Disney's Gross Prediction before covid

Thip Rattanavilay, Master's in data science

Bellevue University

Abstract

There are multiple factors and national trends that could affect the output and consumption of the Walt Disney Company. As we enter the outbreak of Covid-19 last year, the world has seen an enormous impact on Gross Domestic Product and unemployment. The entertainment industry and the Walt Disney Company felt the same effects. The Walt Disney Company furloughed 77,000 employees as they were forced to shut down all major parks, cruises, and other entertainment facilities because of the coronavirus outbreak worldwide.

This project analyzes the use of features extracted from network representations of the Disney Movie Gross profit found Kaggle etc. before Covid-19. I am hoping to show that through the use of these features, it is possible to build more powerful prediction models compared to common baseline methods. Movies make a high profile, billion-dollar industry and prediction of movie revenue can be very lucrative. Predicted revenues can be used for planning both the production and distribution stages. Hence, the tough job of predicting a movie's gross revenue can be simplified with the help of modern computing power and the historical data available as movie databases.

Disney's Gross Prediction before covid

Introduction

The Walt Disney Company is a global entertainment and media company headquartered in Burbank, California. It was founded on October 16, 1923, as the Disney Brothers Studio, an animation company. In the past 89 years, the company has flourished, employing 156,000 people globally. Its business can be broken into five segments: Media Networks, Parks & Resorts, Studio Entertainment, Consumer Products, and the Disney Interactive Media Group. The Walt Disney Company first began as the Disney Brothers Studio; this business segment was the platform on which it all began. Today, Disney Studios continues to bring high quality films, music, and stage plays worldwide. Over the year Disney has acquired or begun ventures such as Marvel Studios, Touchstone Pictures, Pixar Animation Studios, Disney Music Group, Disneynature and Walt Disney Studios Motion Pictures.

Business Problem Statement / Hypothesis

Box office revenue prediction is an important problem in the film industry that governs financial decisions made by producers and investors. Generally, these predictions are made using data science algorithms and statistical techniques as described in this analysis. While these approaches are common practice, they often only provide a coarse estimate of revenue prediction before a film has been released. This project aims to develop a computational model for predicting Disney's box office revenues based on public data for movies extracted from popular movie databases (post covid). Whereas the fact that approximately 25% of the gross revenue gets accumulated in the first weekend of screening; indulged them to use the first weekend collection and the number of screenings to build another more accurate prediction model. Furthermore, to find out the impact of film-critics and award nominations, they built another model using rating given by a well-known film critic and academy award nominations. There results showed that the use of opening weekend business predicts the gross revenue most accurately among all the other models.

Dataset

The data contains 579 Disney movies with list of predictor variables (See figure 1) includes genre, MPAA ratings, country of origin, star power, production budget, indicator variable for sequels of earlier movies, indicator variables for release during certain holiday periods of the year, number of screenings in the first weekend, rating of the movie by well-known film critic and the academy award nominations.

Figure 1:

