

Computer Monitor Pricing

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Design



Client: Computer monitor customers

Objective: Explore monitor pricing: how prices are decided?

Goal: Be able to predict monitor prices given certain set of monitor specifications

Data

- ▶ Monitor data scraped from
- ▶ Target: Monitor pricing



New! LG - 34" UltraWide Full HD IPS Monitor with VESA Display HDR 400 and AMD FreeSync - Black

Model: 34WQ500-B SKU: 6505062

★★★★☆ (3 reviews)

Get it today

\$329.99

Add to Cart

Open-Box: from \$275.99

- ▶ Features: monitor specifications

2560 x 1080
Maximum Resolution



- Ideal for movies
- Easily find Full HD content
- Good for work and school from home

What's the difference in monitor resolution?

34 inches
Screen Size



- 33"+
- Great in larger gaming spaces
- Good for replacing multiple home office monitors

Which monitor size is best?

100Hz
Refresh Rate



- 60Hz - 100Hz
- Good for Full HD videos
- Ideal for work and school from home

What is refresh rate?

▶ Final Cleaned Data

```
<class 'pandas.core.frame.DataFrame'>
```

```
RangeIndex: 502 entries, 0 to 501
```

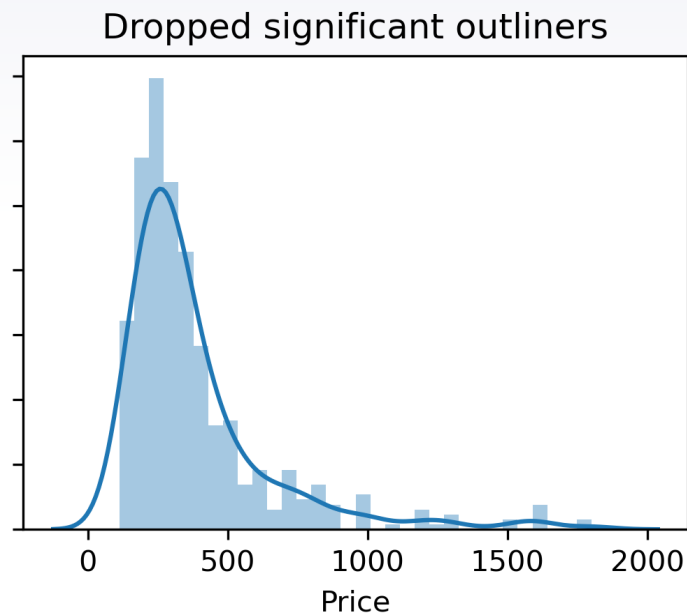
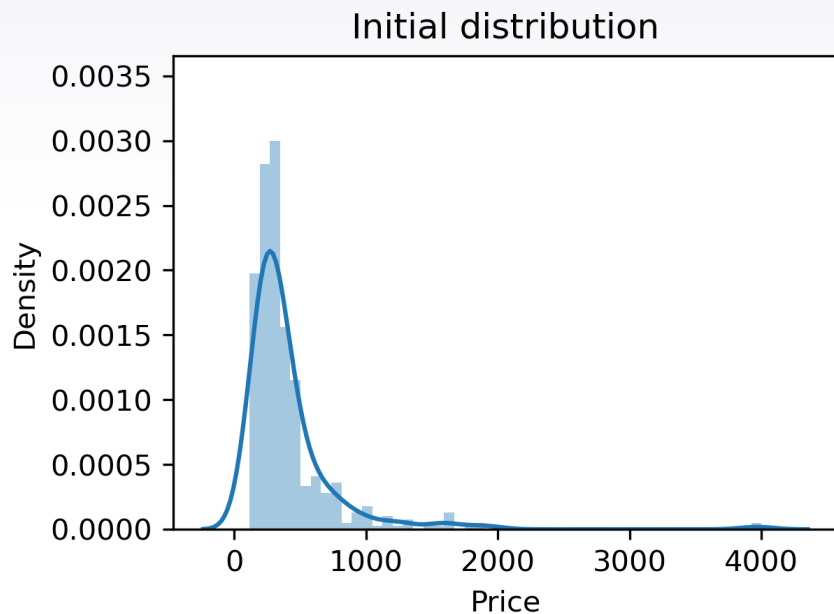
```
Data columns (total 25 columns):
```

