Explaining IMDb Ratings by Actor and Director Characteristics

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2018-02-02

The Question

Can we explain movie rating by actor and director characteristics, leaving out details about the contents of the movie (genre, topic, title, etc.)?

The More Interesting Question

In particular, how does actor **diversity** fit in?

The Data

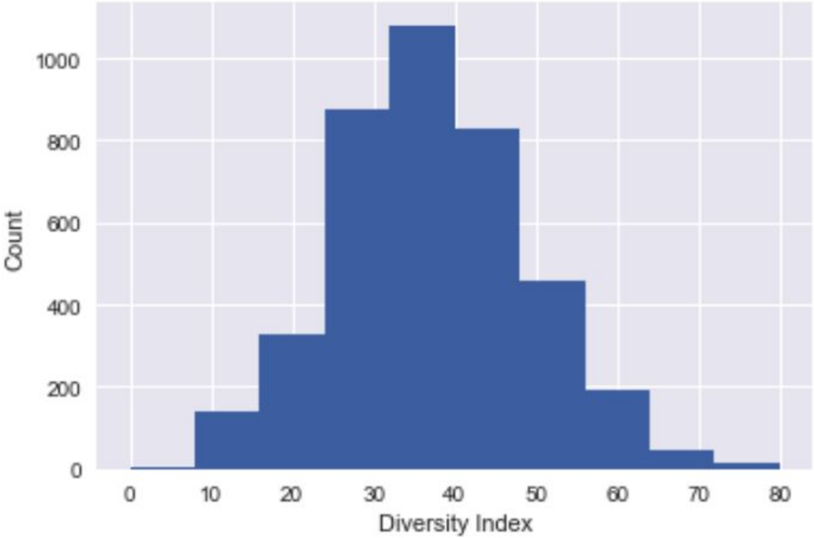
- Source: IMDb
- Selection: United States, 1990 - 2018, > 500 Votes
- Actor Characteristics
  - Acting Roles and Other Roles
  - Media Presence
  - Award Wins and Nominations
  - *Gender*
  - *Birth Country*
  - *Age at Time of Release*
- Director Characteristics
  - Directing Roles and Other Roles
  - Media Presence
  - Award Wins and Nominations

The Diversity Index

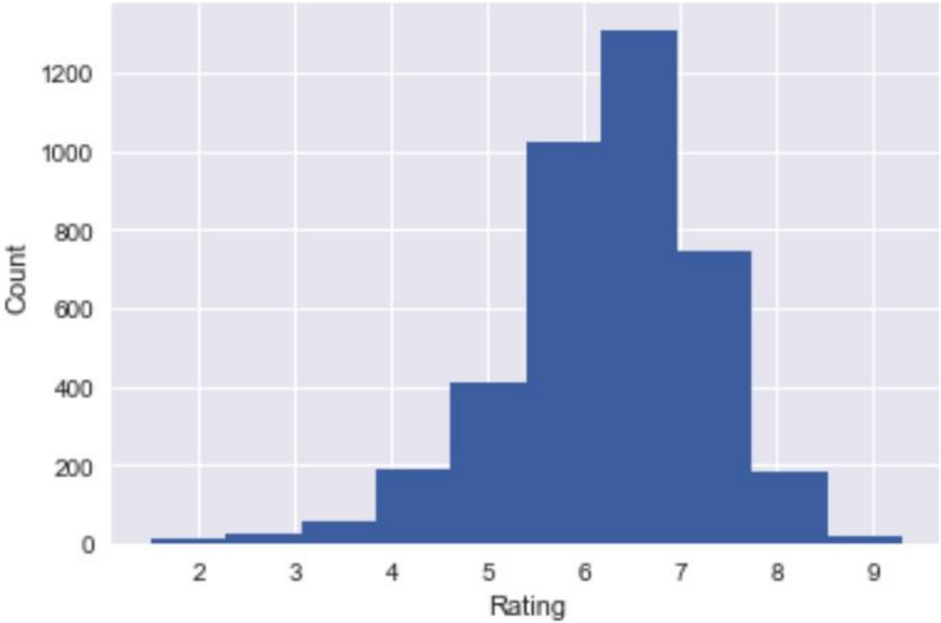
Composite of:

