Sarcasm Detection Using Bidirectional Encoder Representation from Transformers and Graph Convolutional Network

*Abhilash M Nair, *Bhadra Jayakumar, *Sanjay Muraleedharan, **Dr. Anuraj Mohan,
*UG Scholar, **Assistant Professor, Department of Computer Science and Engineering,
NSS College of Engineering, Palakkad

Introduction

- Sarcasm refers to the use of words that mean the opposite of what you really want to say, especially in order to show irritation, or just to be funny.
- Example;
  - *"I like to be ignored!"* - Sarcastic
  - *"I don't like not to be ignored"* - Non Sarcastic
- Our aim is to develop a system that gives the output sarcastic or non sarcastic for the given text input.
- Combinational advantages of both BERT & GCN is used to develop our proposed model.

Problem Statement

To design a system that determine whether a given text message is sarcastic or not. Sarcastic comments, tweets or feedbacks can be misleading for data mining activities and sentiment evaluation from text cannot detect sarcastic contexts. In this scenario, an efficient sarcasm detection system is required which can be improved by using BERT and GCN.

Mathematical Definition: Given a set of statements, $S = \{s_1\ s_2\ s_3 \ldots s_n\}$, a defined set of classes $C = \{0, 1\}$ where 0 and 1 denotes non sarcastic and sarcastic labels respectively, and a training set with the labeled statements, the task is to learn a classifier, $f : S \rightarrow C$ i.e. to learn a function that can predict the labels of an unknown text input.

Objective

- To create the model of sarcasm detection system:
- That uses BERT and GCN which has the advantages of both graph convolutional networks and transformer architectures because
  - Graphs can develop longer dependencies between word embeddings, and
  - Transformer models have the ability to recognize the context of longer sentences and even reply-response contexts.
- By creating an affective and dependency graph using
  - SenticNet common knowledge base, which is about concept-level sentiment analysis, that leverage the denotative and connotative information associated with words and multiword expressions.
  - A dependency tree formed using the word to word relation from a given sentence.

Methodology

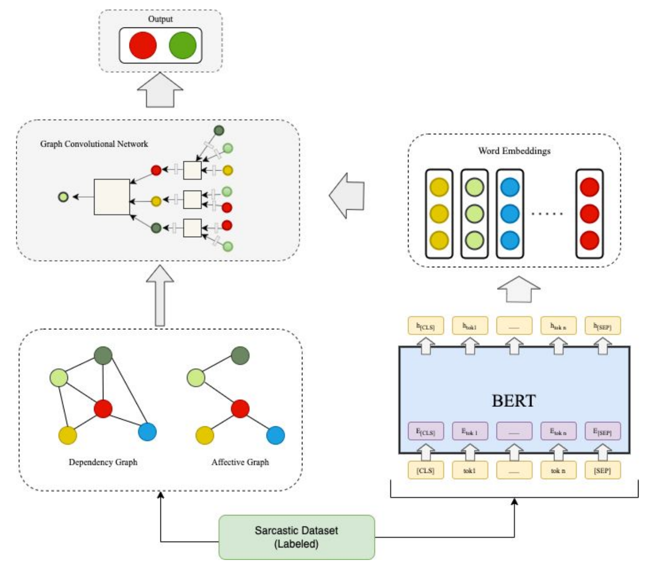

Fig. 1 : Proposed System - BERT-GCN

Our approach includes:

- Creating affective and dependency graphs from the sentences which can represent the sentiment with the help of SenticNet and word-to-word connections within the sentences.

$$D_{i,j} = 1 \qquad A_{ij} = |S(w_i) - S(w_j)|$$

- Generation of word embedding using BERT and hence features of each sentences by,

$$\boldsymbol{H} = \{\boldsymbol{h_1}, \boldsymbol{h_2}, \ldots \boldsymbol{h_n}\} = BERT(\boldsymbol{x})$$

- Passing the affective graph and dependency graph alternatively and iteratively to the graph convolution network which is fed to a softmax normalization layer in the final stage, to produce the sarcastic probability of the given sentences.

$$\boldsymbol{g^l} = ReLU\left(\boldsymbol{H}ReLU\left(\boldsymbol{A}\boldsymbol{g^{l-1}}\boldsymbol{W_a^l} + \boldsymbol{b_a^l}\right)\boldsymbol{W_d^l} + \boldsymbol{b_d^l}\right)$$

$$\hat{\boldsymbol{y}} = softmax(\boldsymbol{W_o}\boldsymbol{g^l} + \boldsymbol{b_o})$$

