

Investigating hybrid models

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Florian Coustures

MS-DS

florian.coustures@ensae.fr

Clara Minel

3ème année voie DSBD, MIE

clara.minel@ensae.fr

Abstract

1 Problem Framing

While lexicon models are very useful for performing sentiment analysis on text data, they seem to perform poorly on analyzing unstructured social media content such as tweets. They consist in aggregating scores assign to a set of vocabulary that is able to capture sentiment polarity. However, static lexicons models fail at adapting to the context and the content of the text and consequently, they perform poorly when predicting sentiment polarity of each tweet. Tweets are increasingly used for assessing client satisfaction. In this project, we will try to assess the customer services of different airlines through social media content. Thus, the aim of this project is to combine regular lexicon methods with simple natural language processing algorithm to combine the convenience of lexicon models and the ability to adapt to the content of machine-learning models. By combining both types of models with a weighted average ensemble, we aim at increasing the performance of social media sentiment analysis as recently done in the literature by Bashar(2022) (Bashar, 2022) and Muhammad(2014) (Muhammad et al., 2014).

2 Experiments Protocol

Firstly, we compute several descriptive statistics on the dataset itself, as presented in Appendix A1 and then on the tweet data, presented in Appendix A2. This enables us to understand the structure of our dataset. Our experiment consists in implementing a static lexicon model on our tweet dataset and comparing standard NLP models such as TF-IDF. Then, we compute the BERT model

to use a more advance approach on the dataset. Finally, we implement a hybrid approach, using a weighted average ensemble that combines results from the TF-IDF approach to the Lexicon approach.

3 Results

Results from the Afinn model, TF-IDF, BERT and the hybrid approach are presented in appendix A3 to A6. Overall the lexicon model seems overall to underperform relatively to other approaches when predicting labels. This mainly due to the fact that lexicon models poorly adapt to the context. Following the literature, we create a hybrid approach to solve the shortcomings of the lexicon models. This hybrid approach seem to overall underperform relative to the TF-IDF model, as shown in our code ¹, however, when analyzing the confusion matrix, the model performs better for predicting negative and positive tweets. Thus, this model is quite interesting for sentiment polarization.

4 Discussion/Conclusion

For future research it would be interesting to test the Hybrid Lexicon model with Bert. Concerning this dataset, we could also limit ourselves to a positive-negative polarity (by excluding neutral), or consider the confidence level of the sentiment for more complex models.

Let's see how our sentiment analysis on social networks can be insightful. In this case, an airline could compare itself to its competitors, better determine the expectations of its customers and thus improve its customer service. With an automatised analysis, a company would also be able to quickly identify changes in brand perception and quickly correct a problem before it becomes too serious.

¹Google Colab : <https://colab.research.google.com/drive/1Gs5LQo-uiz1Ce52CIqb-et45BBc6cJEE?usp=sharing>

