Sticker Shock:
Bay Area Housing Market

REDFIN

Predicting Home Prices with Linear Regression

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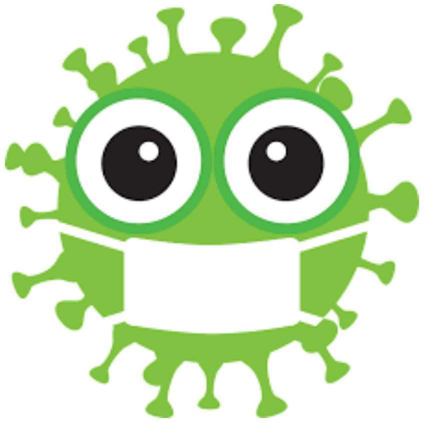
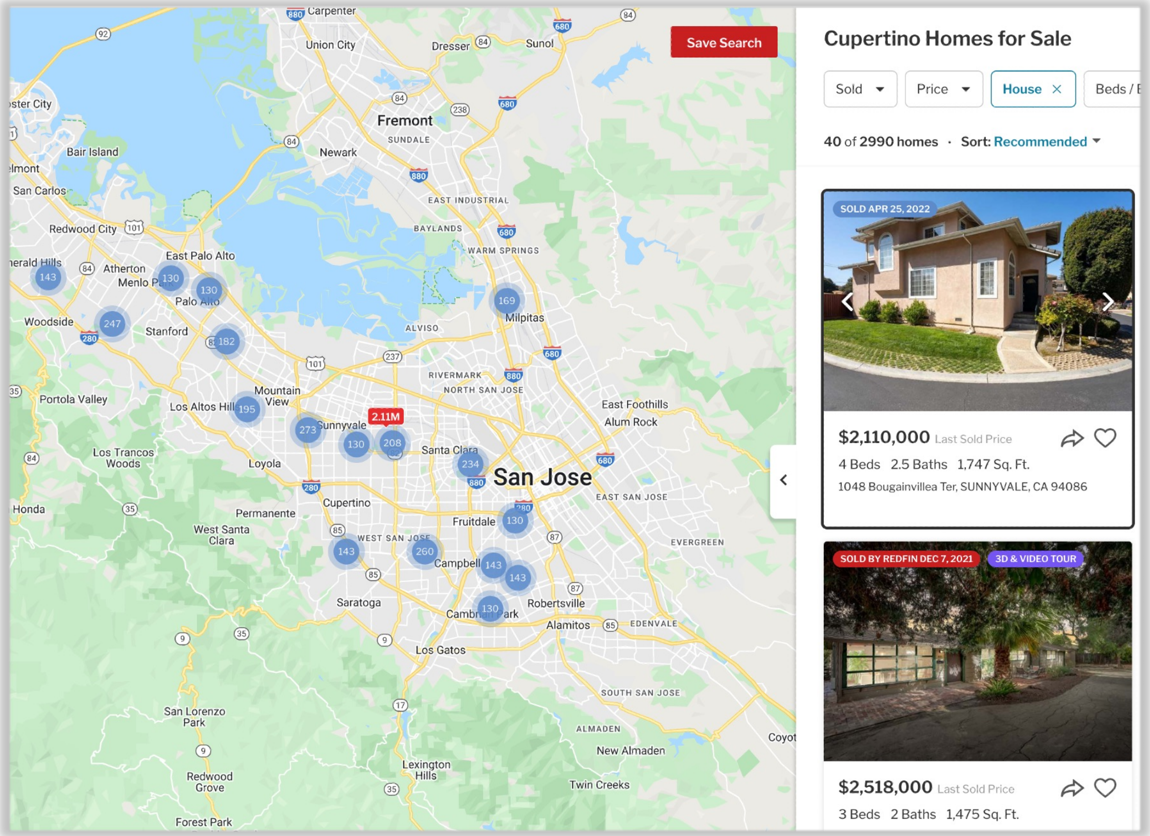
Why Home Prices?

- Covid-19
- Inflation
- Economic Downturn
- Supply chain shortages



Why Redfin?

- Web Scraping-Friendly
- Extensive Real Estate Listings
- Feature-Rich Data and Filters



Cupertino Homes for Sale

40 of 2990 homes · Sort: Recommended

SOLD APR 25, 2022

$2,110,000 Last Sold Price

4 Beds 2.5 Baths 1,747 Sq. Ft.

1048 Bougainvillea Ter, SUNNYVALE, CA 94086

SOLD BY REDFIN DEC 7, 2021 3D & VIDEO TOUR

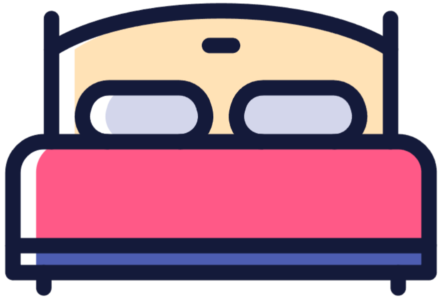
$2,518,000 Last Sold Price

3 Beds 2 Baths 1,475 Sq. Ft.

EDA

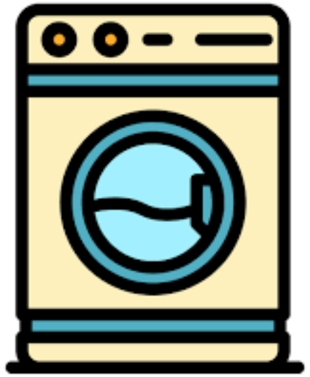
- Single Family Homes
- Sold within last 6 months
- 1600+ Data points
- 13 Features
- 7 Cities
- 18 Zip Codes

Data Point Example



Sold Price

- Beds
- Baths
- Floors
- Garage
- Lot Size
- Home Size
- Year Built
- School Score
- Laundry
- Heating
- A/C
- Pool
- City



Sold Price Stats

Mean:	$3.03 M
Standard Deviation:	$1.23 M
25% Percentile:	$2.10 M
50% Percentile :	$2.83 M
75% Percentile :	$3.70 M

