MoodTwt: An Application for Sentiment Analysis of Bilingual Tagalog-English Trending Twitter Topics Using Softmax Regression

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***Abstract*— MoodTwt is an Application for Sentiment Analysis of Bilingual Tagalog-English Tweets using Softmax Regression. Given an input topic, tweets regarding that topic are gathered and labelled whether they have a positive, neutral, or negative sentiment. Softmax Regression is also called Multinomial Logistic Regression and was used as the machine learning algorithm. With 19,458 tweets as the training data that were manually tagged, the machine learning model was able to achieve an accuracy of 82.12%, precision of 82.11%, recall of 82.13%, and F1 of 81.97%, well within the 70%-90% range of acceptable industry standards. The application is able to display the most common sentiment for each topic, with a graph that shows the date the tweet was posted and the confidence of the model of the predicted sentiment of a specific tweet.**

***Index Terms*— Sentiment, Sentiment Analysis, Natural Language Processing, Web Scraper, Machine Learning, Tokenization, Social Media, Algorithm**

I. Introduction

The internet has become the world's largest collection of unfiltered human opinions, especially on social media. Twitter is one of the biggest social media platforms in the world, with it being the top 5 social media platform in the Philippines (Statista Research Department & 23, 2022). Twitter is a website where people can post their thoughts with 280 characters. These posts, called *tweets*, can sometimes appear on the trending list depending on the number of posts with the same hashtags or words that appear on the tweet. With millions of posts per day, there has been growing interest in using tweets to be able to gauge the opinions of the public on specific topics.

Sentiment Analysis typically gives an output based on a given text on whether an opinion has an emotion of positive, negative, or neutral. Most of the sentiment analysis performed is usually on predominantly English text, while there is little research on bilingual Tagalog-English sentiment analysis. There are some websites that offer sentiment analysis on tweets, but none that offer sentiment analysis for the bilingual mode that Filipino twitter users usually post on.

This research aims to create an application, called *MoodTwt*, that will be able to provide users with the sentiments of topics in the Philippines on Twitter. The results of a manual sentiment analysis and using machine learning will be compared to determine its accuracy. With this application, users can learn what the public's opinions on a specific topic and each specific tweet whether it leans positively, negatively, or neutral.

A. Background of the Study

Sentiment analysis is used to measure the emotions or perceived opinions on a given set of words, which are used to drive decisions. Sentiment analysis can use a lexicon-approach, a dictionary where each words have their own scores

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on their positivity, negativity, and neutrality, and polarity values. It can also use supervised machine learning, where given a set of tweets that has already been labeled as either positive, negative, or neutral, it can classify a new set of data. Using a Filipino-English bilingual lexicon like FilCon (Keen, 2015) or a machine learning algorithm like the *Softmax Regression* algorithm, it can be used to process the information that has been inputted, which will output the sentiment of the given info. By using a web scraper for Twitter to collect tweets, sentiment analysis on the topics is possible. The application in this study would be able to produce the sentiments of a given topic of Filipino-English bilingual tweets using a supervised machine learning model using Softmax Regression.

B. Statement of the Problem

There is little work on Bilingual Tagalog-English application that can produce the public sentiment on different Filipino topics on Twitter, specifically, using sentiment analysis that can determine a topic's sentiment whether it is positive, negative, or neutral.

C. Objectives of the Study

This study aims to develop an application that can analyze public sentiments on Philippine Twitter topics whether they are positive, negative, or neutral with sentiment analysis with a supervised training machine-learning model using Softmax Regression. Specifically:

1) : Develop a machine-learning model that uses Softmax Regression within industry standards, 70%-90% accuracy (Barkved, 2022).

2) : Develop an application that allows users to find the public's sentiments on Philippine Twitter topics and display the results in a satisfactory manner.

D. Significance of the Study

Having an easy-to-access application that can perform sentiment analysis will help students have an easier time conducting studies on Tagalog-English bilingual Twitter. It will also help corporations gauge the public's opinion on their own products and make them act accordingly. Learning the reactions of Filipino netizens on specific government policies and actions will help officials to pursue fairer laws and policies. A regular citizen can use this app if they are simply curious about the current sentiments of fellow citizens on the topic they are interested in.

E. Definition of Terms

1) Sentiment: an opinion, attitude, or judgement on a specific topic.

2) Sentiment Analysis: a natural processing language technique for determining a data's sentiment, usually categorized as being positive, negative, or neutral.

3) Natural Language Processing: NLP for short, is a field of computer science involving the computer processing of human language.

4) Machine Learning: a program that can learn to act in a certain way using a set of data.

5) Tokenization: in NLP, breaking down text data into smaller units for NLP methods.

6) Program: a set of instructions that a computer follows.

7) Algorithm: a set of instructions that is followed to perform computations.

