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# CS 584: DETECTING DISCUSSION TOPICS AND SENTIMENT IN REDDIT THREADS

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## ABSTRACT

The goals of this project are to successfully break down and discover topics as well as sentiments to those topics within Reddit threads. Doing this successfully would make research far easier as instead of having to manually read through reddit threads for research this algorithm could find the general purpose of the discussion for the user.

## 1 Introduction

Understanding online discussions is crucial for tracking public sentiment and discourse. This project aims to identify the core topic of Reddit discussion threads and determine whether users express positive or negative sentiment towards it. Social media analysis has significant implications for policymakers, businesses, and researchers by revealing trends, controversies, and public opinion shifts. Using the Reddit Russia-Ukraine Conflict Dataset from Kaggle, we will apply topic modeling to extract discussion themes and sentiment analysis to classify attitudes. The project will focus on: Extracting key topics from Reddit threads and analyzing sentiment towards those topics.

## 2 Related Work

Understanding discussion topics and sentiment in online forums is a well-explored area in Natural Language Processing (NLP), with applications in social media monitoring, opinion mining, and misinformation detection. Language models help predict and analyze textual patterns. N-gram models, which consider sequences of words, have been used to identify frequent terms and phrases in discussions. However, they struggle with long-range dependencies and require smoothing techniques to handle unseen words. Sentiment classification is commonly performed using lexicon-based methods, machine learning models, or deep learning approaches. Pretrained transformers like BERT and RoBERTa have significantly improved sentiment detection, particularly in handling sarcasm, ambiguity, and domain-specific language. Most prior research focuses on either topic detection or sentiment analysis separately, rather than integrating them to understand sentiment toward specific discussion topics. Additionally, sentiment models often struggle with contextual meaning shifts in long discussion threads, where users respond to evolving narratives. Building on prior work, this project will: Combine topic modeling with sentiment analysis to provide context-aware sentiment classification, leverage transformer-based models to improve accuracy in real-world Reddit discussions and evaluate performance on large-scale datasets like the Reddit Russia-Ukraine Conflict Dataset from Kaggle.

## 3 Methodology

To detect topics, we model each Reddit post  $\mathbf{x}_i$  as a vector in  $\mathbb{R}^d$  (e.g., using TF-IDF or bag-of-words). We then treat topic detection as a multi-class classification problem, learning parameters for each topic  $k$ . Specifically, we use *softmax logistic regression*:

$$P(y = k \mid \mathbf{x}_i) = \frac{\exp(\mathbf{w}_k^\top \mathbf{x}_i)}{\sum_{c=1}^K \exp(\mathbf{w}_c^\top \mathbf{x}_i)},$$

where  $K$  is the total number of topics.

For sentiment analysis, we instead perform *binary classification* (positive vs. negative) via *sigmoid logistic regression*:

$$P(y = 1 \mid \mathbf{x}_i) = \sigma(\mathbf{w}^\top \mathbf{x}_i) = \frac{1}{1 + \exp(-\mathbf{w}^\top \mathbf{x}_i)}.$$

In both cases, we minimize the cross-entropy loss with respect to the model parameters using gradient descent.

## 4 Experimental Setup

In this section, we outline how we design our experiments to assess whether logistic regression and feed-forward neural networks can accurately determine the topic and sentiment of Reddit discussions. We pose two main questions: (1) Can a multi-class logistic regression model or MLP effectively identify discussion topics? and (2) Does a binary logistic regression or MLP model suffice for accurate sentiment classification? To answer these questions, we specify our chosen dataset, define relevant evaluation metrics, and compare against several baseline methods.

### 4.1 Data

Our experiments use the publicly available Russia-Ukraine Conflict Dataset from Kaggle, which comprises Reddit threads spanning various time periods and subreddits. Each post contains user-generated text along with metadata such as timestamps and subreddit names. For our specific experiment, we focus on a subset of roughly 50,000 posts. Before modeling, we perform standard text preprocessing: removing punctuation, converting to lowercase, and tokenizing. We then transform each post into a TF-IDF vector to capture term frequency while adjusting for globally common terms.

### 4.2 Evaluation Metrics

**Topic Classification (multi-class).** We primarily measure *accuracy*, defined as

$$\text{Accuracy} = \frac{\text{Number of correctly classified samples}}{\text{Total number of samples}}.$$

Additionally, we compute a *macro-averaged F1* score, which is especially useful for imbalanced topic distributions.

**Sentiment Analysis (binary).** Here, we report *precision* ( $P$ ), *recall* ( $R$ ), and *F1*, where

$$F1 = 2 \times \frac{P \times R}{P + R}.$$

Precision captures how many predicted positives are correct, whereas recall indicates how many actual positives were identified, with *F1* balancing both.

### 4.3 Comparison Methods

To contextualize our results, we compare our approach against several baselines:

1. **Naïve Bayes (NB)** [1] — a classic probabilistic classifier that is often a strong baseline for text classification.
2. **Support Vector Machine (SVM)** [2] — a popular discriminative method known for handling high-dimensional feature spaces, making it ideal for text data.
3. **Random Forest (RF)** [3] — an ensemble method using decision trees, offering robustness to overfitting.

We selected these methods for their widespread usage in NLP classification tasks and their interpretability, allowing us to highlight differences in performance and computational efficiency against our logistic regression and MLP solutions.

## 5 Results

Will be completed for the final submission as denoted by project guidelines in canvas modules

## References

<https://www.kaggle.com/datasets/tariqsays/reddit-russiaukraine-conflict-dataset>