GABSA-PT: Graph Neural Networks for Aspect-level Sentiment Analysis in Portuguese Language

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Abstract

Aspect-based Sentiment Analysis is a Natural Language Processing task that aims to extract aspects from an opinionated text and identify the sentiment expressed by the opinion holder towards these aspects. Graph-based text representation has been shown to bring benefits to this task. While studies have demonstrated the effectiveness of this representation for ABSA using Graph Neural Networks in English, more work currently needs to be done evaluating this methodology for Portuguese language. In this article, we adapt a GNN known as DualGCN for sentiment classification using Brazilian Portuguese data. The model created using this approach achieved satisfactory results with a balanced accuracy of 75%.

Introduction

Sentiment Analysis (SA) area is the field that seeks to identify and classify the opinions and emotions of the author of a text for an entity (Feldman, 2013). This field can bring numerous benefits in situations with an extensive amount of opinionated texts. It enables the creation of automatic analyses of the entities targeted by the opinions, thus facilitating visualizing of these data.

As de Freitas (2015) described, SA can be done at different levels. However, the most commonly used levels are document, sentence, and aspect level. Where the aspect level is the lowest granularity, the analysis is performed on all entities that can be attributed to an opinion or sentiment (Liu, 2012).

Aspect-Based Sentiment Analysis (ABSA) is divided into two tasks, the Aspect Extraction (AE) task, and the Aspect Sentiment Classification (ASC) task (Liu, 2012). In this article, we only focus on the second task.

Although the most common representation is the transformation of the text into an embedding, additional information can be added to increase the model's efficiency. Since texts are formed based on syntax, it is possible to use linguistic relationships between words as additional information in data representation. One way to take advantage of these relationships is through graph representations.

Studies have shown that the utilization of Graph Neural Networks (GNNs) have demonstrated results that may surpass traditional Convolutional Neural Networks (CNNs) in certain tasks (Defferrard, Bresson, and Vandergheynst, 2016). GNNs are NN that use graphs as their input format. Textual data seems well-suited for graph representation, as the relationships between words can be captured through the edges of nodes, representing the words themselves.

So far, no studies have demonstrated the effectiveness of using GNNs for the task of ABSA using Brazilian Portuguese data. However, some works, such as the study by Li et al. (2021), show promising results using data in English.

This study aims to analyze and assess the utilization of an adapted version of the GNN architecture referred to as DUALGCN, proposed by Li et al. (2021), using Brazilian Portuguese data.

Related Works

The work of Li et al. (2021) explores the solution to the ABSA problem using GNNs for the English language. They study using two GCNs to estimate the aspect polarity, one GCN to identify semantic correlations, and other GCN to analyze text syntactic structures. The authors combine the outputs of the other two models and provide the estimate of the ASC task. The authors evaluated their approach on three public datasets: restaurant reviews, laptop reviews from the 2014 SemEval competition (Pontiki et al., 2014), and tweets (Dong et al., 2014). The proposed model outperformed all other baseline models, with results of 74.74% in F1 for the restaurant reviews, 74.29% for the tweet, and 78.08% for the laptop reviews.

Methodology

Our proposed method transforms the input text of hotel reviews into graph-formatted data. After this transformation, we use the graph to train a modified version of the DualGCN architecture developed by Li et al. (2021). The aspects have already been annotated beforehand.

Dataset

The chosen dataset was created from New York, Las Vegas, Paris, and Porto Alegre hotel reviews. All data were extracted from the TripAdvisor website, written in Brazilian Portuguese Language, and have at least 300 characters.

The sentiment associated with the aspect can be only one of three values: positive, negative, or neutral.

The corpus consists of 3797 annotations, with 1031 reviews and 77 different aspects. As we can see, the same review can mention more than one aspect, thus appearing multiple times in the corpus.

The chosen dataset is imbalanced, so we use an oversampling data augmentation method to handle this.

Graph Representation

After expanding the training dataset as previously described, it is necessary to represent the data set in graph form. The chosen approach in this work is as follows:

1. each node in the graph represents a word;
2. each edge represents the linguistic relationship between words.