8) Application: a program that is designed and written for specific purposes of a user.

9) Satisfaction: the fulfillment of a user's expectations.

F. Scope and Delimitations

There is expected to be around 20,000 training data for the sentiment analysis machine learning model with the given time frame of data collection. The model is also expected to perform analysis on foreign data such as different languages or gibberish. The number of respondents for the satisfaction survey is expected to be below 30. The scraper is also based on Twitter's search engine.

II. Review of Related Literature

The internet has become the new gold mine of the 21st century due to the massive amounts of data that has been pouring on every website. This led to the development of sentiment analysis, translating the human emotions from the vastness of the internet (Wright, 2009). Sentiment analysis has been performed on different kinds of data such as news articles, Facebook comments, Twitter posts, etc.

There are multiple challenges in the field of sentiment analysis (Xia et al., 2011). There are some words that can be used subjectively and objectively like the word "crude" in a description, or a type of oil. Some words can have different connotations on different contexts, like in the study of Pacol and Palaoag (2021), where the word "fast" is generally positive, but negative a teaching context. Two objects can also be described with different sentiments in the same sentence, called entity recognition. Sarcasm detection, where a person says the opposite of what they really mean, has been one of the main sources of errors in accuracy detections in sentiment analysis studies. Thwarted expressions are phrases that have a sentiment value that is opposite of what it truly conveys once the full expression has been combined. This can be frequent in Twitter because of the limitation of character number, where people will post a reply to their tweets to continue their train of thought. The main challenge that this paper will pursue is contribution to the lacking number of sentiment analysis research conducted in non-English data.

The method of analysis can be different with varying amounts of use and accuracy. In the study by Kharde and Sonawane, (2016), they compared the different sentiment analysis techniques on English Twitter data. There are four main approaches to sentiment analysis, which are machine-learning based, lexicon-based, cross-lingual, and cross-domain approaches. Their study has found that machine-learning based approaches such as Support Vector Machines (SVM), Naïve Bayes, and Logistic Regression have the highest accuracy.

These different methods have been applied to the sentiment analysis topics that focuses on the Philippine setting. Torio et al. (2018) conducted a sentiment analysis on the implementation of the Kto12 program of the Philippines, a program where the education system has been changed. Using SVM machine learning, they have found that 64% of the sentiments on the topic are positive while 36% are negative. Bilog (2020) conducted a sentiment analysis study on Filipino, English, and Taglish comments on Facebook using Naïve Bayes. C.K Pastor (2020) conducted a study on the sentiments of students on the Synchronous Online Delivery of Instruction during the quarantines due to the COVID-19 pandemic using an API for sentiment analysis. Pastor gathered data using surveys and found that majority of students are unpleased with the situation. Some studies like Pacol and Palaoag (2021) and Imperial et al. (2018) conducted sentiment analysis using a lexicon produced by Keen et al. (2015) called FilCon, which has 22,380 words based on Filipino-English bilingual dictionaries. FilCon uses polarity values aligned to SentiWordNet 3.0 (Baccianella et al. 2010), a lexicon that is publicly available for sentiment analysis usage. Macrohon et al. (2022) used a semi-supervised approach to analyze Philippine Presidential Election 2022 tweets using Multinomial Naive Bayes and yielded an accuracy of 84.83%. The tweets they classified are similar to this study, which are Tagalog and English into positive, negative, and neutral polarities. Ramadhan et al. (2017) used Softmax Regression to perform sentiment analysis on tweets about Jakarta's Governor Election and achieved an accuracy rate of 74

There are some websites that offers sentiment analysis. MonkeyLearn is a website that offers a sentiment analysis API that can conduct batch sentiment analysis using machine learning models (Pascual, 2019). Sentiment Viz is a website where a user can input a keyword and produce the sentiment analysis on that specific topic on Twitter, where it produces a visual heatmap of the sentiments of 300 gathered tweets (Ramaswamy & Healey, 2019). While Sentiment Viz is comprehensive with its visuals, they are limited to the English language. MonkeyLearn was considered for the study but the free API limits queries available per month.