#	Column	Non-Null Count	Dtype
0	brand	502 non-null	object
1	Price	502 non-null	float64
2	rating	502 non-null	float64
3	review_count	502 non-null	float64
4	Refresh_Rate	502 non-null	float64
5	Contrast_Ratio	502 non-null	float64
6	Response_Time	502 non-null	float64
7	Synchronization_Technology	502 non-null	object
8	Panel_Type	502 non-null	object
9	Curved_Screen	502 non-null	object
10	Brightness	502 non-null	float64
11	Screen_Size	502 non-null	float64
12	HDR	502 non-null	object
13	Smart_Display	502 non-null	object
14	Touch_Screen	502 non-null	object
15	Quantum_Dot_Technology	502 non-null	object
16	Headphone_Jack	502 non-null	object
17	Voice_Assistant	502 non-null	object
18	Wall_Mountable	502 non-null	object
19	Anti_Glare	502 non-null	object
20	Speaker	502 non-null	object
21	Webcam	502 non-null	object
22	Weight	502 non-null	float64
23	Resolution	502 non-null	object
24	Total_Pixels	502 non-null	int64

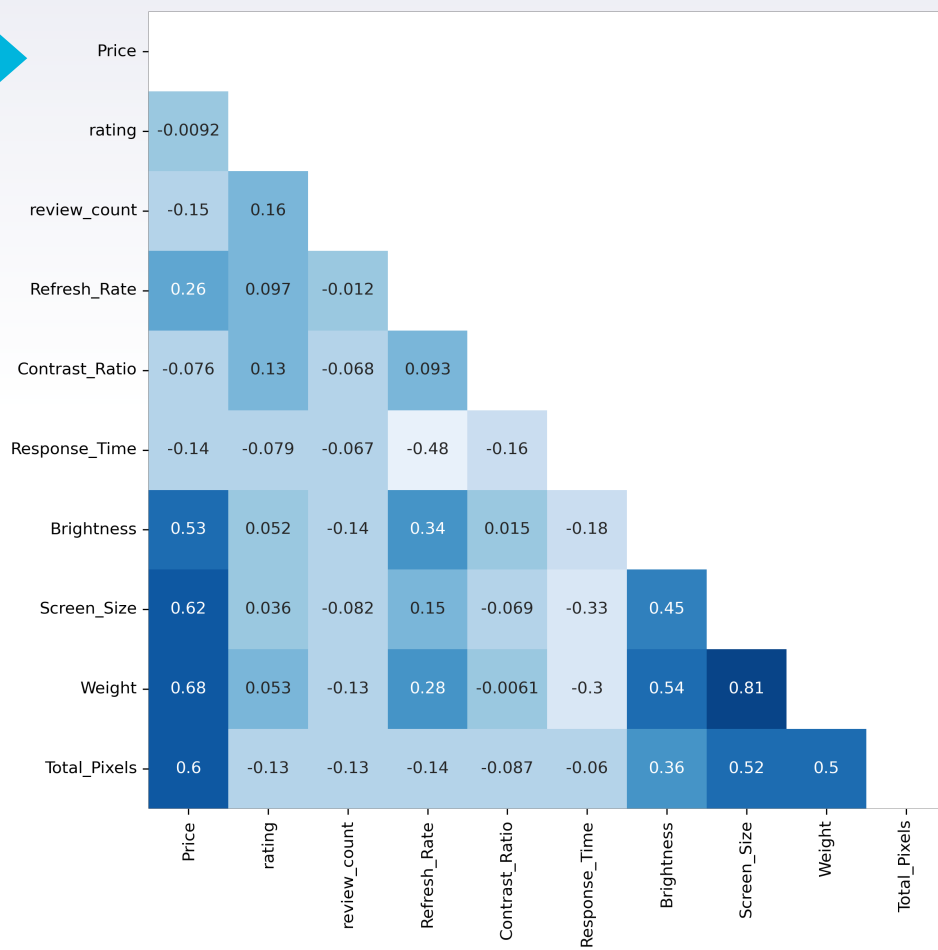
```
dtypes: float64(9), int64(1), object(15)
```

```
memory usage: 98.2+ KB
```

