Predicting Opening Weekend Box Office Performance

From IMDB Search Frequency of Principal Cast Members

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Agenda

1. Project Objective
2. Data Overview
3. Key Features
4. Exploratory Data Analysis
5. Feature Engineering
6. Modeling Box Office Sales
7. Conclusion & Next Steps

1

Project Objective

Defining Project Goals

The Problem Statement

- How much does casting affect the hype surrounding a movie's release?
- Evaluate the impact of cast popularity on opening weekend box office ticket sales.

STALLONE STATHAM LI LUNDGREN NORRIS CREWS COUTURE
HEMSWORTH ALSO VAN DAMME WITH WILLIS AND SCHWARZENEGGER
THE EXPENDABLES 2
16
BACK FOR WAR

2
Data Overview

Scraping and Cleaning from Data Sources

2014 ~ 2017

4 years of box office data

994

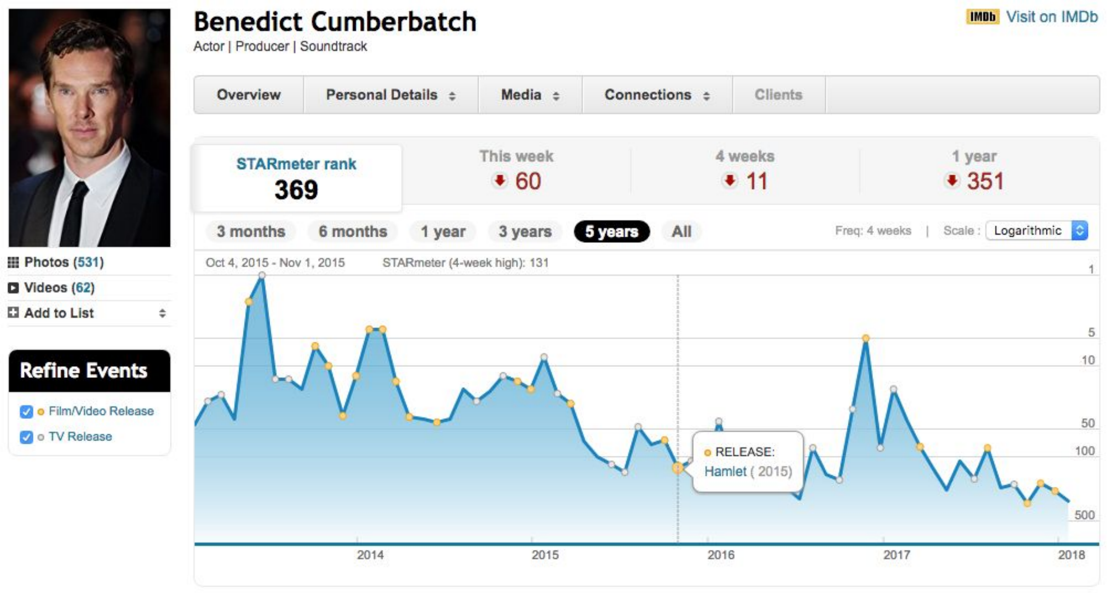
Movies available w/ box office data

8

Total features for model (raw)

- IMDB
  - Release Date
  - Opening Weekend Gross
  - Metacritic / IMDB Reviews
  - Genre
  - MPAA Rating
  - Principal Cast
- IMDB Pro
  - STARmeter Data (next slide)
  - Number Theaters

IMDB Pro’s STARmeter



Benedict Cumberbatch

Actor | Producer | Soundtrack

STARmeter rank 369

This week ↓ 60

4 weeks ↓ 11

1 year ↓ 351

Freq: 4 weeks | Scale : Logarithmic

Oct 4, 2015 - Nov 1, 2015 STARmeter (4-week high): 131

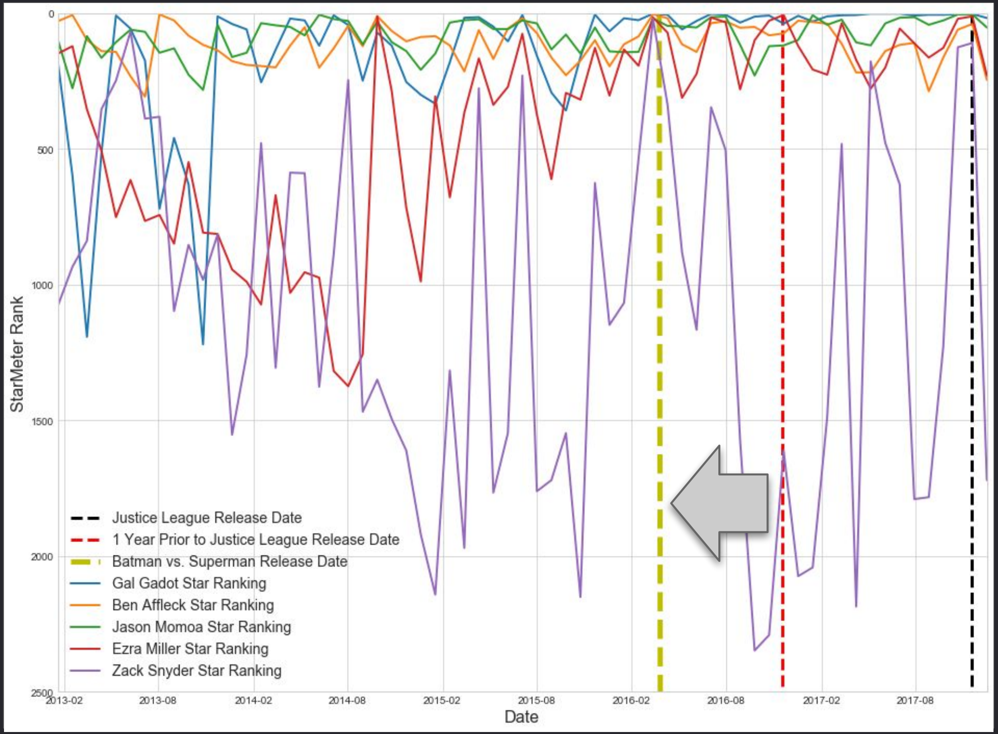
RELEASE: Hamlet (2015)

- Cast / Crew ranking based on IMDB search frequency
- Presented as time series data
- Scraped via Python / Selenium

