

Analysis on Text for Sarcasm Detection Using Machine Learning: Survey

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ABSTRACT

Nowadays, people using sarcasm in their daily communication with others. In person communication sarcasm detection is not that complex but text communication it's very difficult. People share their views, opinions, comments on others post over social media like Twitter, Reddit, Facebook, YouTube, LinkedIn, Media, Blogs, Discussion forums and WhatsApp etc. Researcher have been applied so many approaches to detect sarcasm in text but not yet reached 100% accuracy. It's a challenging task to researchers finding sarcasm on text like social media platforms, newspapers, product reviews, movies reviews, comments on YouTube and feedbacks etc. Sarcasm in text can be irony, humour and criticism with positive words convey negative meaning. Sarcastic statements create confusion whether sarcasm used or not in their statement. So far Research have done on sarcasm detection with text information but emojis, numbers, empty messages also conveying sarcasm. In this paper, addressing approaches and challenges to find sarcasm detection and performance measurements of existing research like recall, precision and accuracy.

Keywords-sarcasm, sentiment analysis, social media, machine learning, NLP.

1. INTRODUCTION

Sarcasm is a common element in communication including text, voice, image and etc to humorous, criticize or satirical. Automatically text classified as sarcastic and un sarcastic is challenging task because it involves ambiguity. Sarcasm is the way to criticize the people with positive words. Everywhere everyone, every topic using sarcasm in their communication over social media, in person communication. Nowadays, people depend on AI search engines to browse information, if Machine gives sarcasm in their result is also not possible to classify sarcastic or un sarcastic. People need one interface to communicate over world its social media. Day to day increase the usage of social media over internet. There is no restriction to express their views, feedback, reviews and comments to criticize someone sarcastically. Sarcasm can be expressed in written communication by quotation marks, emojis, capitalization italicizing or bold text and sarcasm tag. Figure1 shows over the past decade, interest in this filed increased gradually in terms of published papers.

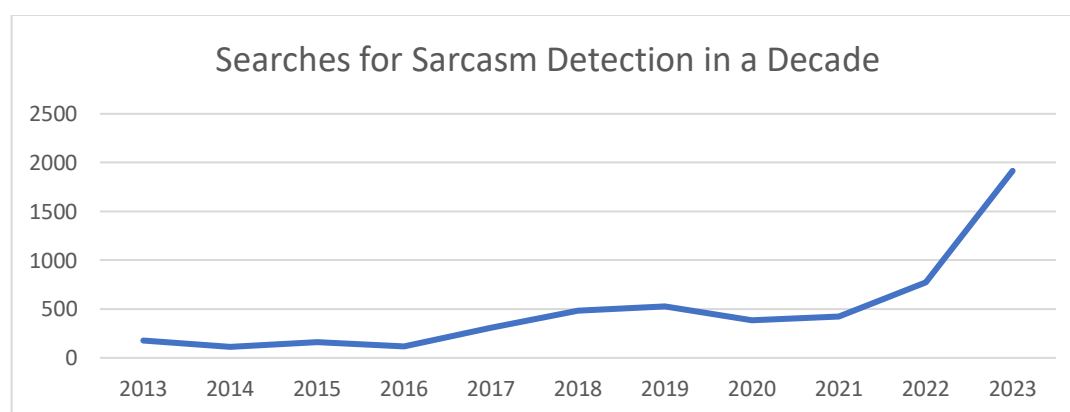


Figure 1: published papers in a decade on sarcasm detection

Natural Language and Processing (NLP) technology used to sarcasm detection on social media but difficult to detect 100% accuracy due to sarcasm increased extensively across social media[1].NLP play a vital between human and computational system and it allowing to understand human language and speaker intension[2].To identify sarcasm on text sentiment analysis required but sarcasm is challenging task of the sentiment analysis to get accurate result and to improve the performance of sarcasm on text sentiment analysis is a process to understand public post either they used sarcasm or not in their text[3].Now a days e-services including sarcasm analysis in their business to scale branding[4], [5].Sarcasm using almost all topic in daily on social media and source of news[5].Sarcasm detection on text difficulty level differs with

respective speaking language, so need to understand background very carefully[6]. Figure 2 shown some of attributes used to detect sarcasm in text data.