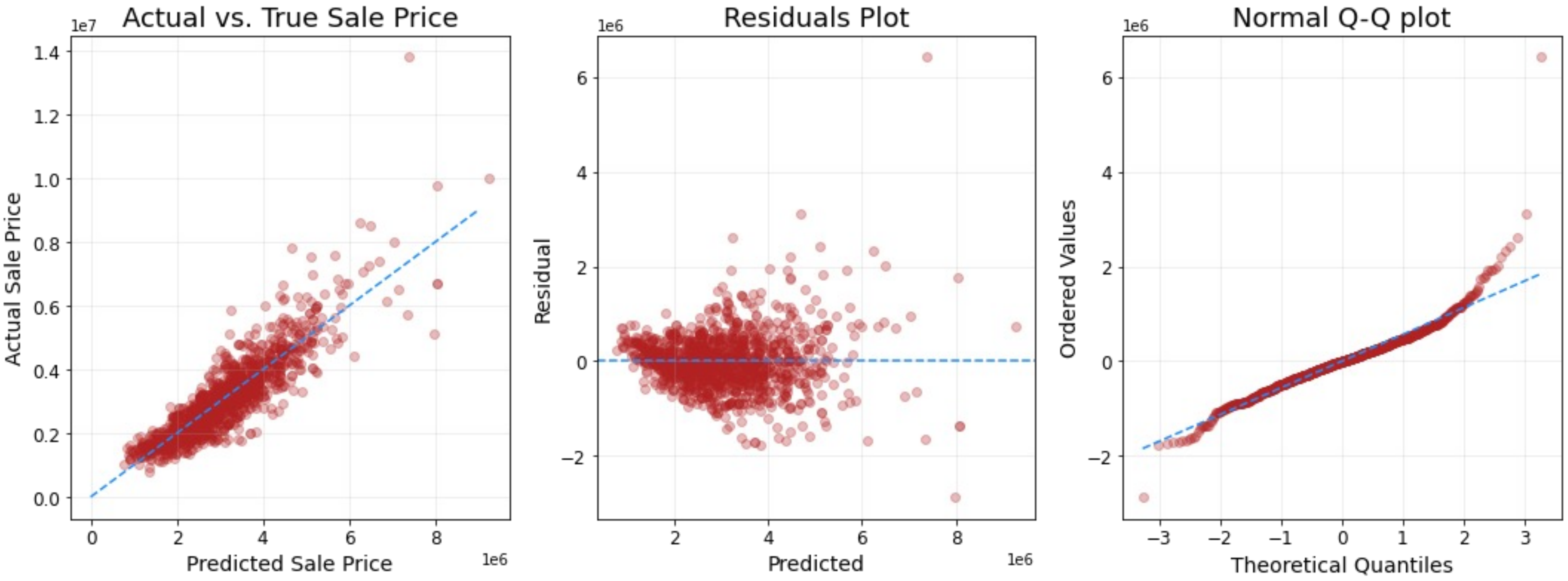
* For Homes in Santa Clara County

Model Performance (Before)

R-Squared:	0.783
Adjusted R-Squared:	0.782
Mean Absolute Error:	$416,244
Root Mean Squared Error:	$586,488

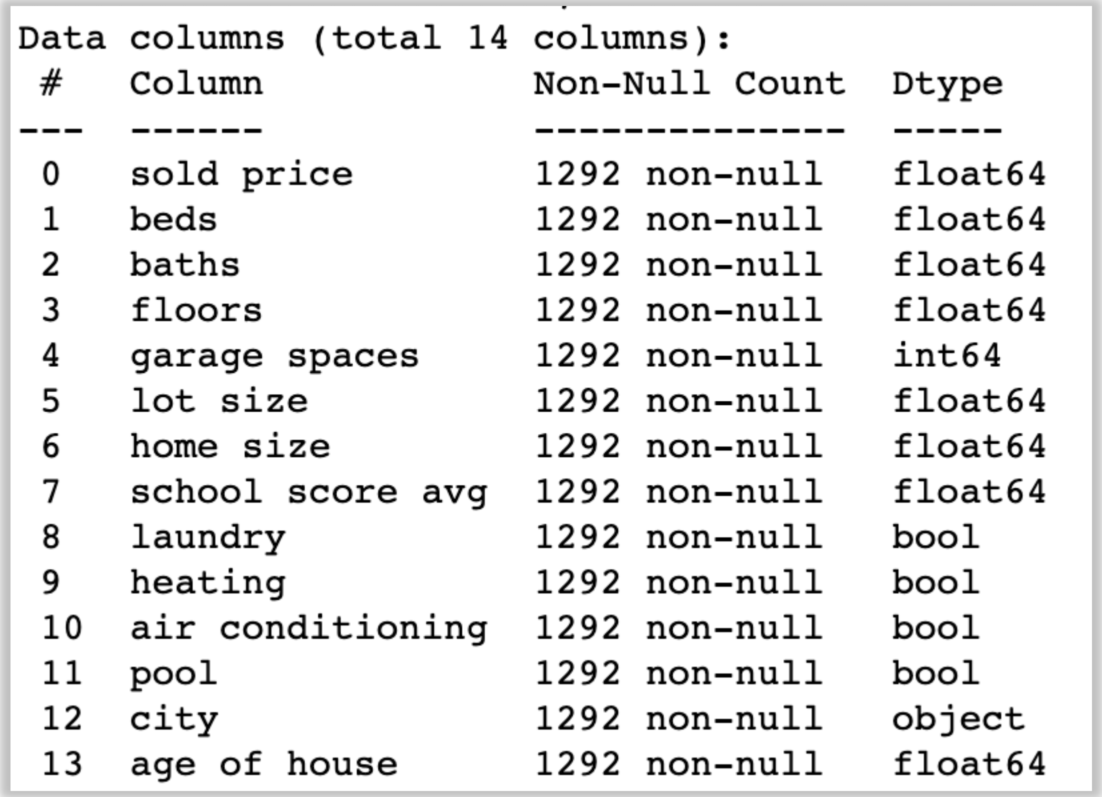
* Baseline Linear Regression - Untouched Dataset

Model Evaluation (Before)

