This project uses **Natural Language Processing (NLP)** to analyze sentiment in Amazon product reviews, which will make it easier to understand understand customer feedback without manually reading through thousands of reviews. By automating sentiment classification, we can quickly identify trends in how customers feel about a product and allow us to quickly tell whether they love it, hate it, or fall somewhere in between.

Before settling on our final NLP approach, we looked at various NLP methods that could be used for sentiment analysis. We considered **deep learning models** like LSTMs and transformers (e.g., BERT), which are good at capturing complex language patterns. While these models can achieve high accuracy, they require much more computational power and training data. Since our dataset consists of structured reviews with clear sentiment patterns outlined in the data, we decided to take a more efficient approach using **traditional machine learning models** that offer just as strong performance without excessive required computational power.

The process starts with cleaning up the text to remove unnecessary elements like extra spaces, punctuation, and common filler words. Reviews are then categorized as positive, neutral, or negative based on their star ratings, where 1 or 2 is negative, 3 is neutral, and 4 or 5 is positive. Since negative or neutral reviews often appear less frequently, we use **SMOTE (Synthetic Minority Over-sampling Technique)** to balance things out, ensuring the models don't get biased toward the more common sentiment categories.

To classify sentiment, we use two machine learning models. The first is **Logistic Regression combined with TF-IDF vectorization**, which helps identify the most important words influencing sentiment. For example, words like *"refund"* signal a negative review, while *"amazing"* indicated a positive one. The TF-IDF approach ensures that common but unimportant words don't overshadow the ones that truly matter. As mentioned above, with SMOTE balancing, this model avoids favoring one sentiment over another, making its predictions more accurate.

The second model is **Multinomial Naïve Bayes**, a fast and reliable method for text classification. It works by finding the probability of a review belonging to each sentiment category based on the words it has. While it assumes each word appears independently of the others, it still does a great job of capturing patterns in how people may express sentiment. Despite being simple, Naïve Bayes is still widely considered one of the best-performing models for text-based tasks like this.

Beyond just classifying reviews, the project also focuses on making the results easy to interpret and actionable for businesses. **Word clouds** will tell us the most frequently used words in each sentiment category, giving a quick visual summary of what customers are saying. **Trigram analysis** helps find key three-word phrases that appear often in positive and negative reviews.