Mananghaya & Albacea (2019) has proposed a method

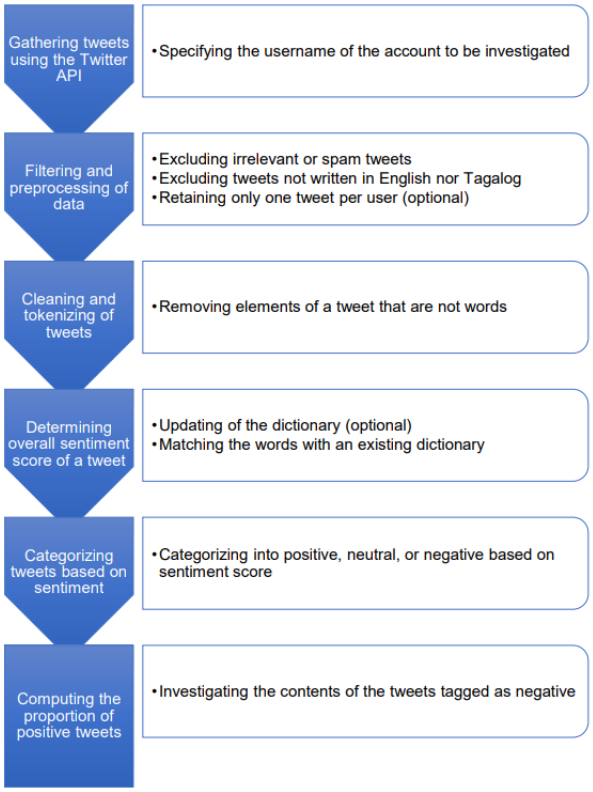

Fig. 1. Flowchart for conducting sentiment analysis studies

for estimation of customer satisfaction on the services of the Philippine Department of Foreign Affairs using sentiment analysis. This study will closely follow the flowchart of the methodology of this study and apply it to a service that can provide the proportion of sentiments for a specific topic on Filipino-English bilingual Twitter.

To be able to know if the sentiment analysis model has good performance, Barkved (2022) states that anything greater than 70% is a great model performance and 70%-90% accuracy is realistic in industry standard.

To measure the satisfaction of users on the application, Kiradoo, G (2020) has recommended the use of survey methods such as Customer Satisfaction Score (CSAT), Customer Effort Score (CES), and Net Promoter Score (NPS). This study will use CSAT and according to the American Customer Satisfaction Index, a good CSAT score for computer software is 76% (Birkett, 2021).

III. Methodology

A. Technologies

1) Twint: Twint is a Twitter scraping tool written in Python that can scrape tweets from specific users, topics, hashtags, and trends without gathering sensitive information like emails and phone numbers (Poldi, 2017). This tool can gather up to 3200 tweets per query. By entering a specified topic, users can gather data that the regular Twitter API doesn't allow, and it can be used without user authentication.

2) Pandas: Pandas is a Python library built for data manipulation and analysis. This will be used to hold the data that will be used for training and testing.

3) Natural Language Toolkit: Natural Language Toolkit (NTLK) is a library for natural language processing written in Python. This library will be mainly used in this study for preprocessing of the dataset by cleaning and tokenizing tweets.

4) Scikit-learn: Scikit-learn (sklearn) is a free machine learning library for Python. It offers various algorithms which can be used for the creation of AI models. This study will be using sklearn to split the dataset into train-test, create a TfidfVector, and the Softmax Regression algorithm for the model to train the sentiment analysis machine.

5) Streamlit: Streamlit is a python-based framework for app-building, built specifically for Data Science and Machine Learning. This will be used for the front end of the application.

B. Preprocessing and Statistical Treatment

tweet	sentiment
@binjinganda143 @PrincessYelena Ng lunar eclipse kz kaya ganyan intindihin n lng ntin claâœŒï¸â,âœŒï¸â,	negative
I'm still moody, bitter, and salty from not seeing that total lunar eclipse. Ako na nga lang mag-glow. Chariz. Lol. Bye.	negative
hindi ko na manage i document from the start. https://t.co/W3LblAEWnr	negative
moon bleeds red as it passes through the Earthâ€™s shadow on November 8, 2022â€"the final total lunar eclipse until 2025. https://t.co/L35OUmgydi	neutral
at 5pm onwards before lunar eclipse https://t.co/KgRNYOHCYp	neutral
are the statues of saints atop the main building. UST is the oldest existing Catholic institution of higher learning in all of Asia. https://t.co/1D8Bc45Aqt	neutral
curiosity towards astronomy. ðŸ¤ðŸ'« To satisfy your inquisitive intellect, here's our ChEknow trivia this November relating to astronomy. https://t.co/JUXy0VEhu8	positive
November 08 - Lunar Eclipse sighting sa UPLB Freedom Park (had fun looking sa telescope galing huhu) https://t.co/qqRvn3RDVn	positive
Just sharing my lunar eclipse experience which I did in a cemetery (where my dad is). We used to observe the night skies and so I wanted to share this with him to remember the old times. @Edwelda @lunareclipse @stargazing @astronomy https://t.co/eKEOC2z5KU	positive

Fig. 2. Sample Tweets from the Training Dataset

1) Data Collection: The training dataset, comprised of a total of 19,458 tweets were gathered using modified pre-existing data sets on Tagalog and English tweets such as the *hate_speech_filipino* data set (Cheng, 2019), neutral tweets from the *Pre-processed Twitter tweets* data set (Yadav, 2017),

and personally gathered tweets using Twint, with its location configured around the Manila area such that the scraper only receives Tagalog-English tweets. These tweets were from Philippine trending topics from August 2022 to Novemeber 2022. Some of these topics include *"EDSA Busway", "PVL2022", "National ID", "FirstDarna", "RunBTSComeback", and "ZAYN MALIK"*. Each tweet is manually-classified into three categories: positive, negative, and neutral using prior researches as guidelines on how to label the tweets. This data set will be split by *sklearn's train_split* method and be used to build the sentiment classifier model.