Data Deep dive (1): Distribution of Target



Data Deep dive (2): Obvious Relationships



Notable relationship with target:

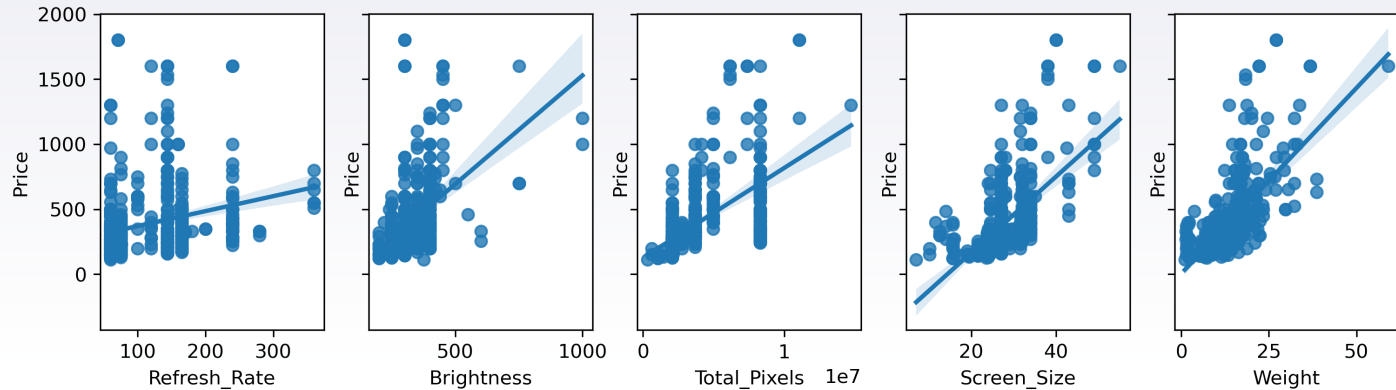
- ▶ Refresh Rate: 0.26
- ▶ Brightness: 0.53
- ▶ Total Pixels: 0.6
- ▶ Screen Size: 0.62
- ▶ Weight: 0.68

Warning of multicollinearity:

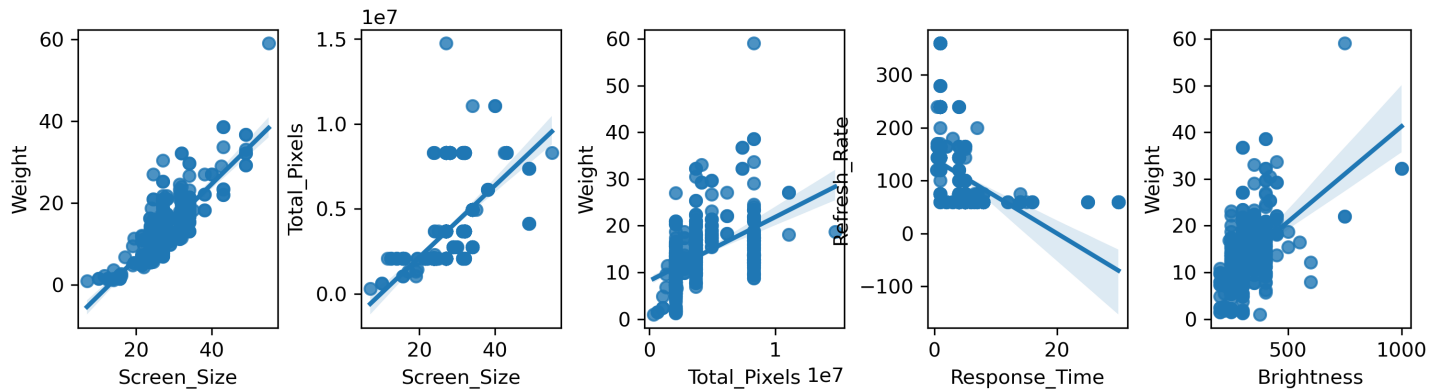
- ▶ Screen Size & Weight: 0.81
- ▶ Screen Size & Total Pixels: 0.52
- ▶ Total Pixels & Weight: 0.5
- ▶ Response Time & Refresh Rate: -0.48
- ▶ Brightness & Weight: 0.45
- ▶ Screen Size & Brightness: 0.45
- ▶ Total Pixels & Brightness: 0.36

