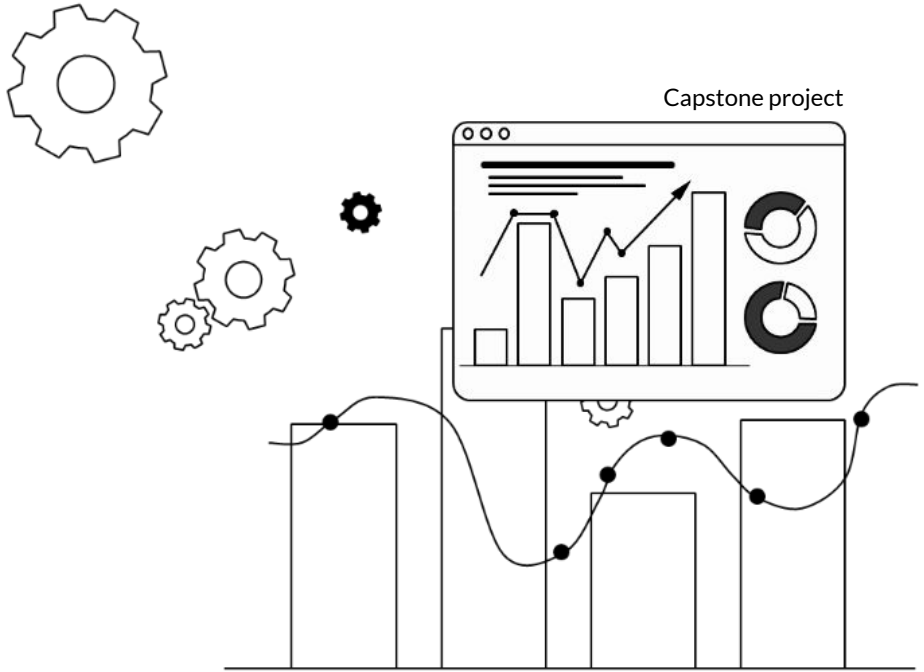
AMAZON PRODUCT REVIEW

TOYS & GAMES : INVENTORY OPTIMIZATION AND DEMAND FORECASTING

ANALYSIS



Capstone project

Guided by Dr. Amit Kumar
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AGENDA OF THE PROJECT

1. Understand the business problem
2. Understand the data
    2.1. Derive insights from past data
    2.2. Identify the important constituents
    2.3. Identify the important characteristics
3. Plan for the next term
4. Recommendations to solve the business problem

BUSINESS PROBLEM

Excess inventory takes up space and resources that could be used elsewhere. Business need balancing just enough inventory to meet the customer's demands. This ensures that logistics costs stay low by eliminating issues such as running out of stock, backorders and overstocking.

The business also needs to forecast demand to plan and strategize their products and activities accordingly for resourceful and efficient functioning.

OBJECTIVES

- Optimize inventory management by identifying the product categories based on the product sentiments
- Predict categories that could be in demand based on the sentiments and sales

DATA UNDERSTANDING

What data is available? Product details and Review details of the products
How much data is available? 1996 - 2018

Challenges in the given data

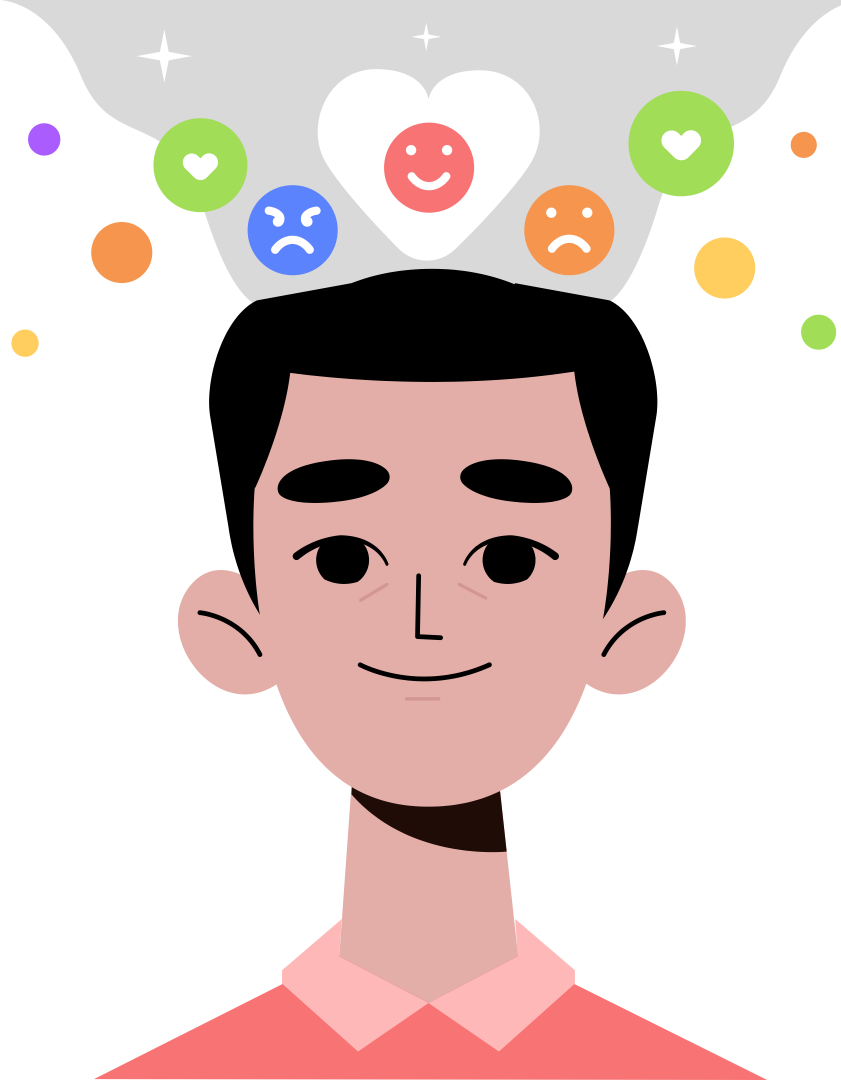
1. Few fields didn't have information- more than 70% of missing values - Drop fields
2. Records having missing values- more than 20% of missing values - Drop records

```
Cleaned data
Shape: (1280016, 9)
COLUMN             DATATYPE        NULL VALUES
-----------------------------------------
overall            float64         0.00%
verified           bool            0.00%
reviewTime         datetime64[ns]  0.00%
asin               object          0.00%
reviewText         object          0.00%
summary            object          0.00%
category           object          0.00%
brand              object          0.00%
price              float64         0.00%
```

