The Topic-Sentiment Analysis and Relevance System (TSAR)

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OUR TEAM

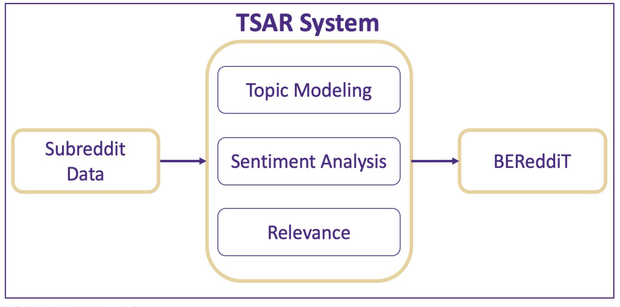
Our team is composed of 4 incredible UW MSDS students, Preston Stringham, Andrew Zhou, Hasnah Said, and Sai Muktevi. Our backgrounds include software development, mathematics, and information technology.

INTRODUCTION

The TSAR system is a data pipeline that utilizes Natural Language Processing (NLP) techniques to identify conflicting viewpoints on Reddit.com. Reddit.com is an online platform where people can come together to share news, discuss different topics, and comment on others posts or comments. Reddit is made up of more than two million communities, each community is known as a 'subreddit' and is dedicated to a specific topic.

To uncover conflicting viewpoints in subreddits, TSAR system leverages the transformer-based machine learning technique Bidirectional Encoder Representations from Transformers (BERT) for topic modeling, sentiment analysis, and relevance scores to measure the similarity between posts and their comments. The findings from our TSAR system will be displayed on a visualization dashboard: BEReddiT.

METHODOLOGY



The TSAR System Pipeline

Dataset: Subreddit Corpus

Our dataset consists of 50 subreddits that were scraped using Asynchronous Python Reddit API Wrapper (AsyncPRAW) with the following configurations due to API limitations:

> Latest posts categorized as 'hot' by reddit were used
> Maximum of 1,000 posts per subreddit
> Maximum of 100 comments per post
> Maximum of 10,000 comments per subreddit

The raw data is passed into a preprocessor module to transform the data into a format that can be understood and analyzed by the TSAR system. The preprocessor module produces a subreddit dataframe, post dataframe, and a comments dataframe.

Components of the TSAR System:

Topic Modeling: What are posts talking about?

Our topic modeling component uses BERTopic to generate topics for posts and comments. BERTopic is a technique that leverages transformers (BERT embeddings) and a custom class-based TF-IDF to create dense clusters to produce easily interpretable topics. The three stages of our topic modeling component is illustrated below:

BERTopic topic modeling stages

Sentiment Analysis: Can we identify conflict with sentiment?

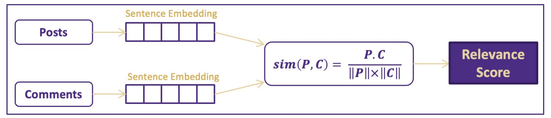
> The sentiment analysis component is implemented using the pretrained Hugging Face Transformers model: 'nlptown/bert-base-multilingual-uncased-sentiment'. This model is fine-tuned for sentiment analysis in six languages. It predicts the sentiment of each post's body text and comments as a rating between 1 (negative) and 5 (positive). Each submission is assigned a sentiment score for each rating and the rating with the highest score is deemed as the sentiment for that submission.

> We believe posts and comments sentiment set the tone for discussion and negative comment sentiment might indicate conflict.

Relevance Analysis: Are the comments in the discussion relevant to the post?

The final component in our TSAR system finds how relevant the comments are to the original post. We used cosine similarity and BERT embeddings to find the relevance scores for each comment.

> **Cosine Similarity:** We used this to determine how similar the comments are to their posts is cosine similarity. Mathematically, it measures the cosine of the angle between two vectors projected in a multi-dimensional space. The two vectors that are used in this component are the sentence embeddings (obtained by a BERT model) of the comments are to their posts.



Relevance score using cosine similarity

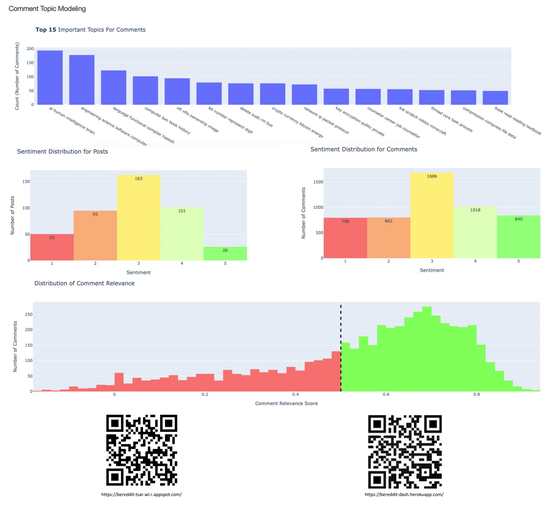
> **One-Sample Wilcoxon Test:** This test is used to determine comment relevance for the entire subreddit. This test is the p-value obtained from a one-sample Wilcoxon test with the alternate hypothesis: subreddit median relevance < 0.5; having a p-value less than 0.10 leads us to conclude that we have enough evidence to believe that comments are not relevant to their posts.

RESULTS

BEReddiT: TSAR Dashboard

Using the Python package Dash, we created an interactive dashboard visualization of the results generated by our pipeline. Our dashboard was deployed on Google Cloud and Heroku, you can visit our app by scanning the QR codes or visiting the URL below the QR codes on your web browser.

Below are some snapshots of topic modeling, sentiment analysis, and comments relevance plots that are based on the analysis of r/computerscience as well as the QR codes:



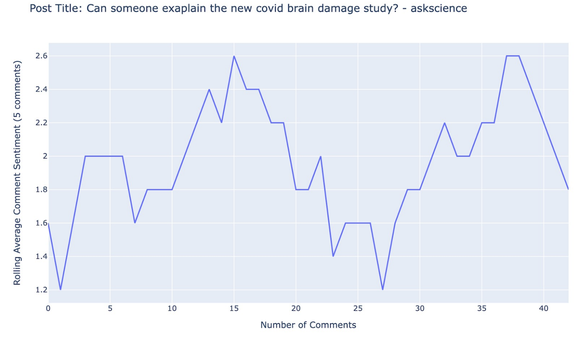
Conflicting Viewpoints: Identifying Bias, Influence and Polarizing Views

We used posts and comments sentiment scores as well as their relevance score to identify conflicting viewpoints in subreddits. We calculated the controversy score by finding how much the sentiment of a post comments deviates from the sentiment of the post itself:

$$controversy\ score = comments\ sentiment\ score - post\ sentiment\ score$$

To illustrate conflicting viewpoints, we produced the following interactive plots for a given subreddit on our dashboard:

The first plot visualizes the average comment relevance compared to the average controversy for each subreddit. This gives insight into how focused and polarizing the discussions in each subreddit is likely to be.



The second plot shows how comments sentiment change over time for a given post as more users participate in this discussion and the number of comments grow.

CONCLUSION

In this project, we have successfully implemented the Topic-Sentiment Analysis and Relevance (TSAR) system. TSAR is a complex data engineering pipeline that was developed using powerful Natural Language Processing techniques to identify conflicting viewpoints on the popular social media platform Reddit.com. We utilized BERT models from Hugging Face Transformers to implement our topic modeling, sentiment analysis, relevance scoring components. To better understand the conflicting viewpoints in subreddit, the results from our TSAR system is displayed on our visualization webapp BEReddiT.