

# Sarcasm Detection in News Headlines using Evidential Deep Learning-based LSTM and GRU

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## Abstract

Sarcasm has become quite inter-related with the day to day life of all. In news robust sarcasm is often used to grab the attention of the viewers. This research aims to detect sarcasm using Evidential deep learning. This technique uses uncertainty estimations for identifying the sentiments from news headlines dataset. Also, LSTM and GRU have been used with Evidential deep learning approach. The purpose of using LSTM is that it can classify texts from headlines in order to analysis the sentiments. Moreover, we have used GRU which is an recurrent neural networks (RNN) and it effectively models sequential data. The architecture of the GRU network is ideally suited for identifying dependencies and extended contextual relationships within news headings. Overall, our proposed model uses Evidential deep learning based LSTM and GRU to identify the sentiments of robust sarcasms from news headlines.

**Keywords:** keyword1, Keyword2, Keyword3, Keyword4

# 1 Introduction

Sarcasm is used to express feeling in a humouric way where positive words are generally used to make a statement but it contains a negative meaning in the written text. Using sarcasm is a technique to grab attention of others as this type of statements are often very facetious. Sarcasm is also used to express an opinion on a particular viewpoint. In this research, we have used Evidential deep learning technique to analyze the sentiment of news headlines. Evidential deep learning entails the incorporation of uncertainty estimation into deep learning models through the utilisation of Bayesian inference procedures. The model can identify circumstances when it lacks adequate data or runs across unclear inputs thanks to uncertainty estimations. Uncertainty estimation also supports with the assessment of model confidence. It is crucial to have a grasp of the dependability and trustworthiness of the model's predictions in order to be able to use it in key applications such as medical diagnosis and legal analysis. We have also integrated LSTM with Evidential deep learning and the purpose of it is to identify the sentiment of the news headlines. LSTM can process each word in news headlines in sequence and the final output of it is used to classify the sentiment of the respective headline.

## 2 Related Works

Robust sarcasm detection from news headlines is a challenging with the use of Evidential deep learning. There are some related works with sarcasm detection. Various kind of techniques has been used to detect the sentiment analysis of sarcasms.

In the paper [1], the authors have experimented with an algorithm of STSM which is sentiment topic sarcasm mixture. A lot of features has been used for the development of the model such as pragmatic features and lexicon based. The main concept of this model is that the influence of some topics in detecting sarcasm is more than others.

Paper [2] provides an ensemble model to detect sarcasm on the internet. The used dataset is prepared on previously trained various word-embedding models. Here weighted average obtained the highest accuracy in case of both the datasets. Authors of paper [3] proposed a model named C-Net. It extracts contextual knowledge from texts in a serial fashion way. Then it categorises the texts into sarcastic or non-sarcastic.

Authors of [4] built a transformer based method where recurrent CNN-RoBERTA model is used to find the sarcasm in given statements. In paper [5], authors have proposed a new behavioral model for detecting sarcasm. They have used a lexicon-based technique. Their SCUBA model can detect whether a person is sarcastic or not using past data. This model uses various approach and among them SCUBA++ achieves the highest accuracy 92.94%.

The authors of [6] used a set of features. The features are derived in a manner that utilises various components of the tweet and encompasses various forms of sarcasm. Their proposed approach achieves higher accuracy of 83.1% compared to some baseline approaches like n-grams.

### 3 Dataset

In our research, we have used the news headlines dataset [7]. The purpose of using this dataset is to avoid label and language noise. This dataset contains sarcastic News headlines from the news website named TheOnion. On the other hand, this dataset also contains non-sarcastic and real parts which has been collected from the HuffPost news website. In this dataset there are 28,619 headlines which contains both sarcastic and non-sarcastic. The language used in the headlines of this dataset is formal as all the writings have been done by professional writers. That is why there is very little chance of spelling mistake in the headlines. Also, as one of the news website that provided only the sarcastic texts, that is why there is high chance that the quality of label is controlled in the respective dataset.

## 4 Methodology

### 4.1 Evidential deep learning

Evidential deep learning is used in natural language processing (NLP) to resolve the limitations of conventional deep learning models. This technique used uncertainty estimations. The weights and biases in this model are treated as random variables with prior distributions by Bayesian neural networks (BNNs), which were used in its construction. We use variational inference, a method that improves the Evidence Lower Bound (ELBO) by repeatedly changing the variational distribution to closely resemble the real posterior distribution, to approximate the posterior distribution over the model parameters. In order to further improve our ability to estimate uncertainty, Monte Carlo Dropout is applied. By making numerous forward passes with dropout enabled, we are able to acquire various predictions by using dropout both during training and inference. The fluctuation seen in these forecasts offers insightful information about the level of uncertainty around the model's results. Also, confidence intervals are derived from uncertainty estimations. Instances where the model lacks assurance or runs across inputs that are intrinsically unclear are indicated by higher uncertainty levels. The model's confidence is shown by variables like predictive variance, entropy, or quantiles of the predictive distribution.