In this way, we can extract the information in the review and the relationships between words, providing additional details for network learning and may prove beneficial. All graphs are generated using the spaCy library (Honnibal and Montani, 2017), utilizing the creation of syntactic dependency trees feature of spaCy[1]. Figure 1 shows an example of a syntactic dependency tree.

Graph Neural Network

We chose the architecture defined by Li et al. (2021) for the model creation. This choice was made due to the excellent results the authors obtained using it for the ABSA task in English. We changed the glove embedding used in the original architecture (Pennington, Socher, and Manning, 2014) to a glove embedding trained with Brazilian Portuguese data (Hartmann et al., 2017). This architecture consists of three modules: **SynGCN**, **SemGCN**, and **BiAffine**. A BiLSTM (Graves and Schmidhuber, 2005) encoder was used to create the hidden vectors.

The **SynGCN** module aims to analyze the syntax of the review, for which it uses a dependency probability matrix constructed from a state-of-the-art dependency parser[2] (Mrini et al., 2019).

The **SemGCN** module is responsible for analyzing the semantic relationships between words. This module uses an attention matrix, in contrast to SynGCN, which uses the dependency probability matrix. The attention matrix is obtained through a self-attention mechanism.

The **BiAffine** module seeks to connect the knowledge between the previous two modules through a BiAffine transformation application.

Results

The Aspect-Based Sentiment Analysis in Portuguese (ABSAPT) competition (da Silva et al., 2022), organized by the Artificial Intelligence Innovation Hub at the Federal University of Pelotas in 2022, focused on the subtasks of ABSA proposed by Liu (2015), AE and ASC. The competition was carried out using accommodation review data from the TripAdvisor website. In this work, we use the same dataset provided by the challenge organizers for both training and testing data. We will compare the results obtained with the four best-performing approaches in the competition, considering the ASC task.

Table 1 presents the test data results. The table is in descending order by BAcc, and the results in bold are from our approach's derived model.

Table 1: Results in the Test Data.

Approaches	BAcc	Precision	Recall	F1
Gomes et al. (2022)	0.82	0.81	0.82	0.81
Neto et al. (2022)	0.78	0.76	0.78	0.77
DualGCN_PT (ours)	**0.75**	**0.76**	**0.75**	**0.75**
Assi et al. (2022)	0.62	0.65	0.62	0.61
Heinrich and Marchi (2022)	0.62	0.65	0.62	0.61

Overall, the results of the models proposed in this study showed better performance compared to some works that participated in the ABSAPT competition, surpassing the third-best-performing team in the competition. However, there is still room for improvement. Using a dependency parser trained using Brazilian Portuguese data for the SynGCN module could improve the performance of these models. Unfortunately, we could not create a LAL-Parser using Brazilian Portuguese data due to a need for more training data.

The models that took first and second place in the ABSAPT competition uses technologies based on Transformers.The authors of the DualGCN architecture conducted experiments with the original BERT model for the sentence encoding task and achieved positive results, indicating a possible improvement in task performance.

Final Remarks and Further Works

Our proposed adaptation for the ABSA task for the Portuguese language achieved good results, even surpassing some models proposed for the ABSAPT competition that use Transformer-based technologies, which are widely studied in the academic field due to their excellent performance in NLP tasks. However, there is room for improvement, as our model has not yet surpassed the current state of the art for the ABSA task using this dataset. We believe this is due to the fact that we used a syntax analyzer model trained on English data, and using a model trained on Brazilian Portuguese data could bring improvements in performance. In addition, as mentioned earlier, we used the Oversampling technique to address the problem of data imbalance, but the use of other alternatives to deal with this issue may bring additional benefits to the model.

[1]https://spacy.io/

[2]https://github.com/KhalilMrini/LAL-Parser

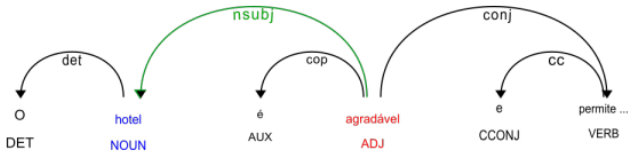

Figure 1: Syntactic Dependency Tree Example using spaCy. Source: Corrêa (2021).

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