Data Deep dive (3)

Relationship between Features & Target



Relationship between Features



Baseline OLS

```
train_val_test(x,y)
```

```
train r score: 0.594
validation r score: 0.629
test r score: 0.658
```

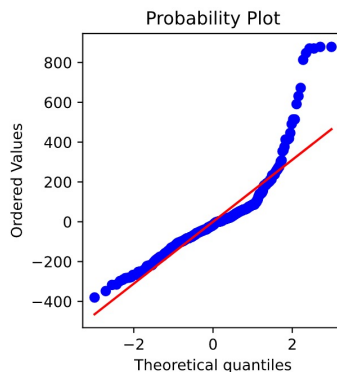
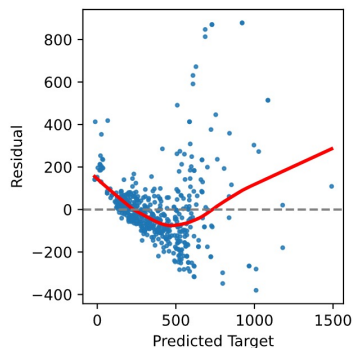
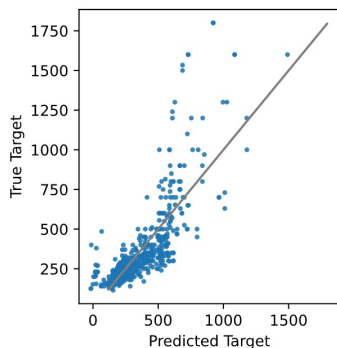
```
KFold3_cross_validation(x,y)
```

```
Simple regression scores: [0.54588404 0.59138039 0.5834882 ]
Simple mean cv r^2: 0.574 +- 0.02
```

```
KFold5_cross_validation(x,y)
```

```
Simple regression scores: [0.52381485 0.607549 0.59280324 0.01615653 0.63758722]
Simple mean cv r^2: 0.476 +- 0.233
```

Diagnostic Plots



Dep. Variable:	Price	R-squared:	0.616
Model:	OLS	Adj. R-squared:	0.609
Method:	Least Squares	F-statistic:	86.49
Date:	Wed, 15 Jun 2022	Prob (F-statistic):	4.55e-95
Time:	17:16:36	Log-Likelihood:	-3249.7
No. Observations:	496	AIC:	6519.
Df Residuals:	486	BIC:	6562.
Df Model:	9		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
const	-414.2909	76.457	-5.419	0.000	-564.518	-264.064
rating	3.4965	11.775	0.297	0.767	-19.640	26.633
review_count	-0.0163	0.016	-1.041	0.299	-0.047	0.014
Refresh_Rate	1.0760	0.166	6.479	0.000	0.750	1.402
Contrast_Ratio	-2.833e-07	2.38e-07	-1.189	0.235	-7.51e-07	1.85e-07
Response_Time	9.3568	2.292	4.083	0.000	4.854	13.860
Brightness	0.3492	0.113	3.091	0.002	0.127	0.571
Screen_Size	7.5140	2.419	3.106	0.002	2.761	12.267
Weight	11.6788	2.214	5.276	0.000	7.329	16.028
Total_Pixels	4.313e-05	4.22e-06	10.215	0.000	3.48e-05	5.14e-05

Omnibus:	247.326	Durbin-Watson:	1.903
Prob(Omnibus):	0.000	Jarque-Bera (JB):	1674.416
Skew:	2.088	Prob(JB):	0.00
Kurtosis:	10.974	Cond. No.	3.70e+08