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 579 entries, 0 to 578
Data columns (total 6 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   movie_title             579 non-null    object
 1   release_date            579 non-null    object
 2   genre                   562 non-null    object
 3   mpaa_rating             523 non-null    object
 4   total_gross             579 non-null    int64
 5   inflation_adjusted_gross  579 non-null    int64
dtypes: int64(2), object(4)
memory usage: 27.3+ KB
```

The variables that I will be using for this project are:

- movie_title
- release_data
- genre
- mpaa_rating
- total_gross
- inflation_adjusted gross

There were slight inconsistencies between the Disney datasets in the Data World workspace. Therefore, most of our data preprocessing involved rectifying those inconsistencies.
This includes:

- Filtering out voice actors/roles that were not in a Disney animated feature film
- Filtering out live action movies that are not relevant to our project
- Adding missing movie box office revenues
- Adding missing voice actors & roles of Disney animated feature films
- Formatting the dates in the movies dataset for consistency
- Filling in IMDB ratings for the movies
- Joining the Academy Award dataset with the movies dataset to obtain the wins for the movies of interest
- Joining the Academy Award dataset with the voice actors dataset to obtain the wins for the voice actors of interest

Methods

The goal is to use Multiple Linear Regression to have an accurate predictive model using the CRISP-DM method, the approach was broken down into six simple steps. Each step consists of the tasks that need to be performed before moving on to the next phase.

Business understanding: Determine resources availability, project requirements, assess risks and contingencies, and conduct a cost-benefit analysis.

Data understanding: Examine the data and document its surface properties like data format, number of records, or field identities. Dig deeper into the data. Query it, visualize it, and identify relationships among the data.