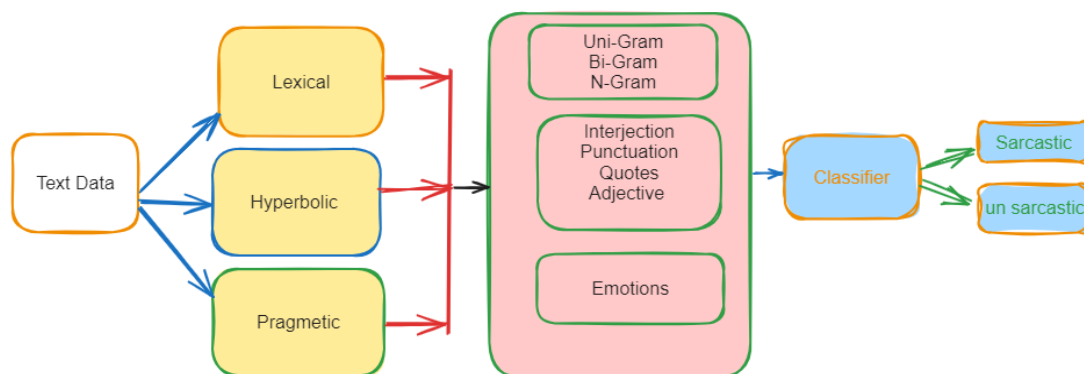


Figure 2: attributes used in Sarcasm detection on text

2. LITERATURE SURVEY

R. Misra and P. Arora et al. [7] addressed difficult challenge of sarcasm prediction in text and also addressed past limitations of sarcasm detection research by introducing high quality and comparatively large-scale news headline data set. They did performance analysis in terms accuracy with implementation of baseline and hybrid neural network reached almost 90% accuracy as quantitative result.

D Olaniyan et al.[8] explored the field of textual data sarcasm detection. He proposed advanced deep learning technique including LSTM (Long Short-Term Memory) networks with attention mechanism. In this paper they achieved accuracy 99.86% than other existing models like linguistic patterns and syntactic, deep learning paradigm, contextualized embeddings and multimodal fusion.

O. Vitman et al.[5] proposed four pre-trained transformers and CNN (Convolutional Neural Networks) model. In this research experimented on four various domain datasets and shown improved results as binary classification like sarcastic and non-sarcastic text than existing results.

T. Yue et al.[1] proposed Knowledge Fusion Network (KnowleNet)and done experiment on sarcasm detection based on pre-existing knowledge and semantic similarity between text and image. Finally, KnowleNet achieved higher accuracy 92.69% and F1 score 91.21%.

S. Muhammad Ahmed Hassan Shah et al.[2] in his research have been used Machine Learning and Deep Learning for text classification. He proposed Modified Switch Transformer (MST) to identify sarcasm on Arabic Tweets for that he used ArSarcasm dataset which contains Arabic tweets. Proposed model has reached 66.81% accuracy even without preprocessing the data.

D Sandor et al.[9] addressed machine learning and deep leaning model were used to classify sarcastic and non-sarcastic over 1.3 million social media comments. Done experiment with various models such as Logistic Regression, Ridge Regression, Support Vector Machine and Linear Support Vector. In his paper compared machine learning model and deep learning model results, BERT (Bidirectional Encoder Representations from Transformers) based model gave best performance results than machine learning models.

Li et al.[10] discussed deep learning technology, graph neural network and weighted pooling methods to transform into graph classification. The performance of proposed method is compared sequence-based models and Graph Neural Network to show significant improvements.

Ali, Rasikh, et al.[11] addressed GMP-LSTM (Global Max Pool -Long Short-Term Memory) layer) model to achieve better results than existing models with dataset which includes 26,700 headlines 11,700 sarcastic and 14,900 non-sarcastic headlines and achieved accuracy 92.5486%.