EXPLORATORY DATA ANALYSIS

Inventory components: Category, Brand
Measuring parameters: Price, Rating, Time

1. Which is the category & brand with best rating?
2. What are the contributing factors for good rating ?
3. Does price affect the rating of products? What is the relationship?
4. Is there a relationship existing between price and sales?
5. Are the top rated categories & brand consistent with time?
6. How are the poorly rated products different from well rated products?



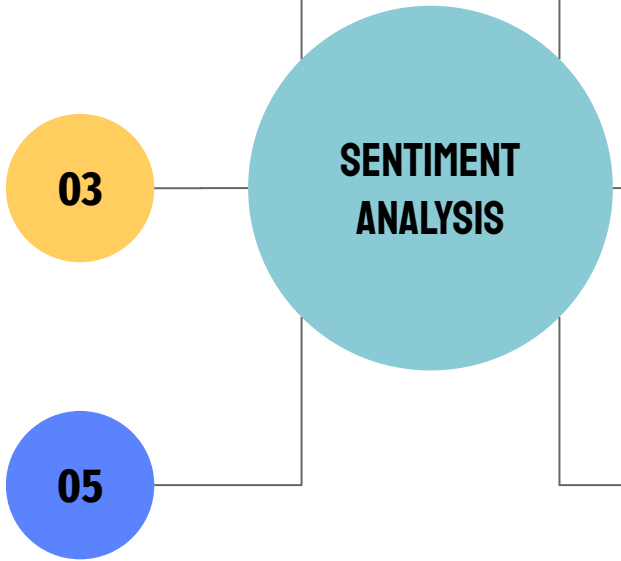
SENTIMENT ANALYSIS

Sentiment analysis is used to determine if the data is positive, negative or neutral

AIM

To analyse the sentiment of review text to determine the categories and brands having positive, negative or neutral sentiment

METHODOLOGY FOR SENTIMENT ANALYSIS



Sentiment labelling

Labelling the sentiment of the reviews based on overall ratings

Data Cleaning

To fix or removing incorrect, corrupted, incorrectly formatted, duplicate, or incomplete data within a dataset.

Text Normalization

To reducing the different forms of a word to one single form

Removing stopwords

Stopwords are the English words which does not add much meaning to a sentence

Classification Modelling

Making a classification model to predict the sentiment to text

Sentiment Prediction

Predicting the sentiment of each review text.

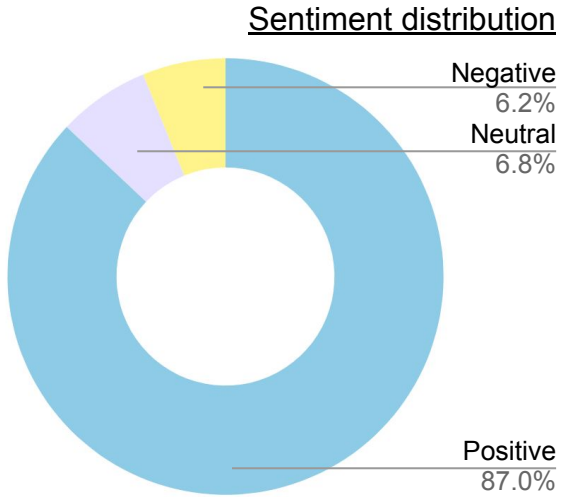
CLASSIFICATION

Objective
To develop an automated system to analyze and monitor an enormous number of reviews