3
Key Features

From IMDB Pro

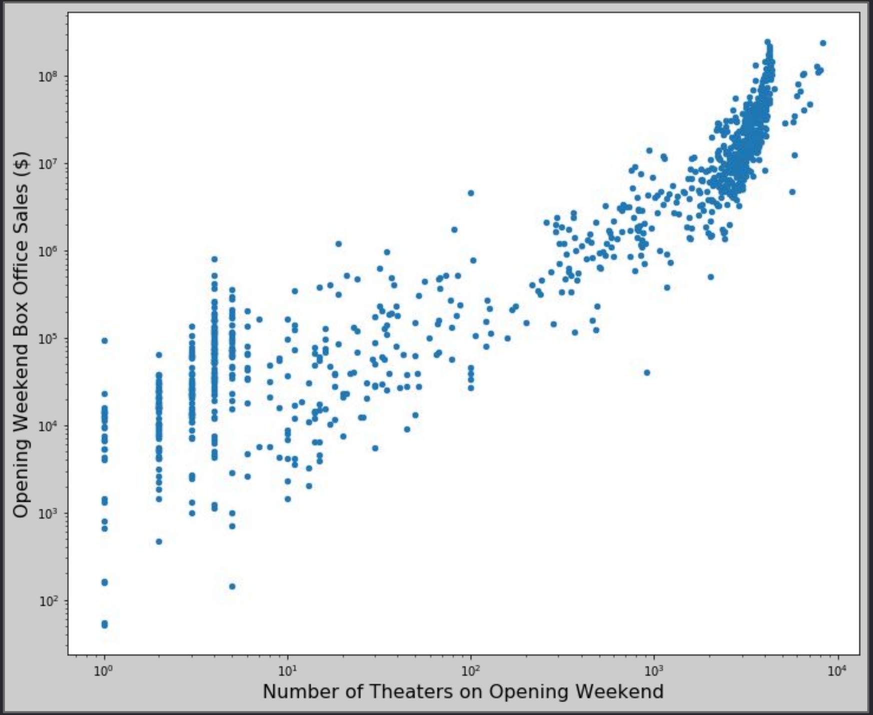
Using IMDB Pro's StarMeter Data



- Feature defined as minimum star ranking prior to 12 months before release date.

- A film's "Star Power" is based on average of top 5 star rankings

Opening Weekend Gross per Theater



- Number of theaters is highly correlated with overall opening weekend gross

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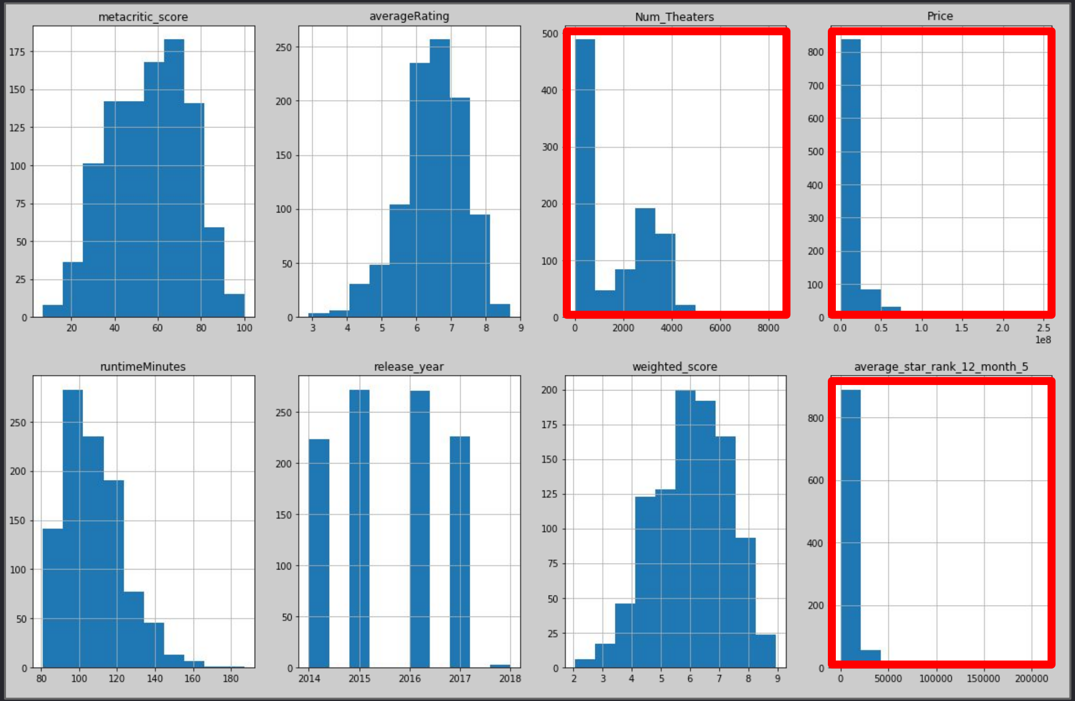
Data Analysis

Exploring the Data

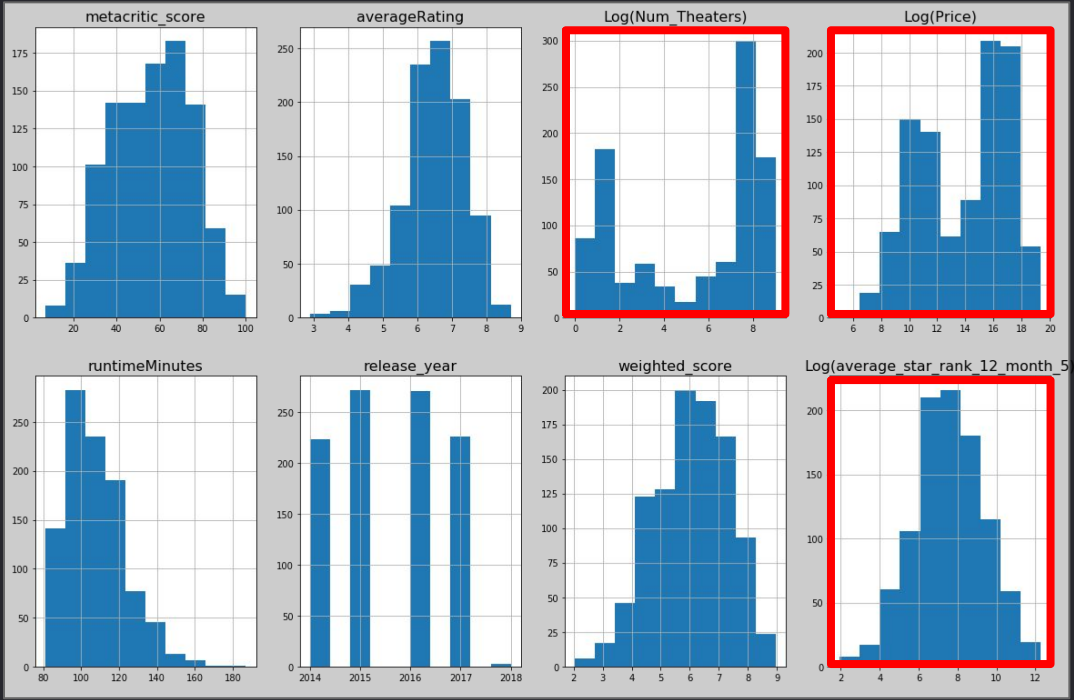
Continuous Features



- All continuous features should have normal distribution.