Sharma, Dilip Kumar, et al.[12] addressed various sarcasm detection techniques are employed in analysing social media posts, including BERT, LSTM, and fuzzy logic. Discussed in his research overview of challenges and techniques used in

sarcasm detection on social media. To overcome drawbacks of existing techniques fuzzy logic is applied for final phase of classification in sarcasm detection. Used twitter data set, SARC and Headlines dataset, done experiment with 3 datasets. With proposed model, SARC, Headlines, and Twitter datasets achieved accuracy values of 85.38%, 90.81%, and 86.80% respectively.

A. Rahma et al.[13]addressed Artificial Intelligence techniques with Arabic tweets dataset and investigated challenges of sarcasm detection in Arabic dataset. He has done survey on different search databases such as Springer, Science Direct, ACM digital library, IEEE explore and others in-terms of articles, conferences and survey papers.

Y. Y. Tan et al.[14]author proposed deep multi-task learning sentiment analysis for sarcasm detection. Done experiments on two different databases and evaluated the performance in-terms of precision, recall and F1 scores. In experiment-1 dataset divided into 80% training and 20 % for testing, achieved sentiment classification F1 score 91% and sarcasm classification 92%. In experiment-2 used datasets are reddit dataset, twitter US airline dataset and twitter dataset. In this experiment evaluate the performance and compared with Bi-LSTM model.

Sharma, D.K at el.[15]proposed hybrid auto encoder-based model using BERT (bidirectional encoder representations from transformer), USE (universal sentence encoder) and LSTM (long short-term memory) auto-encoder with 3 variant datasets like social media, self-annotated reddit corpus and headlines. He discussed challenges of sarcasm detection of content type, slangs and abbreviations. The proposed model achieved better performance results than existing models.

Ranganath Kanakam at el.[16]addressed approaches and performances analysis for sarcasm detection in text on social media using machine learning algorithms including feature extraction, classification, lexicon-based approach, rule-based approach, pattern-based approach, and deep learning-based approach. In his research presented outline of approaches and performance values from 2016 to 2020 reputed journal and conference papers.

Muaad, Abdullah Y., et al.[17]in this paper discussed machine learning and deep learning models to detect sarcasm automatically with different datasets. They provided results for both binary classification and multiclassification using AraBERT classifier. Compared evaluation results of both binary and multi classification in terms of overall accuracy.

Patil et al.[18] author addressed comparison various models of sarcasm detection and proposed Linear SVC, stochastic gradient descent models with reddit dataset. In his research using stochastic gradient descent achieved 68% accuracy and cross validation 85% accuracy and also with an ensemble model achieves 61% accuracy, with standard linear SVC 64%.and implemented conventional binary prediction and cross validation to enhance accuracy.

N. Zhu et al.[19] discussed and shown results cultural and comment type impact of interpretation and use of sarcasm. In this paper studied and compared in terms of results of sarcasm usage participants from UK and China and also done descriptive statistics of speaker, reader and recipient perspective of both China and UK. Finally, they find Chinese being used more sarcastic than UK participants with sarcasm, aggression, amusement and politeness rating measures.

Zhang et al.[20] proposed self-adaptive representation model and done experiment on two datasets available in public like memotion 6992 examples which contains graphics and text and MUSTARD with 345 sarcastic and 345 non-sarcastic conversations. Proposed model contains self-adaptive model, multi- model processing and representation fusion. They achieved better result on performance of sentiment analysis and sarcasm.

3. METHODS USED IN SARCASM DETECTION

MACHINE LEARNING APPROACHES

Main goal of Machine Learning algorithms or applications is to train computers to perform tasks that humans can do just as well as[21].To identify sarcasm in text, various machine learning algorithms are existed. Let have a look on each briefly.