Data
Feature: Review text
Label: Sentiment

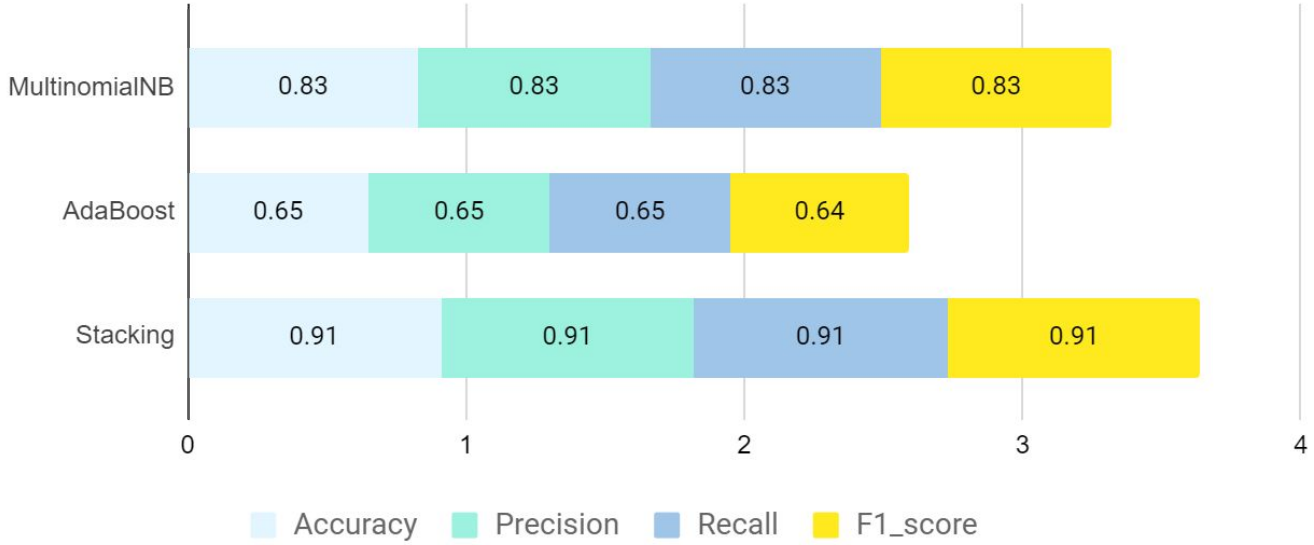
Challenges: Large data size | Imbalance in data
Solution: Stratified random sampling

Data shape: 12,80,016 records



EVALUATION OF CLASSIFICATION MODELS

Scores vs Classification model



Stacking Classifier is comparatively the best model

INFERENCE

Based on reviewer sentiments

TOP 5 CATEGORIES WITH POSITIVE SENTIMENT

Party Supplies
Remote & App Controlled Vehicles & Parts
Dress Up & Pretend Play Accessories
Polyester
Dress Up & Pretend Play Hats

TOP 5 CATEGORIES WITH NEUTRAL SENTIMENT

Train Cars- Locomotives
Trains & Accessories- Couplers & Trucks
Dress Up & Pretend Play- Costumes
Sports & Outdoor Play
Trains & Accessories

TOP 5 CATEGORIES WITH NEGATIVE SENTIMENT

Sports & Outdoor Play
Remote & App Controlled Vehicles & Parts
Hobby Building Tools & Hardware
Arts & Crafts
Baby & Toddler Toys

TOP 5 BRANDS WITH POSITIVE SENTIMENT

Galison
World of Harmony Music
LEGO
Bell AH-1S Cobra helicopter model
Beanie Baby

TOP 5 BRANDS WITH NEUTRAL SENTIMENT

Child's Play, Inc.
Melissa & Doug
Fisher-Price
Ditty Bird
U.S. Games Systems

TOP 5 BRANDS WITH NEGATIVE SENTIMENT

Therapy Game HQ
Brighter Child
Gold and Bear
DIdj
Evil Hat Productions

CLUSTERING

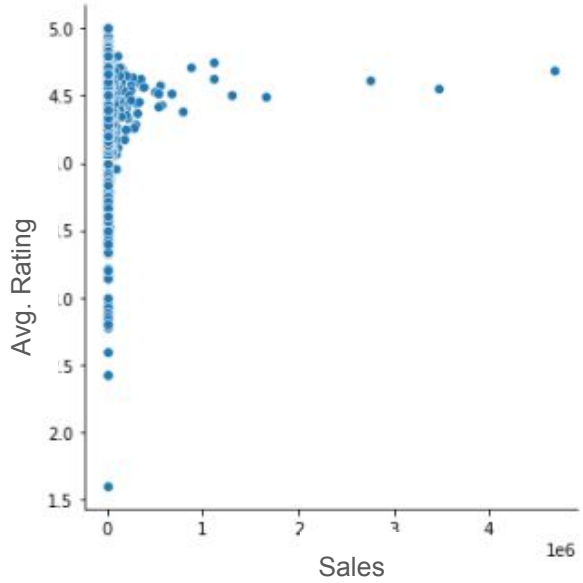
Data shape: 717 records

Objective
Grouping similar categories into one cluster and based on cluster properties giving suggestions to improve the sales