- Learning Objective is defined as,

$$\min_{\Theta} L = -\sum_{k=0}^{N} y \log(\hat{y})$$

Datasets Description

Dataset	Train		Test	
	Sarcastic	Non-Sarcastic	Sarcastic	Non-Sarcastic
Riloff	282	1051	35	113
Headlines	2516	2504	570	410

Table 1. Statistics of datasets

Results & Analysis

Model	Headlines		Riloff	
	Acc. (%)	F1 Score (%)	Acc. (%)	F1 Score (%)
LSTM	56%	36%	78%	75%
CNN	76%	36%	81%	43%
GCN	87.2%	86.8%	86.5%	76.35%
BERT-GCN	**90.7%**	**89.6%**	**88.3%**	**87.7%**

Table 2 : Results of different models compared to BERT-GCN

1. Accuracy and loss plots

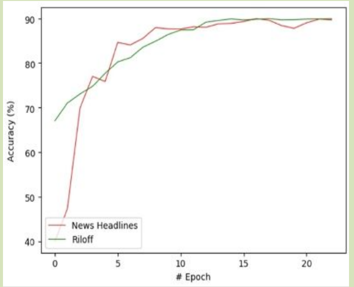

Fig. 2 : Accuracy vs Epochs

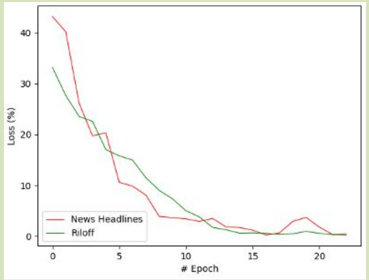

Fig. 3 : Loss vs Epochs

2. Impact of GCN layers

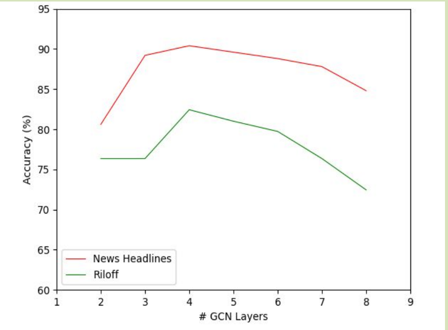

Fig. 4 : Impact of GCN layers

Inferences

- The model obtains an accuracy of **90.7%** using news headline dataset and an accuracy of **88.3%** with the Riloff dataset.
- From the loss plot, it can be inferred that the model exhibits a steady decrease in loss as the training progresses.
- The effect of GCN layer shows that the model produced steady increase in the in accuracy and achieved the peak value with four GCN layers after which a drop in the accuracy is observed with the increasing number of layers.

Conclusions & Future works

- Solutions to sarcasm detection include several conventional models based on deep learning architectures like deep neural networks and LSTM networks, which usually follow a text mining approach.
- Recent studies with text data show that using BERT architecture can give better accuracy even for small datasets, and since sarcasm detection requires deep semantic information about the text, graph based methods can capture global information features and structural relationships.
- In this work, we propose a method to combine the capabilities of both text based and graph based approaches, and use it to improve the performance of sarcasm detection from text.
- We design a BERT-GCN architecture for sarcasm detection and demonstrate the advantages of the system by conducting experiments with the News-Headline dataset and Riloff Datasets.
- As part of the future work, we aim to incorporate attention mechanism to the graph convolutional network that can learn the further aspects of the sarcastic sentences, and generate a representation that depicts the relation of the nearby words to the word in consideration.

References

[1] Lou, C., Liang, B., Gui, L., He, Y., Dang, Y. and Xu, R., 2021, July. Affective dependency graph for sarcasm detection. In *Proceedings of the 44th International ACM SIGIR Conference on Research and Development in Information Retrieval* , pp. 1844-1849.

[2] Babanejad, N., Davoudi, H., An, A. and Papagelis, M., 2020, December. Affective and contextual embedding for sarcasm detection. In *Proceedings of the 28th international conference on computational linguistics* , pp. 225-243.

[3] Liang, B., Su, H., Gui, L., Cambria, E. and Xu, R., 2022. Aspect-based sentiment analysis via affective knowledge enhanced graph convolutional networks. *Knowledge-Based Systems*, *235*, p.107643.

[4] Misra, R. and Arora, P., 2019. Sarcasm detection using hybrid neural network. *arXiv preprint arXiv:1908.07414.*

[5] Lydia Xu, Vera Xu, 2019, *Sarcasm detection, Stanford University Publication.*

Presented at International Conference on Machine Learning and Data Engineering, Sept 2022, held at UPES University, Dehradun. Proceedings in Procedia Computer Science, Elsevier.