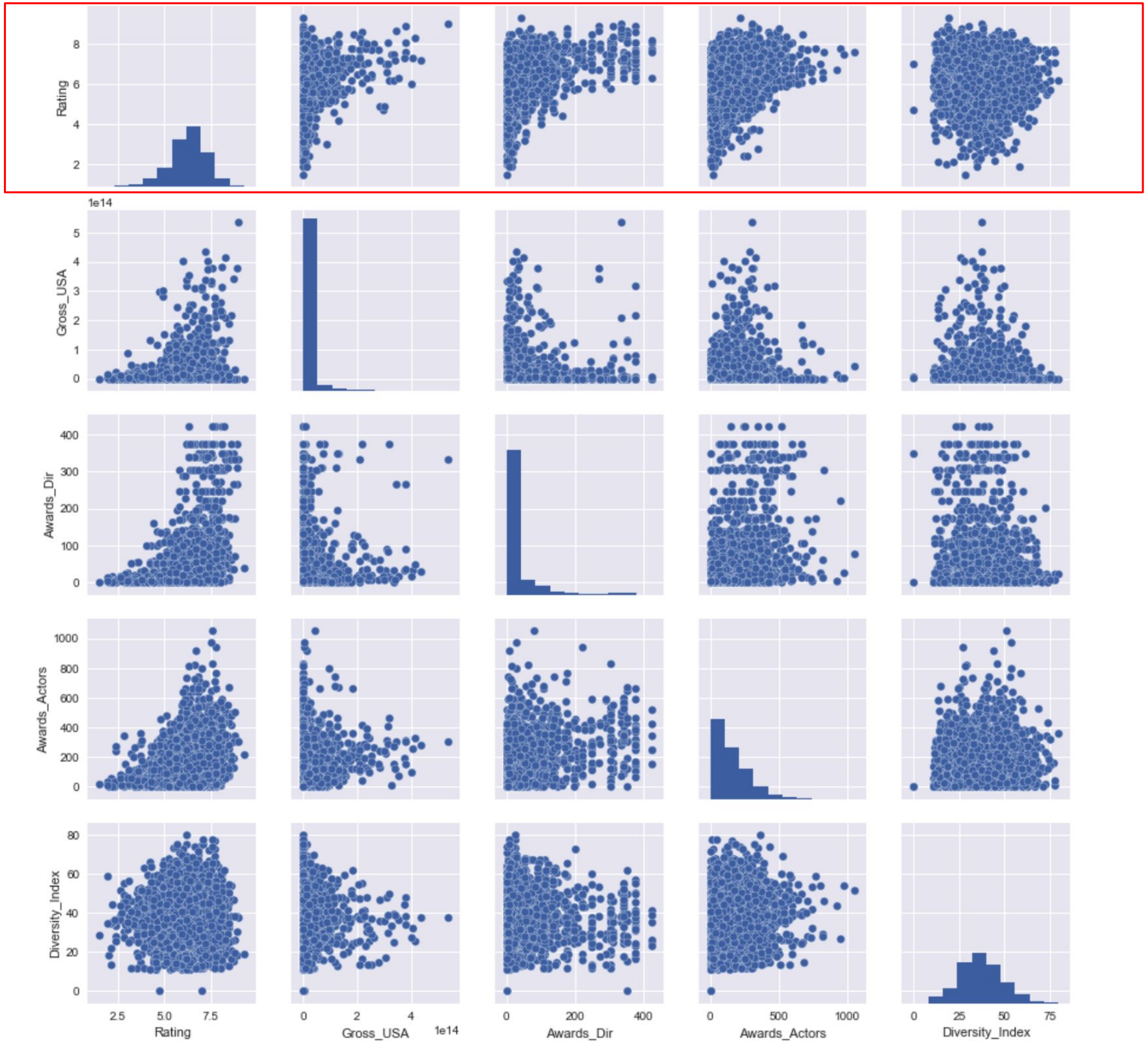
- Share of Female Actors
- Difference in Birth Countries among Actors
- Age Spread among Actors

The Diversity Index (spread)

