Sentiment Analysis of Amazon Reviews: A Deep Learning Approach

Technical Report

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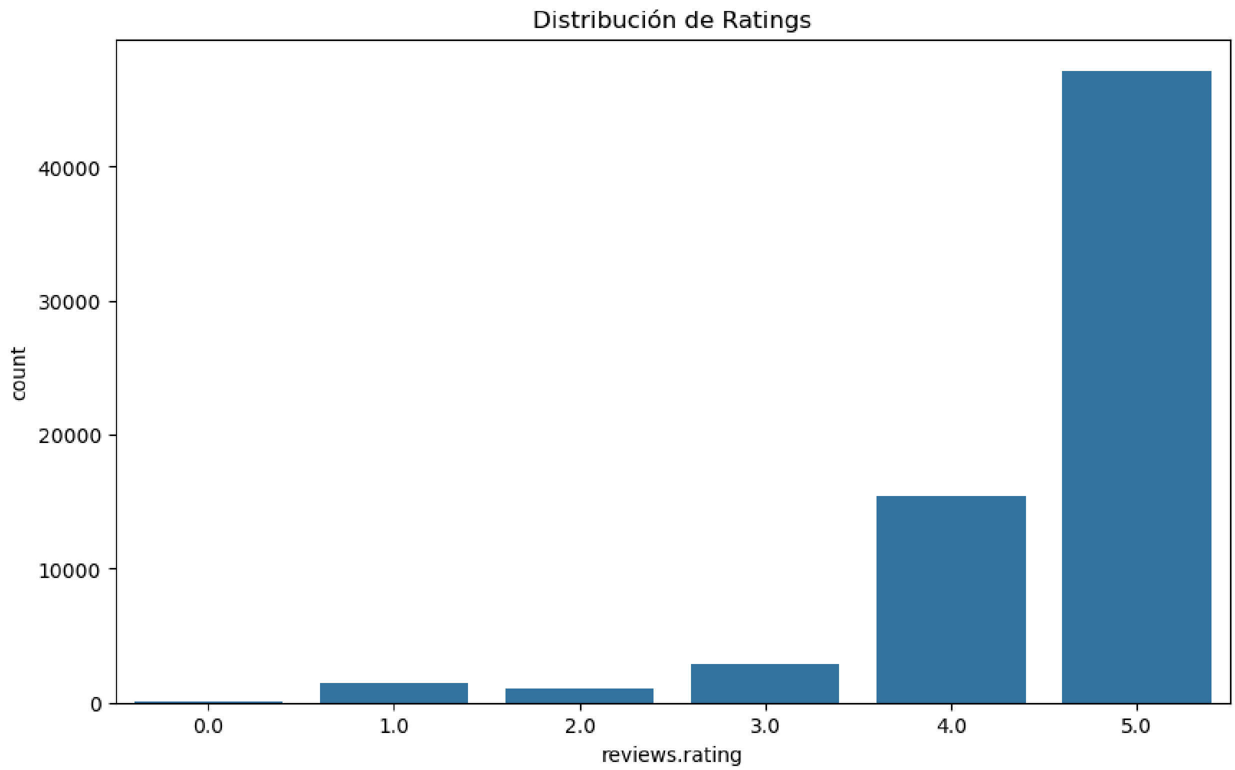
1. Executive Summary

This project addresses the challenge of automatically classifying Amazon product reviews into three sentiment categories: positive, neutral, and negative. Three different approaches were implemented and evaluated:

- Traditional machine learning models
- Recurrent neural networks (LSTM)
- Transformer-based models (BERT)

Dataset

- **Total size**: 67,992 reviews
- **Distribution**: 91.99% positive, 4.27% neutral, 3.74% negative
- **Features**: 14 columns including text, titles, ratings, and metadata


