Time-series analysis of geographic depression scores on Twitter using BERT

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Introduction:

Mental health is critical in everybody's life and unfortunately there is no easy way for health care organizations to measure the community's mental health and depression level.

With temporal and geolocation context, health organisations would be able to make important policy decisions regarding where to invest in a mental health clinic or rescue centres, since it would be clear which areas need such intervention the most. Therefore, It's important for every health care organizations to have set of tools that gives insights information about people's mental health.

Our Approach

This project uses an NLP transformer called BERT to analyze scraped twitter data and provide depression predictions on user's tweets.

Based on BERT model results, we calculated a depression score and used time-series analysis to find any trend and seasonality patterns using a 3-month moving average with seasonal decompose model.

We then developed a Tableau dashboard to present the findings using an interactive geographical heat map as well as visualizations on depression score analysis over time.

Are we solving the problem?

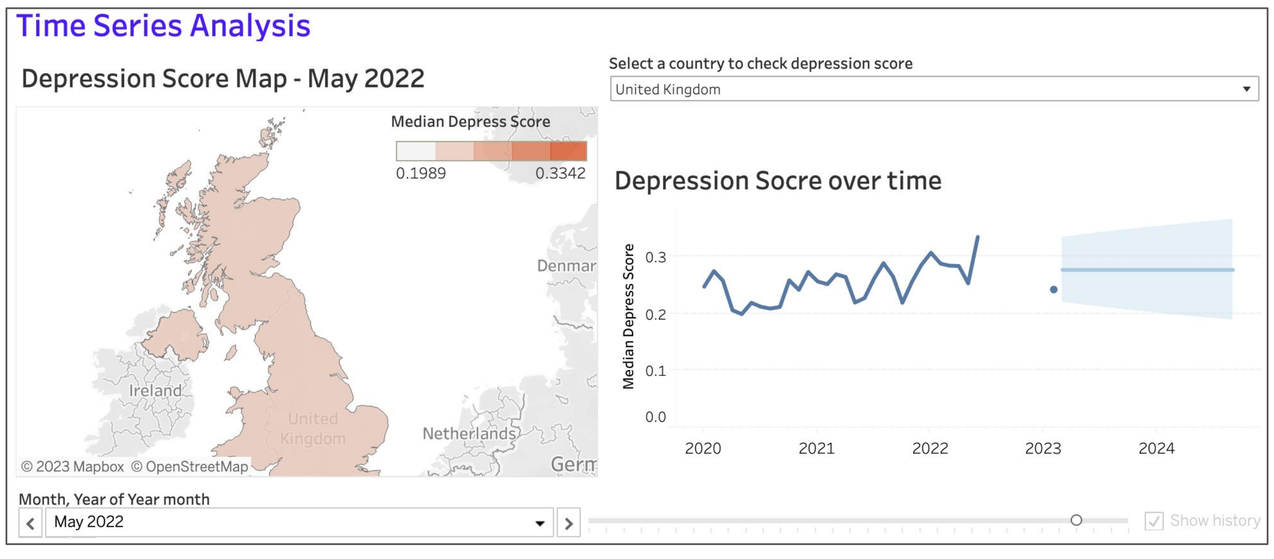
Our approach will solve the problem of little temporal and geolocation context for health organisations simply because it presents this information in an interactive visualisation so that a decision maker in the health space can compare countries within regions and hence prioritise interventions based on current depression scores, and the historical trend over time.

Innovations with our approach:

Two value enhancing innovations are proposed:

1. Integrate time series analysis with BERT prediction results to provide healthcare organizations with more contextual information on the trend and seasonality of depression tweets by country.
2. Develop an interactive visualization tool enabling healthcare users to identify patterns of depression in the country of interest. By doing so, this tool will help healthcare organizations to plan and prepare their resources more effectively.

See full dashboard here: Depression Detection with BERT using Twitter Data



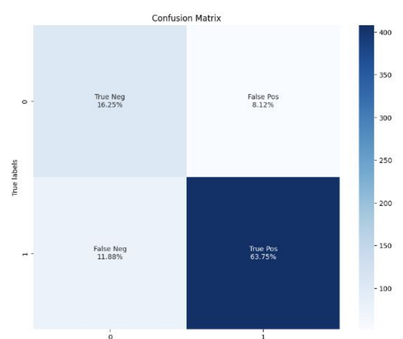
Data:

We obtained the data by scraping twitter using code found on GitHub. The scraper targeted tweets using the hashtag "depression" and the data was stored in JSON files. The raw JSON dataset's size is approximately 3,5 GB, comprising of "922,949" tweets from 2020-2023. To extract relevant information from the dataset, we focused our analysis on several key features including "Tweet content," "Tweet date," "Tweet hashtags," "Retweet count," "Favorite count," and "Locations.