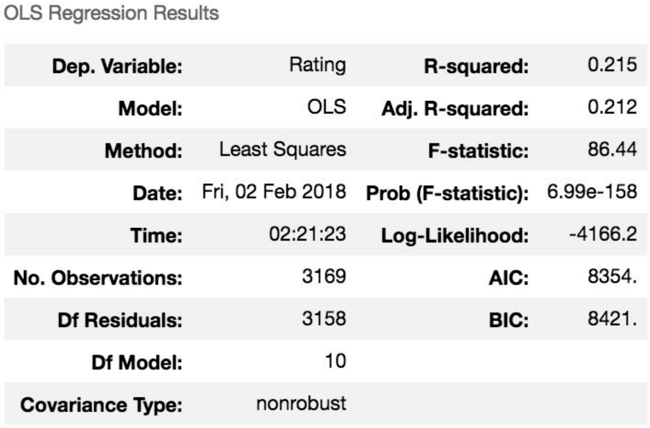


The Ratings



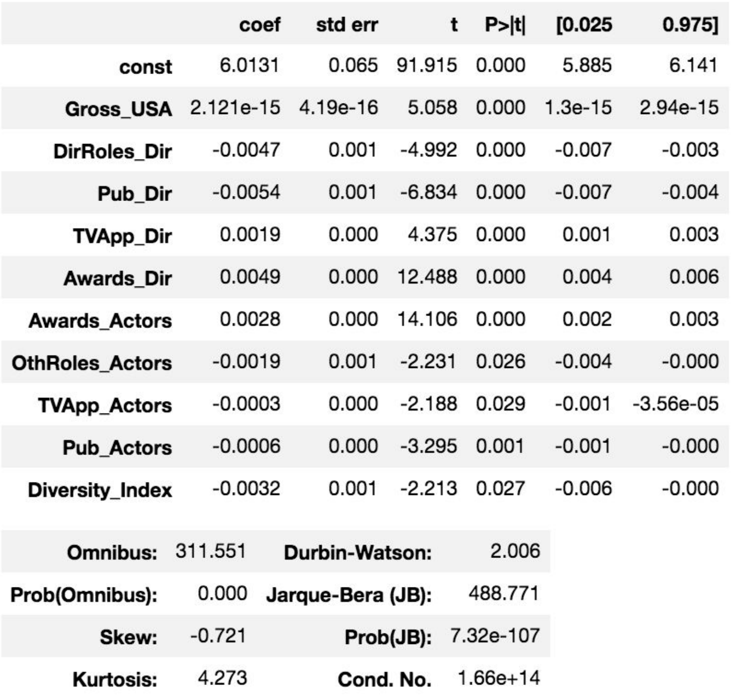

Rating
8
6
4
2
1e14
Gross_USA
5
4
3
2
1
0
Awards_Dir
400
300
200
100
0
Awards_Actors
1000
800
600
400
200
0
Diversity_Index
80
60
40
20
0
2.5
5.0
7.5
Rating
0
2
4
Gross_USA
1e14
0
200
400
Awards_Dir
0
500
1000
Awards_Actors
0
25
50
75
Diversity_Index

Feature and Model Selection



OLS Regression Results

Dep. Variable:	Rating	**R-squared:**	0.215
Model:	OLS	**Adj. R-squared:**	0.212
Method:	Least Squares	**F-statistic:**	86.44
Date:	Fri, 02 Feb 2018	**Prob (F-statistic):**	6.99e-158
Time:	02:21:23	**Log-Likelihood:**	-4166.2
No. Observations:	3169	**AIC:**	8354.
Df Residuals:	3158	**BIC:**	8421.
Df Model:	10		
Covariance Type:	nonrobust		



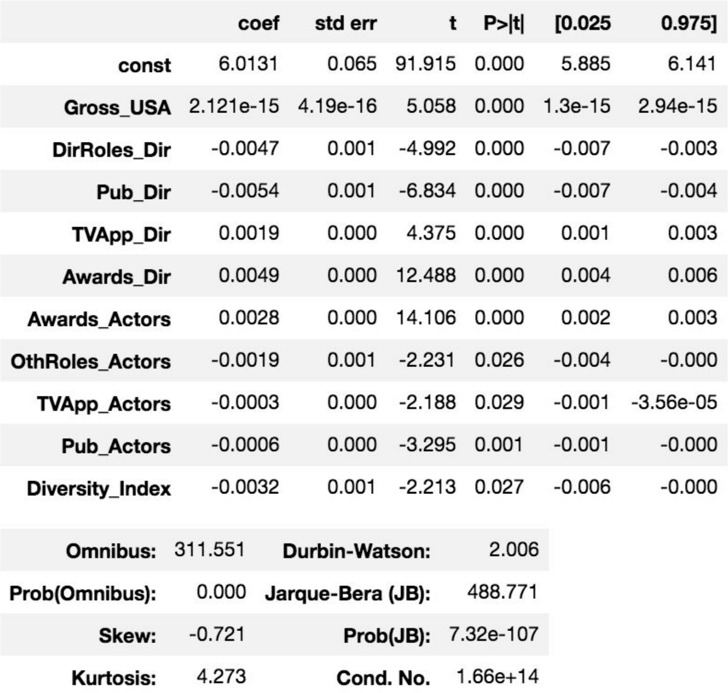
	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
const	6.0131	0.065	91.915	0.000	5.885	6.141
Gross_USA	2.121e-15	4.19e-16	5.058	0.000	1.3e-15	2.94e-15
DirRoles_Dir	-0.0047	0.001	-4.992	0.000	-0.007	-0.003
Pub_Dir	-0.0054	0.001	-6.834	0.000	-0.007	-0.004
TVApp_Dir	0.0019	0.000	4.375	0.000	0.001	0.003
Awards_Dir	0.0049	0.000	12.488	0.000	0.004	0.006
Awards_Actors	0.0028	0.000	14.106	0.000	0.002	0.003
OthRoles_Actors	-0.0019	0.001	-2.231	0.026	-0.004	-0.000
TVApp_Actors	-0.0003	0.000	-2.188	0.029	-0.001	-3.56e-05
Pub_Actors	-0.0006	0.000	-3.295	0.001	-0.001	-0.000
Diversity_Index	-0.0032	0.001	-2.213	0.027	-0.006	-0.000