Data preparation: Determine which data sets will be used and document reasons for inclusion/exclusion. A common practice during this task is to correct, impute, or remove erroneous values.

Modeling: Determine which algorithms to try (e.g. regression, neural net). Pending your modeling approach, you might need to split the data into training, test, and validation sets. Generally, multiple models are competing against each other, and the data scientist needs to interpret the model results based on domain knowledge, the pre-defined success criteria, and the test design.

Evaluation: Do the models meet the business success criteria? Which one(s) should we approve for the business? Based on the previous three tasks, determine whether to proceed to deployment, iterate further, or initiate new projects.

Deployment: Report final results. Develop and document a plan for deploying the model. Conduct a project retrospective about what went well, what could have been better, and how to improve in the future.

Disney's Trend, Genre and Gross Prediction

For my project I have found and created visuals based on my analysis, I categorize the Walt Disney Company's different sources of revenue into 5 general categories: Disney top ten movies at the box office and movie genre trend, genre popularity, Disney gross per year per title (genre vis movies count), and revenues over year (post covid). I will present the increases and decreases in revenue for each category as well the overall revenue (expressed in billions of USD) of the company from 1992-2016 (a period of 24 years) and lastly, I will compare the multi regression test, and provide which model is best for Disney.

5 general categories:

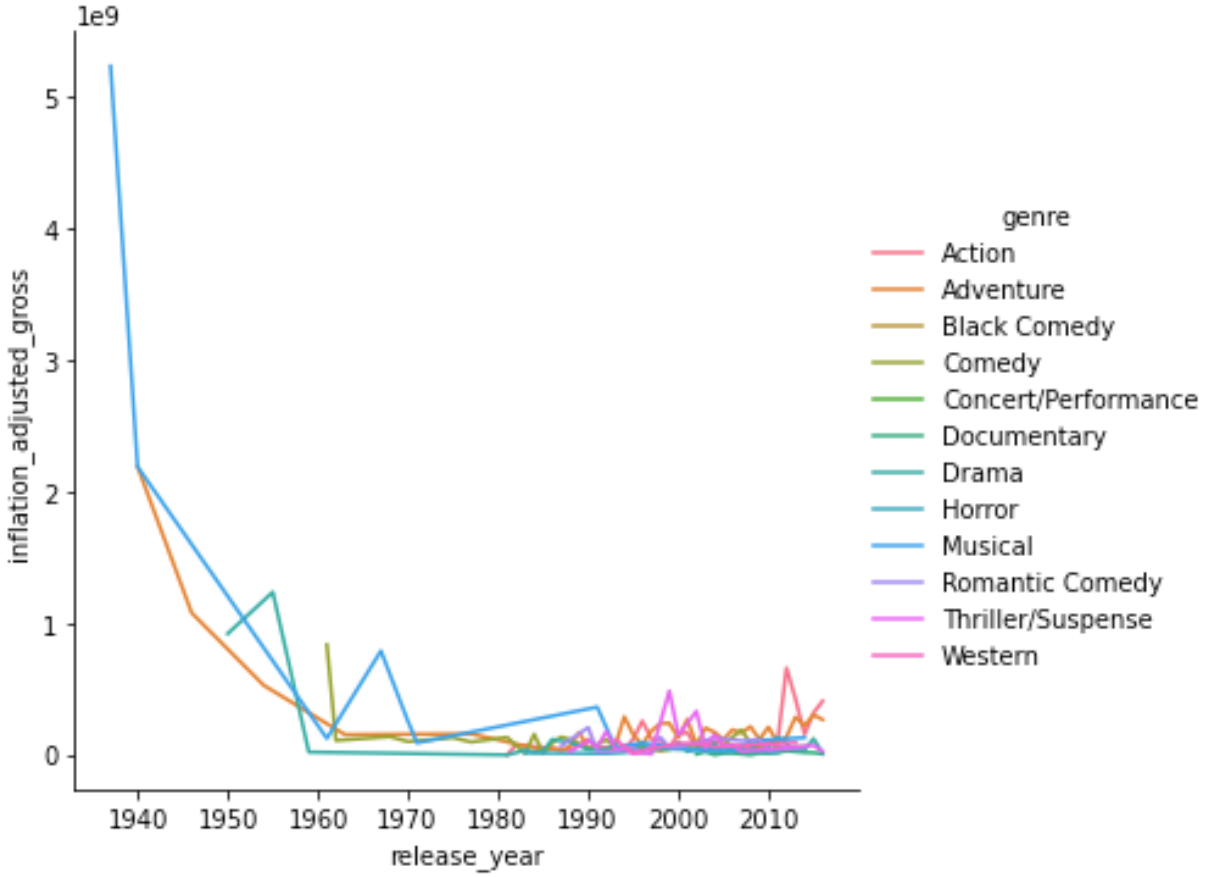
Top 10 Movies at the box office

	movie_title	release_date	...	inflation_adjusted_gross	year
0	Snow White and the Seven Dwarfs	1937-12-21	...	5228953251	1937
1	Pinocchio	1940-02-09	...	2188229052	1940
2	Fantasia	1940-11-13	...	2187090808	1940
8	101 Dalmatians	1961-01-25	...	1362870985	1961
6	Lady and the Tramp	1955-06-22	...	1236035515	1955
3	Song of the South	1946-11-12	...	1078510579	1946