A new data set for testing manually (valid dataset) was created that was not from the *sklearn's train_split*. This was done by grabbing tweets from new trending topics from Twitter, namely *BerMonths* and *Leni Robredo*.

2) Cleaning and Filtering of Tweets: After building the training dataframe, a new column named *filtered_tweet* is created. Special entities along with its accompanying word from the tweets like hashtags (#) and mentions (@) have been removed. Links were also removed. Then, every word has been converted to lowercase for easier processing in the vector space.

$$tf\,idf\,(t, d, D) = tf\,(t, d)\,.\,idf\,(t, D)$$

Where:

$$tf\,(t, d) = log\,(1 + freq\,(t, d))$$

$$idf\,(t, D) = log\,(\frac{N}{count\,(d \in D{:}t \in d)})$$

Fig. 3. TF-IDF formula

3) Feature Extraction: Feature extraction transforms data into quantifiable numbers that can be performed on by machine learning algorithms. This can be done through tokenization and vectorization of the data.

To tokenize the tweets, stop words were removed first using NLTK's English stop words that contains words such as "and", "the", "a", "an" etc. A Tagalog stop word corpus by Gene Diaz (2016) was also added, which contains words such as "ako", "at", "dahil", "ka", etc. Word Tokenization, also called unigrams, was used where single words are used for building the vector dictionary.

TF-IDF, short for Term Frequency - Inverse Document Frequency, is used as the vectorizer to transform the tokenized tweets. This statistical measure is used to quantify the relevance of a word in a document (tweet) in a set of documents (Stecanella, 2019). The figure above shows the calculated TF-IDF score for the word t in a document d from a document set D. *sklearn's TfidfVectorizer* function was used.

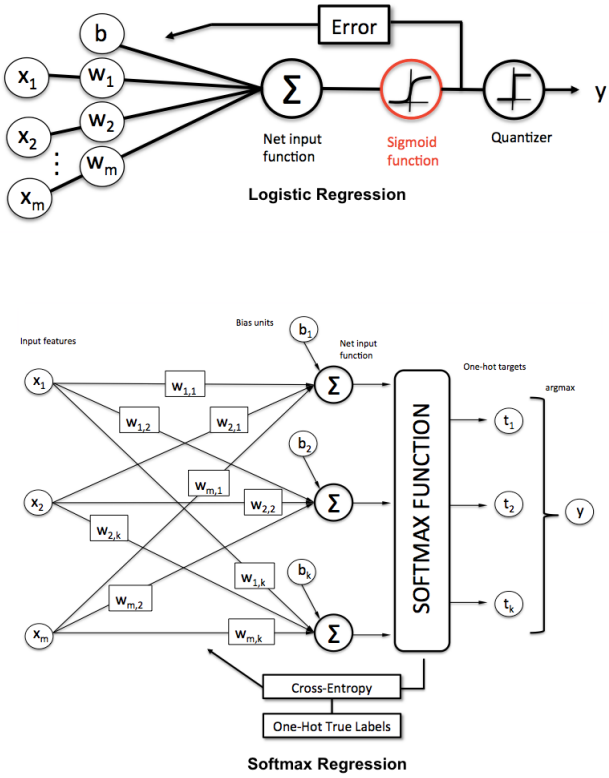

Fig. 4. Softmax Regression and how it relates to Logistic Regression

4) Multinomial Logistic Regression: Multinomial Logistic Regression, also known as Softmax regression, is a supervised machine learning algorithm used for classification problems of mutually-exclusive classes where the output can be more than two possible values (Raschka, 2016). It is called Softmax regression because the sigmoid function is replaced with the softmax function. *"The softmax function computes the proba-*

$$P(y = j \mid z^{(i)}) = \phi_{softmax}(z^{(i)}) = \frac{e^{z^{(i)}}}{\sum_{j=0}^{k} e^{z_k^{(i)}}},$$

where we define the net input z as

$$z = w_0 x_0 + w_1 x_1 + \ldots + w_m x_m = \sum_{l=0}^{m} w_l x_l = \mathbf{w}^T \mathbf{x}.$$

(w is the weight vector, x is the feature vector of 1 training sample, and w_0 is the bias unit.)