Omnibus:	311.551	**Durbin-Watson:**	2.006
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	488.771
Skew:	-0.721	**Prob(JB):**	7.32e-107
Kurtosis:	4.273	**Cond. No.**	1.66e+14

Feature and Model Selection

Things to note:

- Negative Coefficient for Diversity
- Positive Coefficients for Actor and Director Awards



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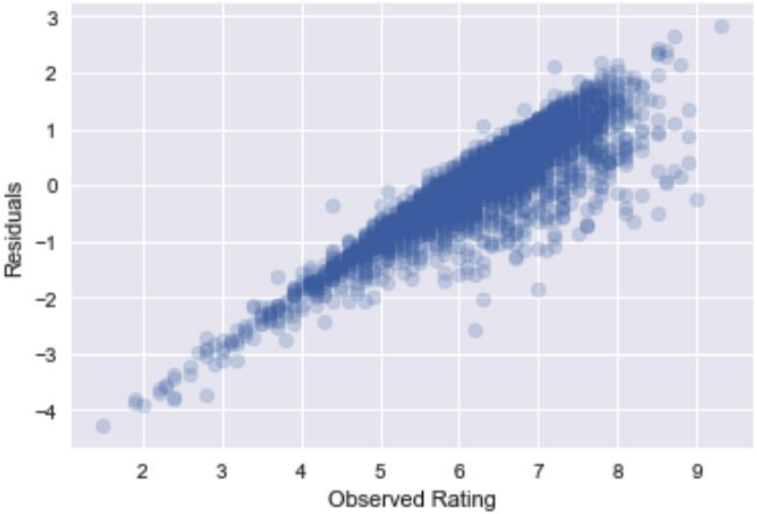
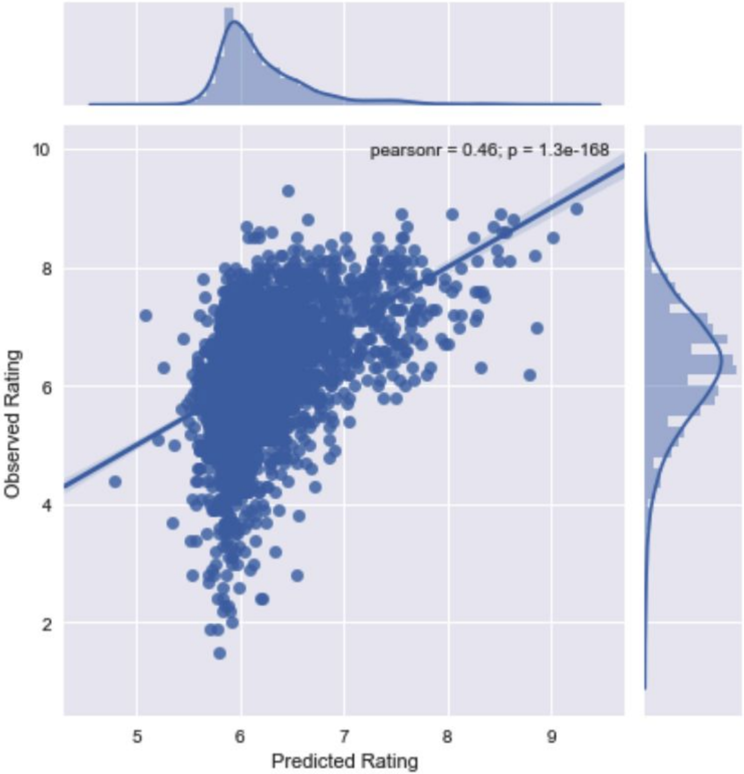
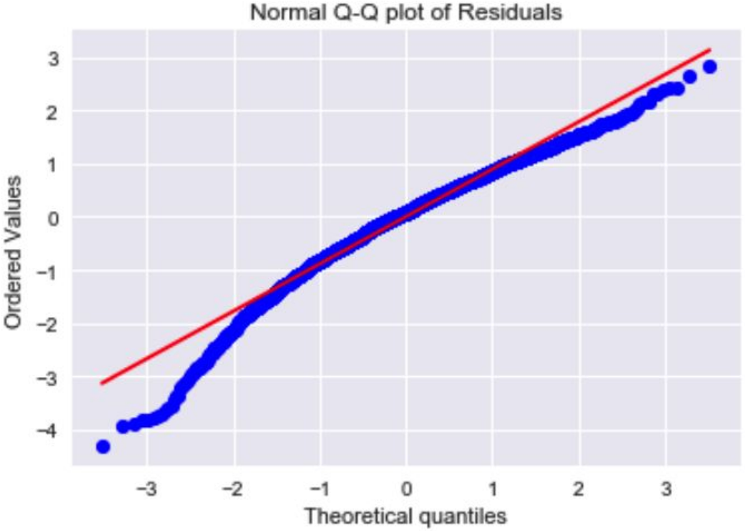
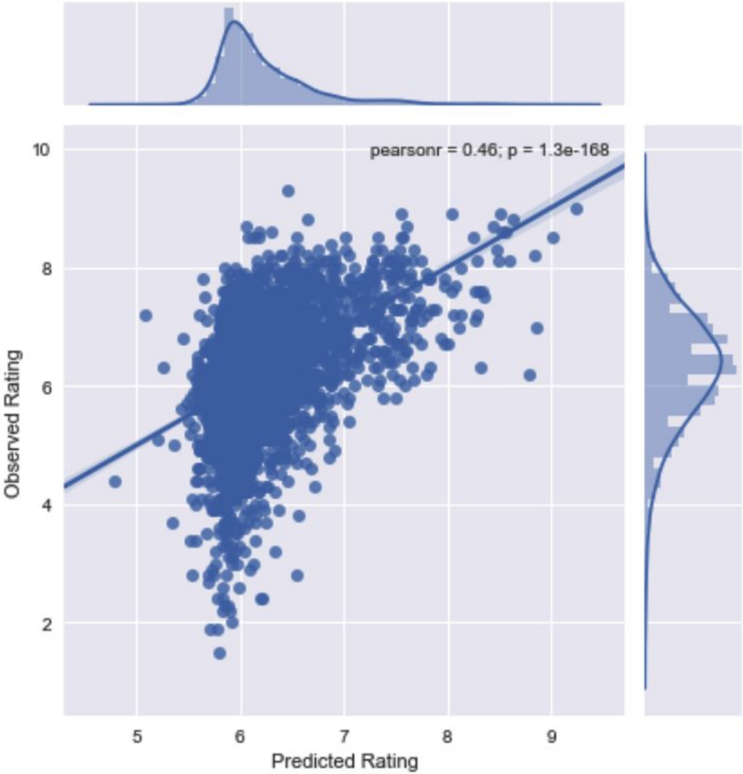