### 4.2 LSTM

LSTM is known as Long Short Term Memory. The idea to use LSTM is that it can be used to classify texts and to analyze sentiment of texts. LSTM uses the mechanism of memory cell where it has three gates connected to each of the cell. Input gate, forget gate and output gate. With the use of these LSTM is capable to retain any information or to forget it. A sigmoid activation function is used to decide which data to keep or discard from input or previous cell. This technique makes predictions based on the relevant data. Along with the capability to use memory cell it can make effective predictions in order to analyze the sentiment of any written text. For analyzing sentiment it also uses an embedding layer. This layer helps to map each word of a sentence and each word here gets a vector representation and after training it can learn the most informative vector representation for each word. The model then

processes sequence of word vectors and a sentiment based on the prediction is achieved. It also uses backpropagation strategy for training the data. For cross checking the performance of LSTM metrics like accuracy, precision, recall and F1 score can be used.

### 4.3 GRU

GRU is a form of architecture for recurrent neural networks (RNN) that effectively models sequential data. GRU incorporates gating mechanisms that allow the network to capture and retain pertinent data over extended sequences. This gating mechanism, which consists of reset and update gates, permits the model to selectively update and retain pertinent information while discarding irrelevant or redundant data. The GRU's gating mechanism regulates the passage of information through the network, allowing it to capture textual dependencies and contextual information. Backpropagation through time (BPTT), which extends the concept of backpropagation to sequential data, is used to train the GRU model. This method allows for the efficient updating of the model's weights and biases by propagating error gradients over time. GRU is utilised to assess a model's ability to generalise to unobserved data by evaluating its performance on the validation and test sets. GRU permits the network to selectively update and retain pertinent data while discarding irrelevant or redundant data. This mechanism facilitates comprehension of the subtleties of sarcasm and tone in headlines.

## 5 Results and Analysis

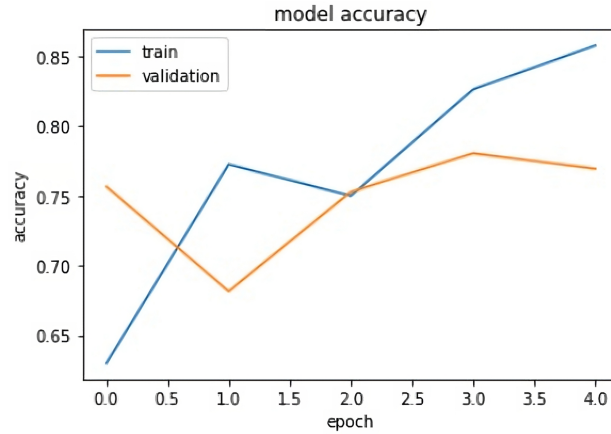
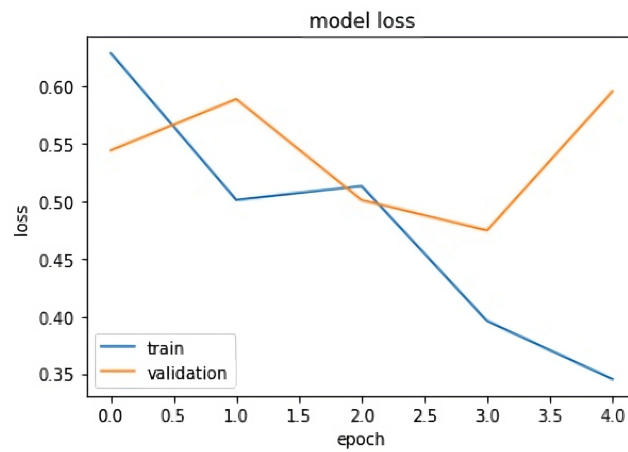


Fig. 1 Model Accuracy

## 6 Discussion

Discussions should be brief and focused. In some disciplines use of Discussion or 'Conclusion' is interchangeable. It is not mandatory to use both. Some journals prefer a



**Fig. 2 Model Loss**

section ‘Results and Discussion’ followed by a section ‘Conclusion’. Please refer to Journal-level guidance for any specific requirements.

## 7 Future Works

## 8 Conclusion

Conclusions may be used to restate your hypothesis or research question, restate your major findings.

## References

- [1] Krishnan, N., Rethnaraj, J., Saravanan, M.: Sentiment topic sarcasm mixture model to distinguish sarcasm prevalent topics based on the sentiment bearing words in the tweets. *Journal of Ambient Intelligence and Humanized Computing* **12** (2021) <https://doi.org/10.1007/s12652-020-02315-1>
- [2] Goel, P., Jain, R., Nayyar, A., Singhal, S., Srivastava, M.: Sarcasm detection using deep learning and ensemble learning. *Multimedia Tools and Applications* **81** (2022) <https://doi.org/10.1007/s11042-022-12930-z>
- [3] Jena, A., Sinha, A., Agarwal, R.: C-net: Contextual network for sarcasm detection, pp. 61–66 (2020). <https://doi.org/10.18653/v1/2020.figlang-1.8>
- [4] Potamias, R., Siolas, G., Stafylopatis, A.: A Transformer-based Approach to Irony and Sarcasm Detection
- [5] Rajadesingan, A., Zafarani, R., Liu, H.: Sarcasm detection on twitter: A behavioral modeling approach. *WSDM 2015 - Proceedings of the 8th ACM International Conference on Web Search and Data Mining*, 97–106 (2015) <https://doi.org/10.1145/2684822.2685316>
- [6] Bouazizi, M., Ohtsuki, T.: A pattern-based approach for sarcasm detection on twitter. *IEEE Access* **4**, 5477–5488 (2016)
- [7] Misra, R., Arora, P.: Sarcasm detection using news headlines dataset. *AI Open* **4**, 13–18 (2023) <https://doi.org/10.1016/j.aiopen.2023.01.001>