Data
Feature: Sales, Rating

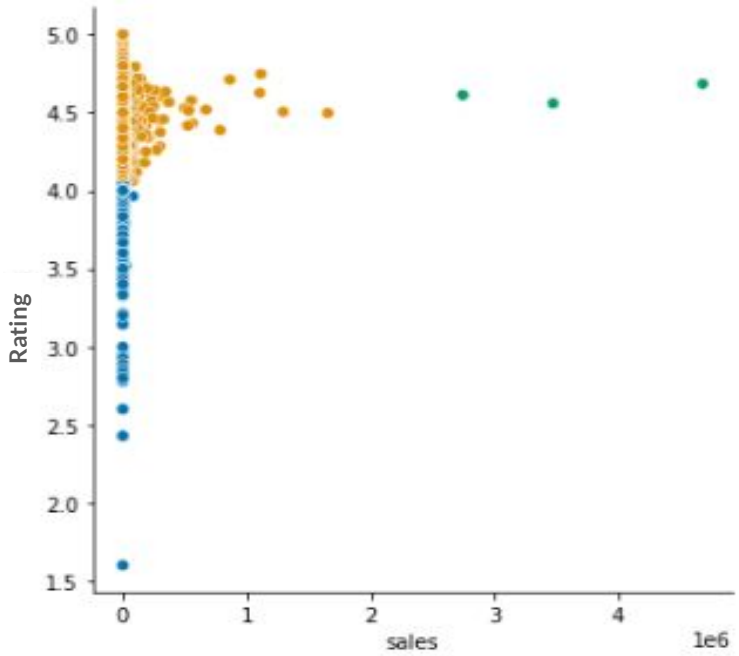
Models
Based on our data we are performing distance based clustering algorithms:

- ❏ K Means
- ❏ Agglomerative

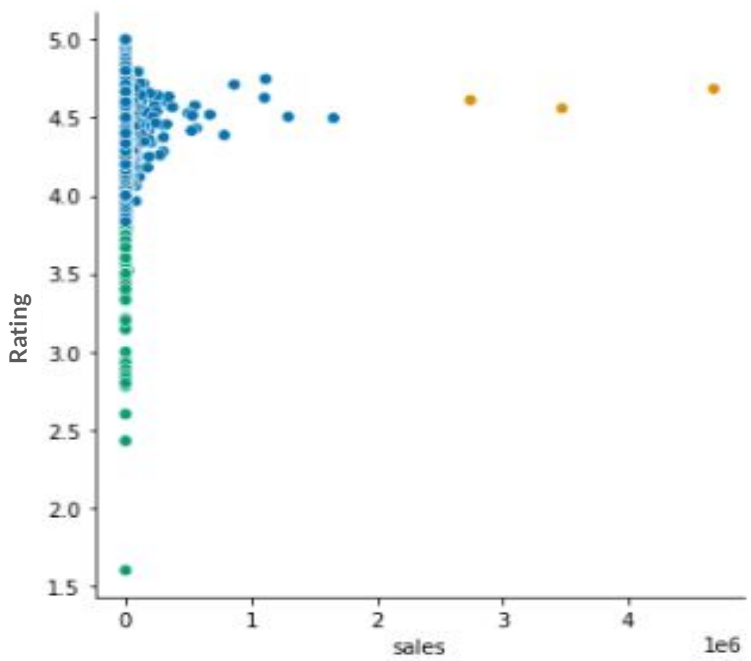


MODEL COMPARISON

K MEANS



AGGLOMERATIVE



As we can observe both clustering algorithms provides almost similar results.
We are selecting **K Means** model as it is least computational expensive as compare to Agglomerative clustering.

INFERENCE

Best model: **K Means** Clusters

CLUSTER 0
MODERATE PERFORMING

Cluster 0	Rating	Sales	Price
Mean	4.43	$41,662	$24
Max	5	$1,653,801	$523
Min	3.83	$10	$1

CATEGORIES

Costumes
Cases & Stands
Party Favors

CLUSTER 1
BEST PERFORMING

Cluster 1	Rating	Sales	Price
Mean	4.62	$3,630,773	$49
Max	4.68	$4,678,258	$64
Min	4.56	$10	$39

CATEGORIES

Action Figures & Statues
Dolls
Building Toys & Building Sets

CLUSTER 2
NEEDS IMPROVEMENT

Cluster 2	Rating	Sales	Price
Mean	3.38	$1,132	$13
Max	3.8	$20,737	$87
Min	1.6	$10	$1

CATEGORIES

Hats
Headbands
Pretend Phones

RECOMMENDATIONS

- First cluster (**Moderate performing**) is having good ratings but average sales. As observed the categories with less price is giving better sales and purchase frequency of those products is also high, so to improve the sales it is recommended to drop the price.

- Second cluster (**Best performing**) is having good ratings as well as sales. So, these categories should not be tampered.

- Third cluster (**Needs Improvement**) is having worst response in terms of rating as well as sales. So, complete overhauling is required to improve their ratings

TIME SERIES ANALYSIS

Time series analysis is a specific way of analyzing a sequence of data points collected over an interval of time.

OBJECTIVE

To get the scenario of the sales in future .

