2743.429	5.280	0.000

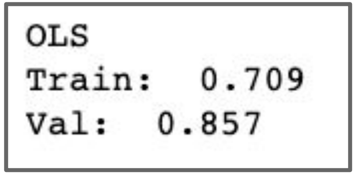

Diagnostic Plots
1e6
True Target
0
1
2
3
4
5
6
0
2
4
6
Predicted Target
1e6
1e6
Residual
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
0
1
2
3
4
Predicted Target
1e6
Probability Plot
1e6
Ordered Values
3
2
1
0
−1
−2
0
2
Theoretical quantiles

Feature Engineering

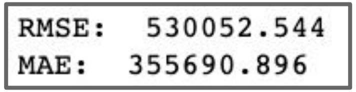
We continue to underperform for unique properties,
e.g. sweeping downtown views, beachfront locations.

Create new variable, `*near_ocean*`

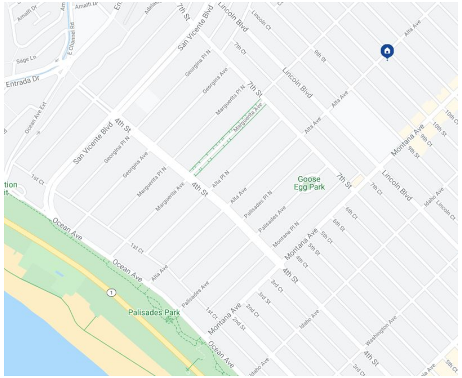




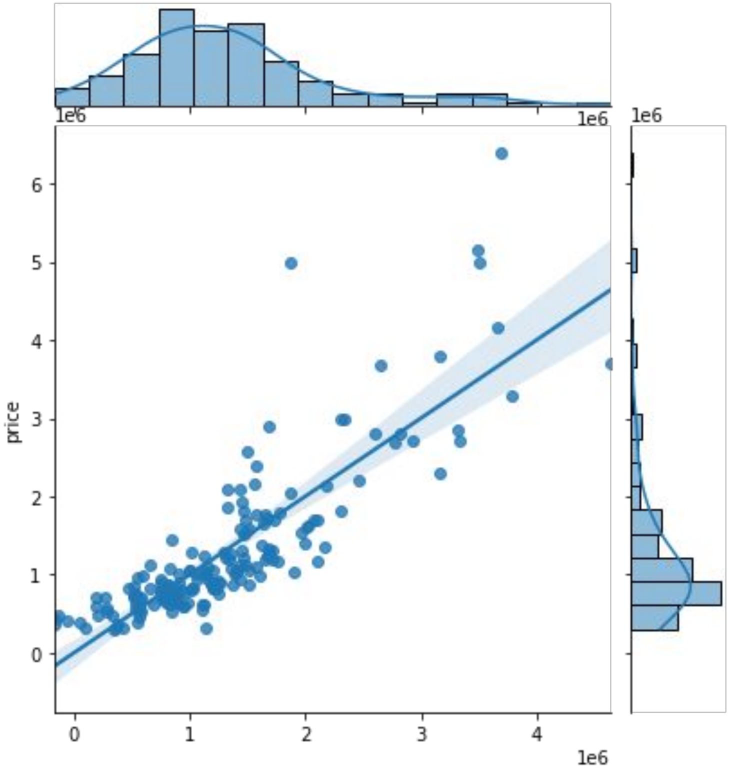
```
OLS
Train:   0.709
Val:   0.857
```

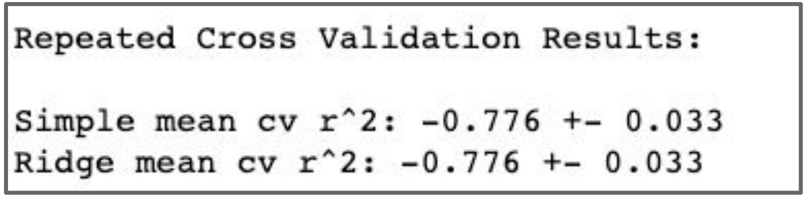


```
RMSE:   530052.544
MAE:   355690.896
```



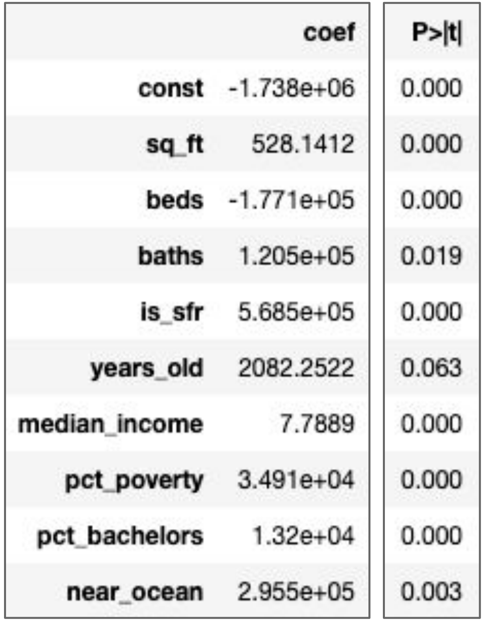
Final Interpretive Model





```
Repeated Cross Validation Results:

Simple mean cv r^2: -0.776 +- 0.033
Ridge mean cv r^2: -0.776 +- 0.033
```