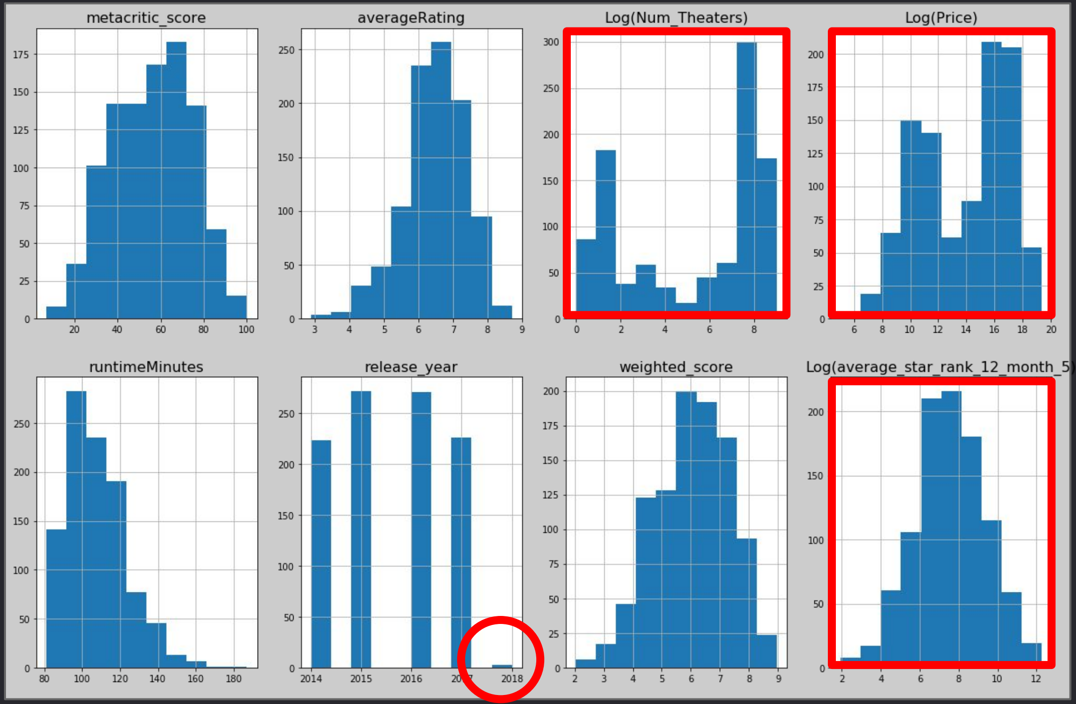
- Issues:
  - Opening Weekend Gross
  - Number of Theaters
  - Star Power

Continuous Features



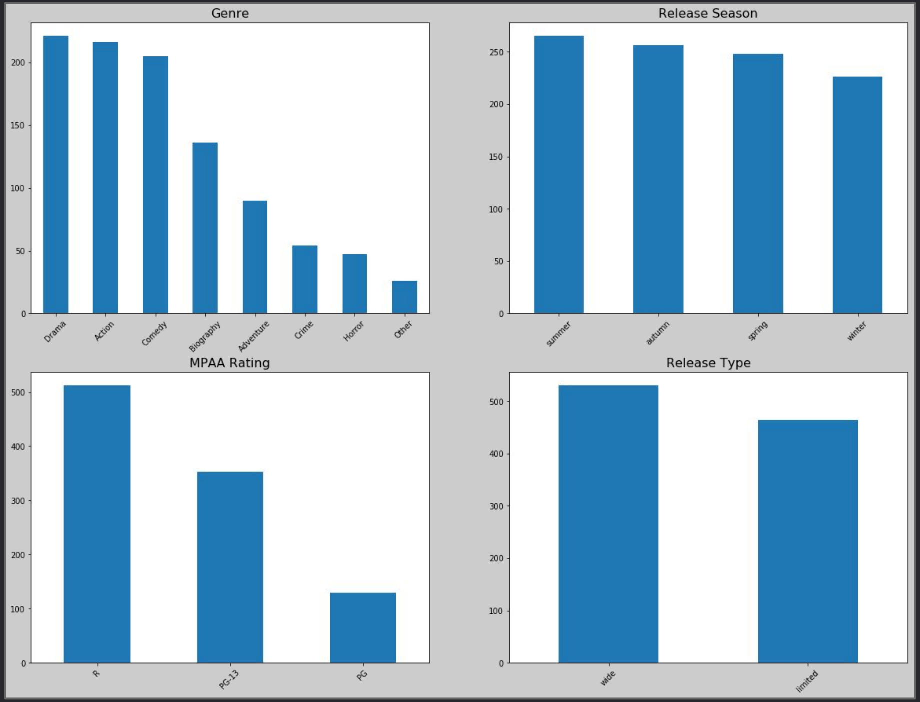
- All continuous features should have normal distribution.
- Logarithmic transform applied to skewed data.

Continuous Features



- All continuous features should have normal distribution.
- Logarithmic transform applied to skewed data.
- Removed all 2018 data points

Categorical Features



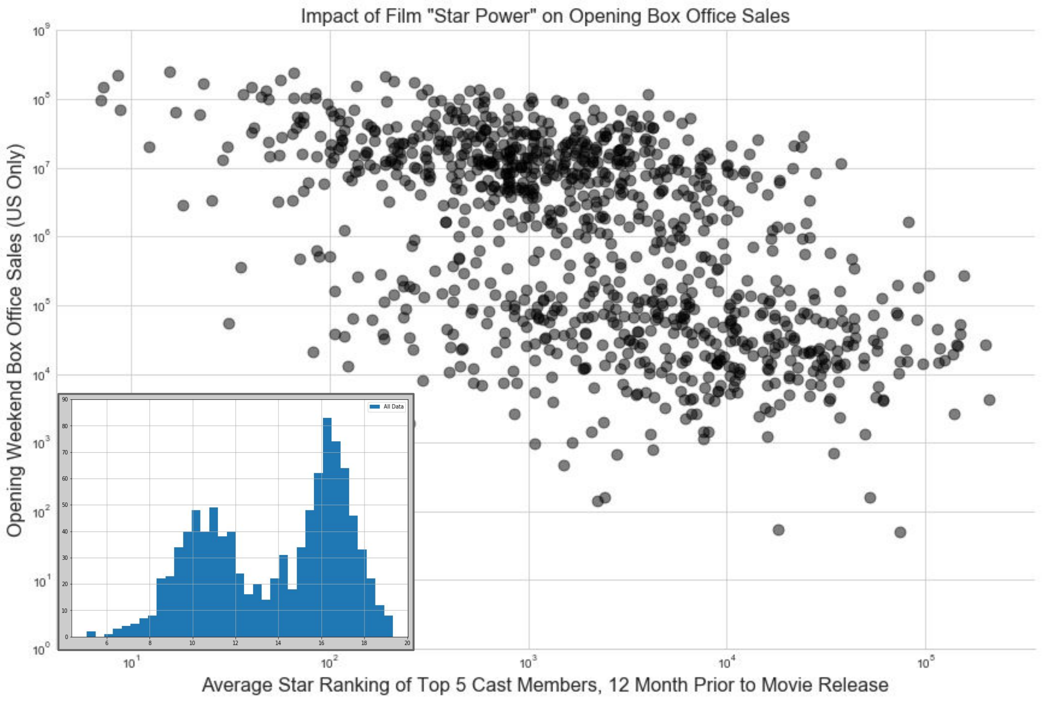
- Movie Genres
  (Action, Drama, Comedy, etc.)
- Release Season
  (Spring, Summer, Autumn, Winter)
- MPAA Rating
  (PG, PG-13, R)
- Film Release Type
  (Wide vs. Limited)