METHODOLOGY - DEMAND FORECASTING OF PRODUCTS

with respect to their sentiments

SPLITTING DATA INTO SENTIMENTS

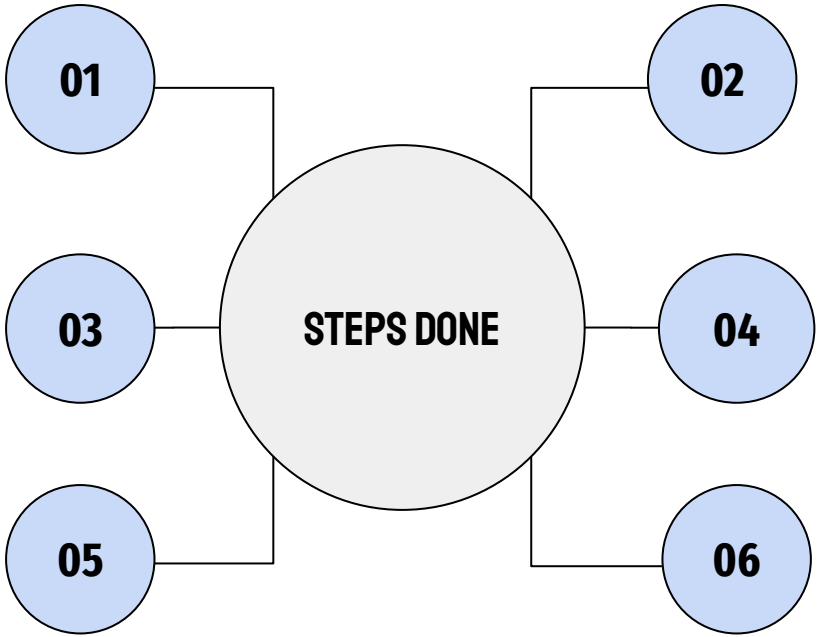
Using filtering split the data into positive, negative and neutral sentiments

DECOMPOSITION OF DATA

Make the decomposition plot of each data to see the time series components in data .

TIME SERIES MODELING

SARIMA model on positive, negative, neutral sentiments products



RESAMPLING

Resample the data on monthly basis to remove noise and make the continuity in data

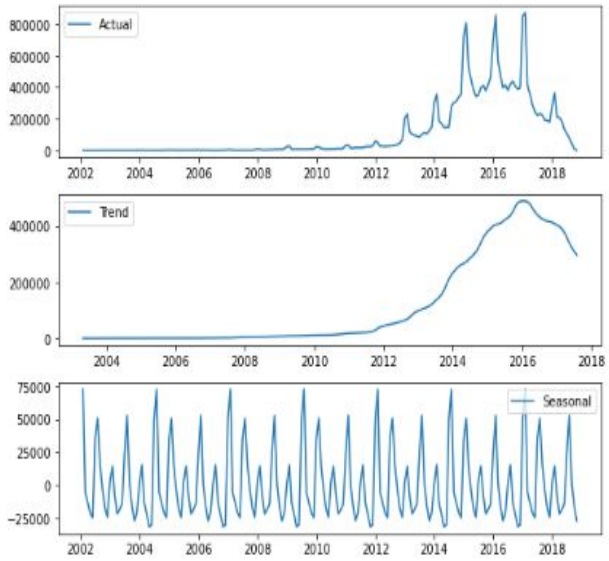
STATIONARITY CHECK

Check whether the data is stationary or not with the help of Augmented Dickey Fuller test .

DEMAND FORECASTING

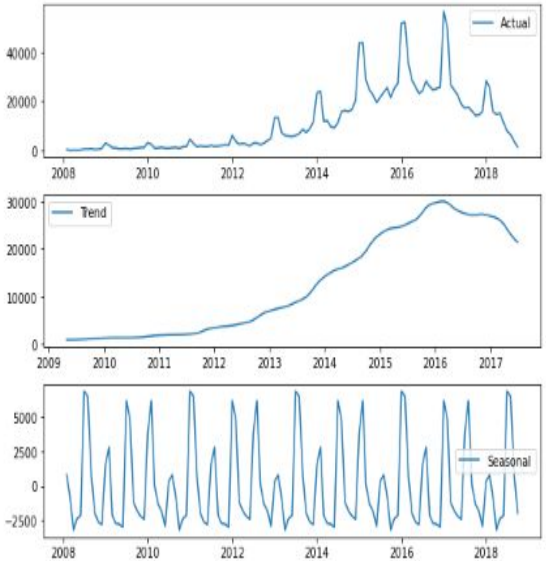
Based on the best model perform demand forecasting for year 2019