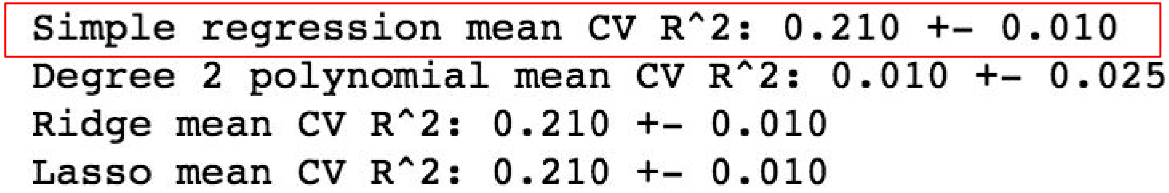


Feature and Model Selection

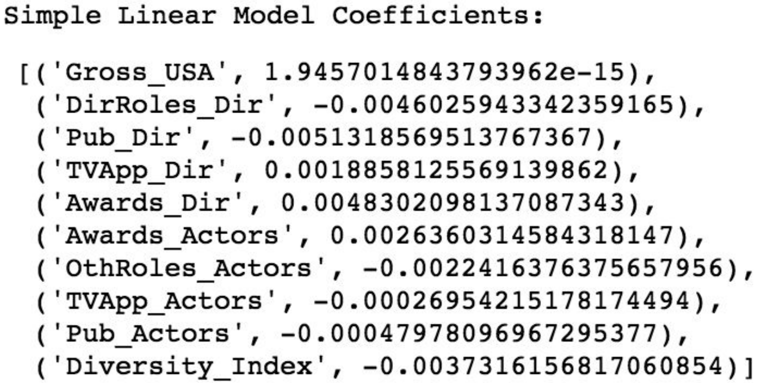




The Preliminary Results



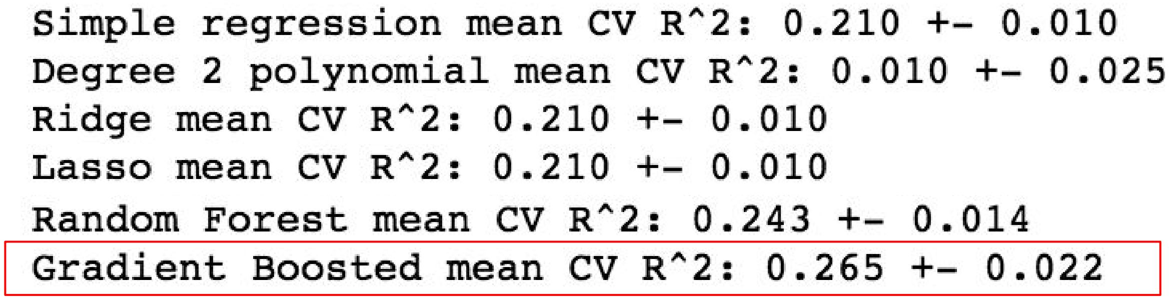
```
Simple regression mean CV R^2: 0.210 +- 0.010
Degree 2 polynomial mean CV R^2: 0.010 +- 0.025
Ridge mean CV R^2: 0.210 +- 0.010
Lasso mean CV R^2: 0.210 +- 0.010
```



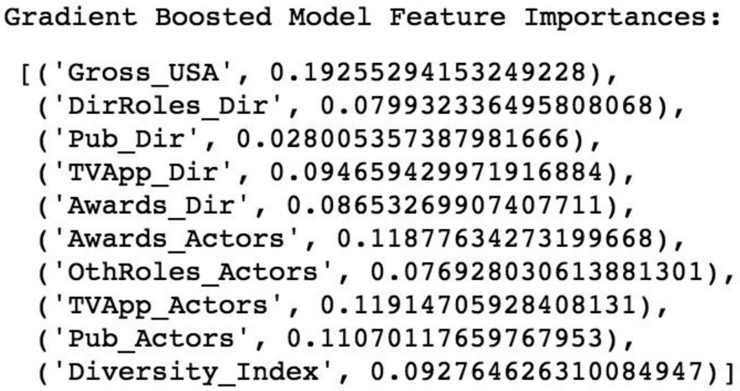
```
Simple Linear Model Coefficients:

 [('Gross_USA', 1.9457014843793962e-15),
  ('DirRoles_Dir', -0.0046025943342359165),
  ('Pub_Dir', -0.0051318569513767367),
  ('TVApp_Dir', 0.0018858125569139862),
  ('Awards_Dir', 0.0048302098137087343),
  ('Awards_Actors', 0.0026360314584318147),
  ('OthRoles_Actors', -0.0022416376375657956),
  ('TVApp_Actors', -0.00026954215178174494),
  ('Pub_Actors', -0.00047978096967295377),
  ('Diversity_Index', -0.0037316156817060854)]
```

The Preliminary Results



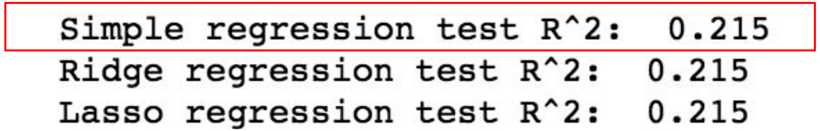
```
Simple regression mean CV R^2: 0.210 +- 0.010
Degree 2 polynomial mean CV R^2: 0.010 +- 0.025
Ridge mean CV R^2: 0.210 +- 0.010
Lasso mean CV R^2: 0.210 +- 0.010
Random Forest mean CV R^2: 0.243 +- 0.014
Gradient Boosted mean CV R^2: 0.265 +- 0.022
```



