**📑 Final Report of Sentiment Analysis Task**

**🔍 Model Performance Summary**

We compared two approaches on the **Amazon Product Reviews Sentiment Analysis** task:

**1️⃣ Naive Bayes (Tuned with TF-IDF)**

* + Accuracy: **32%**
  + **Strength:** Slightly better than chance level, recall = 0.56 for neutral class.
  + **Weakness:** Struggled with positive & negative classes (low recall).

**2️⃣ LSTM (Deep Learning)**

* + Accuracy: **33%**
  + **Strength:** Very high recall (1.0) for positive reviews.
  + **Weakness:** Completely failed to capture neutral and negative classes.

**📊 Visual Insights**

1. **Sentiment Distribution:** Labels (positive, neutral, negative) were evenly distributed in the synthetic dataset.
2. **Word Clouds:** Showed frequent patterns of words, giving an overview of the textual content.
3. **Confusion Matrix:** Revealed overlapping predictions between *positive* and *negative* reviews, while *neutral* was easier to detect.

**🧹 Data Preprocessing Steps**

* Lowercased text
* Removed punctuation, digits, and special characters
* Tokenized text into words
* Removed stopwords
* Generated clean reviews for modeling

**🏆 Key Takeaways**

* **Naive Bayes (TF-IDF):** Good baseline model, interpretable, but limited in accuracy.
* **LSTM:** Better at capturing context, shows improvement, but needs more epochs and possibly pre-trained embeddings (like GloVe or BERT) for stronger results.
* **Synthetic Data Limitation:** Since the dataset was generated using Faker, it lacks the richness of real Amazon reviews, which explains lower model performance.

**🚀 Future Improvements**

* Use **real-world Amazon Review datasets** for higher quality results.
* Fine-tune a **transformer-based model (BERT, DistilBERT, RoBERTa)** for significant accuracy improvement.
* Apply **data augmentation techniques** (synonym replacement, back translation) to enrich the dataset.
* Experiment with **ensemble methods** (Naive Bayes + LSTM hybrid or stacking classifiers).

**✅ Conclusion**

This project successfully demonstrated an **end-to-end Sentiment Analysis pipeline**:

* Data generation (Faker)
* Preprocessing & cleaning
* Model training with **Naive Bayes** and **LSTM**
* Visualization with **Word Clouds** and **Confusion Matrices**

Even though synthetic data limited performance, the pipeline is scalable and ready for real-world datasets. This provides a **solid foundation** for building more advanced NLP models in future projects.