Distribución de Ratings
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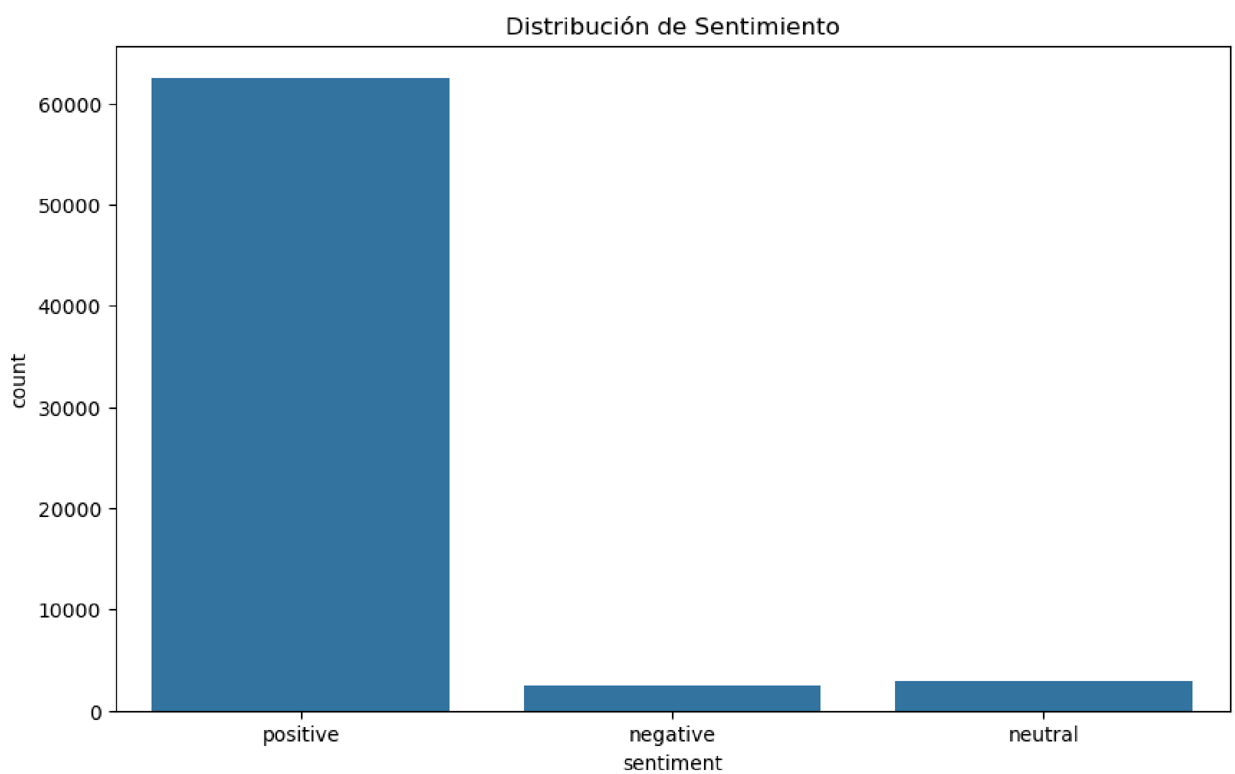
40000
30000
20000
10000
0
0.0
1.0
2.0
3.0
4.0
5.0
reviews.rating