Supervised Learning

Supervised machine learning techniques train the system with labelled date sets to classify text as sarcastic or non-sarcastic. Support Vector Machine (SVM), Random Forest and Decision Tree methods are few supervised learning approaches but they have their own limitation to handle high dimensional and complex data[22].Most of the researcher have proved SVM achieved better results in English language than other classifiers[23]SVM classify the text based on count of positive and negative words in the given predefined words list as sarcastic or non-sarcastic [24]. Combination of Random Forest (RF)

and SVM achieved better results than rest as a rule-based approach[25]SVM is binary linear classification, main goal is to separate data into multiple groups of data from trained data and widely used in various fields because of its effectiveness [26].Optimized methods such as penalty and kernel parameter SVM can improve the prediction performance[16]

Random Forest

One of the ensembles learning categories in machine learning is Random Forest (RF). RF features are ensemble of decision trees, Random Feature selection and Bootstrap Aggregation. RF widely used in various fields in classification and regression tasks[23].RF contains 4 basic process steps such as random sample selection, feature selection, decision tree construction and last prediction. Random Forest is best algorithm for analysis of user behavioural data and classify them[27]Random Forest has its own limitations like compared individual decision trees, consumes more time when training large no. of decision trees and not good for small set of data.

Decision Tree

One of the easy and popular supervised machine learnings is decision tree. Decision Tree model usually denoted tree structure (flowchart structure) in which leaf nodes and non-leaf nodes represented by test and prediction respectively[28]. In this model provided data set break down into smaller data set to predict class. Decision tree has limitation that not handles noise data[16] Decision Tree is a common classification algorithm implemented in various application and key features are splits, types of nodes, decision criteria, tree depth and prunin but overfitting is a limitation of decision tree. decision tree prediction rate will be reduced when modification has done in training data.[29]

DEEP LEARNING APPROACHES

Natural Language Processing

NLP is connection between machine and human to understand, analysis and interpreting the human languages for machine[30]Sentiment Analysis (SA) is an application of Natural Language Processing. In text mining Sentiment Analysis playing vital role to identify opinion, sentiments and subjectivity of text. SA includes Emotion Detection, Building Resources and Transfer Learning. Where Emotion Detection extract the explicit and implicit emotions with analysis of sentences. Transfer Learning mapping data analysis outcomes from source domain to destination or target domain and Building Resources constructing lexica and corpora based on polarity. SA done analysis level wise such as document, sentence, phrase and aspect level [31], [32][33]SA used in educational institutions to extract student opinion from their feedback and sentiment analysis tools also used in education domain[33].Nowadays Sentiment Analysis playing vital to classify the data based on human behaviour and applicable for structural, semi-structural and unstructured data.SA has its own applications and challenges[34]Sentiment analysis using machine learning and deep learning to classify negative and positive sentiment[14].To enhance customer experience and satisfaction sentiment analysis extended in recent research[35]However, sarcasm detection still has a long way to go if the aim of NLP research is create models that can match human level competence[36]

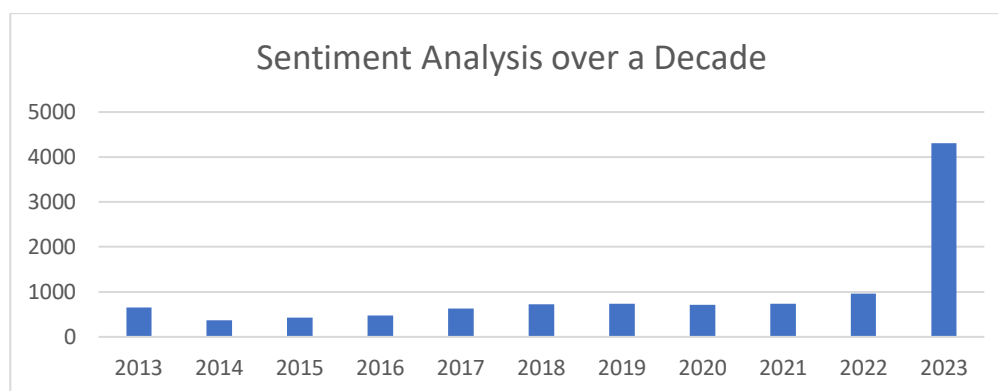


Figure 2: published papers using sentiment analysis over past decade

Research on trending technology over a decade sentiment analysis along with machine learning and deep learning to categorize the people's opinion over social media about review on movies, products and services[37]. Figure 2 shows

published papers with sentiment analysis over past decade. Researcher have used datasets in their research with different sources. Some of datasets listed in table 1.