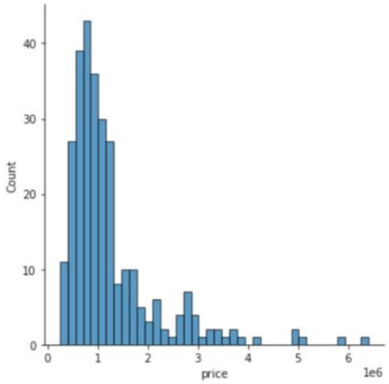


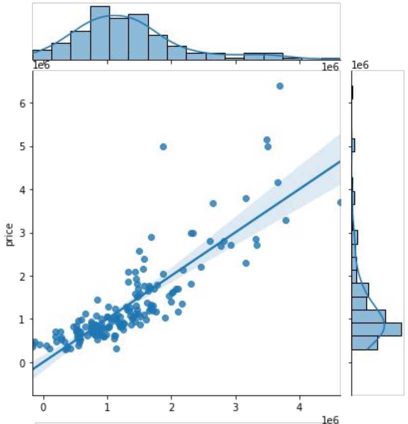
	coef	P>|t|
const	-1.738e+06	0.000
sq_ft	528.1412	0.000
beds	-1.771e+05	0.000
baths	1.205e+05	0.019
is_sfr	5.685e+05	0.000
years_old	2082.2522	0.063
median_income	7.7889	0.000
pct_poverty	3.491e+04	0.000
pct_bachelors	1.32e+04	0.000
near_ocean	2.955e+05	0.003

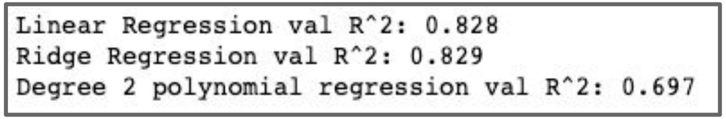
Final Predictive Model

Before log transformation

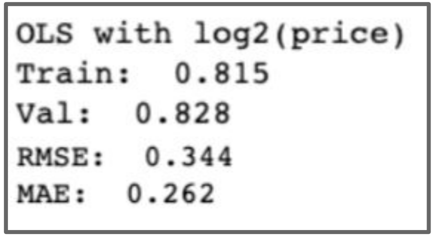
Target = prices







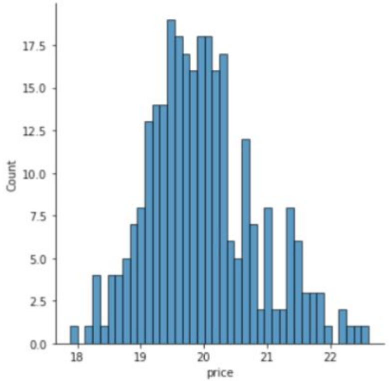
```
Linear Regression val R^2: 0.828
Ridge Regression val R^2: 0.829
Degree 2 polynomial regression val R^2: 0.697
```

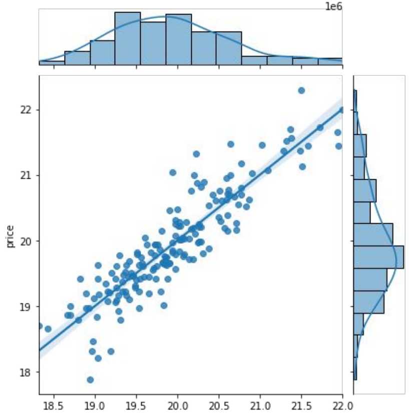


```
OLS with log2(price)
Train:  0.815
Val:  0.828
RMSE:  0.344
MAE:  0.262
```

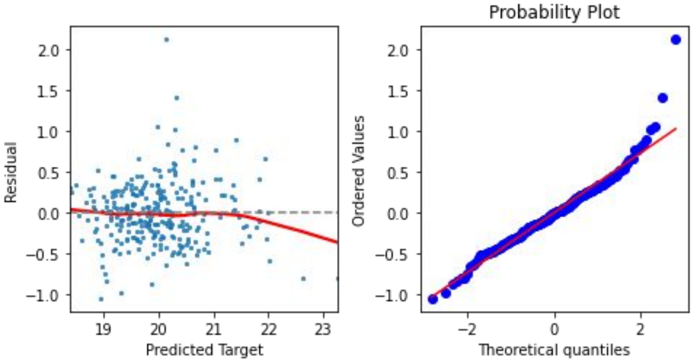
After log transformation

Target = log2(prices)





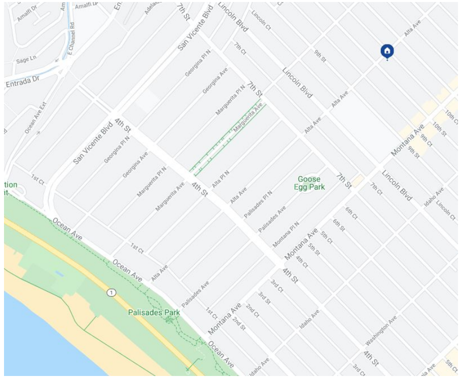
Diagnostic Plots



Future Work

To improve our model, include additional features:

- Lot size
- Has view or Floor Number (if condo)
- Proximity to ocean (miles)



To improve business relevance:

- Predict rate of return for investment properties
- Model sale price vs. predicted monthly rent