5
Feature Engineering

Modifying Model Features

Star Power

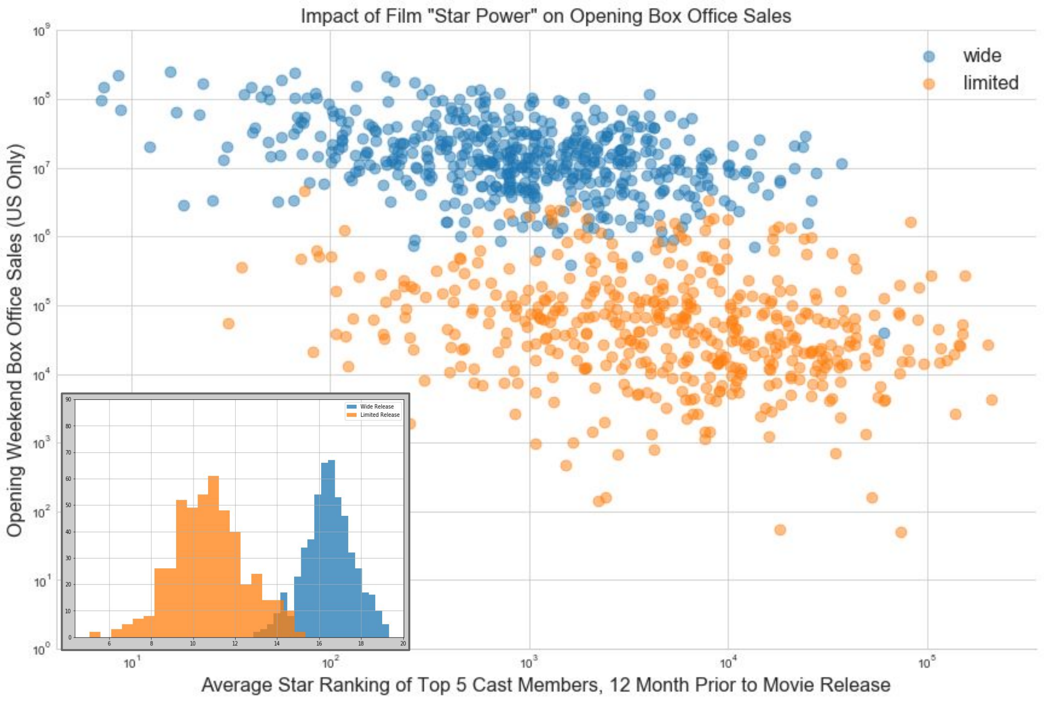
- Opening Weekend Gross vs. Star Ranking alone does not show a clear linear relationship.



Star Power

- Opening Weekend Gross vs. Star Ranking alone does not show a clear linear relationship.