DECOMPOSITION OF SALES OF PRODUCTS WITH POSITIVE SENTIMENTS



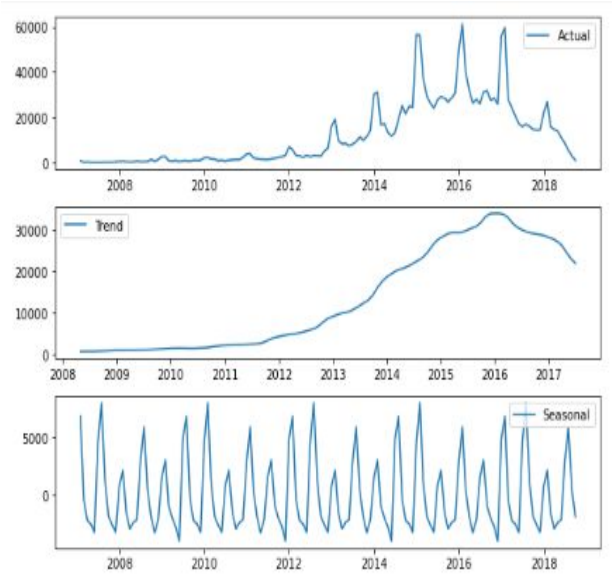
- **Trend**: Sales increased till 2016 and then started falling
- **Seasonality**: seasonality is observed after every 2 years and the fluctuations is between 2.5K to 75K

DECOMPOSITION OF SALES OF PRODUCTS WITH NEGATIVE SENTIMENTS



- **Trend**: Sales increased till 2016 and then started falling
- **Seasonality**: seasonality is observed after every 2 years and the fluctuations is between 2.5K to 6K

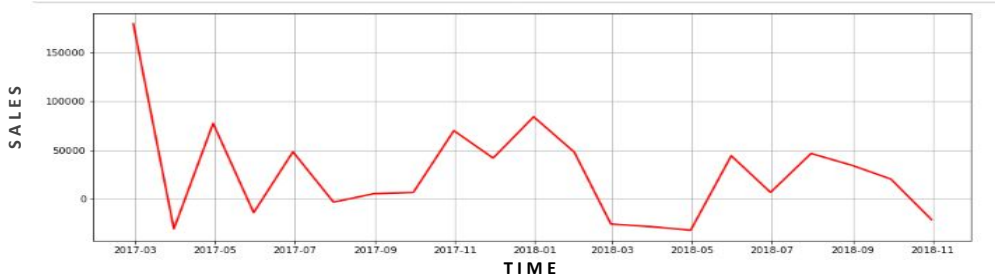
DECOMPOSITION OF SALES OF PRODUCTS WITH NEUTRAL SENTIMENTS



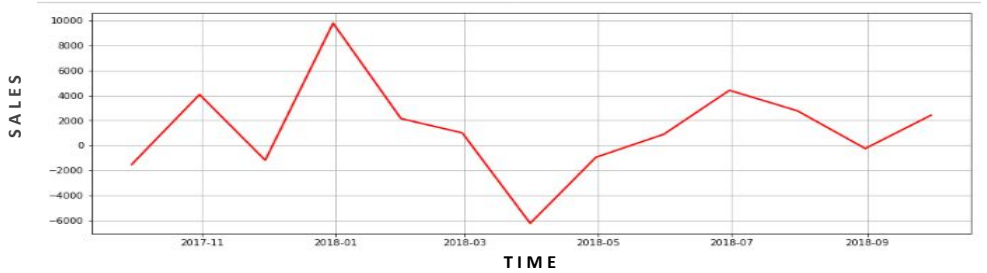
- **Trend**: Sales increased till 2016 and then started falling
- **Seasonality**: seasonality is observed after every 2 years and the fluctuations is between 1.5K to 6K