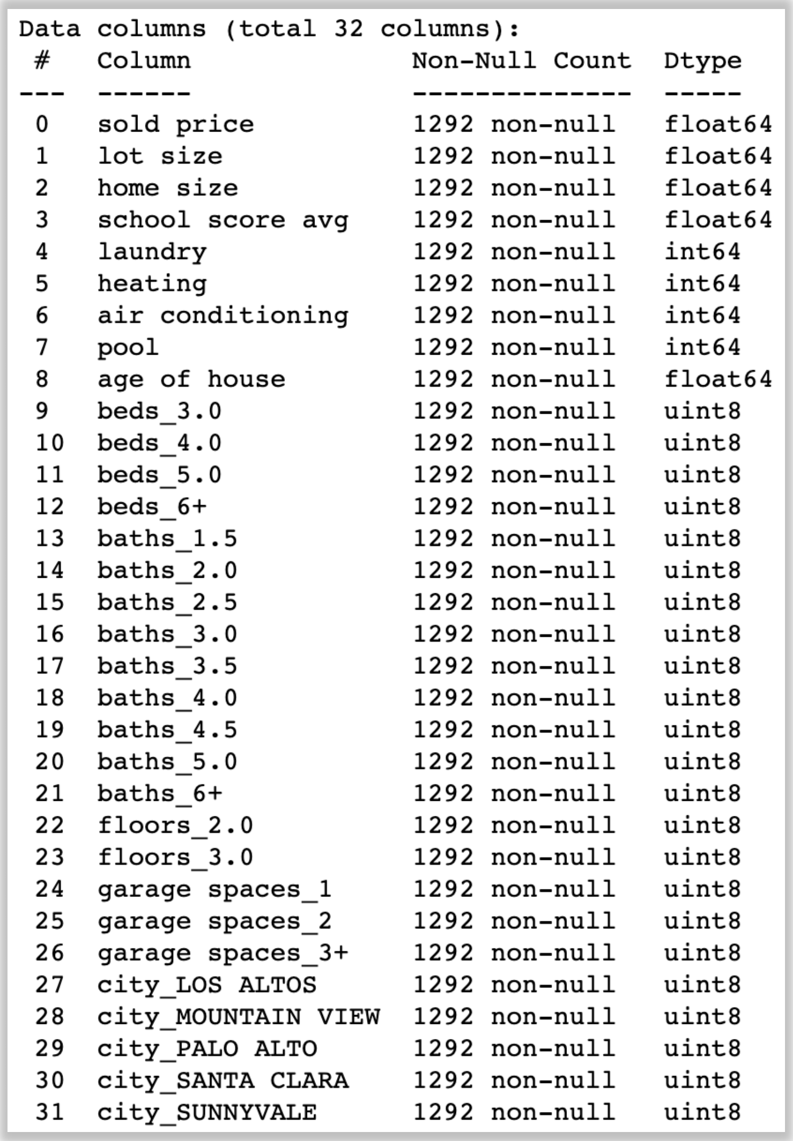


* Baseline Linear Regression - Untouched Dataset

Feature Engineering

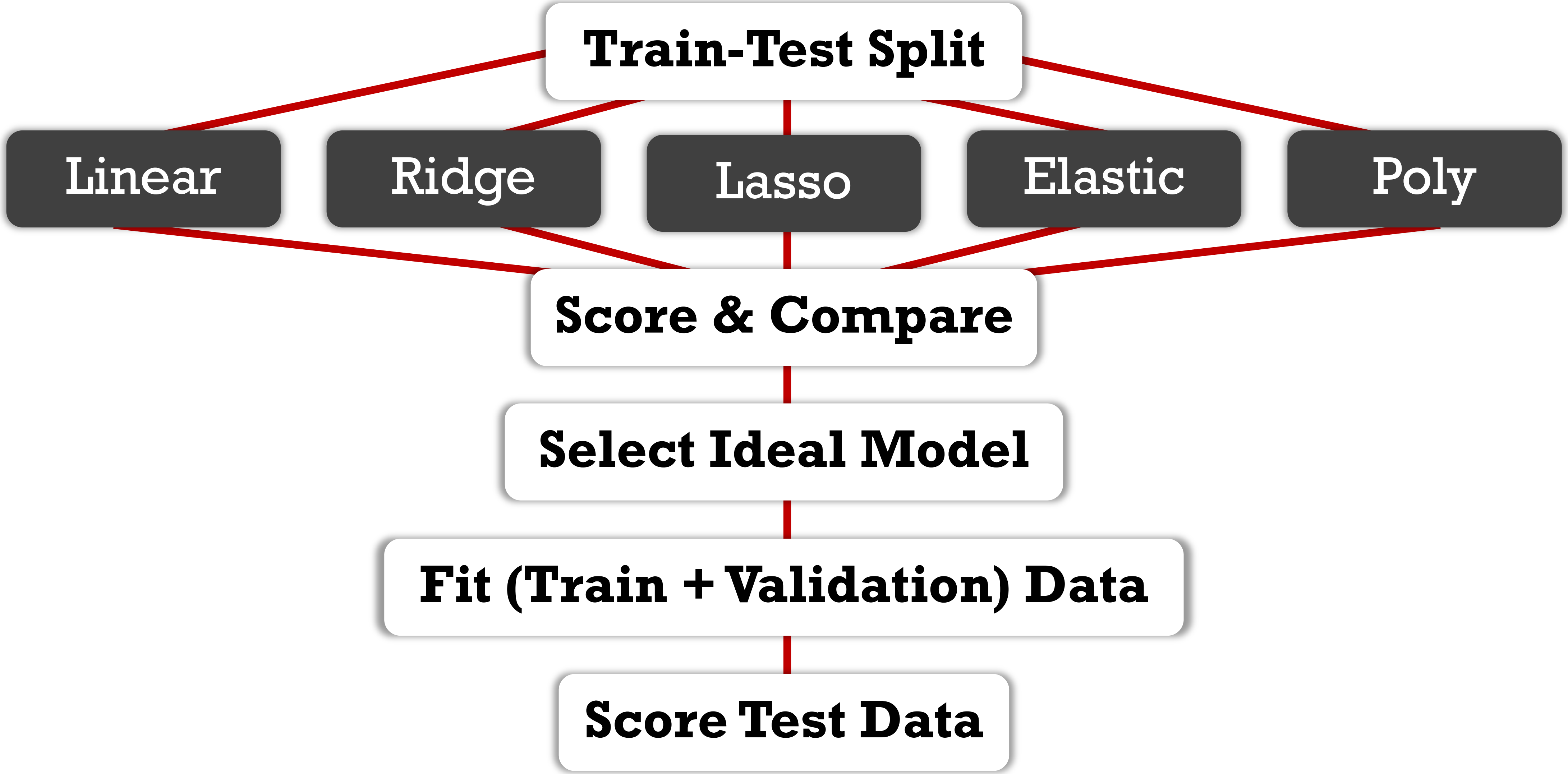


```
Data columns (total 14 columns):
 #   Column             Non-Null Count  Dtype
---  ------             --------------  -----
 0   sold price         1292 non-null   float64
 1   beds               1292 non-null   float64
 2   baths              1292 non-null   float64
 3   floors             1292 non-null   float64
 4   garage spaces      1292 non-null   int64
 5   lot size           1292 non-null   float64
 6   home size          1292 non-null   float64
 7   school score avg   1292 non-null   float64
 8   laundry            1292 non-null   bool
 9   heating            1292 non-null   bool
 10  air conditioning   1292 non-null   bool
 11  pool               1292 non-null   bool
 12  city               1292 non-null   object
 13  age of house       1292 non-null   float64
```



```
Data columns (total 32 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   sold price            1292 non-null   float64
 1   lot size              1292 non-null   float64
 2   home size             1292 non-null   float64
 3   school score avg      1292 non-null   float64
 4   laundry               1292 non-null   int64
 5   heating               1292 non-null   int64
 6   air conditioning      1292 non-null   int64
 7   pool                  1292 non-null   int64
 8   age of house          1292 non-null   float64
 9   beds_3.0              1292 non-null   uint8
 10  beds_4.0              1292 non-null   uint8
 11  beds_5.0              1292 non-null   uint8
 12  beds_6+               1292 non-null   uint8
 13  baths_1.5             1292 non-null   uint8
 14  baths_2.0             1292 non-null   uint8
 15  baths_2.5             1292 non-null   uint8
 16  baths_3.0             1292 non-null   uint8
 17  baths_3.5             1292 non-null   uint8
 18  baths_4.0             1292 non-null   uint8
 19  baths_4.5             1292 non-null   uint8
 20  baths_5.0             1292 non-null   uint8
 21  baths_6+              1292 non-null   uint8
 22  floors_2.0            1292 non-null   uint8
 23  floors_3.0            1292 non-null   uint8
 24  garage spaces_1       1292 non-null   uint8
 25  garage spaces_2       1292 non-null   uint8
 26  garage spaces_3+      1292 non-null   uint8
 27  city_LOS ALTOS        1292 non-null   uint8
 28  city_MOUNTAIN VIEW    1292 non-null   uint8
 29  city_PALO ALTO        1292 non-null   uint8
 30  city_SANTA CLARA      1292 non-null   uint8
 31  city_SUNNYVALE        1292 non-null   uint8
```