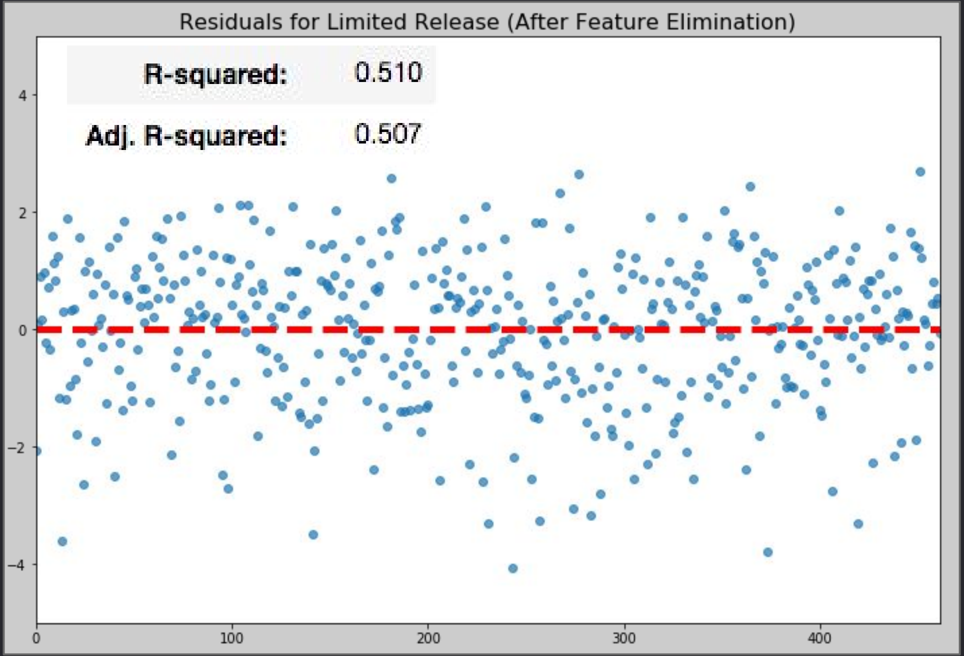
- “Limited Release”: # Theaters < 600



6
Modeling Box Office Sales

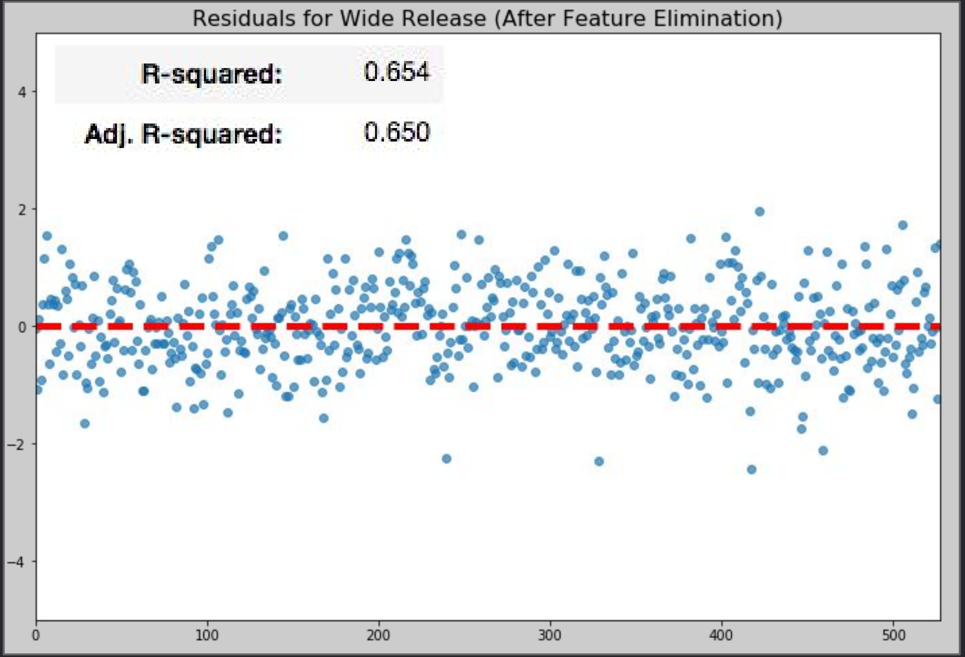
Final Model Results

Limited Release - Feature Selection



- Model trained on all data.
- Features selected based on individual p-values.
- Remaining features:
  - Num_Theaters
  - Runtime_Minutes
  - Star_Power

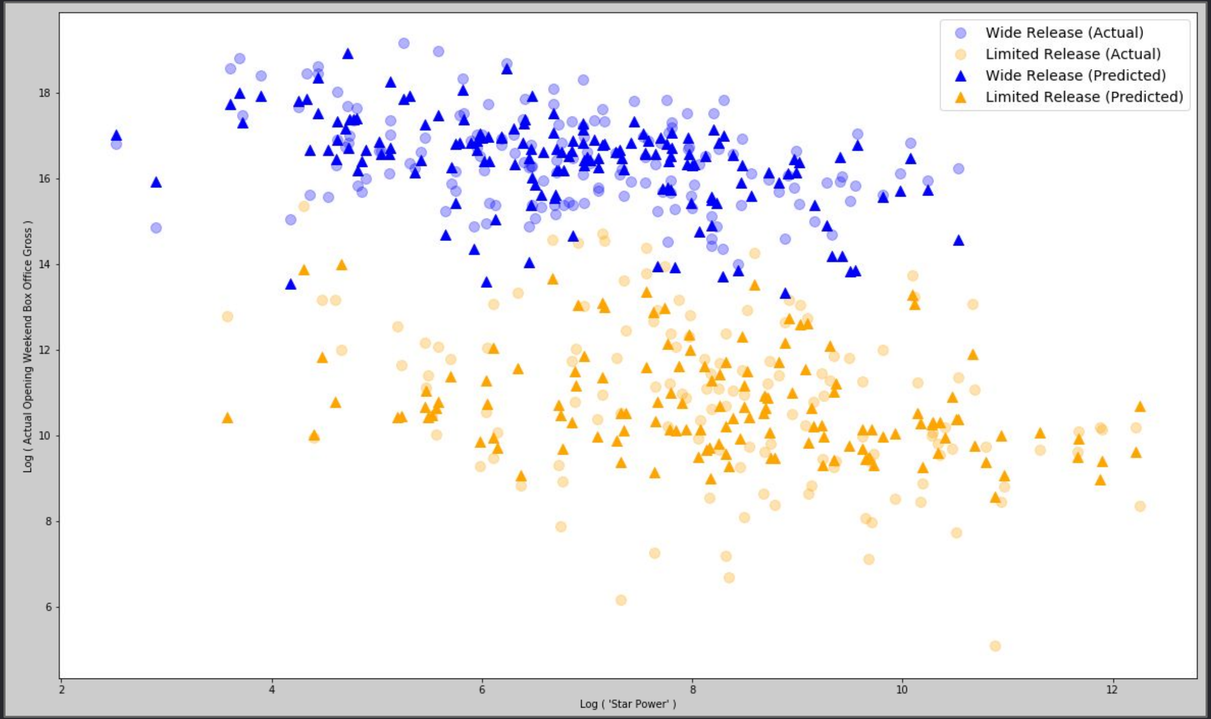
Wide Release - Feature Selection



- Model trained on all data.
- Features selected based on individual p-values.
- Remaining features:
  - Num_Theaters
  - Runtime_Minutes
  - Star_Power
  - Release_Year
  - Rated_R
  - Release_in_Spring

Predicted vs. Actual Opening Weekend Gross

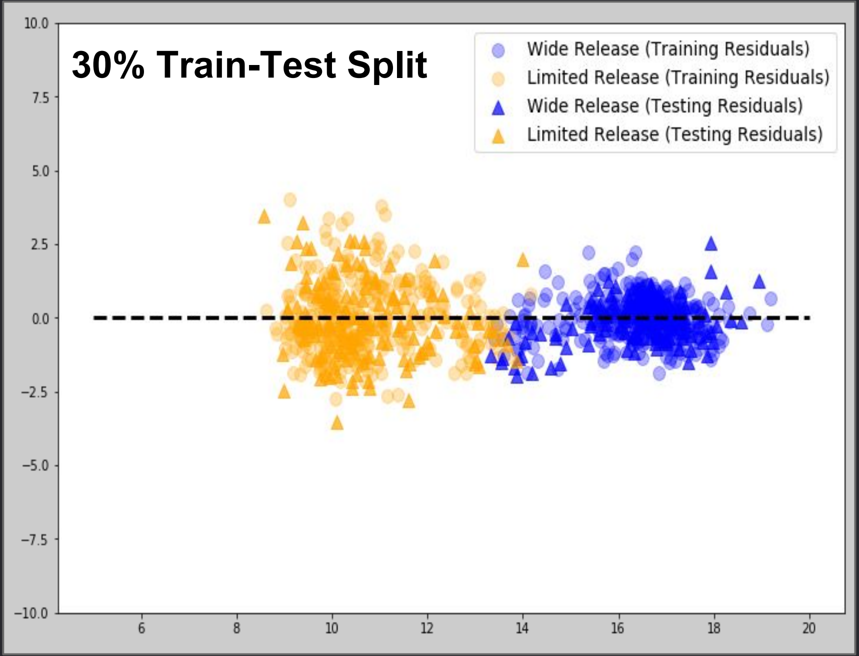
- 70-30 random train-test split
- Test data shown
- Predicted results within expected range



Residuals for Train/Test Split

- Model trained 70% of data, and validated on remaining 30%.
- Cross-Validation score aligns with observed results.