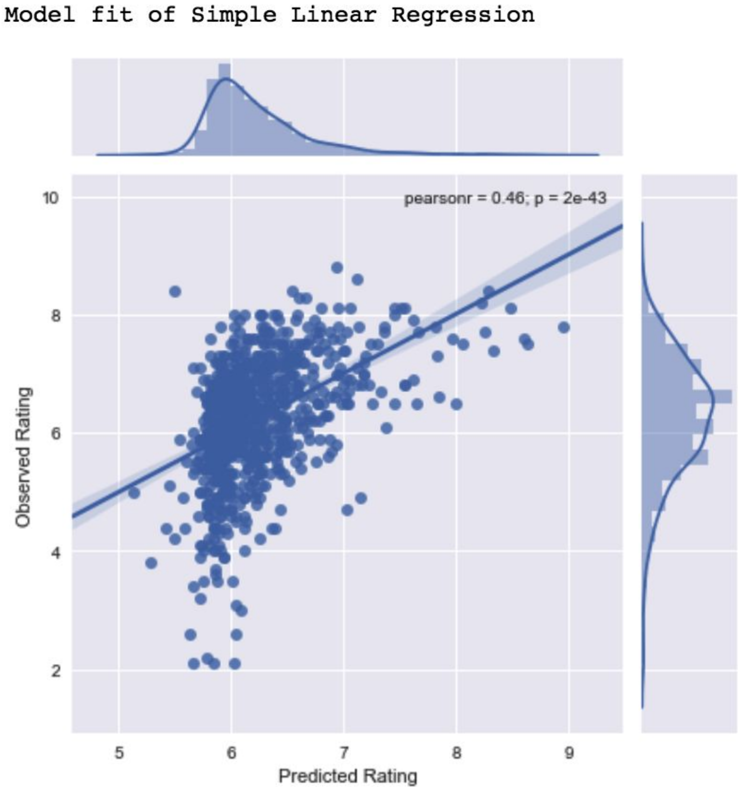
```
Gradient Boosted Model Feature Importances:

 [('Gross_USA', 0.19255294153249228),
  ('DirRoles_Dir', 0.07993233649580806 8),
  ('Pub_Dir', 0.028005357387981666),
  ('TVApp_Dir', 0.094659429971916884),
  ('Awards_Dir', 0.08653269907407711),
  ('Awards_Actors', 0.11877634273199668),
  ('OthRoles_Actors', 0.076928030613881301),
  ('TVApp_Actors', 0.11914705928408131),
  ('Pub_Actors', 0.11070117659767953),
  ('Diversity_Index', 0.092764626310084947)]
```

The Test Results

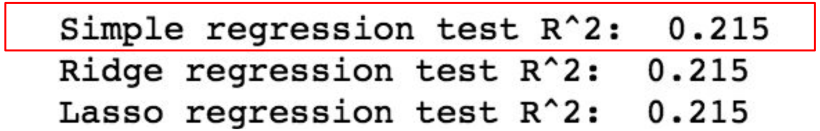


```
Simple regression test R^2:   0.215
Ridge regression test R^2:   0.215
Lasso regression test R^2:   0.215
```



Model fit of Simple Linear Regression

The Test Results



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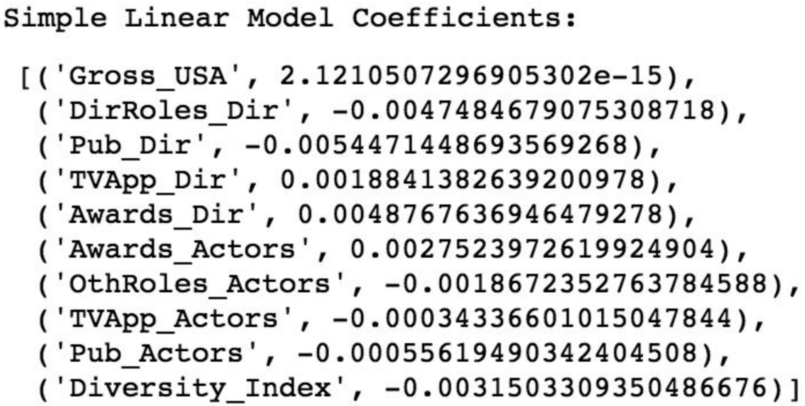


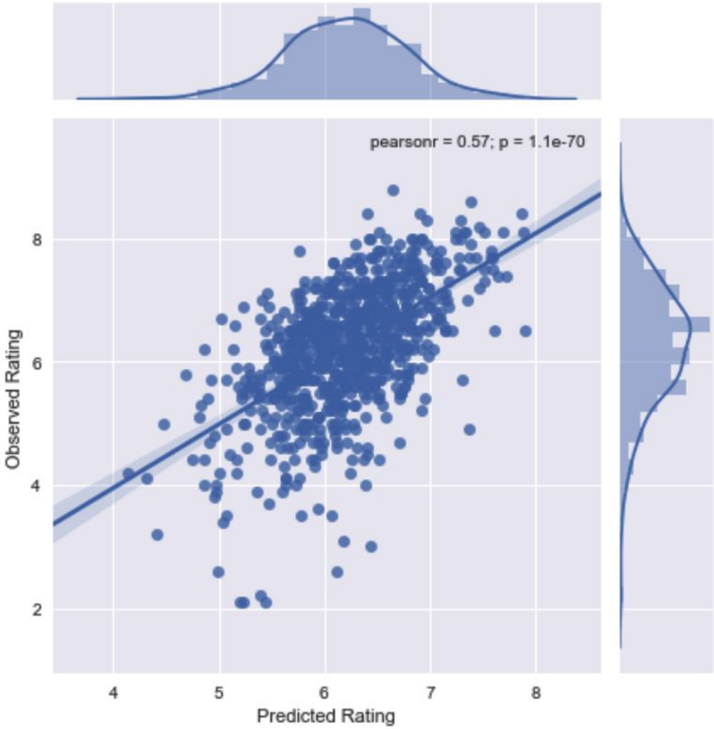
```
Simple Linear Model Coefficients:

 [('Gross_USA', 2.1210507296905302e-15),
  ('DirRoles_Dir', -0.004748467907530871 8),
  ('Pub_Dir', -0.0054471448693569268),
  ('TVApp_Dir', 0.0018841382639200978),
  ('Awards_Dir', 0.0048767636946479278),
  ('Awards_Actors', 0.0027523972619924904),
  ('OthRoles_Actors', -0.0018672352763784588),
  ('TVApp_Actors', -0.0003433660101504784 4),
  ('Pub_Actors', -0.0005561949034240450 8),
  ('Diversity_Index', -0.0031503309350486676)]
```