Fig. 5. Softmax function

bility that this training sample x(i) belongs to class j given the weight and net input z(i). So, we compute the probability p(y = j — x(i); wj) for each class label in j = 1, . . . , k." Since the application will try to predict a tweet's sentiment into positive, negative, and neutral, this algorithm is appropriate. *sklearn's LogisticRegression* function with *multi_class="multinomial"* was used.

5) Performance Measure: To measure the performance of the supervised training machine learning model, four indexes can be used according to Kharde and Sonawane, (2016), which are accuracy, precision, recall, and F1:

$$Accuracy = (TP + T + TN)/(TP + T + TN + FP + F + FN)$$

$$Precision = TP/(TP + T + TN)$$

$$Recall = TP/(TP + F + FN)$$

$$F1 = (2 * Precision * Recall)/(Precision + Recall)$$

Accuracy measures the true predictions from the entire data set, precision measures the true positives from the true predictions, recall measures how many true positives does the model label as positive, and F1 is a balance for precision and recall (Shung, 2020). These can be calculated using these values from a confusion matrix of the results.

	Predicted Positive	Predicted Neutral	Predicted Negative
Actual Positive	True Positive (TP)	False Neutral(F)	False Negative (FN)
Actual Neutral	False Positive (FP)	True Neutral (T)	False Negative (FN)
Actual Negative	False Positive (F{)	False Neutral(F)	True Negative (TN)

Fig. 6. Confusion Matrix

This will be used on manually validated data sets, while *sklearn's built-in score* method will be used for the training dataset.

6) Application Satisfaction: A survey on Google Forms has been prepared for test users to measure the satisfaction on the application using CSAT. The questions are: "How satisfied are you with the sentiment analysis application?" and "How satisfied are you with the user interface?". Both questions are answered by a rating of 1-5, where 1 is "Very Unsatisfactory" and 5 is "Very Satisfactory". The CSAT formula, CSAT (%) = (Number of satisfied users / Total Respondents) x 100, where the number of satisfied users is how many scores are 4 and 5, is then applied. The users are mainly college students.

IV. Results and Discussion

After data preparation and pre-processing, the total number of tweets were 19,458. *sklearn's train_split* method that splits the tweet data set into 70% training and 30% testing was used to build the classifier model.

A. Model Performance

```
Accuracy: 0.8212685280937607
F1 score: 0.8196971130636078
Recall: 0.8212685280937607
Precision: 0.8211144927639213

Classification report:
              precision    recall  f1-score   support

          -1       0.88      0.86      0.87      2372
           0       0.76      0.66      0.70      1215
           1       0.79      0.87      0.83      2215

    accuracy                           0.82      5802
   macro avg       0.81      0.80      0.80      5802
weighted avg       0.82      0.82      0.82      5802
```

Fig. 7. *train_test_split* metric scores

Using *sklearn's metrics* library, the accuracy, precision, recall, and F1 score of the model was computed. The accuracy was 82.12%, Precision was 82.11%, Recall was 82.13%, and F1 was 81.97%.

For valid testing, the model predicted the sentiments of gathered tweets from *BerMonths* and *Leni Robredo*. For *BerMonths*, the accuracy was 88%, Precision was 77.27%, Recall was 85%, and F1 was 80.95%. For *Leni Robredo*, the