Long Short-Term Memory (LSTM)

Long short-term memory has become an essential tool in deep learning and significantly improved capabilities of sequence modelling. LSTM network is a special kind of Recurrent Neural Network (RNN) that solves the issues of disappearing gradients by utilizing additional standard units known as memory cell and by training LSTM, we can guarantee improved performance and reduces the loss[38][39]. LSTM incorporate cell unit and three different gates such as input, output and forget gates and explicitly designed to avoid long-term dependency problem and ability to understand hoe sequence prediction problems involve order dependence. In LSTM input output and forget has specific purpose, input gates decide information to be added to the cell, output gates decide information to be provided as output from cell and finally forget gates decided to be removed from the previous cell[40]. LSTM and Bidirectional LSTM variants of RNN to improved sarcasm classification [14],[41].LSTM able to remember past and future context. Attention mechanism model using for LSTM to include common sense to detect sarcasm[42].LSTM is employed to extract short- and long-term dependencies to predict sarcasm detection[43]

Pragmatic Analysis

Pragmatics deals with the way the people using words in their daily conversation. Under pragmatics the way used words either politeness or rudeness. Pragmatics actually deals with meaning of speaker rather than the statement. Pragmatics is scientific study of two words in context. The study of sarcasm is separate pragmatic category of non-literal language[44] Linguistic and pragmatic approaches fail to provide precise and comprehensive definition of sarcasm[45]

Word Embeddings

One of the Challenging's of NLP is capturing the context in which a particular word used. The solution is Word Embedding (WE). Word Embedding basically numerical representation of words. These numbers required to train the machine learning algorithms because we can't train the system with words and word are represented as vector in n-dimensional with distributed and continuous. Frequency based and prediction-based are the types of word embeddings. word embedding mostly worked on text-based approach with machine learning algorithms to create word lexicons[46]Word2Vec and GloVe are the pre-trained word embeddings which immediately uses the large corpus globally. In word Embedding, capture the words in terms of morphological, syntactic and semantic properties. In order to encode semantic information word embedding used co-occurrence matrix data sets[47]

Transformer models

One of the deep learning models is Transformer. It performs parallel processing to increase the scalability and performance. Transformers works bidirectional model that takes context in both direction like forward and backward directions. In transformers training process is very fast. In transformer input is tokenized and labelled by numbers then after word embedding methods used either Word2Vec or Glove to convert word to vector. To decide positive and negative polarity from text bidirectional encoder representation form transformers are used [33]with variant transformers achieved accurate results with confusing text with very limited labels[48]. Architecture of transformer contains feed-forward, multi head attention and masked multi head attention[49].

Table 1: some of existing dataset used on their research

S. No	Dataset	Records	Year of Publication	Author Names	Journal/Conference Name
1	ArSarcasm	27000 Arabic Tweets	2023	Shah S, Shah S[2]	IEEE Access
2	Headlines Semeval IAC SARC	28,619 4792 3260 10,10,826	2023	Misra R, Arora P[7]	AI Open
3	Hurricanesarc	random sample 15,000 tweets	2023	Sosea T, Li J, Caragea C[50]	arxiv
4	SARC/movies SARC/technology	5240 4553 5216	2023	O. Vitman, Y. Kostiuk, G. Sidorov, and A. Gelbukh [5]	Expert Systems with Applications