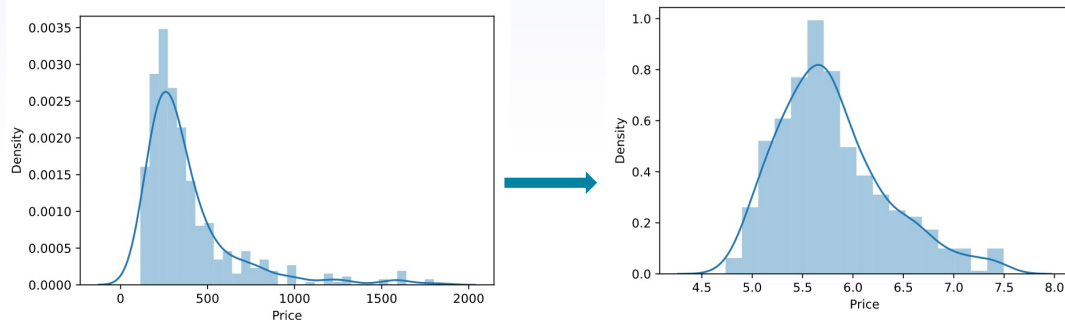
Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

[2] The condition number is large, 3.7e+08. This might indicate that there are strong multicollinearity or other numerical problems.

Feature Engineering(1)

- ▶ Drop insignificant features
- ▶ Log transformation on target
- ▶ Add polynomial terms & interaction terms



```
train_val_test(x,y)
```

```
train r score: 0.738
validation r score: 0.74
test r score: 0.664
```

R score improved but overfit

```
KFold3_cross_validation(x,y)
```

```
Regression scores: [0.69955686 0.71784872 0.63479348]
Mean cv r^2: 0.684 +- 0.036
```

```
KFold5_cross_validation(x,y)
```

```
Regression scores: [0.679269 0.72165913 0.73456801 0.56923704 0.66944311]
Mean cv r^2: 0.675 +- 0.058
```

Dep. Variable:	Log_Price	R-squared:	0.728
Model:	OLS	Adj. R-squared:	0.724
Method:	Least Squares	F-statistic:	163.3
Date:	Wed, 15 Jun 2022	Prob (F-statistic):	1.34e-132
Time:	00:32:22	Log-Likelihood:	-75.277
No. Observations:	496	AIC:	168.6
Df Residuals:	487	BIC:	206.4
Df Model:	8		

Covariance Type: nonrobust

	coef	std err	t	P> t	[0.025	0.975]
const	4.7329	0.183	25.831	0.000	4.373	5.093
Refresh_Rate	0.0022	0.000	8.461	0.000	0.002	0.003
Brightness	0.0035	0.001	5.795	0.000	0.002	0.005
Screen_Size	-0.0626	0.013	-4.887	0.000	-0.088	-0.037
Weight	0.0178	0.004	4.641	0.000	0.010	0.025
Total_Pixels	1.611e-07	4.3e-08	3.747	0.000	7.66e-08	2.46e-07
Screen_Size^2	0.0015	0.000	5.182	0.000	0.001	0.002
Brightness^2	-3.15e-06	6.2e-07	-5.078	0.000	-4.37e-06	-1.93e-06
Screen_Size*Pixel	-2.141e-09	1.46e-09	-1.471	0.142	-5e-09	7.18e-10

Omnibus:	16.772	Durbin-Watson:	1.958
Prob(Omnibus):	0.000	Jarque-Bera (JB):	17.659
Skew:	0.426	Prob(JB):	0.000146
Kurtosis:	3.359	Cond. No.	2.00e+09

Feature Engineering(2)

Add Dummies

```
train_val_test(x,y)
```

```
train r score: 0.851  
validation r score: 0.789  
test r score: 0.723
```

```
KFold3_cross_validation(x,y)
```

```
Regression scores: [0.74531605 0.72603497 0.73027329]  
Mean cv r^2: 0.734 +- 0.008
```

```
KFold5_cross_validation(x,y)
```