tweet	sentiment	pred_sent	True Posit	True Neut	True Nega	False Posi	False Neut	False Negi	Accuracy	0.78
Remind lang natin si Mark Lopez na tinawag na	negative	negative	0	0	1	0	0	0	Precision	0.564103
Calling Leni Robredo Lutang and Madumb like	negative	negative	0	0	1	0	0	0	Recall	0.709677
@_rainbowfighter @lenirobredo Sauce,	negative	negative	0	0	1	0	0	0	F1	0.628571
"Dr. Atty. Leni Robredo" Doctor daw, pero walang	negative	negative	0	0	1	0	0	0		
When you dont have to weaponize troll army and your credentials speak for themselves. VP Leni	positive	negative	0	0	0	0	0	1		
@pads_nosi @lenirobredo God is moving in ways	positive	negative	0	0	0	0	0	1		
Si Atty @lenirobredo aping api na sa mga trolls	negative	negative	0	0	1	0	0	0		
Opo. Trending po kayo My President, Atty Leni	positive	negative	0	0	0	0	0	1		
#RealTalk si @lenirobredo ang abogada at ngayon Dra. daw diumano at sang katutak ang	negative	negative	0	0	1	0	0	0		
@ElsieMaySese @hwanplatsx @lenirobredo That is why Madam yung mga Negosyo ng Pulangaw	negative	negative	0	0	1	0	0	0		
@obiwankenobi_8 @inquirerdotnet	negative	negative	0	0	1	0	0	0		
LOOK: President-reject Leni Robredo featured in National Geographic Magazine to show the rest of	neutral	negative	0	0	0	0	0	1		
@rejika22 @CrushMajor @lenirobredo	negative	negative	0	0	1	0	0	0		
@jayduane1 @CrushMajor @lenirobredo Wag na	negative	negative	0	0	1	0	0	0		
isip isip na ng bagong fake news at script para	negative	negative	0	0	1	0	0	0		
wala lang naman talaga toðŸ¤-â€™,¡, Harvard lang	positive	negative	0	0	0	0	0	1		
@lenirobredo Ang PRESIDENTE!!!!	positive	negative	0	0	0	0	0	1		
Ano po sinisilip nâ€™yo my dear Atty? ðŸ˜... Ka-	positive	negative	0	0	0	0	0	1		
@lenirobredo Most prestigious international institutions recognize the success of Atty. Leni	positive	negative	0	0	0	0	0	1		
HEY PEEPS! JUST A REMINDER!! NEVER EVER EVER EVER EVER TRUST WHAT COMES OUT OF LENI	negative	negative	0	0	1	0	0	0		
â€œTurns out, Harvard students arenâ€™t that	positive	negative	0	0	0	0	0	1		
Yass! Leni Robredo, my president!	positive	negative	0	0	0	0	0	1		
WE ARE SO PROUD OF YOU! ðŸ’— Atty. Leni	positive	negative	0	0	0	0	0	1		
@chnohernandez @lenirobredo	negative	negative	0	0	1	0	0	0		
Grabeh ka na talaga madame @lenirobredo.										

Fig. 8. Valid Table from *Leni Robredo* tweets

accuracy was 78%, Precision was 56.41%, Recall was 70.96%, and F1 was 63.85%.

B. Application

Fig. 9. Screenshot of *MoodTwt*

The application, called *Moodtwt*, is created using the model that was built using Softmax regression and *streamlit*. There are two main parts of the application, the sidebar and the main page. In the sidebar, the user can input the topic of interest and the number of tweets they want to view. In the main page, there is the main title of the application *MoodTwt: A Bilingual Tagalog-English Twitter Sentiment Analysis App* and some descriptions like what is the current topic being analyzed and the most common sentiment of the given topic by finding the mode sentiment of all the tweets.

There is also a *Sentiments Over Time* graph that displays the time of when the tweet was posted and the confidence of the label of the tweet using textitsklearn's predict_proba method. The higher the confidence of the label, the bigger

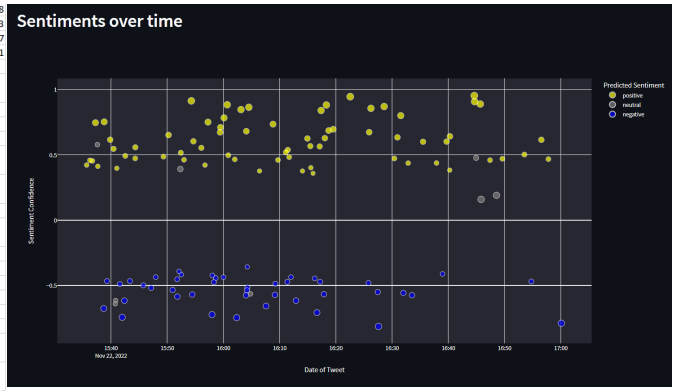

Fig. 10. *Sentiments Over Time* graph

the bubble and the closer the values are to their respective sentiment value, where 1 is positive, 0 is neutral, and -1 is negative. This way, we can view when a certain topic has differing levels of sentiment on a given time due to events that occurred that cannot be simply seen from the *Most Common Sentiment* value. The bubbles are hoverable such that the user can view the specific tweet.