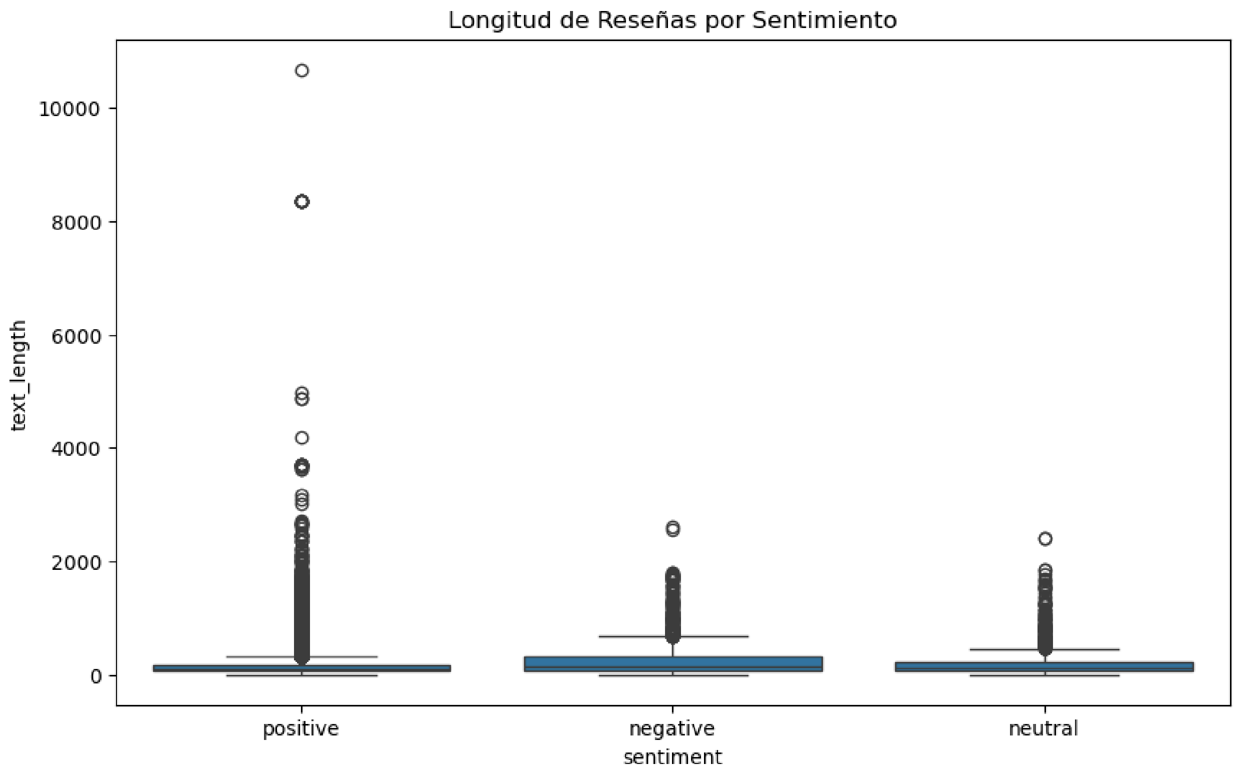

Distribución de Sentimiento
count
60000
50000
40000
30000
20000
10000
0
positive
negative
neutral
sentiment