CV & Regularization

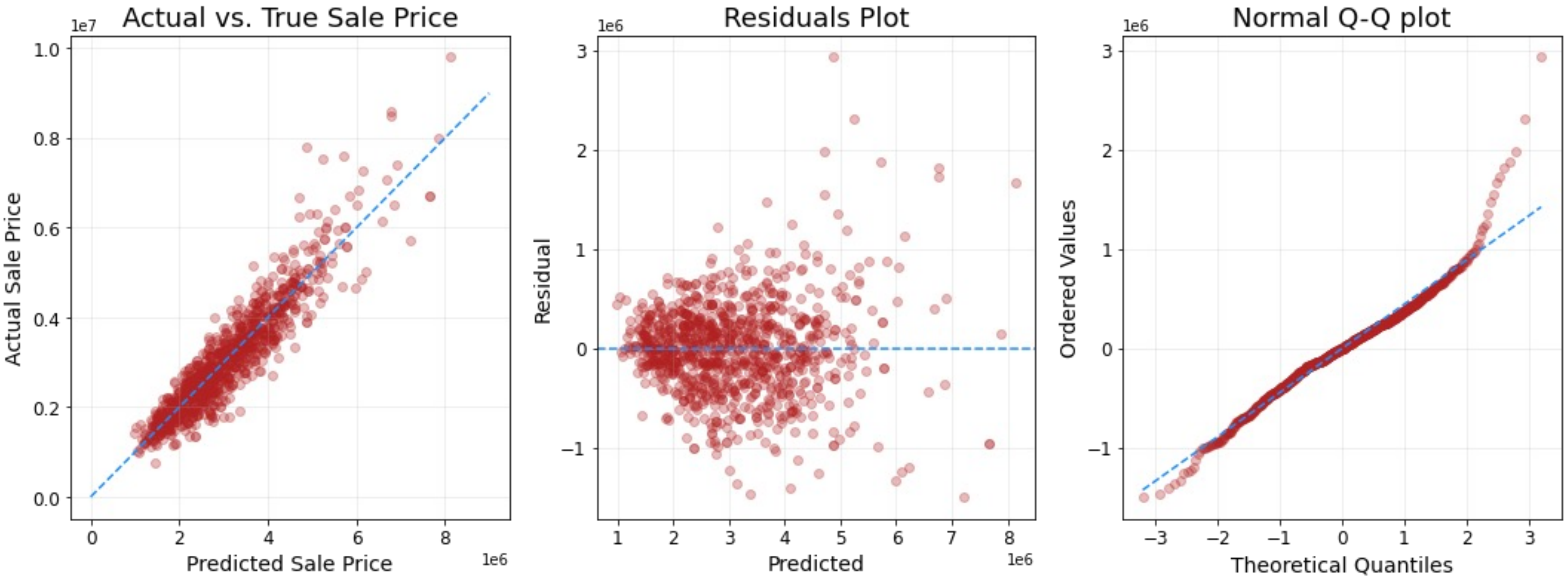


Model Performance (After)

R-Squared:	0.801
Adjusted R-Squared:	0.774
Mean Absolute Error:	$398,667
Root Mean Squared Error:	$543,227

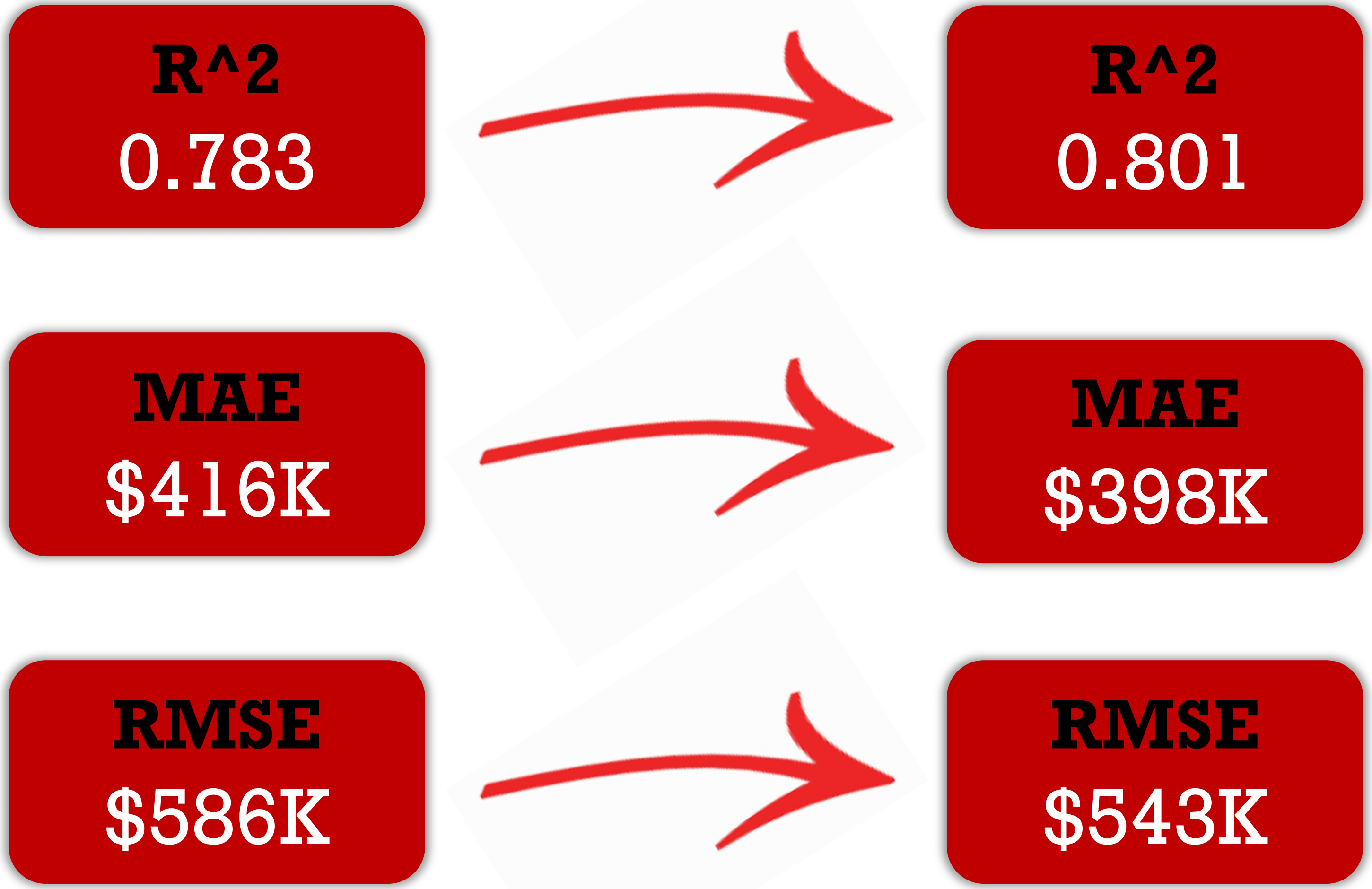
* Elastic Net Regression – Test Dataset

Model Evaluation (After)



* Elastic Net Regression – Test Dataset

Conclusion



R^2

0.783

R^2

0.801

MAE

$416K

MAE

$398K

RMSE

$586K

RMSE

$543K

* Elastic Net Regression – Test Dataset

Conclusion

Interesting Feature Coefficients

home size:	773471.44
school score avg:	269845.16
lot size:	130766.26
*city - palo alto:	336679.56
*city – los altos:	205731.06
age of house:	0.00