ERROR PLOTS

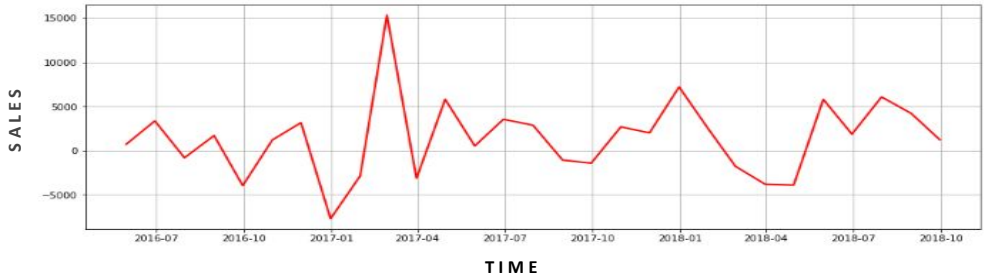
POSITIVE SENTIMENTS



NEGATIVE SENTIMENTS



NEUTRAL SENTIMENTS

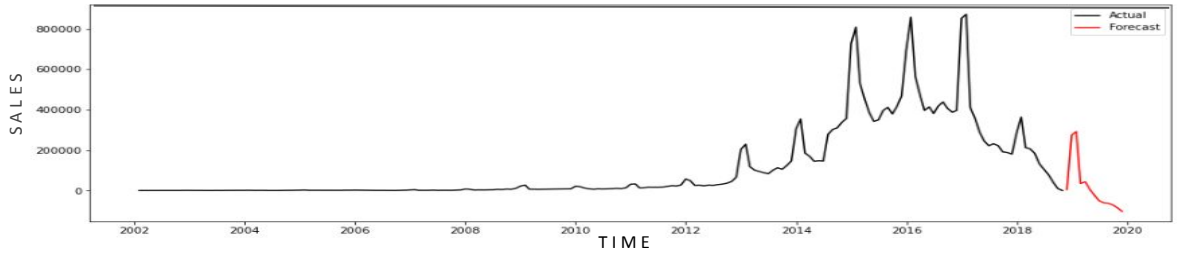


Forecasted total sales for 2019

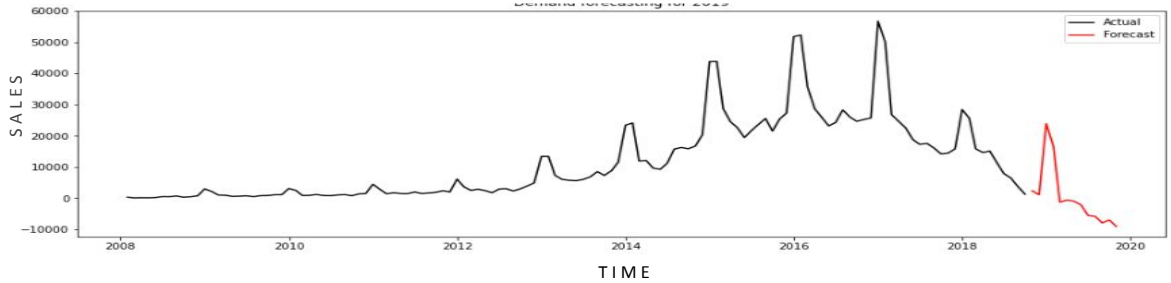
for planning and strategizing inventory

Legend: **Actual** | Forecast

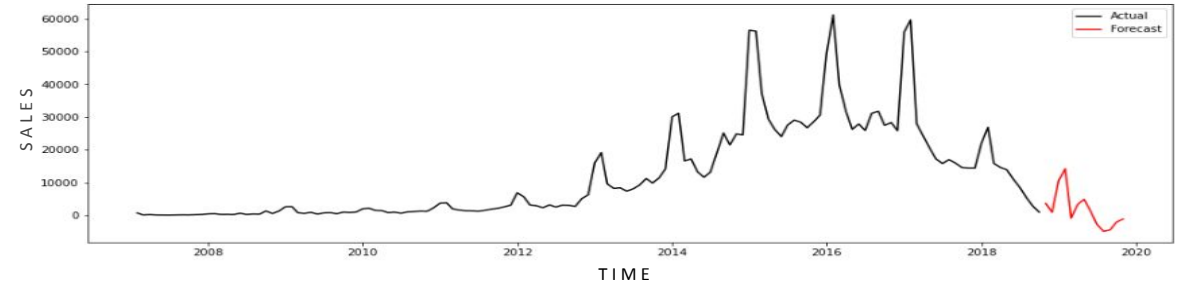
Positive sentiment



Negative sentiment



Neutral sentiment



Inferences

Sales for the products with positive reviews in 2019 will be highest in the end of first quarter around 2.5 lac and then decrease throughout the year .

Sales for negative reviewed products will hit peak at the end of 1st quarter around 20K and decrease as the year passes

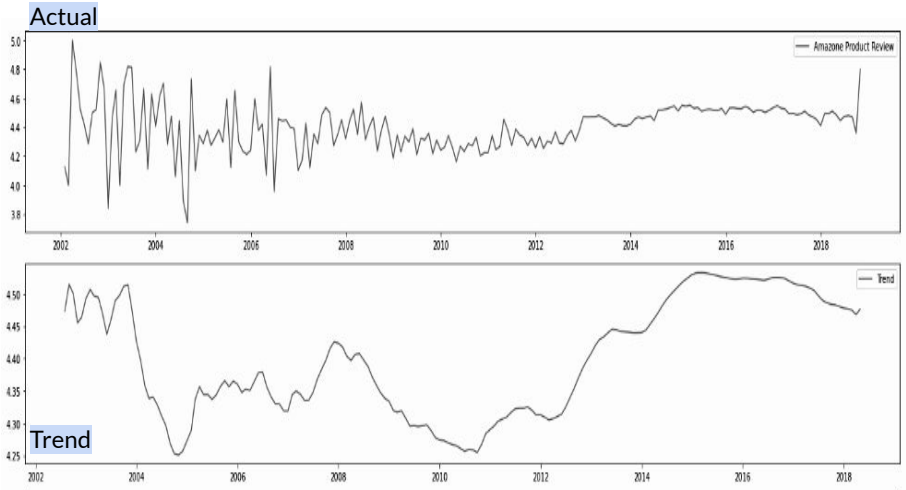
Sales for neural reviewed products will be highest around 10K at the end of first quarter and in 3rd quarter around 5K.