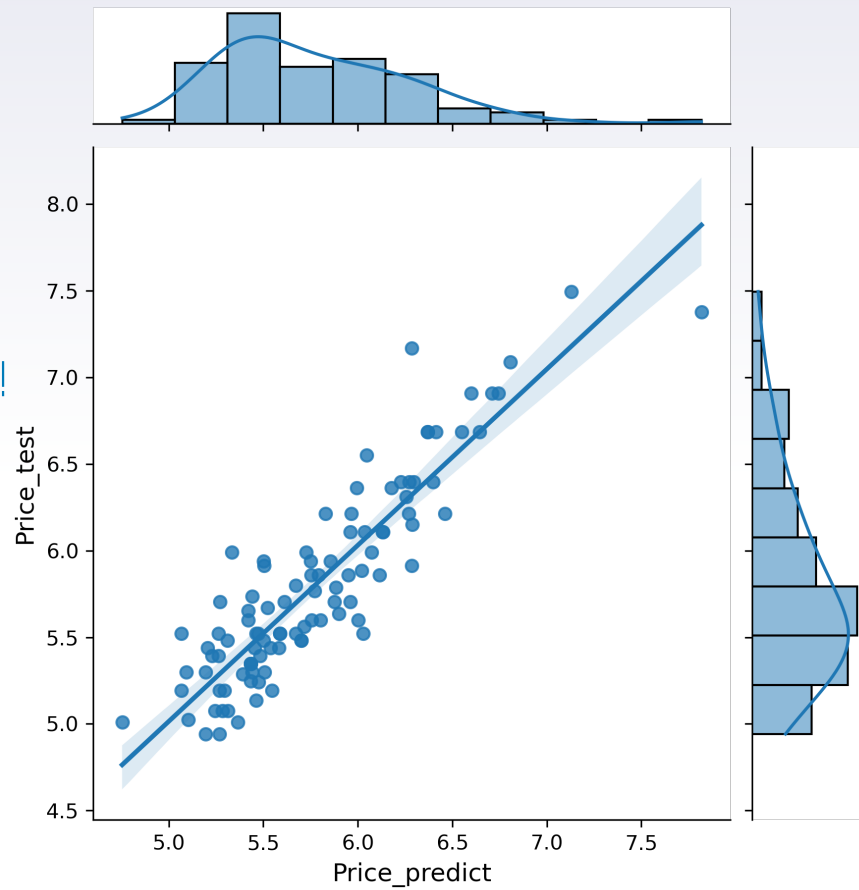
```
Regression scores: [0.78341605 0.66847107 0.82317504 0.66866058 0.75132861]  
Mean cv r^2: 0.739 +- 0.062
```

R score improved but overfit !