* City – Cupertino as reference

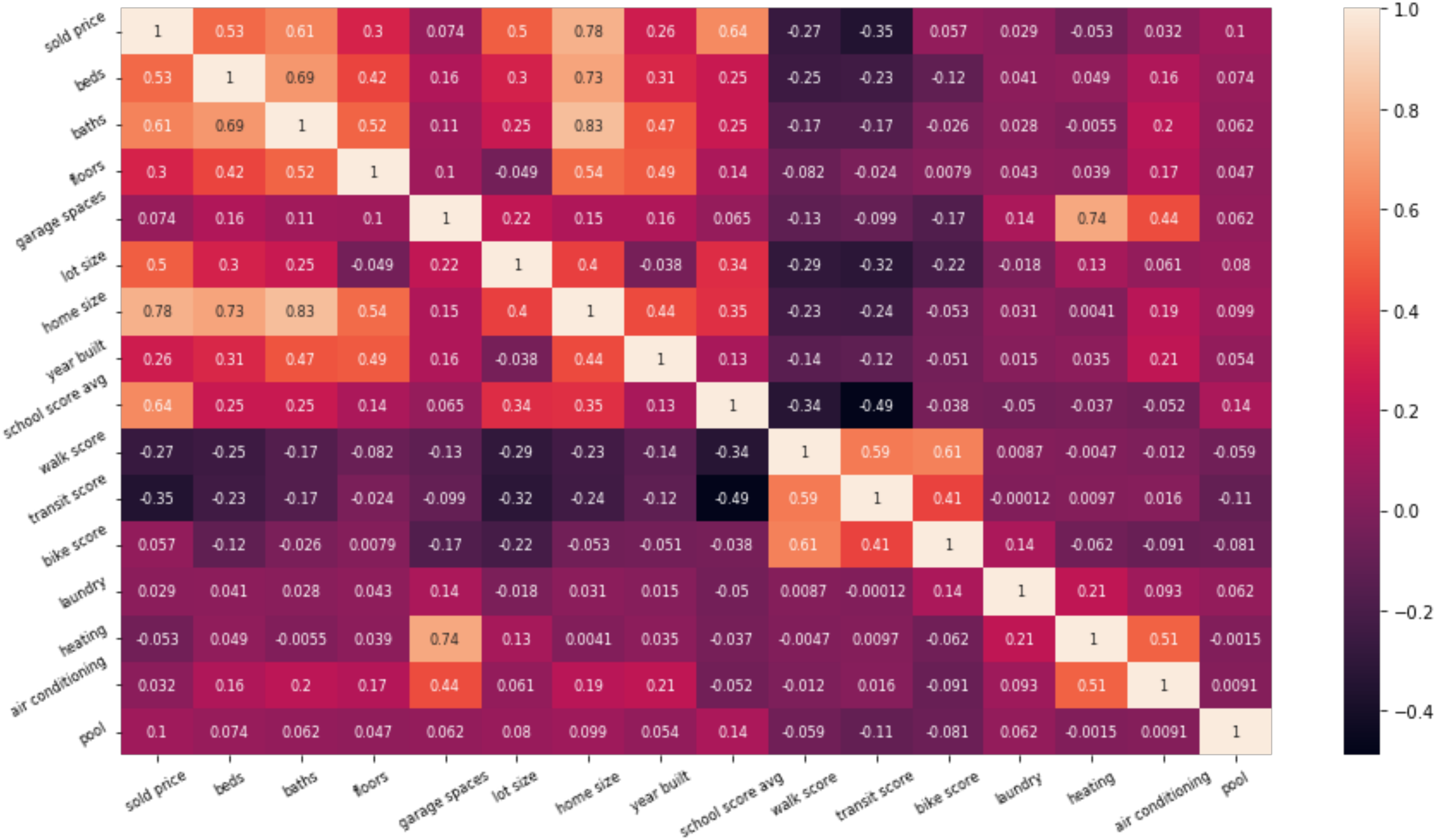
Thank You

REDFIN

Questions?