Tweets

	date	tweet	pred_sentiment	confidence
0	2022-11-22T17:02:46	#PVL2022 semifinals. 🔰 ⚪ Congratulations @clndmgo, @kylenegrito , @HorsemariePower & @KylaAtienza11 of Creamline, @_RemPalma of Petro Gazz, @cgcarandang14 & @Duremdes5 of Chery Tiggo and @rachdaquis03 @GelCayuna08 of Cignal. https://t.co/shxjZbwIRA	positive	0.8243
1	2022-11-22T17:00:06	For Choco, parang Jem is the better setter but Deanna is the better player. Di na nahahabol ni Jem bola pag shank ang first ball. #PVL2022 #ChocoMucho #CMFT	negative	0.7905
2	2022-11-22T16:57:48	FINAL: Cignal defeated Choco Mucho. HD Spikers complete the semis cast joining Creamline, Chery Tiggo and Petro Gazz. @OneSportsPHL #PVL2022 https://t.co/SI20AHF2Ec	positive	0.4680
3	2022-11-22T16:56:33	Jem is a good setter pero pag blocking laglag talaga. AMBOT SA IMO COACH. #PVL2022 #CMFT #ChocoMucho	positive	0.6161
4	2022-11-22T16:54:46	Feeling ko tiga may kulam ung episode ng "I - Connect" Creamline vs Choco Mucho Nafeature si Deanna ending "TALO" F2 vs Cignal Si Aby ending "Talo" Ngayon naman CMFT vs Cignal Si DenDen nmn ending "Talo" Baka mmya si EyeWrist!!! 👀👀👀 #PVL2022 #PVLreinforcedconference	negative	0.4701
5	2022-11-22T16:53:32	Umpisa palang si Des Cheng lang gusto manalo. 😠 #PVL2022	positive	0.5031
6	2022-11-22T16:49:37	I'll praise even more when I don't understand, for I trust in the one who does. For I know I can trust you God. 🙏 This song is for you UBE gals 💜 Mahal ko kayo lahat. In God's perfect time. @CMFlyingTitans #PVL2022 https://t.co/YuSvn2jODZ	positive	0.4707
7	2022-11-22T16:48:34	#PVLReinforcedConference2022 #PVL2022 @cignalHDspiker complete a come-from-behind, 17-25, 25-22, 25-18, 24-14, win over @CMFlyingTitans to close the elims with a 5-3 card. Choco Mucho finished its campaign with a 3-5 card tied with Akari and PLDT	neutral	0.8097
9	2022-11-22T16:47:25	That slide by Madzilla tho #PVL2022	positive	0.4600
10	2022-11-22T16:45:50	Cignal downs Choco Mucho, 17-25, 25-22, 25-18, 25-14, to enter the #PVL2022 semis with a 5-3 slate and 12 points. The HD Spikers have already clinched the last semis berth even before the match ended, making the Final Four after winning two sets. @TheManilaTimes	neutral	0.8408

Fig. 11. Tweets table

There is also a Tweets table such that the user can see each specific tweet and details such as the date it was posted, the predicted sentiment value, and the confidence of the model of that predicted value.

After gathering 22 respondents, the values gathered for "How satisfied are you with the sentiment analysis application?" were 13 responses with "5", 8 responses with "4", and 1 response for "3". For "How satisfied are you with the user interface?" were 12 responses with "5", 7 responses with "4", and 3 responses for "3". With a total score of 40/44, the computed CSAT score was 90.91%.

V. Conclusion and Future Work

With an accuracy of 82.12% and a CSAT score of 90.91%, the model's performance was within the 70%-90% range of industry standard. Therefore, using Softmax Regression for the sentiment analysis of bilingual Tagalog-English trending Twitter topics is viable. With MoodTwt, there is finally an application that satisfactory for those who want to perform sentiment analysis on Philippine trending Twitter topics. The application even works for any topic in general and produces sentiment analysis with modest accuracy.

It is possible for future studies to increase the number of tweets by gathering more tweets in future trending topics in hopes of increasing the performance of the machine learning model. It is also possible in the future to use more labels for more complex sentiments instead of just positive, negative, and neutral. Since Twitter is not just text, but also has images and videos attached, future works could also factor the sentiments of the media alongside the texts that could provide additional context for sentiment analysis.

Appendix I

The GitHub link for the application is available at: *https://github.com/RonCalderon/MoodTwt*

Online version is available at: *https://roncalderon-moodtwt-search-twitter-vjp6s7.streamlit.app/*

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References

[1] Statista Research Department, & 23, M. (2022, March 23). Philippines: Most-used social media platforms 2021. Statista. Retrieved July 11, 2022, from https://www.statista.com/statistics/1127983/philippines-leading-social-media-platforms

[2] Poldi, F. (2017, June 10). TWINT - Twitter Intelligence Tool. From Github: https://github.com/twintproject/twint

[3] Pacol, C., & Palaoag, T. (2021). Bilingual Lexicon Approach to English-Filipino Sentiment Analysis of Teaching Performance. IOP Conference Series: Materials Science and Engineering, 1077(1), 012044. doi:10.1088/1757-899x/1077/1/012044

[4] Keen, D., King, N. M., Lopez, J., Mondares, A., & Ponay, C. (06 2015). FilCon: Filipino Sentiment Lexicon Generation Using Word Level-Annotated Dictionary-Based and Corpus-Based Cross Lingual Approach.