	IAC_V2 Twitter	48108			
5	Ben-Sarc	25636	2023	S. K. Lora, I. Jahan, R. Hussain, R. Shahriyar, and A. B. M. A. Al Islam [48]	Heliyon
6	IEMOCAP	containing 12 hours of audiovisual data	2023	Y. Li, Y. Wang, X. Yang, and S.-K. Im [10]	EURASIP Journal on Audio, Speech, and Music Processing
7	Twitter News Headline & SARC	19816 5854	2023	T. Yue, R. Mao, H. Wang, Z. Hu, and E. Cambria [1]	Information Fusion
8	Twitter (Riloff) Twitter (Pt'acek) Twitter (Ghosh)	1333 8497 42717	2023	Z. Yu, D. Jin, X. Wang, Y. Li, L. Wang, and J. Dang [51]	Proceedings of the 32nd IJCAI
9	MUStARD Memotion	graphic and text dataset containing 6992	2023	Zhang et al. [52]	ACM Transactions on Multimedia Computing, Communications, and Applications
10	News Headlines	26,709	2023	R. Ali et al. [11]	Applied Sciences (Switzerland)
11	Twitter	19816	2023	Yicong Shi, Xiaoli Zhao, Mingxuan Chen[53]	Research Square
12	IAC-V1 IAC-V2 Twitter	1596 5216 3526	2023	Liming Zhou, Xiaowei Xu, Xiaodong Wang[54]	arxiv
13	Facial and Speech emotion reorganization data set.	random	2022	eye M, Missah Y[55]	IEEE Access
14	Reddit IAC	random	2022	Chen W, Lin F[56]	IEEE Access

4. PERFORMANCE REPORT

Summary of research study on existing methods of sarcasm detection on social media and outline performance of proposed model with findings and drawback shown in Table 2.

Table 2: Outline Performance Report of proposed models

Year	Title of the Paper	Author's Names	Journal/Conference	Proposed Model	Findings
2023	Feature-Based Augmentation in Sarcasm Detection Using Reverse Generative Adversarial Network[57].	Suhartono D, Handoyo A, Junior F	Computers, Materials & Continua	Reverse Generative Adversarial Network (RGAN)	Increased F1-Score from 0.066% to 1.054%
2023	Sentiment Analysis and Sarcasm Detection using Deep Multi-Task Learning[14].	Y. Y. Tan, C. O. Chow, J. Kanesan, J. H. Chuah, and Y. L. Lim	Wireless Personal Communications	Deep Multitask learning framework	Improved performance in sarcasm detection and sentiment analysis.