Regression Model	5-Fold Cross-Validation R^2 Score
All Data (Base)	0.16
Limited Release	0.49
Wide Release	0.64



Applying Predictive Model

- 2018 Opening Weekend Box Office Predictions

Movie Title	Release Date	Predicted Gross	Actual Gross	Release Type	% Error
The Post	2018-01-12	$19,783,540	$19,887,979	wide	-0.53 %
Paddington 2	2018-01-12	$18,109,110	$11,001,961	wide	64.60 %

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Conclusion

And Next Steps

Conclusions

Results

- "Star Power" is a factor in predicting opening weekend box office performance.
- Splitting data into two models proved effective.
- Genre removed as feature

Next Steps

- New features to consider:
  - Box office competition
  - Is Sequel?
    (Title/Brand recognition)
  - Other metrics for cast / crew popularity
    (Google Trends, Twitter)

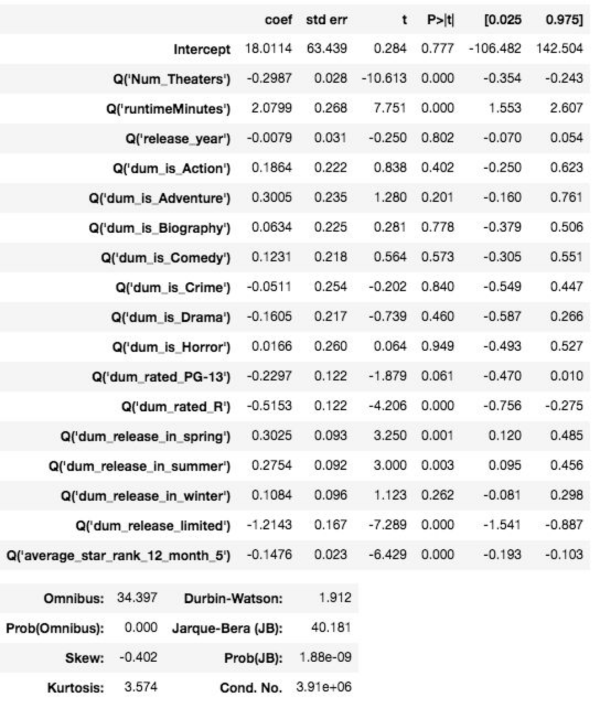
THANKS!

ANY QUESTIONS?

Scraping IMDB Pro’s StarMeter

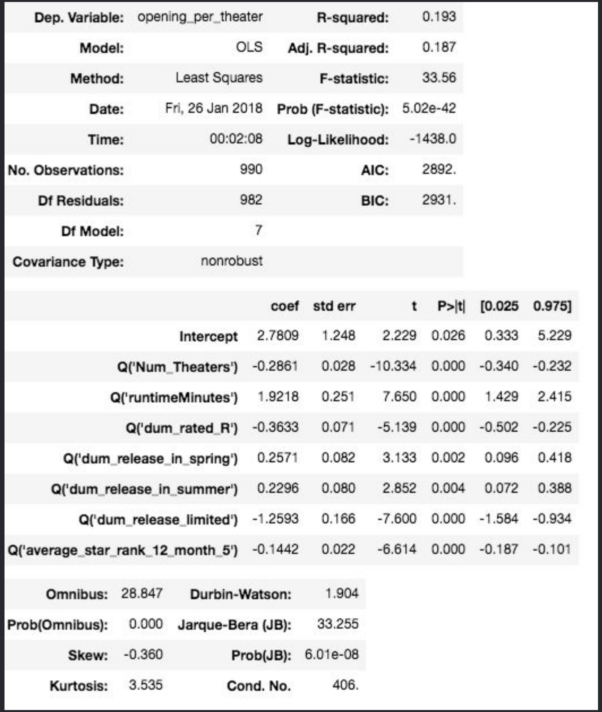
- Visualization uses JavaScript SVG Element
- Scraping using Selenium

All Data - Feature Elimination



	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	18.0114	63.439	0.284	0.777	-106.482	142.504
Q('Num_Theaters')	-0.2987	0.028	-10.613	0.000	-0.354	-0.243
Q('runtimeMinutes')	2.0799	0.268	7.751	0.000	1.553	2.607
Q('release_year')	-0.0079	0.031	-0.250	0.802	-0.070	0.054
Q('dum_is_Action')	0.1864	0.222	0.838	0.402	-0.250	0.623
Q('dum_is_Adventure')	0.3005	0.235	1.280	0.201	-0.160	0.761
Q('dum_is_Biography')	0.0634	0.225	0.281	0.778	-0.379	0.506
Q('dum_is_Comedy')	0.1231	0.218	0.564	0.573	-0.305	0.551
Q('dum_is_Crime')	-0.0511	0.254	-0.202	0.840	-0.549	0.447
Q('dum_is_Drama')	-0.1605	0.217	-0.739	0.460	-0.587	0.266
Q('dum_is_Horror')	0.0166	0.260	0.064	0.949	-0.493	0.527
Q('dum_rated_PG-13')	-0.2297	0.122	-1.879	0.061	-0.470	0.010
Q('dum_rated_R')	-0.5153	0.122	-4.206	0.000	-0.756	-0.275
Q('dum_release_in_spring')	0.3025	0.093	3.250	0.001	0.120	0.485
Q('dum_release_in_summer')	0.2754	0.092	3.000	0.003	0.095	0.456
Q('dum_release_in_winter')	0.1084	0.096	1.123	0.262	-0.081	0.298
Q('dum_release_limited')	-1.2143	0.167	-7.289	0.000	-1.541	-0.887
Q('average_star_rank_12_month_5')	-0.1476	0.023	-6.429	0.000	-0.193	-0.103

Omnibus:	34.397	Durbin-Watson:	1.912
Prob(Omnibus):	0.000	Jarque-Bera (JB):	40.181
Skew:	-0.402	Prob(JB):	1.88e-09
Kurtosis:	3.574	Cond. No.	3.91e+06