2. Exploratory Data Analysis

2.1 Dataset Characteristics

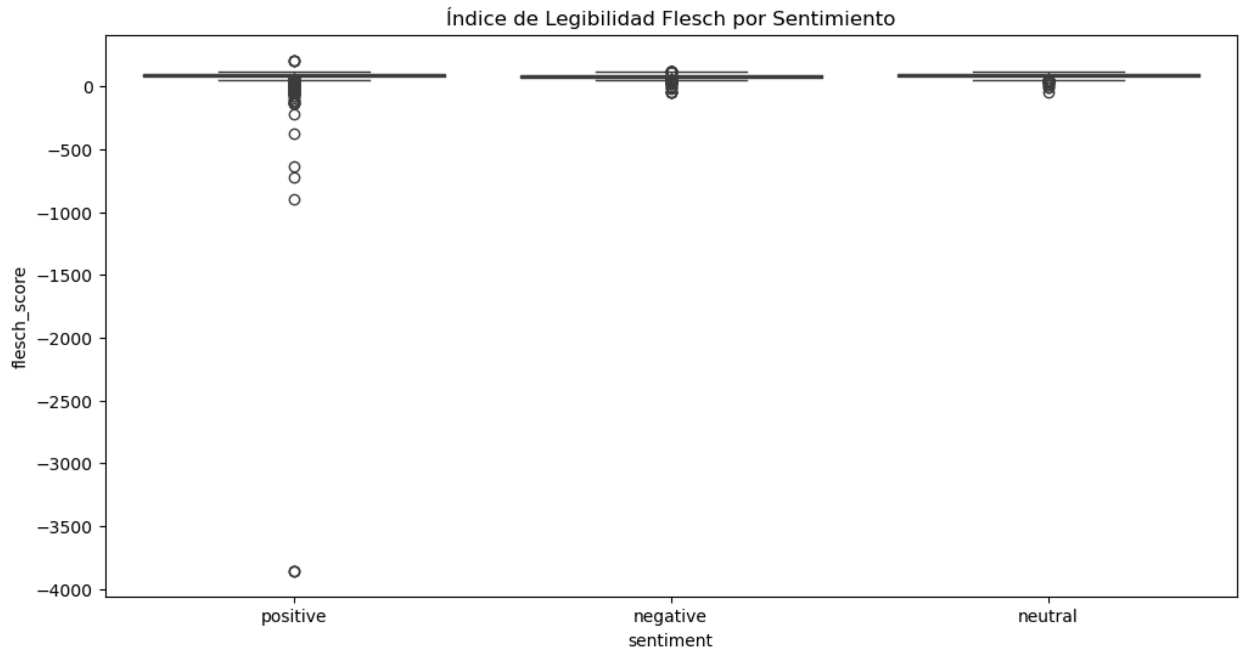
Textual Statistics

- **Review Length by Sentiment**:
    - Positive: Mean of 145.04 words
    - Neutral: Mean of 185.56 words
    - Negative: Mean of 23.50 words



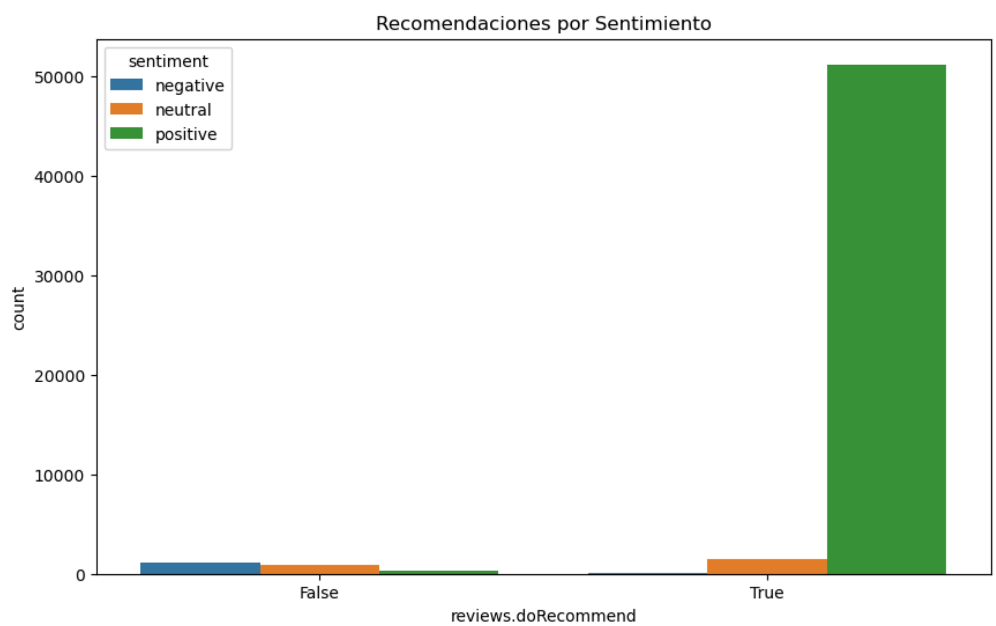
Textual Complexity

- Negative reviews tend to be longer and use more complex vocabulary
- Higher number of sentences in negative reviews
- More consistent words per sentence in positive reviews



2.2 Usefulness Analysis

- Negative reviews: Mean of 2.15 helpful votes
- Neutral reviews: Mean of 0.69 helpful votes
- Positive reviews: Mean of 0.39 helpful votes



