Text Classification Assignment Report

October 29, 2023

1 Introduction

In this report, we will present the results of the Text Classification Assignment, which involves classifying movie reviews into "positive" or "negative" classes using the algorithm mentioned in Figure 4.2 of J & M Chapter 4. We trained various naive Bayes classifiers on the provided movie reviews dataset and evaluated their performance on the test set.

2 Methodology

We downloaded the movie reviews dataset from the provided link. The dataset consists of movie reviews labeled as "positive" or "negative." We use Naive Bayes Classifier which was modelled as follows using the algorithm mentioned in Figure 4.2 of J & M Chapter 4.

2.1 Training

1. Calculate the prior probability log P(c) for each class.
2. Build a vocabulary of unique words in the training dataset.
3. Calculate the likelihood log P($w|c$) for each word in each class.

2.2 Testing

1. Given a test document, compute the class probabilities using the prior and likelihood values.
2. Select the class with the highest probability as the classification for the test document

2.3 Different Features Analysed

Separate Naive Bayes Classifiers were implemented with the following features as per the assignment instructions:

1. Bag of words method using word frequencies
2. Bag of words method using word frequency as 1 (binarization)
3. Content word frequencies (ignoring function words)

4. Content word frequencies of 1 per word (ignoring function words after binarization)
5. Bag of words method using word frequencies after applying the negation feature
6. Bag of words method using word frequency as 1 after applying the negation feature

3 Results- Classifier Performance on Test Set

For each classifier, we ran it on the test set, calculated the confusion matrix, and computed the precision, recall, accuracy, and F1 score (macro averaging). Below, we present the results for each classifier.

3.1 Bag of Words with Word Frequencies

Table 1: Confusion Matrix for Bag of Words with Word Frequencies

		Actual Class	
		Positive	Negative
Predicted Class	Positive	127	33
	Negative	35	125

- Accuracy: 0.7875
- Precision: 0.7875449288951399
- Recall: 0.7875
- F1 Score: 0.7874916988944881

3.2 Bag of Words with Word Frequencies (Binarization)

Table 2: Confusion Matrix for Bag of Words with Word Frequencies (Binarization)

		Actual Class	
		Positive	Negative
Predicted Class	Positive	124	36
	Negative	29	131

- Accuracy: 0.796875
- Precision: 0.79744432703221
- Recall: 0.796875
- F1 Score: 0.7967777549804105

3.3 Content Words with Word Frequencies

Table 3: Content Words with Word Frequencies

		Actual Class	
		Positive	Negative
Predicted Class	Positive	125	35
	Negative	35	125

- Accuracy: 0.78125
- Precision: 0.78125
- Recall: 0.78125
- F1 Score: 0.78125

3.4 Content Words with Word Frequencies (Binarization)

Table 4: Content Words with Word Frequencies (Binarization)

		Actual Class	
		Positive	Negative
Predicted Class	Positive	127	33
	Negative	29	131

- Accuracy: 0.80625
- Precision: 0.8064415259537211
- Recall: 0.8062499999999999
- F1 Score: 0.8062197218315362

3.5 BoW with negation feature

Table 5: Confusion Matrix BoW with negation feature

		Actual Class	
		Positive	Negative
Predicted Class	Positive	127	33
	Negative	38	122

- Accuracy: 0.778125
- Precision: 0.778396871945259
- Recall: 0.778125
- F1 Score: 0.778070818070818

3.6 BoW with negation feature (binarization)

Table 6: Confusion Matrix for BoW with negation feature (binarization)

		Actual Class	
		Positive	Negative
Predicted Class	Positive	126	34
	Negative	27	133

- Accuracy: 0.809375
- Precision: 0.8099682986967242
- Recall: 0.809375
- F1 Score: 0.8092837392893084

While the results from all the classifier are close. It can be observed that binarization slightly improves the results in each case.

4 Analysis of Misclassified Sentences

Naive Bayes classifiers rely on the occurrence and frequency of words in the text to make predictions, and they may not capture more nuanced or context-specific meanings in the text. So several sentences were misclassified. Here are some factors:

- **Mixed Sentiments**: Many reviews express both positive and negative sentiments, making it challenging for Naive Bayes to accurately classify the overall sentiment. Example: One of the reviews which was misclassified as negative seemed mixed, with some positive elements such as a "great soundtrack" and "wonderful scenery" but overall expresses disappointment with character development and the plot.
- **Sarcasm and Irony**: Texts often contain sarcasm and irony, which can be challenging for Naive Bayes classifiers to detect. These devices can lead to a text appearing positive when it's meant to be negative, or vice versa.

- **Context and Tone**: Naive Bayes classifiers don't consider the context or tone of the entire text, which is crucial for understanding sentiment. A positive phrase in a predominantly negative review, for example, might not be sufficient to classify the review as positive. For example, the phrase was "song is so good the actually blues brothers look dull after him" missclassified as negative. This could have been due to the presence of the word "dull" which is more common in negative reviews.

5 Conclusion

In this assignment, we explored various text classification techniques for movie reviews. We implemented and evaluated six different variations of Naive Bayes classifier, considering different feature representations and the negation feature. We also discussed cases of misclassification and the impact of specific linguistic features.