564	Star Wars Ep. VII: The Force Awakens	2015-12-18	...	936662225	2015
4	Cinderella	1950-02-15	...	920608730	1950
13	The Jungle Book	1967-10-18	...	789612346	1967
179	The Lion King	1994-06-15	...	761640898	1994

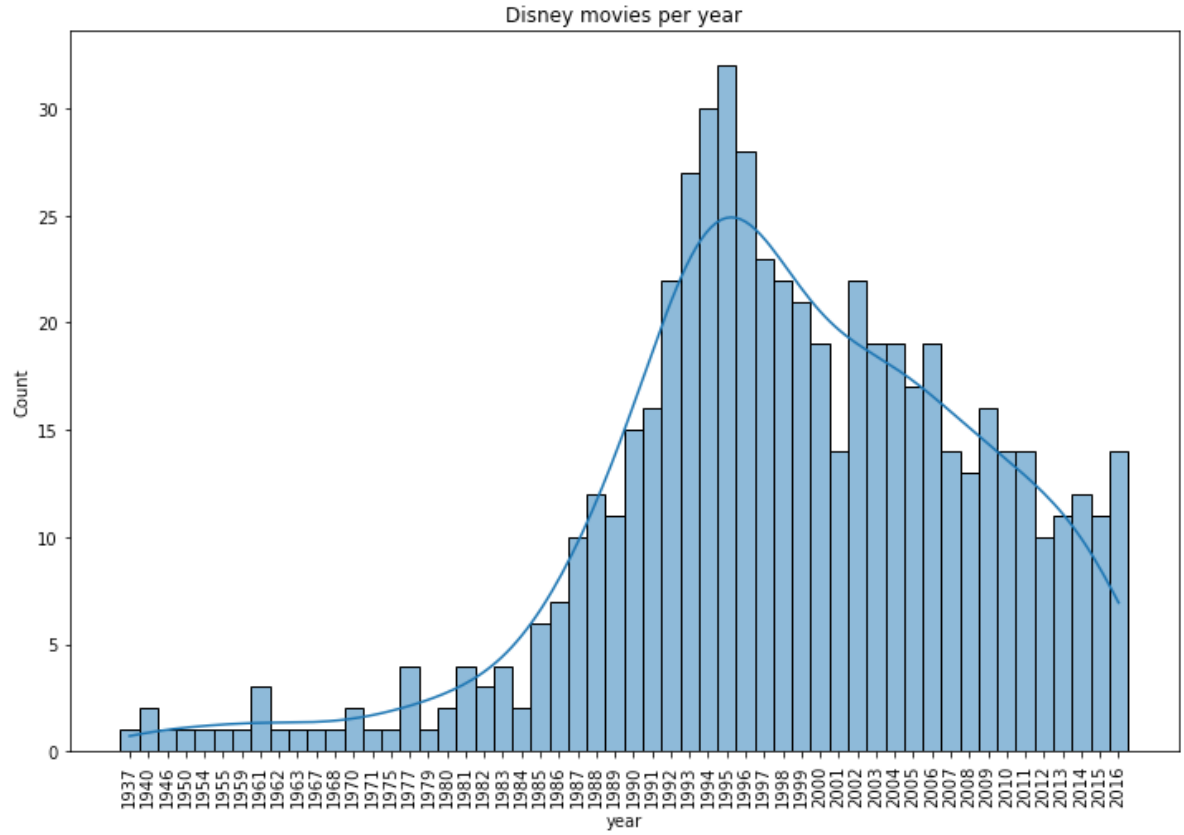
Top 10 Movies Genre Trend

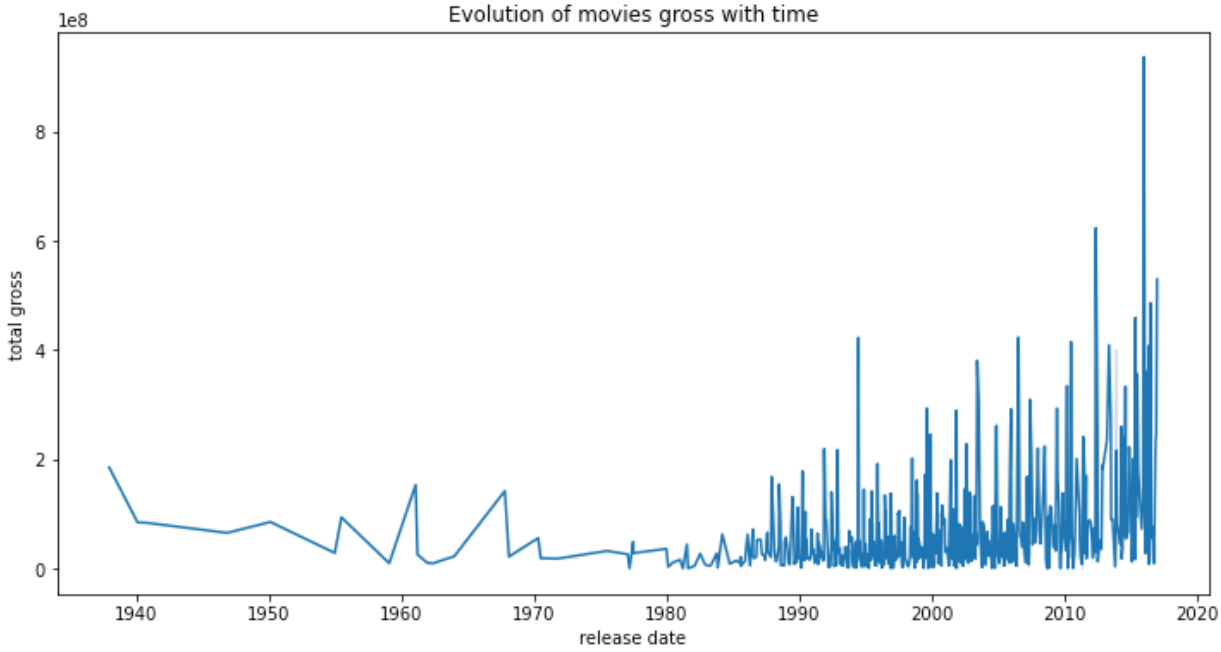
	genre	release_year	total_gross	inflation_adjusted_gross
0	Action	1981	0.0	0.0
1	Action	1982	26918576.0	77184895.0
2	Action	1988	17577696.0	36053517.0
3	Action	1990	59249588.5	118358772.0
4	Action	1991	28924936.5	57918572.5
5	Action	1992	29028000.0	58965304.0
6	Action	1993	21943553.5	44682157.0
7	Action	1994	19180582.0	39545796.0
8	Action	1995	63037553.5	122162426.5
9	Action	1996	135281096.0	257755262.5

Genre popularity trend

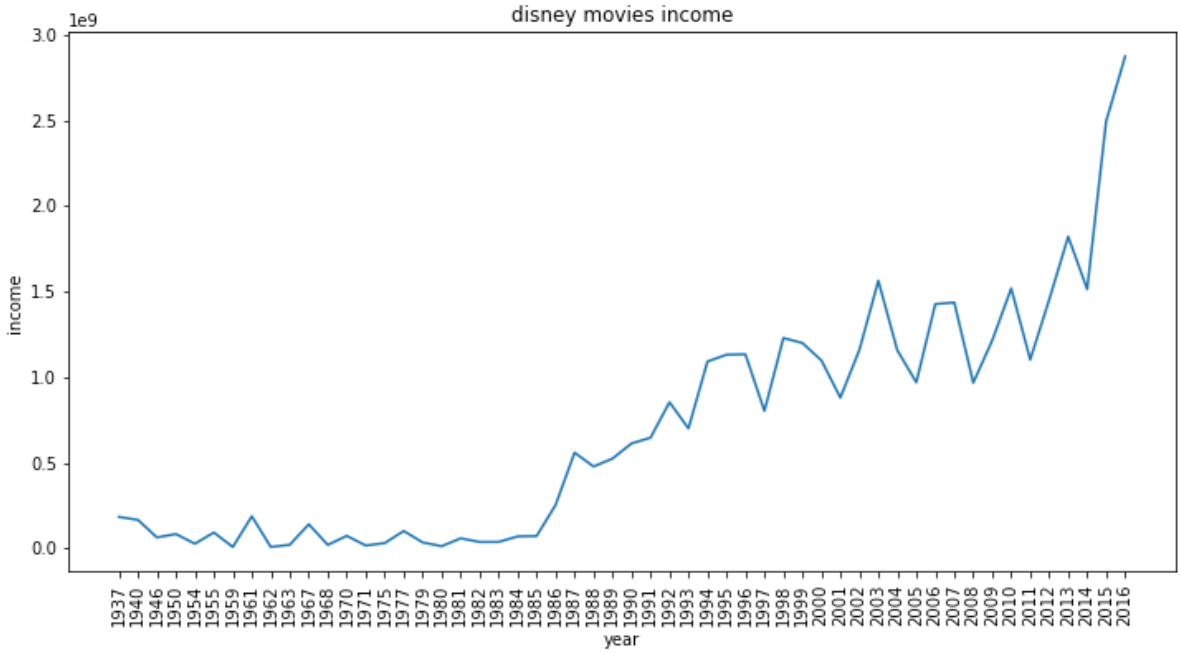


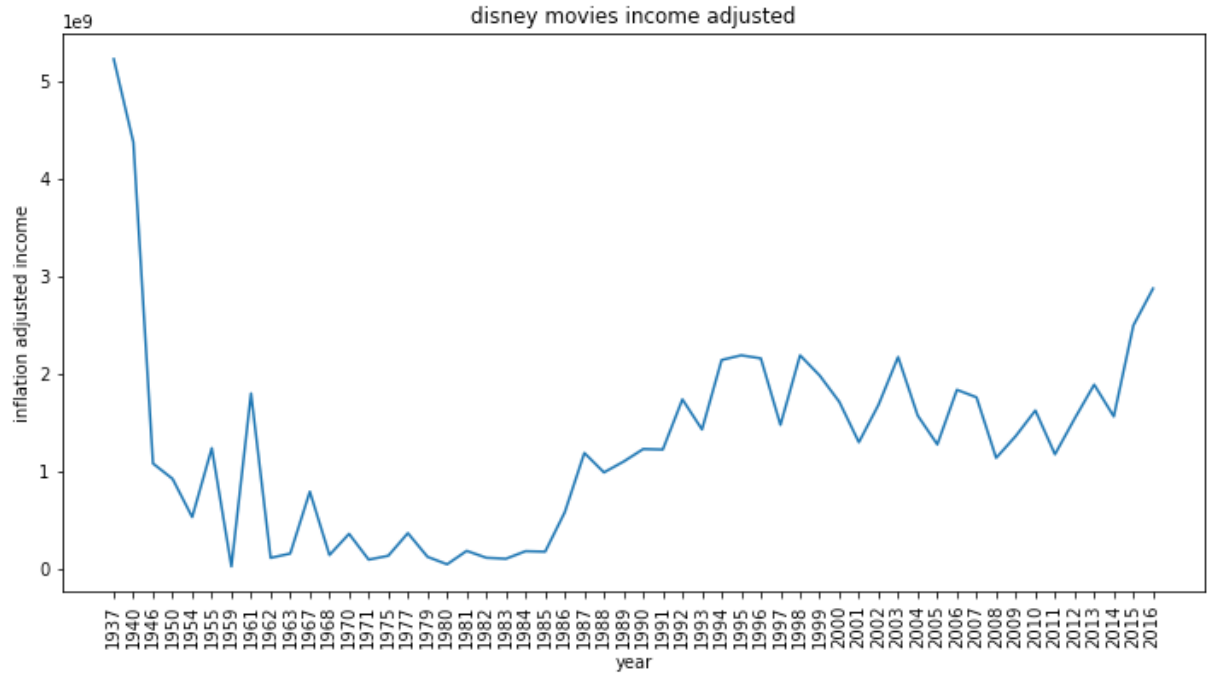
Disney's gross per year



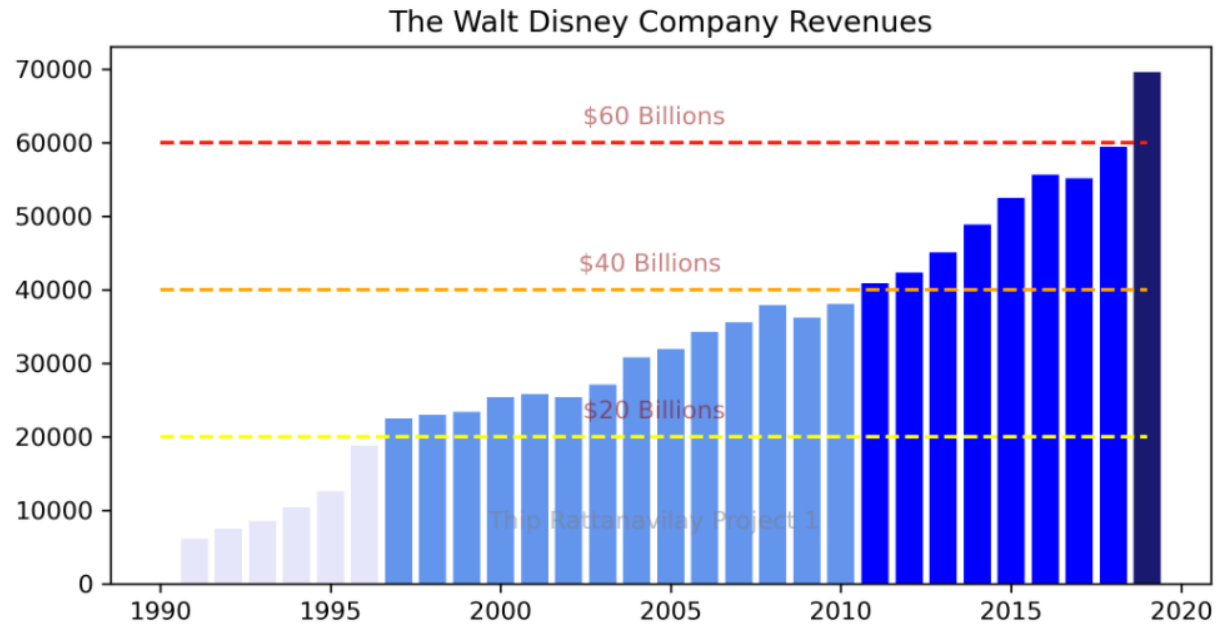


Increases and decreases in revenue for each category





Gross profit per year



Multi Regression testing results:

Linear Regression