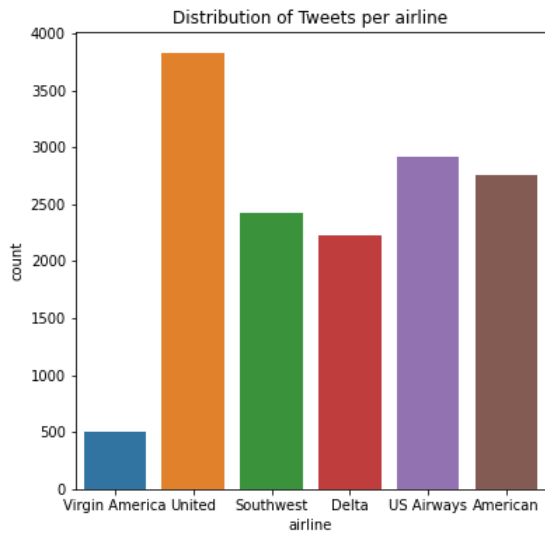


Figure 1: Distribution of airline tweets

Appendix

4.1 A1 - Descriptive statistics regarding tweets sentiment and the distribution across airlines

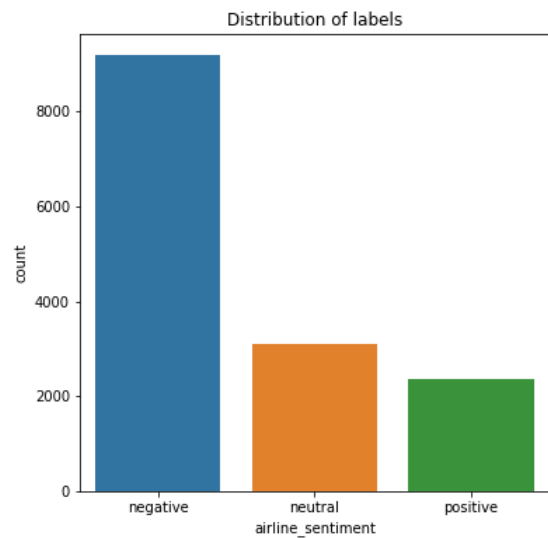


Figure 2: Distribution of tweets sentiment

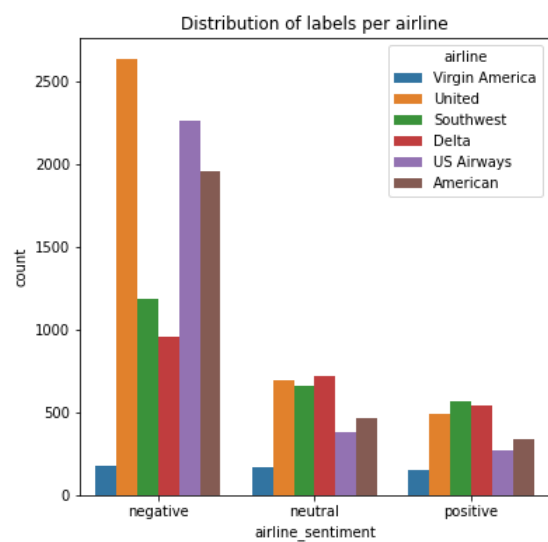


Figure 3: Distribution of labels per airline

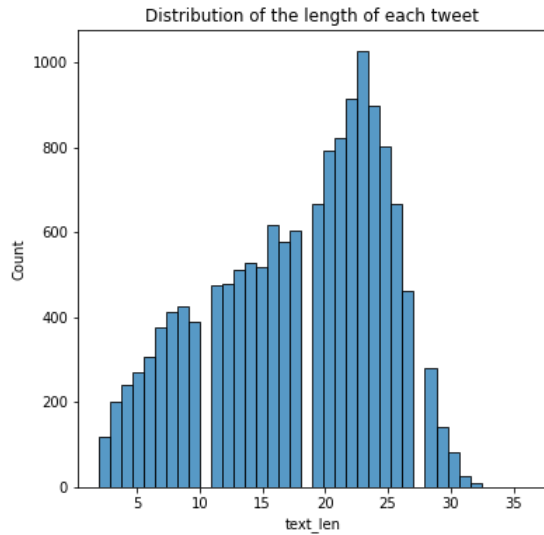


Figure 4: Tweet length

A2 - Descriptive statistics on the tweets data

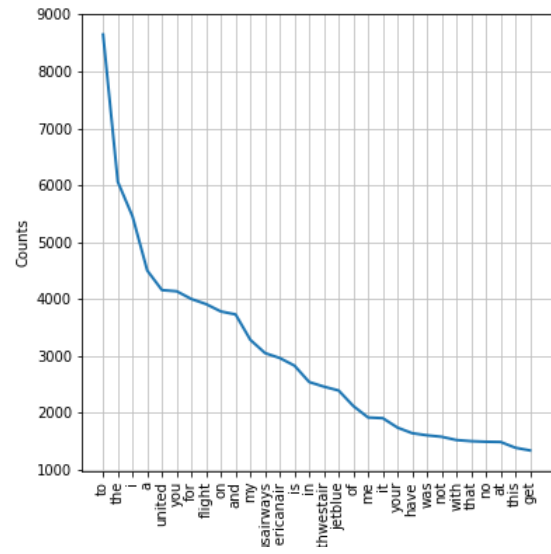


Figure 5: Distribution of the most common words of our dataset

Table 1: Most common words in the tweets

	words	count
0	to	8648
1	the	6060
2	i	5452
3	a	4501
4	united	4157
5	you	4137
6	for	4001
7	flight	3911
8	on	3782
9	and	3730
10	my	3284
11	usairways	3051
12	americanair	2964
13	is	2830
14	in	2542
15	southwestair	2461
16	jetblue	2393
17	of	2120
18	me	1919
19	it	1907

Table 2: Bigrams of our dataset

	bigrams	count
0	(on, the)	533
1	(to, get)	477
2	(for, the)	446
3	(I, have)	435
4	(on, hold)	400
5	(customer, service)	358
6	(to, be)	357
7	(my, flight)	355
8	(in, the)	355
9	(Cancelled, Flightled)	350
10	(for, a)	342
11	(to, the)	323
12	(I, was)	302
13	(@united, I)	296
14	(trying, to)	272
15	(a, flight)	259
16	(out, of)	256
17	(hold, for)	242
18	(need, to)	234
19	(at, the)	234