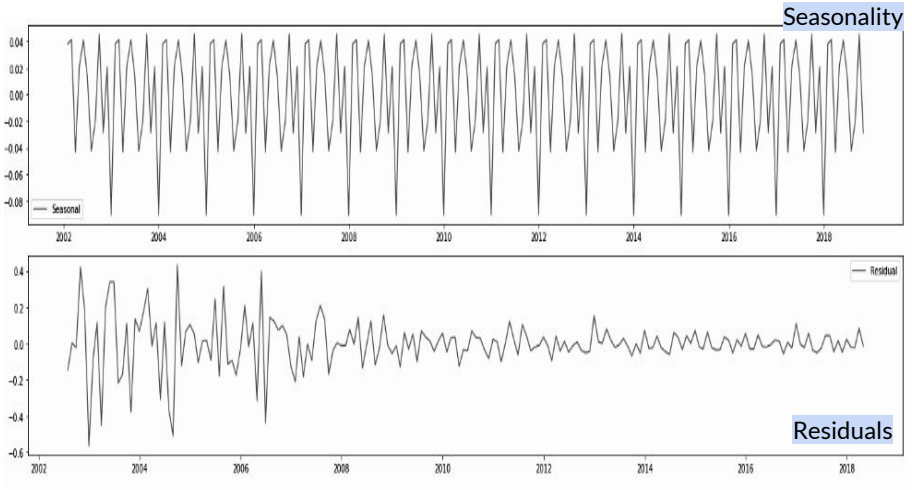
RECOMMENDATIONS

- The total sales for the positively , negatively and neutral reviewed products will decrease in **2019** with comparison to **2018** can be the cause of default in products , high prices , not full fill the expectations of customer. So, we can optimize the inventory by managing the production because the demand of the products will be low throughout the year with comparison to the previous year.

- As we can observe that if the sales can decrease in 2019 we can **manage the production** and also we can give some **discounts & offers** and try to fulfill the **expectations** of the customers , and do more **advertisements** related to the products to attract the customers to increase the demand of the products .

TIME SERIES ANALYSIS FOR OVERALL RATINGS





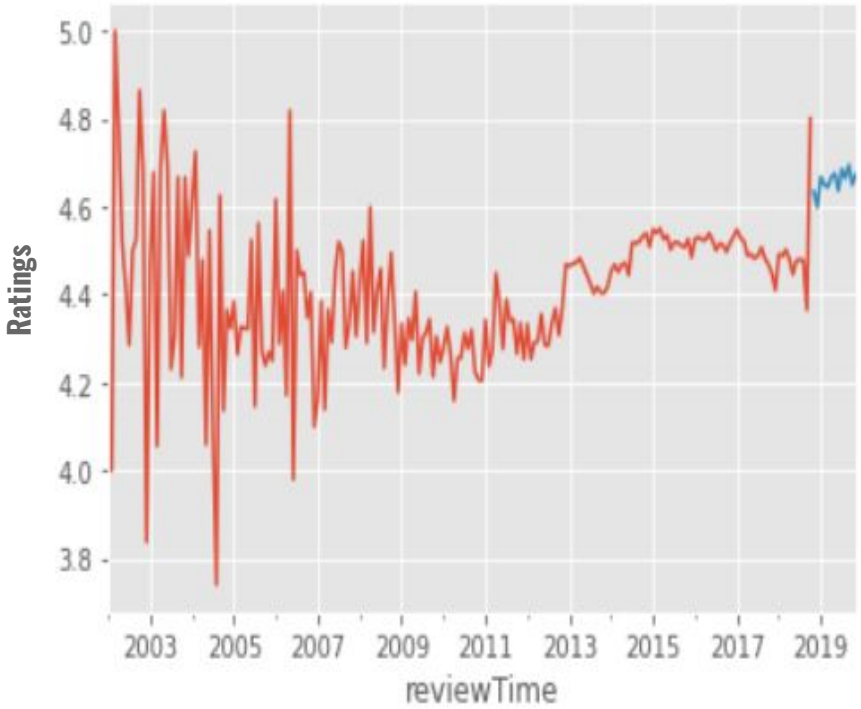
Seasonality - The pattern of data that is present over a specific period

Trend - The value of the data are increased or decreased over time, trend increased after 2012

Residuals - Irregular data falls under random type of chart

From visualization of the data we can find the trend and from exactly what year we can see a change in overall ratings

FORECASTED RATINGS FOR YEAR 2019



INFERENCE

- Overall **rating decreased after 2002** , after 2002 we can hardly see 5 point review for toys and games over the years.
- In 2007 where there is a steep high and low in overall reviews mainly because in 2007 Amazon released its **new logo** and the release of its first **kindle** in america.
- We are predicting the review Time , we can see a steep rise and stability after year 2013 , before 2013 we can see that there was no stability.
- Considering the data from 2002 to 2018 we get to a point that the customers are mostly **happy** with the **toys and games** section of amazon.

RECOMMENDATIONS

- Moderate performing categories is having good ratings but average sales. As observed the categories with less price is giving better sales and purchase frequency of those products is also high, so to improve the sales it is recommended to drop the price.

- Categories which needs improvement is having worst response in terms of rating as well as sales. So, complete overhauling is required to improve their ratings.

- The total sales for the positively , negatively and neutral reviewed products will decrease in **2019** with comparison to **2018** can be the cause of default in products , high prices , not full fill the expectations of customer. So, we can optimize the inventory by managing the production because the demand of the products will be low throughout the year with comparison to the previous year.

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THANK YOU