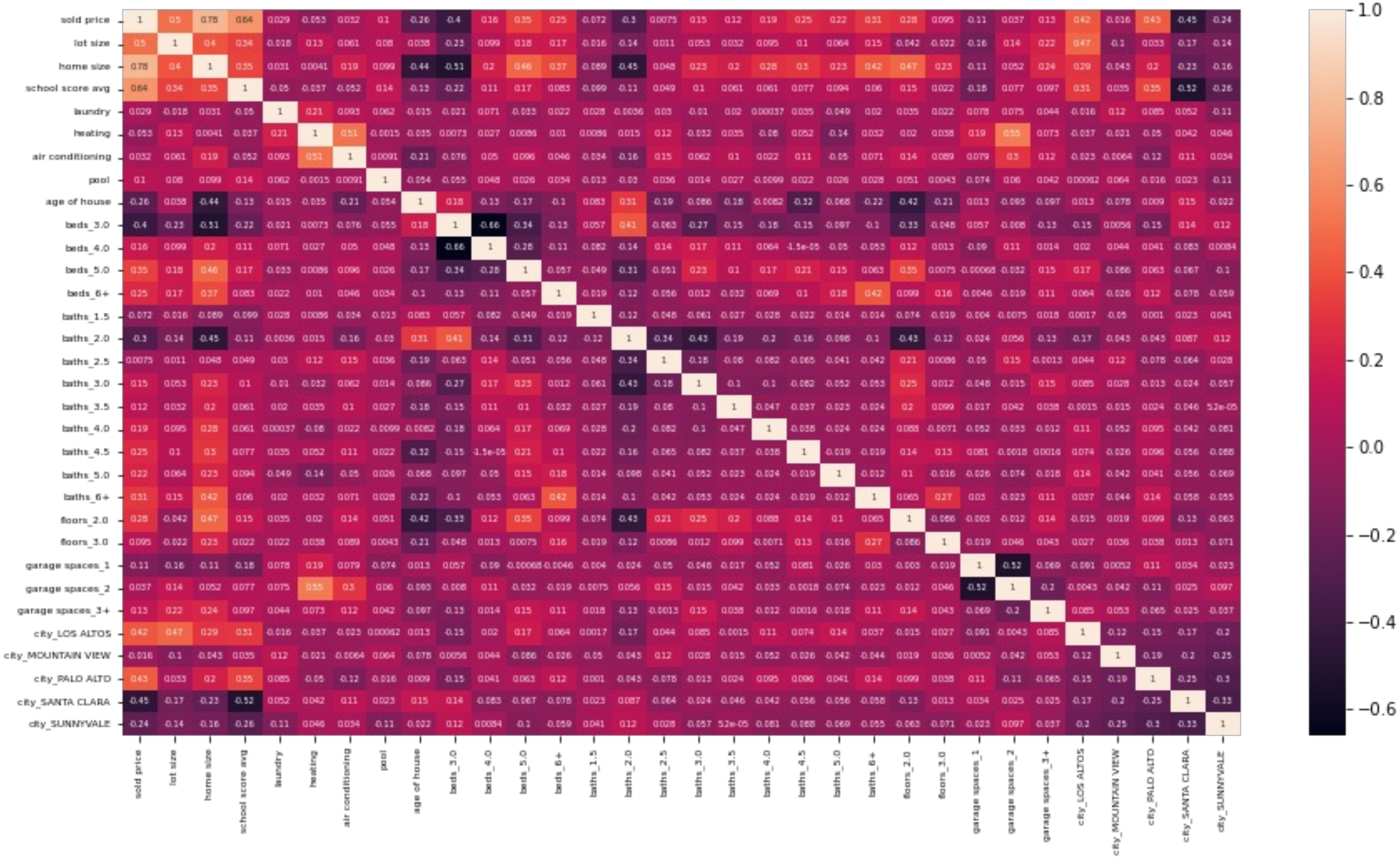
metis 2022 may

Appendix

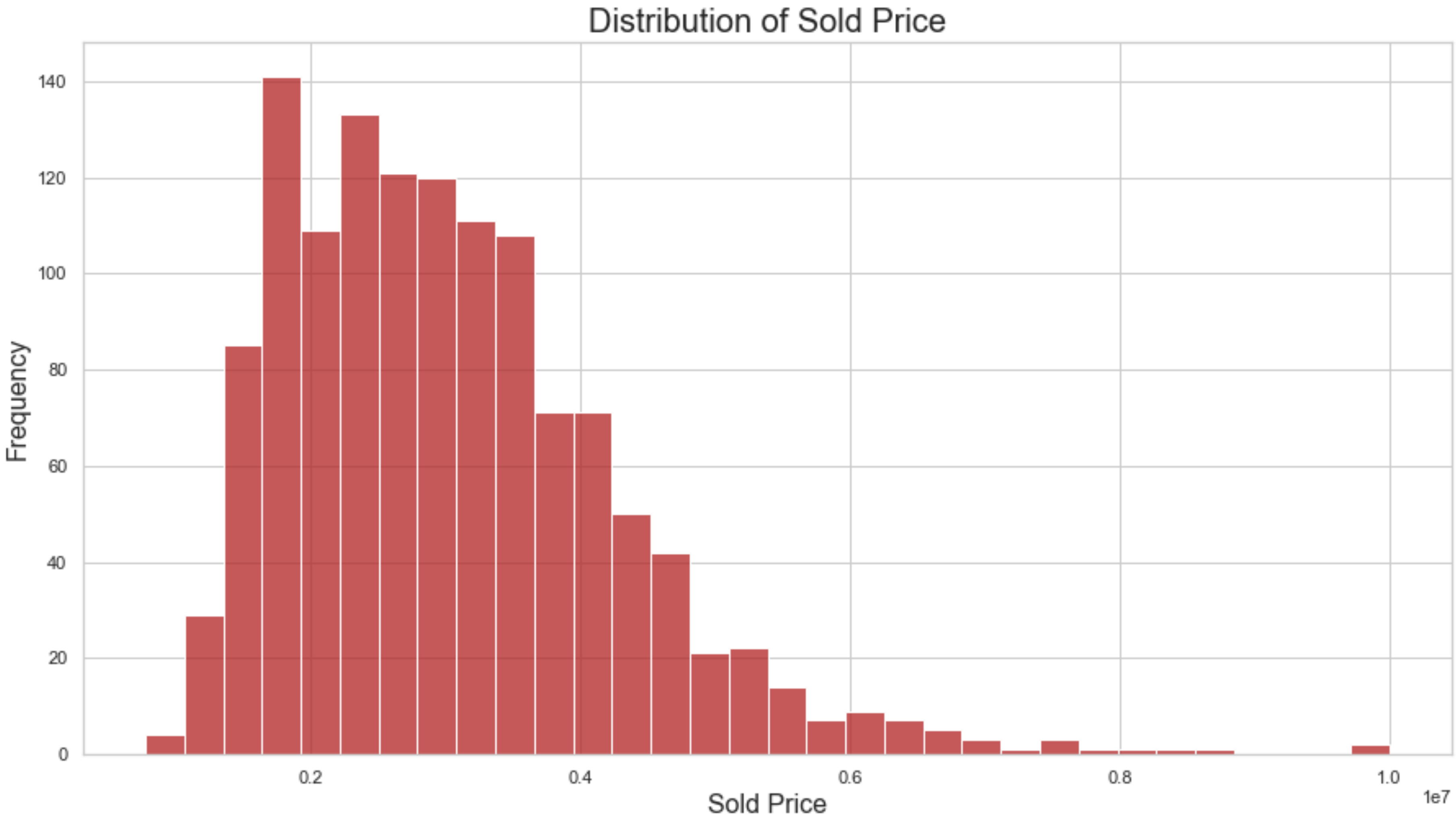


	sold price	beds	baths	floors	garage spaces	lot size	home size	year built	school score avg	walk score	transit score	bike score	laundry	heating	air conditioning	pool
sold price	1	0.53	0.61	0.3	0.074	0.5	0.78	0.26	0.64	-0.27	-0.35	0.057	0.029	-0.053	0.032	0.1
beds	0.53	1	0.69	0.42	0.16	0.3	0.73	0.31	0.25	-0.25	-0.23	-0.12	0.041	0.049	0.16	0.074
baths	0.61	0.69	1	0.52	0.11	0.25	0.83	0.47	0.25	-0.17	-0.17	-0.026	0.028	-0.0055	0.2	0.062
floors	0.3	0.42	0.52	1	0.1	-0.049	0.54	0.49	0.14	-0.082	-0.024	0.0079	0.043	0.039	0.17	0.047
garage spaces	0.074	0.16	0.11	0.1	1	0.22	0.15	0.16	0.065	-0.13	-0.099	-0.17	0.14	0.74	0.44	0.062
lot size	0.5	0.3	0.25	-0.049	0.22	1	0.4	-0.038	0.34	-0.29	-0.32	-0.22	-0.018	0.13	0.061	0.08
home size	0.78	0.73	0.83	0.54	0.15	0.4	1	0.44	0.35	-0.23	-0.24	-0.053	0.031	0.0041	0.19	0.099
year built	0.26	0.31	0.47	0.49	0.16	-0.038	0.44	1	0.13	-0.14	-0.12	-0.051	0.015	0.035	0.21	0.054
school score avg	0.64	0.25	0.25	0.14	0.065	0.34	0.35	0.13	1	-0.34	-0.49	-0.038	-0.05	-0.037	-0.052	0.14
walk score	-0.27	-0.25	-0.17	-0.082	-0.13	-0.29	-0.23	-0.14	-0.34	1	0.59	0.61	0.0087	-0.0047	-0.012	-0.059
transit score	-0.35	-0.23	-0.17	-0.024	-0.099	-0.32	-0.24	-0.12	-0.49	0.59	1	0.41	-0.00012	0.0097	0.016	-0.11
bike score	0.057	-0.12	-0.026	0.0079	-0.17	-0.22	-0.053	-0.051	-0.038	0.61	0.41	1	0.14	-0.062	-0.091	-0.081
laundry	0.029	0.041	0.028	0.043	0.14	-0.018	0.031	0.015	-0.05	0.0087	-0.00012	0.14	1	0.21	0.093	0.062
heating	-0.053	0.049	-0.0055	0.039	0.74	0.13	0.0041	0.035	-0.037	-0.0047	0.0097	-0.062	0.21	1	0.51	-0.0015
air conditioning	0.032	0.16	0.2	0.17	0.44	0.061	0.19	0.21	-0.052	-0.012	0.016	-0.091	0.093	0.51	1	0.0091
pool	0.1	0.074	0.062	0.047	0.062	0.08	0.099	0.054	0.14	-0.059	-0.11	-0.081	0.062	-0.0015	0.0091	1