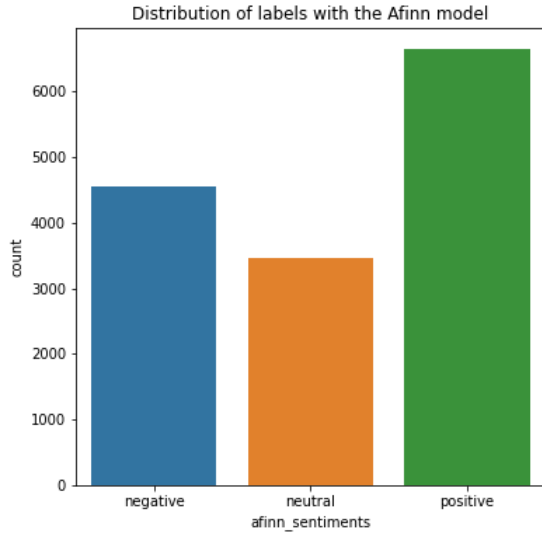


Figure 6: Distribution of labels predicted by the AFINN model

afinn label True label	negative	neutral	positive
negative	0.444541	0.220092	0.335367
neutral	0.122298	0.389480	0.488222
positive	0.035971	0.097334	0.866695

Table 3: Confusion matrix for the AFINN model

4.2 A3. Results AFINN model

4.3 A4. Results TF-IDF model

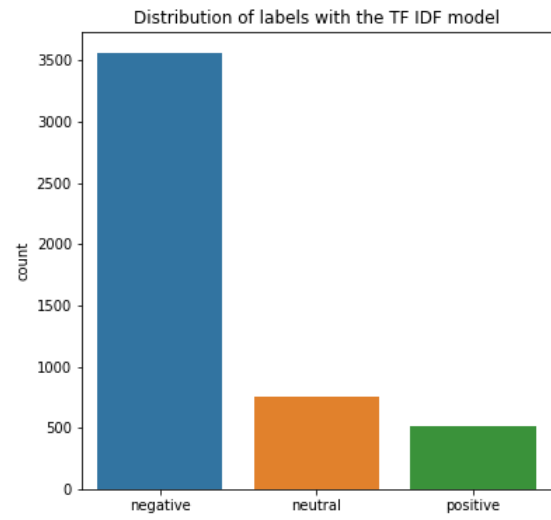


Figure 7: Distribution of labels predicted by the TF-IDF model

Predicted label True label	negative	neutral	positive
negative	0.937439	0.048622	0.013938
neutral	0.446138	0.496951	0.056911
positive	0.297510	0.149410	0.553080

Table 4: Confusion matrix for the TF-IDF model

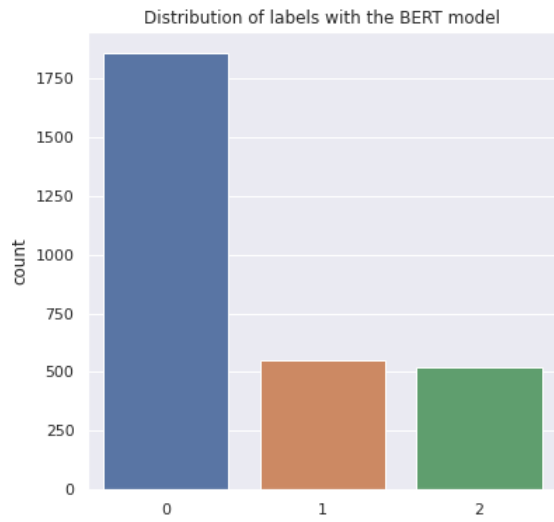


Figure 8: Distribution of labels predicted by the BERT model (0 is negative, 1 is neutral and 2 is positive)

Predicted label True label	negative	neutral	positive
negative	0.912445	0.060573	0.026982
neutral	0.244300	0.640065	0.115635
positive	0.100402	0.094378	0.805221

Table 5: Tweets sentiment with hybrid model with equal weights

4.4 A5. Results from the BERT model

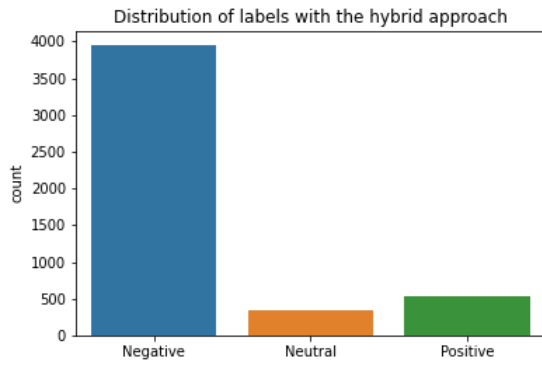


Figure 9: Distribution of labels predicted by the hybrid model

Predicted label True label	negative	neutral	positive
negative	0.974068	0.011994	0.013938
neutral	0.699187	0.252033	0.048780
positive	0.340760	0.086501	0.572739

Table 6: Tweets sentiment with hybrid model with equal weights

References

- Aminu Muhammad, Nirmalie Wiratunga, and Robert Lothian. 2014. A hybrid sentiment lexicon for social media mining. In *2014 IEEE 26th International Conference on Tools with Artificial Intelligence*, pages 461–468. IEEE.
- Md Khayrul Bashar. 2022. A hybrid approach to explore public sentiments on covid-19. *SN Computer Science*, 3(3):1–19.

4.5 A6. Results hybrid models