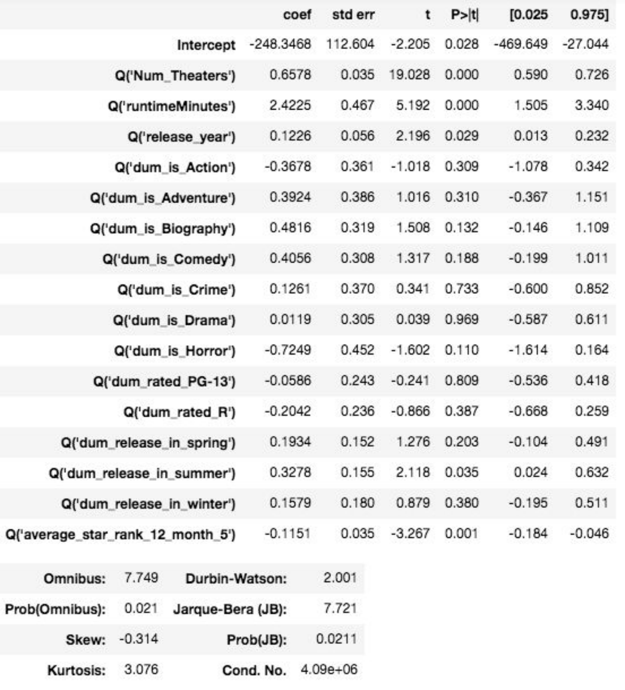


Dep. Variable:	opening_per_theater	R-squared:	0.193
Model:	OLS	Adj. R-squared:	0.187
Method:	Least Squares	F-statistic:	33.56
Date:	Fri, 26 Jan 2018	Prob (F-statistic):	5.02e-42
Time:	00:02:08	Log-Likelihood:	-1438.0
No. Observations:	990	AIC:	2892.
Df Residuals:	982	BIC:	2931.
Df Model:	7		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	2.7809	1.248	2.229	0.026	0.333	5.229
Q('Num_Theaters')	-0.2861	0.028	-10.334	0.000	-0.340	-0.232
Q('runtimeMinutes')	1.9218	0.251	7.650	0.000	1.429	2.415
Q('dum_rated_R')	-0.3633	0.071	-5.139	0.000	-0.502	-0.225
Q('dum_release_in_spring')	0.2571	0.082	3.133	0.002	0.096	0.418
Q('dum_release_in_summer')	0.2296	0.080	2.852	0.004	0.072	0.388
Q('dum_release_limited')	-1.2593	0.166	-7.600	0.000	-1.584	-0.934
Q('average_star_rank_12_month_5')	-0.1442	0.022	-6.614	0.000	-0.187	-0.101

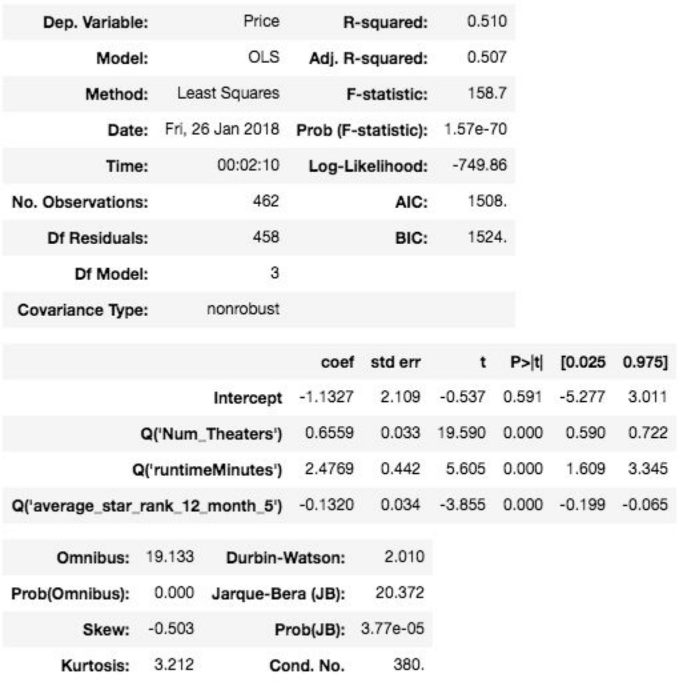
Omnibus:	28.847	Durbin-Watson:	1.904
Prob(Omnibus):	0.000	Jarque-Bera (JB):	33.255
Skew:	-0.360	Prob(JB):	6.01e-08
Kurtosis:	3.535	Cond. No.	406.

Limited Release - Feature Elimination



	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-248.3468	112.604	-2.205	0.028	-469.649	-27.044
Q('Num_Theaters')	0.6578	0.035	19.028	0.000	0.590	0.726
Q('runtimeMinutes')	2.4225	0.467	5.192	0.000	1.505	3.340
Q('release_year')	0.1226	0.056	2.196	0.029	0.013	0.232
Q('dum_is_Action')	-0.3678	0.361	-1.018	0.309	-1.078	0.342
Q('dum_is_Adventure')	0.3924	0.386	1.016	0.310	-0.367	1.151
Q('dum_is_Biography')	0.4816	0.319	1.508	0.132	-0.146	1.109
Q('dum_is_Comedy')	0.4056	0.308	1.317	0.188	-0.199	1.011
Q('dum_is_Crime')	0.1261	0.370	0.341	0.733	-0.600	0.852
Q('dum_is_Drama')	0.0119	0.305	0.039	0.969	-0.587	0.611
Q('dum_is_Horror')	-0.7249	0.452	-1.602	0.110	-1.614	0.164
Q('dum_rated_PG-13')	-0.0586	0.243	-0.241	0.809	-0.536	0.418
Q('dum_rated_R')	-0.2042	0.236	-0.866	0.387	-0.668	0.259
Q('dum_release_in_spring')	0.1934	0.152	1.276	0.203	-0.104	0.491
Q('dum_release_in_summer')	0.3278	0.155	2.118	0.035	0.024	0.632
Q('dum_release_in_winter')	0.1579	0.180	0.879	0.380	-0.195	0.511
Q('average_star_rank_12_month_5')	-0.1151	0.035	-3.267	0.001	-0.184	-0.046

Omnibus:	7.749	Durbin-Watson:	2.001
Prob(Omnibus):	0.021	Jarque-Bera (JB):	7.721
Skew:	-0.314	Prob(JB):	0.0211
Kurtosis:	3.076	Cond. No.	4.09e+06