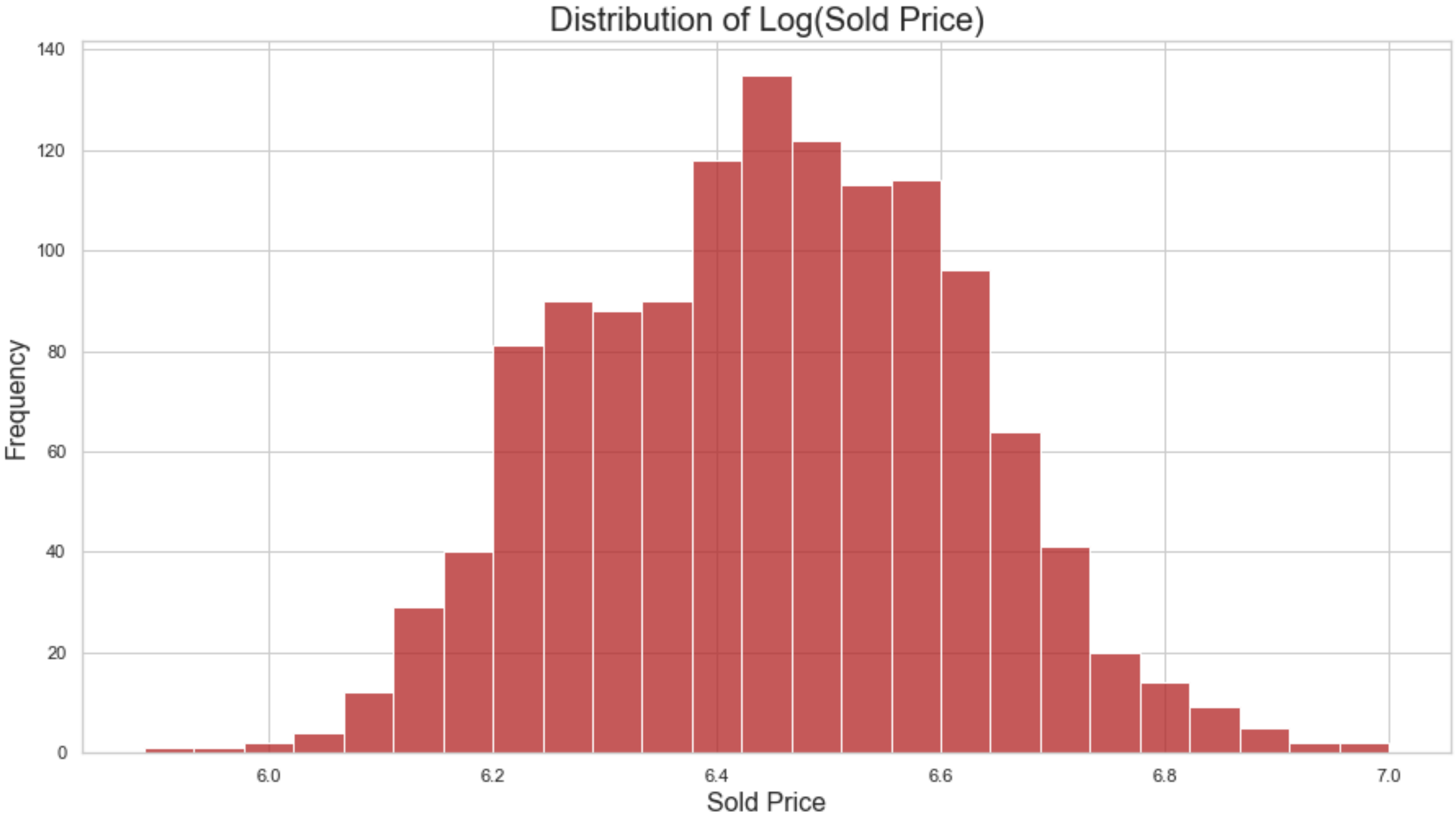
Appendix


sold price
lot size
home size
school score avg
laundry
heating
air conditioning
pool
age of house
beds_3.0
beds_4.0
beds_5.0
beds_6+
baths_1.5
baths_2.0
baths_2.5
baths_3.0
baths_3.5
baths_4.0
baths_4.5
baths_5.0
baths_6+
floors_2.0
floors_3.0
garage spaces_1
garage spaces_2
garage spaces_3+
city_LOS ALTOS
city_MOUNTAIN VIEW
city_PALO ALTO
city_SANTA CLARA
city_SUNNYVALE
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6

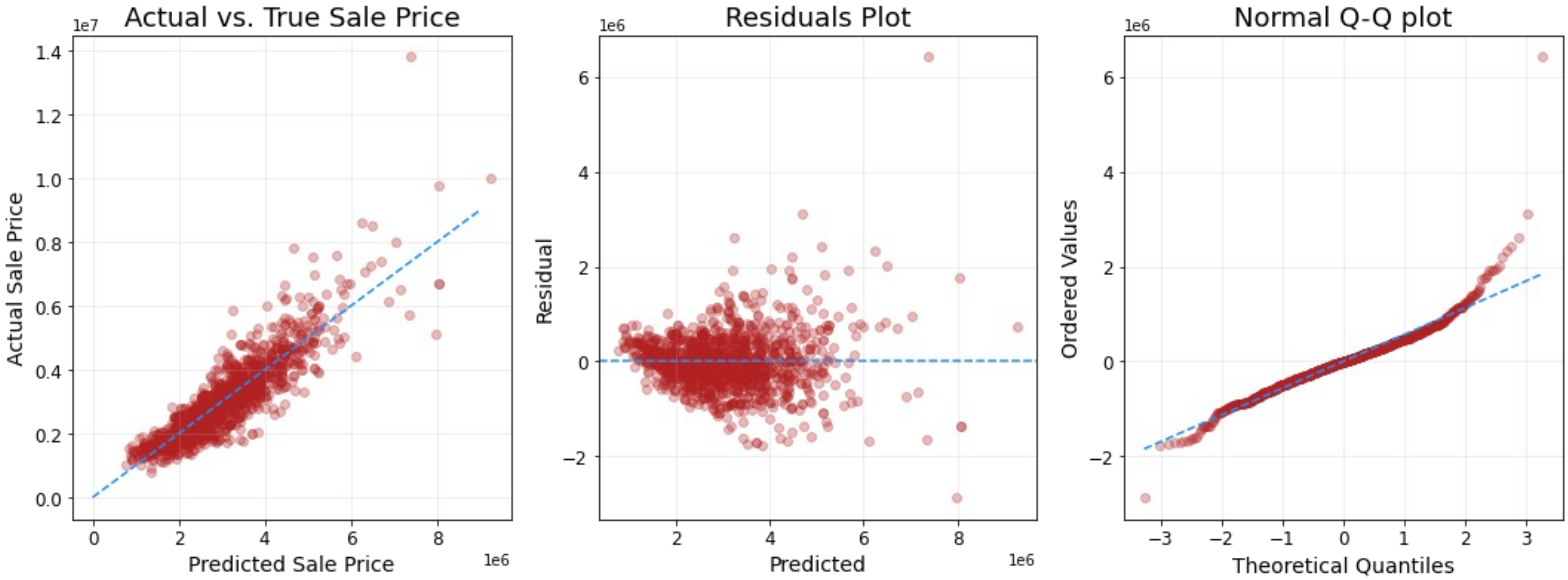
Appendix


Distribution of Sold Price
Frequency
0
20
40
60
80
100
120
140
0.2
0.4
0.6
0.8
1.0
1e7
Sold Price