2023	A transformer-based generative adversarial learning to detect sarcasm from Bengali text with correct classification of confusing text[48].	Lora S, Jahan I,	Heliyon	Transformer-Based Generative Adversarial Mode	Achieves outperformance existing GAN-BERT
2023	Enhanced Semantic Representation Learning for Sarcasm Detection by Integrating Context-Aware Attention and Fusion Network[58].	Hao S, Yao J	Entropy	Contextual Sarcasm Detection Model (CSDM)	Significant improvements in accuracy values 0.69,0.70 and 0.83 on different sets
2023	Comparison of Deep Learning Models for Automatic Detection of Sarcasm Context on the MUSTARD Dataset[59].	A. C. Băroiu and Ștefan Trăușan-Matu	Electronics (Switzerland)	Attn-LSTM	Outperformance of recall (62.3) and F1 score (60.1)
2023	DWAEF: a deep weighted average ensemble framework harnessing novel indicators for sarcasm detection[22].	Sharma R, Deol S	Data Science	Deep Weighted Average Ensemble Framework (DWAEF)	Achieved accuracy 92% and recall 89.59%
2022	Sarcasm-based Tweet-level Stress Detection[60].	Kvtkn P, Ramakrishnu T	Expert Systems	Sarcasm Based Tweet Level Stress Detection (STSD)	achieved s accuracy (5.25% to 9.19%) and F1-Score (0.085 to 0.164) over baseline models
2022	Sarcasm Detection over Social Media Platforms Using Hybrid Auto-Encoder-Based Model[61].	Dilip Kumar Sharma, Bhuvanesh Singh, Saurabh Agarwal.	MDPI	Hybrid Auto Encoder based model	Precision: 92% Recall: 91% Accuracy: 90.8% F-Measure: 91%
2021	Sarcasm Detection Using Deep Learning with Contextual Features[62].	Md Saifullah Razali, Alfian Abdul Halin, Lei Ye, Shyamala Doraiswamy, (Member, Ieee)	IEEE Access	Deep Learning with Contextual Features	Achieved Precision: 0.95 , Recall: 0.94 , Accuracy: 0.94 F-Measure: 0.94
2020	Sarcasm Detection Using Multi-Head Attention Based Bidirectional LSTM[63].	Avinash Kumar, Vishnu Teja Narapareddy, Veerubhotla Aditya Srikanth.	IEEE Access	Multi-head attention-based Bidirectional LSTM(MHA-BiLSTM)	Precision: 72.63% Recall: 83.03% Accuracy: 80.05% F-Measure: 77.48%
2020	Self-Supervised Learning Based Anomaly Detection in Online social media[64].	Kokatnoor, Sujatha Arun, and Balachandran Krishnan	International journal of Intelligent Engineering & Systems	Self-supervised learning	Self-supervised learning 91% accuracy. Logistic Regression - 91 , SVM - 87.60 , Rando Forest- 86.10
2019	Sarcasm Detection Using Soft Attention-Based Bidirectional Long Short-Term Memory Model[65].	L. H. Son, A. Kumar, S. R. Sangwan, A. Arora, A. Nayyar and M. Abdel-Basset	IEEE Access	(sAtt-BLSTM) Soft Attention-Based Bidirectional LSTM	Proposed sAtt-BLSTM achieved 91.60% for SemEval And random tweets obtained 88.28%

5. EXPERIMENTAL RESULTS

We have worked with deep learning algorithms to extract features and classify of text dataset which contain sarcastic and non-sarcastic. We used 40% of data for testing and 60% data for training and result shown in figure 4 and figure 5. For this experiments Keras and TensorFlow libraries are front end and back end respectively. Here the datasets with model along with precision, recall and F1 score accuracy in percentage shown in table 3 and table 4.

Table 3 training dataset

Data set	Model	Precision (%)	Recall (%)	F1 score (%)
Testing	Word2Vec	76	80	82
Testing	Glove	82	83	84

Table 4 testing dataset

Data set	Model	Precision (%)	Recall (%)	F1 score (%)
Training	Word2Vec	79	82	83
Training	Glove	80	81	84

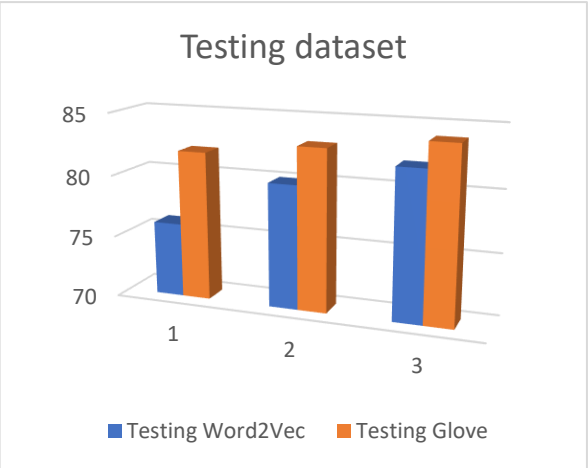


figure 4 showing training result



figure 5 showing testing result

6. CONCLUSION

Sarcasm is a sophisticated and versatile communication in either text, voice or image etc. everyone using sarcastic conversation in their daily life to criticise, tease or make fun to someone. But there is an ambiguity whether he/she used sarcasm in his/her conversation. To clear ambiguity researchers been researching to detect sarcasm in conversation. In this paper, we studied researcher’s methods and datasets have been used in their research work to detect sarcasm on text with irrespective of language. We have done performance report based on methods been used along with findings and drawbacks.

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