	coef	std err	t	P> t	[0.025	0.975]
const	4.6081	0.216	21.321	0.000	4.183	5.033
Refresh_Rate	0.0026	0.000	8.756	0.000	0.002	0.003
Brightness	0.0021	0.001	3.403	0.001	0.001	0.003
Screen_Size	-0.0388	0.014	-2.727	0.007	-0.067	-0.011
Weight	0.0136	0.004	3.754	0.000	0.006	0.021
Total_Pixels	1.485e-07	3.81e-08	3.900	0.000	7.37e-08	2.23e-07
Screen_Size^2	0.0011	0.000	3.985	0.000	0.001	0.002
Brightness^2	-1.89e-06	6.02e-07	-3.141	0.002	-3.07e-06	-7.08e-07
Screen_Size*Pixel	-1.814e-09	1.29e-09	-1.409	0.160	-4.34e-09	7.16e-10
brand_AOC	-0.0142	0.076	-0.186	0.852	-0.164	0.136
brand_AOPEN	-0.5466	0.241	-2.267	0.024	-1.020	-0.073
brand_ASUS	-0.0337	0.056	-0.599	0.549	-0.144	0.077
brand_Acer	-0.0013	0.062	-0.021	0.983	-0.123	0.121
brand_Alienware	0.1172	0.116	1.007	0.314	-0.112	0.346
brand_Asus	-0.0768	0.148	-0.520	0.604	-0.368	0.214
brand_BenQ	0.0338	0.069	0.493	0.622	-0.101	0.168
brand_CORSAIR	0.2168	0.181	1.196	0.232	-0.139	0.573
brand_Dell	0.1042	0.065	1.613	0.107	-0.023	0.231
brand_DoubleSight	-0.1649	0.213	-0.773	0.440	-0.585	0.255
brand_Element	-0.1474	0.142	-1.039	0.299	-0.426	0.131
brand_GIGABYTE	-0.0423	0.074	-0.572	0.568	-0.188	0.103
brand_Geek	0.1410	0.240	0.586	0.558	-0.331	0.613
brand_HP	0.1949	0.070	2.788	0.006	0.057	0.332
brand_LG	0.1402	0.051	2.741	0.006	0.040	0.241
brand_Lenovo	0.1035	0.064	1.615	0.107	-0.022	0.229
brand_MSI	0.0414	0.091	0.455	0.650	-0.137	0.220
brand_NHT	0.5028	0.254	1.978	0.049	0.003	1.002
brand_Philips	-0.0052	0.095	-0.055	0.956	-0.192	0.182
brand_Razer	0.3868	0.163	2.371	0.018	0.066	0.707
brand_SideTrak	0.4274	0.140	3.061	0.002	0.153	0.702
brand_VIOTEX	0.0436	0.241	0.181	0.856	-0.429	0.516
brand_ViewSonic	0.0087	0.068	0.127	0.899	-0.126	0.143
brand_Viewsonic	0.1078	0.261	0.412	0.680	-0.406	0.622
brand_Viotek	-0.1676	0.117	-1.435	0.152	-0.397	0.062
Synchronization_Technology_FreeSync	-0.0619	0.031	-2.014	0.045	-0.122	-0.001
Synchronization_Technology_FreeSync&G-SYNC	0.0329	0.054	0.603	0.547	-0.074	0.140
Synchronization_Technology_G-SYNC	0.1071	0.060	1.779	0.076	-0.011	0.225
Synchronization_Technology_G-SYNC&VSync	0.4593	0.179	2.560	0.011	0.107	0.812
Synchronization_Technology_VSync	0.0150	0.093	0.161	0.872	-0.168	0.198
Panel_Type_IPS	0.1582	0.045	3.506	0.001	0.070	0.247
Panel_Type_MVA	0.0556	0.087	0.639	0.523	-0.115	0.226
Panel_Type_PLS	-0.2104	0.242	-0.868	0.386	-0.687	0.266
Panel_Type_TFT	0.2052	0.113	1.819	0.070	-0.017	0.427
Panel_Type_TN	-0.1001	0.065	-1.543	0.124	-0.227	0.027
Panel_Type_VA	-0.1086	0.051	-2.122	0.034	-0.209	-0.008
Curved_Screen_Yes	0.2777	0.040	6.868	0.000	0.198	0.357
HDR_Yes	0.0621	0.032	1.925	0.055	-0.001	0.125
Smart_Display_Yes	-0.1060	0.115	-0.924	0.356	-0.331	0.119
Touch_Screen_Yes	0.3544	0.131	2.699	0.007	0.096	0.612
Quantum_Dot_Technology_Yes	0.1825	0.080	2.277	0.023	0.025	0.340
Headphone_Jack_Yes	-0.1139	0.029	-3.882	0.000	-0.172	-0.056
Voice_Assistant_Yes	0.0918	0.098	0.941	0.347	-0.100	0.283
Wall_Mountable_Yes	-0.0546	0.035	-1.579	0.115	-0.123	0.013
Anti_Glare_Yes	-0.0731	0.036	-2.028	0.043	-0.144	-0.002
Speaker_Yes	0.0949	0.029	3.266	0.001	0.038	0.152
Webcam_Yes	0.1127	0.065	1.730	0.084	-0.015	0.241

Regularization

- ▶ Elastic Net Regression Wins !
- ▶ R score: train 0.816; test 0.815
- ▶ R-square improves & no longer overfit !



► Important Features

Refresh Rate: 0.150

Brightness: 0.167

Weight: 0.121

Total Pixels: 0.202

Screen_Size^2: 0.219

Note in my final Elastic Net Regression, neither target and features are original data.

Target is log price AND features reflect standard deviation from the mean of the feature data.

Ex: Refresh Rate: 0.150

$\text{Exp}(0.150) = 0.0058$



Future Work

- ▶ Deeper dive into multicollinearity problem
- ▶ Test data on other website's monitor such as microcenter.com