```
lr.coef_: [-8.45002932e+06  1.01818807e+08  8.27411943e+07  2.56580750e+06
 -2.19454233e+07 -5.54481363e+07 -5.36866076e+07 -7.55319603e+06
 -1.49890758e+07  2.26675833e+07 -8.20049795e+07 -4.81507318e+07
  3.74320484e+07  3.65527103e+07  1.18872000e+08 -1.39628293e+08
  3.79678983e+07  3.23053587e+07 -4.95169640e+07]
lr.intercept_: 16965870867.160162
lr train score 0.310, lr test score: 0.237
```

Support Vector Regression (SVR)

```
svr train score -0.081, svr test score: -0.045
```

Decision Tree Regression

```
dt train score 0.935, dt test score: 0.544
```

Random Forest Regressor

```
forest train score 0.874, forest test score: 0.503
```

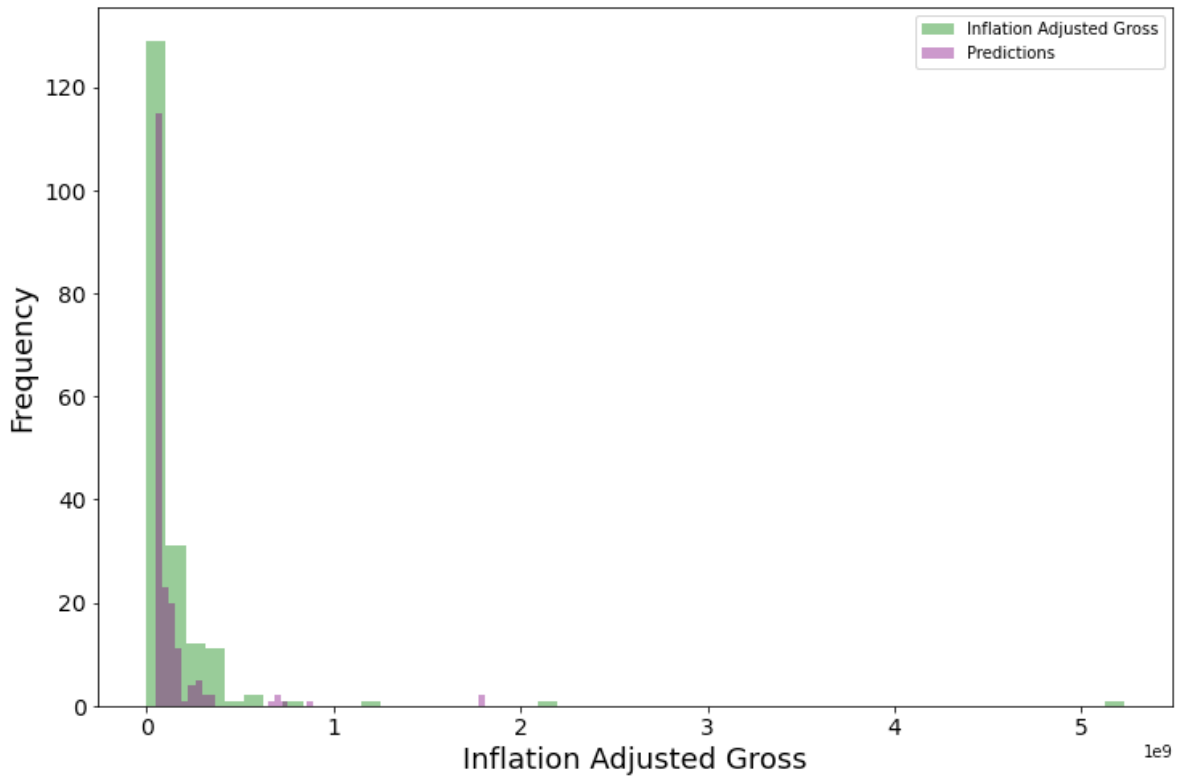
Actual and Prediction

	Actual	Pred
0	6654819	5.011659e+07
1	5497481	7.667689e+07
2	43713554	8.331831e+07
3	234069353	1.346755e+08
4	7829877	8.331831e+07
...	...	...
185	91304495	5.428017e+07
186	36165012	8.331831e+07
187	10111144	6.461867e+07
188	21505832	6.710329e+08
189	116316457	1.786198e+08

As you see here Linear Regression, Support Vector Regression, Decision Tree, Random Forest with grid searching parameters and the best score is 75% on train and 54% on test data. This means that only ~54% of the variance in Inflation Adjusted Revenue can be explained by the current features release date, genre, and ratings. Since we have a complete dataset with all Disney movies produced so far, we need to collect more features like

- movie characters,
- scripts, producer,
- director, budget($),
- audience reviews,
- movie length,
- advertisement related variables etc.

to get a better prediction score on the target variable "Inflation Adjusted Gross".



Conclusion

The aim of this project was to predict the gross revenue of a movie post covid from publicly available data and by using Kaggle and other datasets. During the lockdown period of 2020, Disney plus streaming platforms gained a lot of users! In the exploratory factor analysis (EFA) phase, eight latent factors of the twenty binary genre variables were identified to be used in the regression modeling phase (Multiple Linear Regression).

The conclusion can be drawn from the two sets of regression models that predictions of gross movie revenue during production stage is not very accurate, however after the movie's first week run in the theater, the projection of the final revenue becomes easier.

The models developed in the project are far from perfect. Many other variables could have been considered for the prediction process. I can say that random forest may have resulted in better predicting the gross revenue. Did covid affect Disney's revenue? Yes and no. The streaming service

help provide another source of revenue for Disney, and I can confidently say they are going to be much more profitable for years to come.

Appendix

The data contains 579 Disney movies with six features: movie title, release date, genre, MPAA rating, total gross, and inflation-adjusted gross.

The variables that are used:

- movie_title
- release_data
- genre
- mpaa_rating
- total_gross
- inflation_adjusted gross

EDA

	movie_title	release_date	genre	mpaa_rating	total_gross	inflation_adjusted_gross
0	Snow White and the Seven Dwarfs	1937-12-21	Musical	G	184925485	5228953251
1	Pinocchio	1940-02-09	Adventure	G	84300000	2188229052
2	Fantasia	1940-11-13	Musical	G	83320000	2187090808
3	Song of the South	1946-11-12	Adventure	G	65000000	1078510579
4	Cinderella	1950-02-15	Drama	G	85000000	920608730
...	...	...	...	...	...	...
574	The Light Between Oceans	2016-09-02	Drama	PG-13	12545979	12545979
575	Queen of Katwe	2016-09-23	Drama	PG	8874389	8874389
576	Doctor Strange	2016-11-04	Adventure	PG-13	232532923	232532923
577	Moana	2016-11-23	Adventure	PG	246082029	246082029
578	Rogue One: A Star Wars Story	2016-12-16	Adventure	PG-13	529483936	529483936

Feature

	movie_title	release_date	genre	mpaa_rating	total_gross	inflation_adjusted_gross	decade
0	Snow White and the Seven Dwarfs	1937-12-21	Musical	G	184925485	5228953251	<1950
1	Pinocchio	1940-02-09	Adventure	G	84300000	2188229052	<1950
2	Fantasia	1940-11-13	Musical	G	83320000	2187090808	<1950