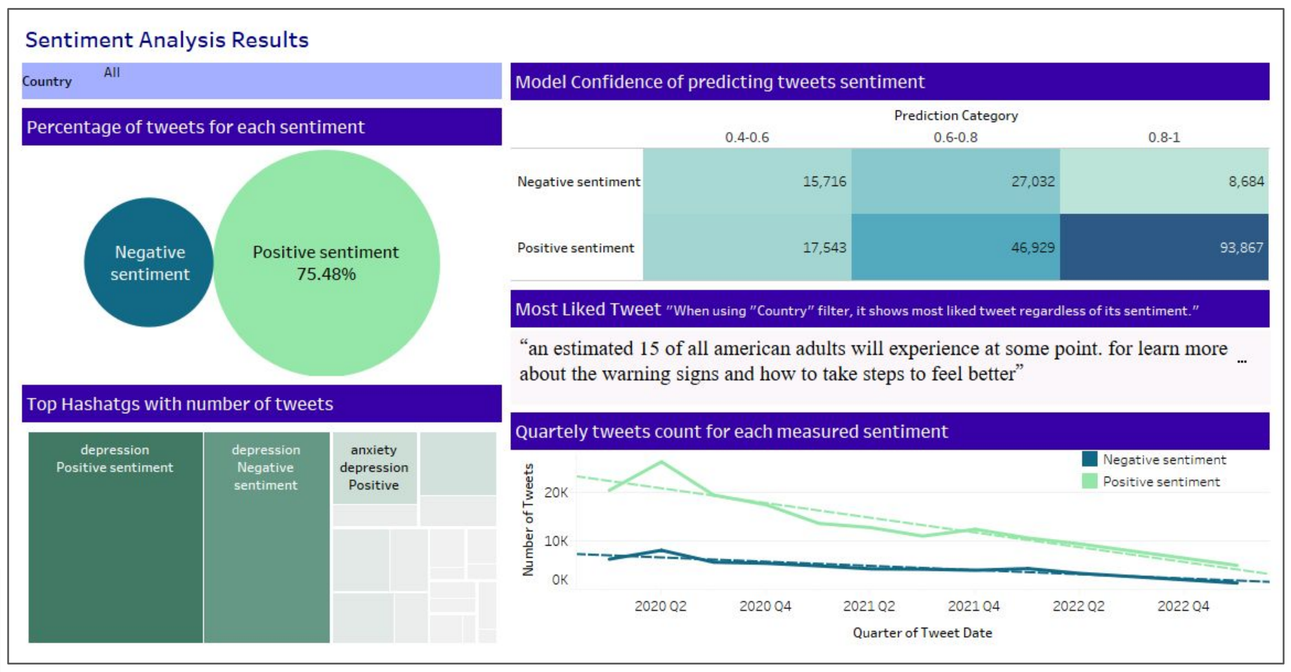
Experiments and results:

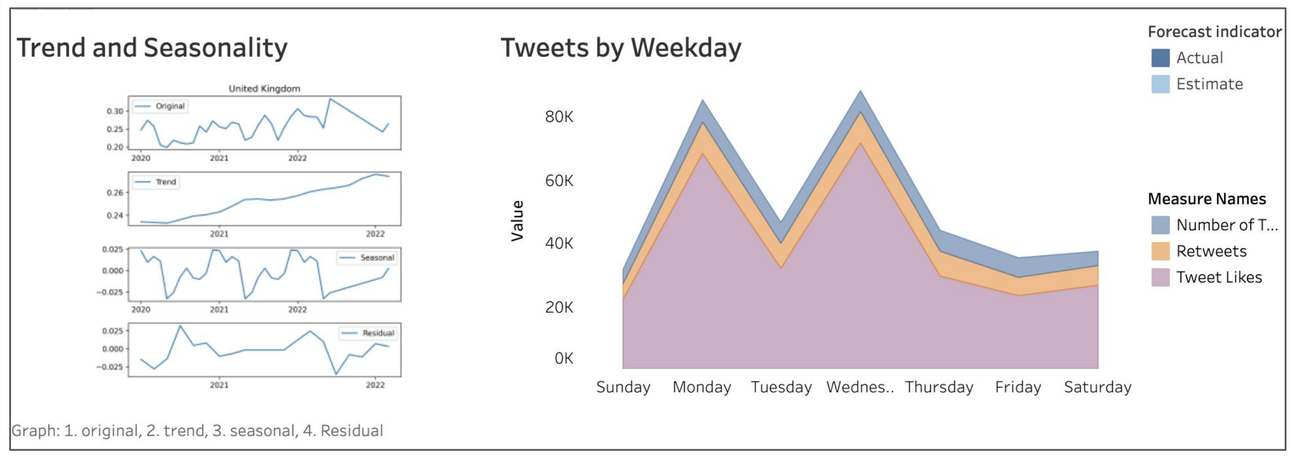
The model was trained on subset of the data and achieved a high accuracy of 80%. BERT was fine-tuned using a training set and evaluated on a testing set using metrics like accuracy, precision, recall, and F1-score, see the next table:

	Precision	Recall	F1-Score
0	0.58	0.67	0.62
1	0.89	0.84	0.86
Accuracy	0.8	0.8	0.8
Macro avg	0.73	0.75	0.74
Weighted avg	0.81	0.80	0.80



From the table; the model has a high accuracy of 0.80, but the precision for negative classification is low at 0.58. However, the precision for positive classification is high at 0.88, and the recall values for both classes are relatively high, indicating that the model is able to identify positive and negative instances to a large extent. The F1-score values for both classes are also relatively high, although lower for positive classification. Additionally, we used a confusion matrix (check above) to evaluate the model performance.





Graph: 1. original, 2. trend, 3. seasonal, 4. Residual