[5] Wright, A. (2009, August 27). Sentiment Analysis Takes the Pulse of the Internet. The New York Times. https://www.nytimes.com/2009/08/24/technology/internet/24emotion.html?_r=1

[6] Kharde, V., & Sonawane, S. (2016). Sentiment Analysis of Twitter Data: A Survey of Techniques. International Journal of Computer Applications, 139(11), 5–15. https://doi.org/10.5120/ijca2016908625

[7] Xia, R., Zong, C., & Li, S. (2011). Ensemble of feature sets and classification algorithms for sentiment classification. Information Sciences, 181(6), 1138–1152. https://doi.org/10.1016/j.ins.2010.11.023

[8] J. O. Torio, R. T. Bigueras and D. E. Maligat, "Sentiment Analysis on Kto12 Program Implementation in the Philippines," 2018 Fourth International Conference on Advances in Computing, Communication & Automation (ICACCA), 2018, pp. 1-5, doi: 10.1109/ICACCAF.2018.8776852.

[9] Pastor, C. K. (2020). Sentiment Analysis of Filipinos and Effects of Extreme Community Quarantine Due to Coronavirus (COVID-19) Pandemic. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3574385

[10] Imperial, J. M., Orosco, J., Mazo, S., Maceda, L., Oco, N., & Roxas, R. (06 2018). A Filipino-English disaster sentiment polarity lexicon.

[11] Baccianella, S., Esuli, A., & Sebastiani, F. (2010, May). SentiWordNet 3.0: An Enhanced Lexical Resource for Sentiment Analysis and Opinion Mining. Proceedings of the Seventh International Conference on Language Resources and Evaluation (LREC'10). http://www.lrec-conf.org/proceedings/lrec2010/pdf/769_Paper.pdf

[12] Mananghaya, A.K. & Albacea, Z.V.J. (2019) An Alternative Method to Estimate Consumer Satisfaction Using Social Media Data: The Case Of The Department Of Foreign Affairs. 14th National Convention on Statistics (NCS).

[13] Ramaswamy, & Healey. (2019, October 17). Tweet Sentiment Visualization App. Sentiment Viz. Retrieved July 15, 2022, from https://www.csc2.ncsu.edu/faculty/healey/tweet_viz/tweet_app/

[14] Bilog, R. J. (2020). Application of Naïve Bayes Algorithm in Sentiment Analysis of Filipino, English and Taglish Facebook Comments. International Journal of Management and Humanities, 4(5), 73–77. https://doi.org/10.35940/ijmh.e0524.014520

[15] Shung, K. P. (2020, April 10). Accuracy, Precision, Recall or F1? - Towards Data Science. Medium. https://towardsdatascience.com/accuracy-precision-recall-or-f1-331fb37c5cb9

[16] Diaz, G. (2016, October 8). Stopwords Tagalog (TL). GitHub. Retrieved November 21, 2022, from https://github.com/stopwords-iso/stopwords-tl

[17] Stecanella, B. (2019, May 10). Understanding TF-ID: A simple introduction. MonkeyLearn Blog. Retrieved November 21, 2022, from https://monkeylearn.com/blog/what-is-tf-idf/

[18] Macrohon, J. J. E., Villavicencio, C. N., Inbaraj, X. A., & Jeng, J.-H. (2022). A Semi-Supervised Approach to Sentiment Analysis of Tweets during the 2022 Philippine Presidential Election. Information, 13(10). doi:10.3390/info13100484

[19] Ramadhan, W. P., Novianty, S. T. M. T. A., & Setianingsih, S. T. M. T. C. (2017). Sentiment analysis using multinomial logistic regression. 2017 International Conference on Control, Electronics, Renewable Energy and Communications (ICCREC). doi:10.1109/iccerec.2017.8226700

[20] Raschka, S. (2016, February 14). What is Softmax regression and how is it related to logistic regression? Sebastian Raschka, PhD. Retrieved November 21, 2022, from https://sebastianraschka.com/faq/docs/softmax_regression.html

[21] Barkved, K. (2022, March 9). How to know if your machine learning model has good performance. Data Science without Code. Retrieved November 22, 2022, from https://www.obviously.ai/post/machine-learning-model-performance

[22] Cheng, C. (2019). Hate speech in Philippine election-related tweets: Automatic detection and classification using natural language processing. Philippine Computing Journal, XIV(1).

[23] Yadav, S. (2017, May 17). Pre-processed Twitter tweets. Kaggle. Retrieved November 22, 2022, from https://www.kaggle.com/datasets/shashank1558/preprocessed-twitter-tweets

[24] Kiradoo, G. (June 30, 2019). Software Engineering Quality to Enhance the Customer Satisfaction Level of the Organization. International Journal of Advanced Research in Engineering and Technology, 10(3), 2019, pp. 297-302, from https://ssrn.com/abstract=3539958

[25] Birkett, A. (2021, June 16). What is customer satisfaction score (CSAT)? HubSpot Blog. Retrieved December 9, 2022, from https://blog.hubspot.com/service/customer-satisfaction-score

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