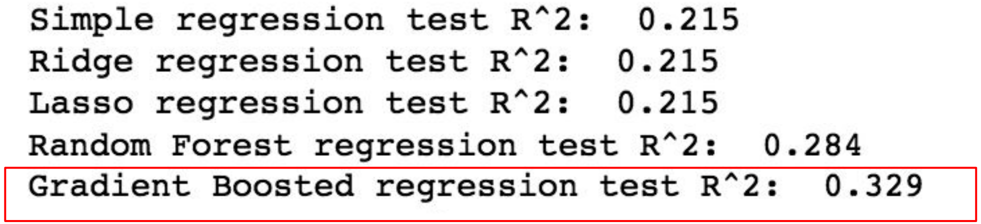
The Test Results

```
Simple regression test R^2:  0.215
Ridge regression test R^2:  0.215
Lasso regression test R^2:  0.215
Random Forest regression test R^2:  0.284
Gradient Boosted regression test R^2:  0.329
```

Model fit of Gradient Boosted Regression



The Test Results



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Ridge regression test R^2:  0.215
Lasso regression test R^2:  0.215
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Gradient Boosted regression test R^2:  0.329
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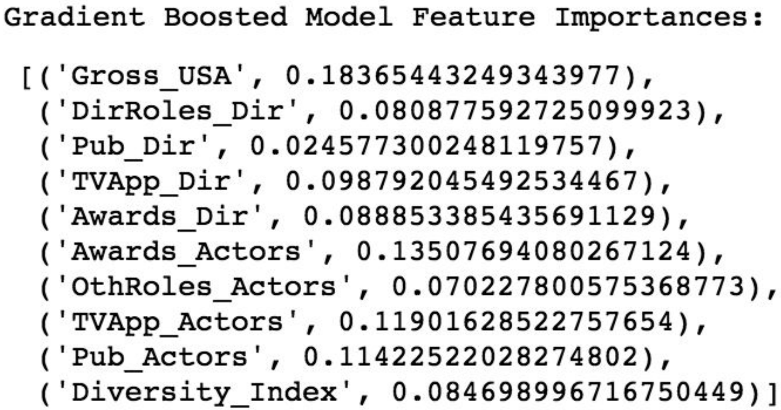

```
Gradient Boosted Model Feature Importances:

 [('Gross_USA', 0.18365443249343977),
  ('DirRoles_Dir', 0.08087759272509923),
  ('Pub_Dir', 0.024577300248119757),
  ('TVApp_Dir', 0.098792045492534467),
  ('Awards_Dir', 0.088853385435691129),
  ('Awards_Actors', 0.13507694080267124),
  ('OthRoles_Actors', 0.070227800575368773),
  ('TVApp_Actors', 0.11901628522757654),
  ('Pub_Actors', 0.11422522028274802),
  ('Diversity_Index', 0.084698996716750449)]
```

Conclusion

- There is some signal about movie ratings in Actor and Director Characteristics.
- More interestingly, the created Movie Diversity Index seems to have some importance as a feature in the models, and in the linear models it seems to have a slightly negative effect.
  - Would be interesting to dig into the voters on IMDb and their characteristics.

Limitations

- Non-normally distributed errors
- Skewed distribution of features

Further Research

- Additional Feature Transformations
- Additional Information
  - Maybe it was too optimistic to want to predict Rating on Actor and Director Characteristics
- Expand Timeframe
  - Scraped data for ~30k movies, there’s more data there!