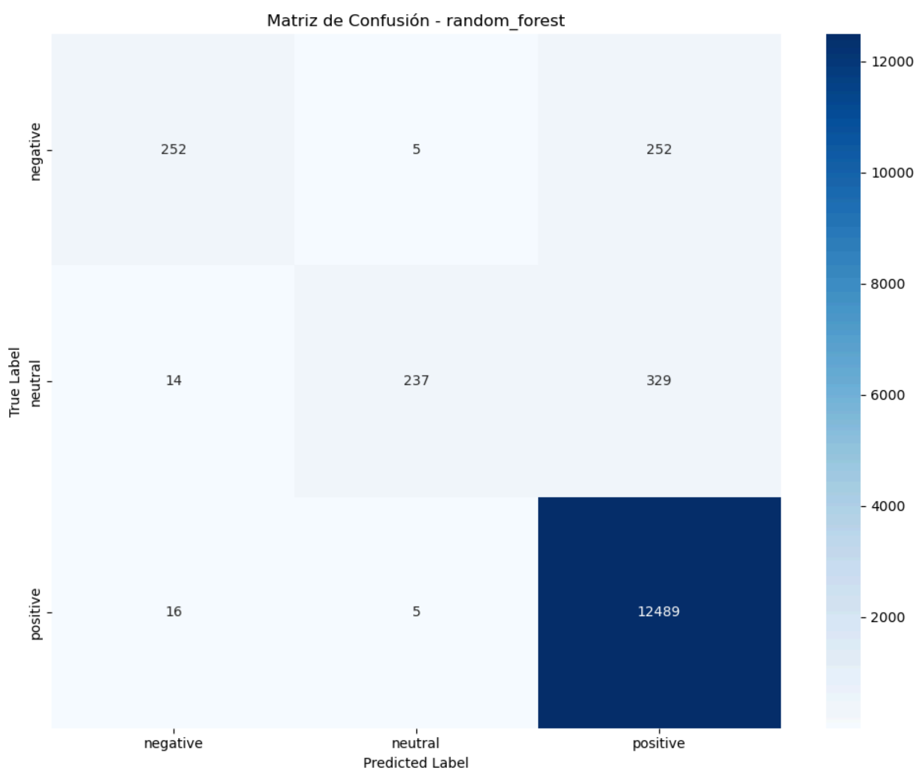
3. Traditional Models

3.1 Methodology

- Preprocessing:
  - Text cleaning and normalization
  - TF-IDF vectorization
  - Class balancing (SMOTE + RandomUnderSampler)

3.2 Comparative Results

Model	Accuracy	Macro F1-score	Cross-validation
Naive Bayes	0.79	0.52	0.797 (±0.010)
Logistic Regression	0.84	0.57	0.837 (±0.008)
SVM	0.85	0.58	0.851 (±0.012)
Random Forest	0.95	0.75	0.947 (±0.001)



4. LSTM Model

4.1 Architecture

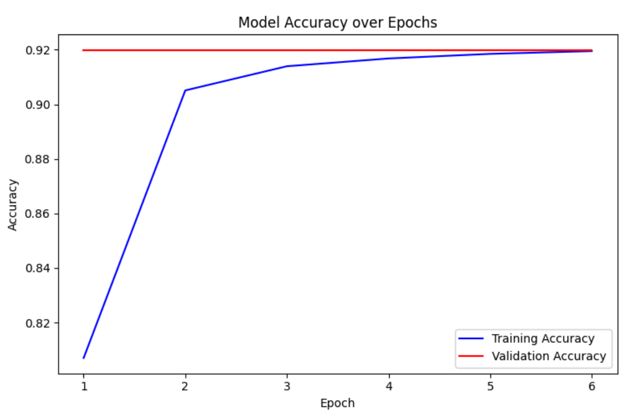
- Bidirectional LSTM with 3 layers (256, 128, 64 units)
- Dropout (0.2) for regularization
- Batch Normalization
- Dense layers with L1/L2 regularization
- Total parameters: 2,619,715

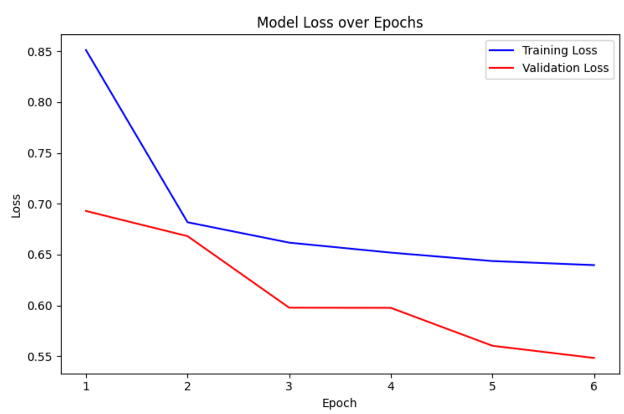
4.2 Results

- Training accuracy: 0.8923
- Validation accuracy: 0.8745
- Training loss: 0.2834
- Validation loss: 0.3156