3	Song of the South	1946-11-12	Adventure	G	65000000	1078510579	<1950
4	Cinderella	1950-02-15	Drama	G	85000000	920608730	<1950
...	...	...	...	...	...	...	...
574	The Light Between Oceans	2016-09-02	Drama	PG-13	12545979	12545979	2010-2020
575	Queen of Katwe	2016-09-23	Drama	PG	8874389	8874389	2010-2020
576	Doctor Strange	2016-11-04	Adventure	PG-13	232532923	232532923	2010-2020
577	Moana	2016-11-23	Adventure	PG	246082029	246082029	2010-2020
578	Rogue One: A Star Wars Story	2016-12-16	Adventure	PG-13	529483936	529483936	2010-2020

10 Question

1. What does the business need?

   Disney needed to stay competitive with platform like Netflix, Amazon, HBO, and Hulu to increase their revenue.

2. What modeling techniques should we apply?

   The techniques that I have used are linear regression, support vector regression, decision tree, and random forest

3. How do stakeholders access the results?

The result can be found my GitHub repository gathered for this project (I will include this on my paper).

4. What is Disney's internal weakness?

   Major weaknesses that Disney must consider in order to protect its product from negative influence. The first is the platform's niche content offerings. Offer something for everyone. Disney plus was a great solution during covid.

5. How many genres are there and are they mixed?

   Disney had quite a few genres, but the most popular genre was "Action"

6. Which production group made the most revenue for Disney?

   I would have to say Snow White and the Seven Dwarfs and fast forward. I would say Star Wars and coming in next is the Marvel Universe

7. Which genre of movie is earning the highest Total Gross Income?

   The data shows that Action movies had the highest total gross income

8. Which movie earns the highest income?

   1# is Snow White and the Seven Dwarfs at $522,895,3251

9. What is the trend of movies over the years (1937-2016)?

   The data showed that Comedy and Musical trend the most from 1937 - 2016

10. Which model best meets the business objectives?

    I feel that Random Forest Regression did the best for the busines

References

The Walt Disney Company. (n.d.). Retrieved from https://www.thewaltdisneycompany.com/

Forte, D. (2017, September 28). Walt Disney launches new online, store shopping experiences. Retrieved March 17, 2019, from https://multichannelmerchant.com/ecommerce/walt-disneylaunches-new-online-store-shoppingexperiences/

Bonomolo, C. (2018, August 29). Disney's streaming service gets its name as new details emerge. Retrieved October 8, 2018, from https://comicbook.com/movies/2018/08/26/disneystreaming-service-new-details-disneyplay/

Alexander, J. (2018, February 06). Disney's stand-alone streaming service won't compete with Netflix in scale. Retrieved October 8, 2018, from https://www.polygon.com/2018/2/6/16981884/disneystreaming-netflix-marvel-star-warspixar-lucasfilm-svod

Alvarez, E. (2018, April 12). ESPN offers a first look at Disney's big plans for streaming. Retrieved October 8, 2018, from https://www.engadget.com/2018/04/12/espn-plusdisney-streamingservice-bamtech/

Anderson, M. (2018, February 6). Will Disney's streaming service roar - or squeak? Retrieved October 8, 2018, from https://www.usnews.com/news/business/articles/2018-02-06/will-disneysstreaming-service-roar-or-squeak

Bartiromo, M. (2019, March 13). Walt Disney World increases ticket prices for most popular days. Retrieved March 14, 2019, from https://www.foxnews.com/travel/waltdisney-world-increasesticket-prices-for-most-popular-days

Thompson, D. (2018, May 17). Disneyflix is coming. And Netflix should be scared. Retrieved October 8, 2018, from https://www.theatlantic.com/magazine/archive/2018/05/disneyflix-netflix/556895/

Mitovich, M. W. (2018, February 09). Disney streaming service FAQ: Will Marvel heroes leave Netflix? Multiple Star Wars series? And more answers. Retrieved October 8, 2018, from https://tvline.com/2018/02/08/star-wars-tv-series-disney-streaming-service-2019/

Krämer, P. (2000). Entering the Magic Kingdom: The Walt Disney company, the Lion King and the limitations of criticism. Film Studies, (2), 44-50,2.