Appendix

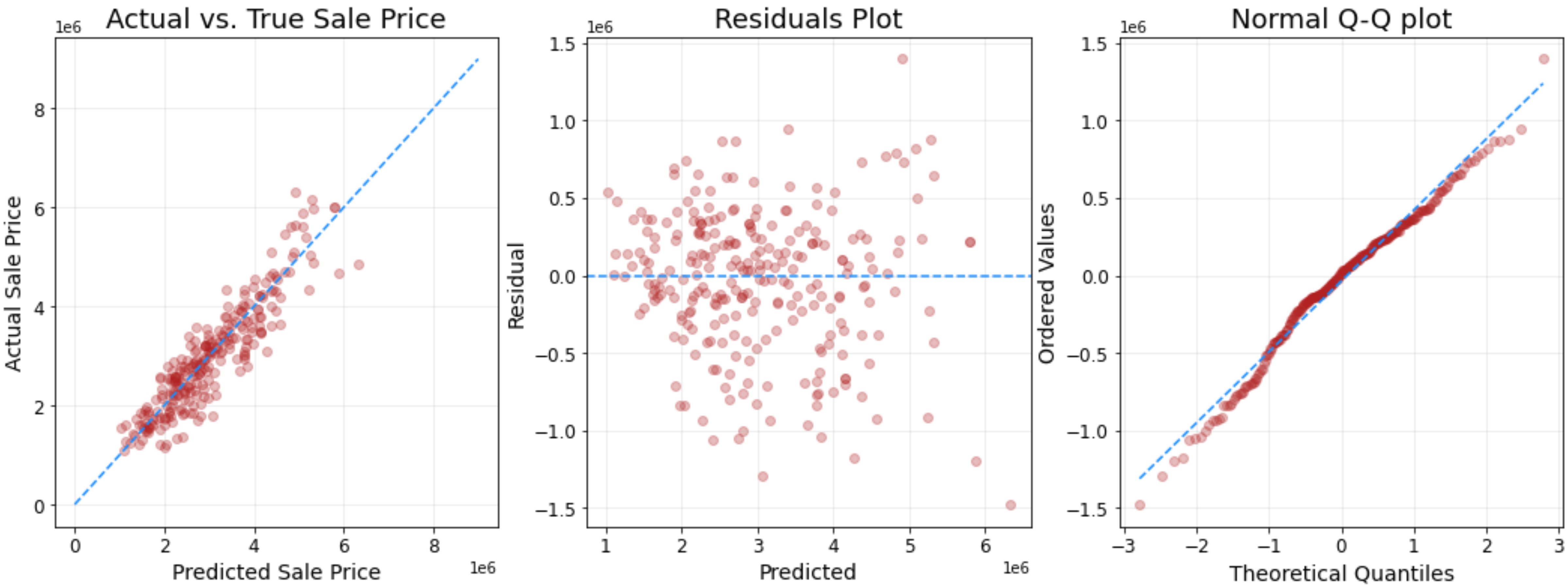

Distribution of Log(Sold Price)
Frequency
0
20
40
60
80
100
120
140
6.0
6.2
6.4
6.6
6.8
7.0
Sold Price

Appendix



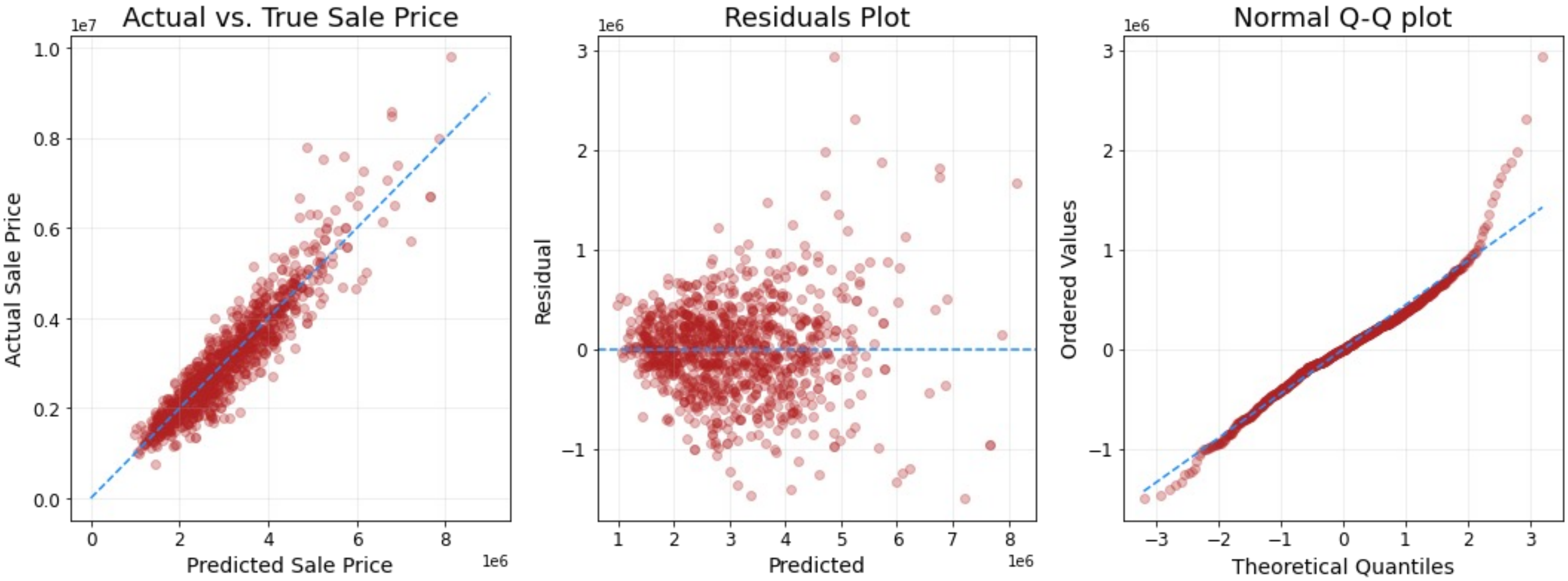
* Baseline Linear Regression – Untouched Dataset

Appendix



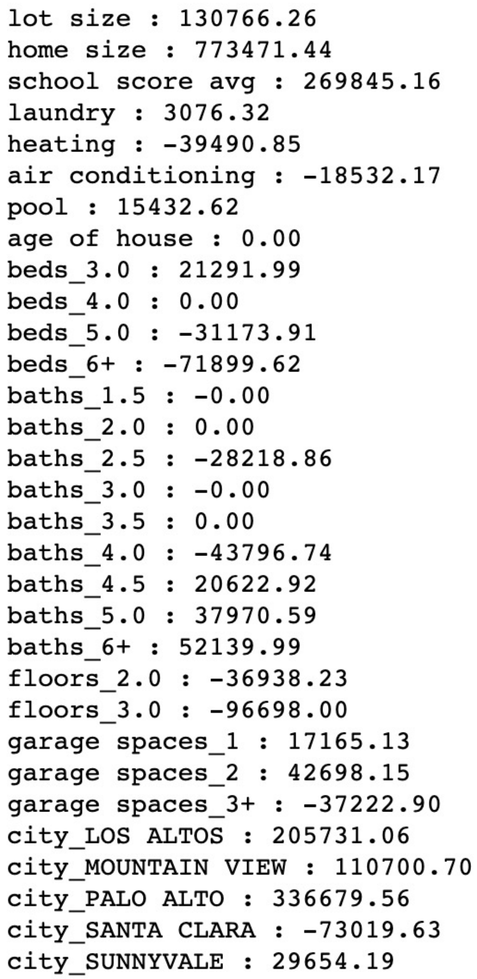
* Elastic Net Regression – Validation Dataset

Appendix



* Elastic Net Regression – Test Dataset

Appendix



```
lot size : 130766.26
home size : 773471.44
school score avg : 269845.16
laundry : 3076.32
heating : -39490.85
air conditioning : -18532.17
pool : 15432.62
age of house : 0.00
beds_3.0 : 21291.99
beds_4.0 : 0.00
beds_5.0 : -31173.91
beds_6+ : -71899.62
baths_1.5 : -0.00
baths_2.0 : 0.00
baths_2.5 : -28218.86
baths_3.0 : -0.00
baths_3.5 : 0.00
baths_4.0 : -43796.74
baths_4.5 : 20622.92
baths_5.0 : 37970.59
baths_6+ : 52139.99
floors_2.0 : -36938.23
floors_3.0 : -96698.00
garage spaces_1 : 17165.13
garage spaces_2 : 42698.15
garage spaces_3+ : -37222.90
city_LOS ALTOS : 205731.06
city_MOUNTAIN VIEW : 110700.70
city_PALO ALTO : 336679.56
city_SANTA CLARA : -73019.63
city_SUNNYVALE : 29654.19
```

* Elastic Net Regression – Feature Coefficients