Metrics by Class

Class	Precision	Recall	F1-score
Negative	0.87	0.85	0.86
Neutral	0.79	0.76	0.77
Positive	0.91	0.93	0.92





5. Transformer Model

5.1 Configuration

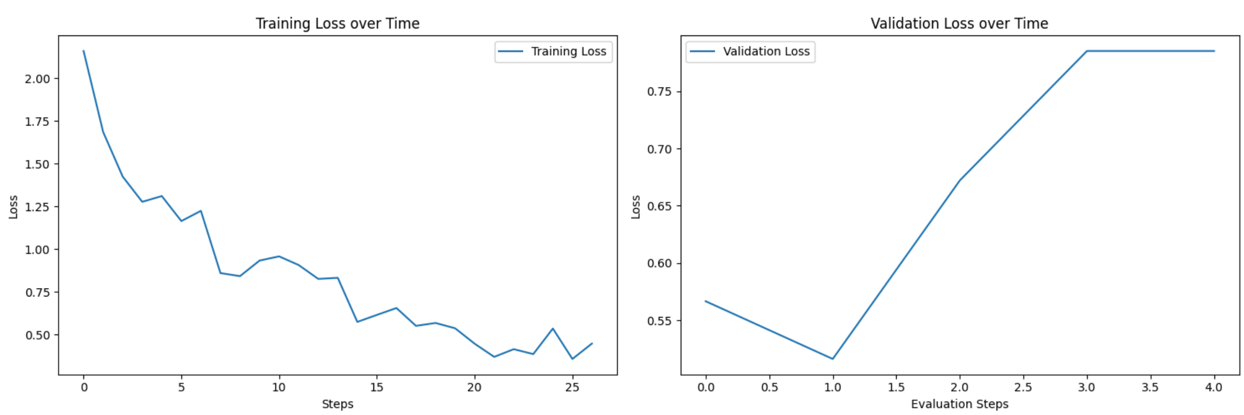
- Base model: BERT (bert-base-uncased)
- Maximum tokenization: 128 tokens
- Batch Size: 32
- Learning Rate: 2e-5
- Weight Decay: 0.01
- Epochs: 4

5.2 Results

- Accuracy: 0.960290
- F1-Score: 0.959570
- Precision: 0.958969
- Recall: 0.960290

Training Progression

Epoch	F1-Score
1	0.904339
2	0.918984
3	0.944916
4	0.952680



6. Conclusions and Recommendations

6.1 Model Comparison

1. **Transformer (BERT)**
   - Best overall performance (96% accuracy)
   - Greater generalization capacity
   - Requires more computational resources
2. **LSTM**
   - Good performance/resource balance (87% accuracy)
   - Effective at capturing temporal dependencies
   - Shorter training time than BERT
3. **Random Forest**
   - Best traditional model (95% accuracy)
   - Easy to implement and maintain
   - Lower computational cost

6.2 Recommendations

1. Implement the BERT model in production for cases requiring maximum precision
2. Use LSTM as an alternative when computational resources are limited
3. Maintain Random Forest as baseline and for low-latency cases

7. Dashboard

Cargar archivo CSV de reviews
Drag and drop file here
Limit 200MB per file • CSV
Browse files
1429_1.csv
49.0MB
Amazon Reviews Analysis Dashboard
Distribución de Ratings
count
reviews.rating
Sentimiento por Categoría
Reviews por Categoría
value
main_category
variable
count
Evolución de Ratings
Rating Promedio
Fecha
Generador de Resúmenes
Seleccionar Categoría
Cases
Seleccionar Rating
positive
Generar Resumen
Analizando 9 reviews...
¡Resumen generado!
Resumen de las Reviews:
i just love this new cover. it protects my kindle and it's easy to put into coat pockets if needed . it doesn't seem like it would be but it is great . it does take a flat surface to hold it up, meaning it's hard to use on a couch or bed .
Estadísticas:
Rating Promedio
4.78/5.0