Text Classification — Sentiment Analysis (MI201 Project 3)

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Abstract—**This work presents a sentiment analysis system for short English texts and compares classical machine learning methods with a transformer-based approach. Using standard vector representations (bag-of-words and TF-IDF), we train and evaluate several classifiers and benchmark them against a model leveraging BERT embeddings. Results are reported with accuracy and macro-F1, highlighting differences in performance, robustness, and computational cost. The study provides practical guidance on selecting an appropriate sentiment classification pipeline under typical resource constraints.**

Index Terms—**sentiment analysis, NLP, text classification, TF-IDF, BERT**

I. INTRODUCTION

Sentiment analysis of short texts becomes fundamentally important when perceptions are considered a critical information asset for product and service owners [1]. This is especially relevant in the development of emotion-driven systems, which can yield meaningful insights to improve the user or customer experience. For example, these insights can lead to adjustments in customer-support strategies or to more targeted marketing campaigns [2]. As a conceptual input for such improvements, search systems or sentiment-analysis approaches can be adapted to focus on the emotions expressed by the target population. In this context, social networks—and more specifically short messages such as tweets and comments on multimedia platforms—are among the most commonly used sources for conducting this type of analysis.

This project focuses on the automatic sentiment analysis of short English texts. First, an exploratory phase is conducted in which the dataset content is preprocessed, and a preliminary analysis of the information is performed using traditional machine-learning methods. Subsequently, the classification stage is carried out with standard classifiers such as Naive Bayes, Logistic Regression, and Linear SVM, using multiple text representation schemes, including bag-of-words, word-level TF–IDF, and character-level TF–IDF. Model performance is reported using accuracy, macro-F1, and complementary metrics to ensure a fair comparison.

Next, a multilayer perceptron (MLP) trained on vectorized text is evaluated, and an alternative based on BERT embeddings is studied to capture contextual semantics. To this end, the performance of MLP models built for each vectorization approach is compared across four network architectures, each adapted to the amount of information provided by the corresponding vectorizer or by BERT, and oriented toward a final three-class classification. In addition, an appropriate depth is defined according to the level of detail in the input representation in order to reduce overfitting on the training data. Dropout layers are also incorporated between hidden layers to further control overfitting and overtraining.

Finally, in order to improve message classification, strategies based on large language models (LLMs) were evaluated by using the API version of the Gemma 3-ab-it (Gemini) model to compare its performance as a short-text classifier against the previously trained models. In addition, LoRA was used to perform an efficient fine-tuning of BERT-based transformers [3].

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ACKNOWLEDGMENT

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