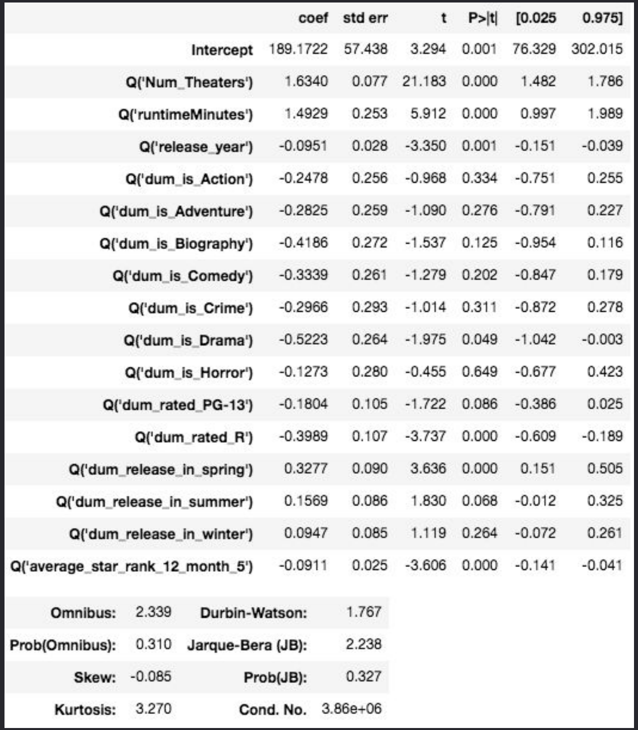


Dep. Variable:	Price	R-squared:	0.510
Model:	OLS	Adj. R-squared:	0.507
Method:	Least Squares	F-statistic:	158.7
Date:	Fri, 26 Jan 2018	Prob (F-statistic):	1.57e-70
Time:	00:02:10	Log-Likelihood:	-749.86
No. Observations:	462	AIC:	1508.
Df Residuals:	458	BIC:	1524.
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-1.1327	2.109	-0.537	0.591	-5.277	3.011
Q('Num_Theaters')	0.6559	0.033	19.590	0.000	0.590	0.722
Q('runtimeMinutes')	2.4769	0.442	5.605	0.000	1.609	3.345
Q('average_star_rank_12_month_5')	-0.1320	0.034	-3.855	0.000	-0.199	-0.065

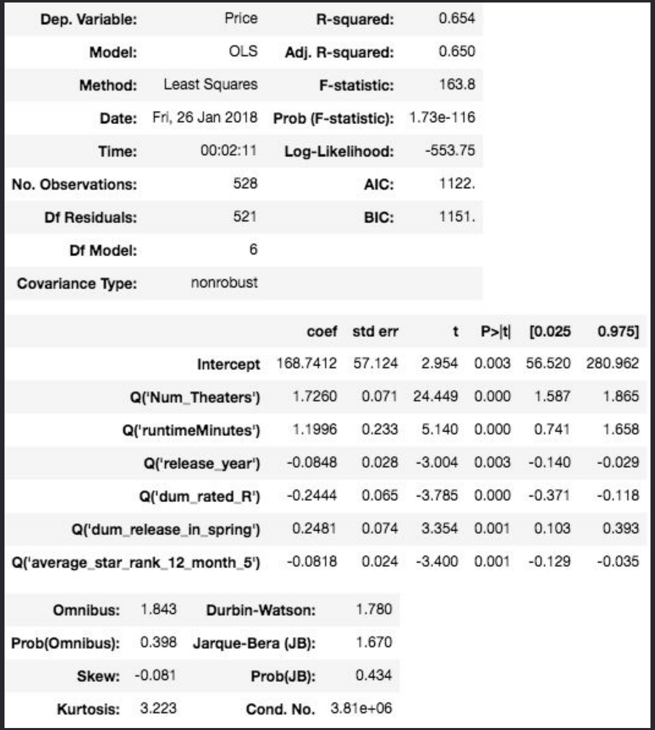
Omnibus:	19.133	Durbin-Watson:	2.010
Prob(Omnibus):	0.000	Jarque-Bera (JB):	20.372
Skew:	-0.503	Prob(JB):	3.77e-05
Kurtosis:	3.212	Cond. No.	380.

Wide Release - Feature Elimination



	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	189.1722	57.438	3.294	0.001	76.329	302.015
Q('Num_Theaters')	1.6340	0.077	21.183	0.000	1.482	1.786
Q('runtimeMinutes')	1.4929	0.253	5.912	0.000	0.997	1.989
Q('release_year')	-0.0951	0.028	-3.350	0.001	-0.151	-0.039
Q('dum_is_Action')	-0.2478	0.256	-0.968	0.334	-0.751	0.255
Q('dum_is_Adventure')	-0.2825	0.259	-1.090	0.276	-0.791	0.227
Q('dum_is_Biography')	-0.4186	0.272	-1.537	0.125	-0.954	0.116
Q('dum_is_Comedy')	-0.3339	0.261	-1.279	0.202	-0.847	0.179
Q('dum_is_Crime')	-0.2966	0.293	-1.014	0.311	-0.872	0.278
Q('dum_is_Drama')	-0.5223	0.264	-1.975	0.049	-1.042	-0.003
Q('dum_is_Horror')	-0.1273	0.280	-0.455	0.649	-0.677	0.423
Q('dum_rated_PG-13')	-0.1804	0.105	-1.722	0.086	-0.386	0.025
Q('dum_rated_R')	-0.3989	0.107	-3.737	0.000	-0.609	-0.189
Q('dum_release_in_spring')	0.3277	0.090	3.636	0.000	0.151	0.505
Q('dum_release_in_summer')	0.1569	0.086	1.830	0.068	-0.012	0.325
Q('dum_release_in_winter')	0.0947	0.085	1.119	0.264	-0.072	0.261
Q('average_star_rank_12_month_5')	-0.0911	0.025	-3.606	0.000	-0.141	-0.041

Omnibus:	2.339	Durbin-Watson:	1.767
Prob(Omnibus):	0.310	Jarque-Bera (JB):	2.238
Skew:	-0.085	Prob(JB):	0.327
Kurtosis:	3.270	Cond. No.	3.86e+06



Dep. Variable:	Price	R-squared:	0.654
Model:	OLS	Adj. R-squared:	0.650
Method:	Least Squares	F-statistic:	163.8
Date:	Fri, 26 Jan 2018	Prob (F-statistic):	1.73e-116
Time:	00:02:11	Log-Likelihood:	-553.75
No. Observations:	528	AIC:	1122.
Df Residuals:	521	BIC:	1151.
Df Model:	6		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	168.7412	57.124	2.954	0.003	56.520	280.962
Q('Num_Theaters')	1.7260	0.071	24.449	0.000	1.587	1.865
Q('runtimeMinutes')	1.1996	0.233	5.140	0.000	0.741	1.658
Q('release_year')	-0.0848	0.028	-3.004	0.003	-0.140	-0.029
Q('dum_rated_R')	-0.2444	0.065	-3.785	0.000	-0.371	-0.118
Q('dum_release_in_spring')	0.2481	0.074	3.354	0.001	0.103	0.393
Q('average_star_rank_12_month_5')	-0.0818	0.024	-3.400	0.001	-0.129	-0.035

Omnibus:	1.843	Durbin-Watson:	1.780
Prob(Omnibus):	0.398	Jarque-Bera (JB):	1.670
Skew:	-0.081	Prob(JB):	0.434
Kurtosis:	3.223	Cond. No.	3.81e+06