

Challenges of Sarcasm Detection for Social Network: a Literature Review

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Abstract - Nowadays, sarcasm recognition and detection simplified with various domains knowledge, among others, computer science, social science, psychology, mathematics, and many more. This article aims to explain trends in sentiment analysis especially sarcasm detection in last ten years and its direction in the future. We review journals with title's keyword "sarcasm" and published from year 2008 until 2018. The articles were classified based on the most frequently discussed topics among others: the dataset, pre-processing, annotations, approaches, features, context, and methods used. The significant increase in the number of articles on "sarcasm" in recent years indicates that research in this area still has enormous opportunities. The research about "sarcasm" also became very interesting because only a few researchers offer solutions for unstructured language. Some hybrid approaches using classification and feature extraction are used to identify the sarcasm sentence using deep learning models. This article will provide a further explanation of the most widely used algorithms for sarcasm detection with object social media. At the end of this article also shown that the critical aspect of research on sarcasm sentence that could be done in the future is dataset usage with various languages that cover unstructured data problem with contextual information will effectively detect sarcasm sentence and will improve the existing performance.

Keywords: sarcasm, recognition, detection, classification, performance

I. INTRODUCTION

According to Big Indonesian Dictionary (*Kamus Besar Bahasa Indonesia*), sarcasm is an expression or style of utterance that has the opposite meaning from the written words in order to insinuate, ridicule, or offend someone, a product, or an institution. A research found that sarcasm consists of components such as a speaker that conveys the utterance for the listener with a certain context that has the meaning of literal proposition but expected to be understood differently or intended scheme [1]. In other words, sarcasm is a sentence that has the

opposite meaning from the written words or spoken words. Because of this different meaning, sarcasm sentences are not easily understood by the reader or hearer. Examples of sarcastic sentences are as follows: "I ordered an item A, but they sent an item B. What an excellent service!". Although there are many positive words and praise words at the end of the sentence, this sentence is a harsh sentence that shows the disappointment of a buyer who orders an item but gets a different piece from what he desired. Irony can be perceived as a result of incongruity between the context and the statement [2], [3], [4]. Meanwhile, sarcasm is also found as a result of incongruity between the context and the statement but more often intended to mention, mock or offend someone, a product or an institution [5], [6].

Every country in the world has its language style, structure, and the rules of the sarcasm sentence as well. Sarcasm detection can be as essential as sentiment analysis, especially for texts written on social media. The most sarcasm detection studies can be found in India, USA, UK, and a few studies have been found using Indonesian language texts. One sarcasm detection study that used Indonesian-language, by using the SVM, Naive Bayes, and Maximum Entropy methods, only got an accuracy value that was no greater than 60% [7]. Though the detection of sarcasm will be needed among public figures, political events, producers of a product, or an organization that uses social media as their communication application with their constituents, customers, or organizations, producer⁴

The difficulty in understanding sarcastic sentences could cause problems with the natural language processing concepts for online news reviews, politician dialogue sentences, institution website, or product monitoring feedback [8]. The most widely used method for detecting sarcasm has been reviewed by Wicana et al. [9]. Several other researchers also explored the part of sarcasm, such as the theory of sarcasm itself, the nature of syntax, psycholinguistics from sarcasm, lexical

features, the nature of semantics, and others. This literature research will focus on figurative sentences as part of the sentiment analysis area, which is currently widely written on social media, online discussions, and news forums. The aim of this article is to show most commonly approaches to detect sarcastic sentences and examine published literature to provide insights for future sarcasm detection systems to practitioners and researchers.

II. METHODS

Explaining research chronological, including research design, research procedure, in the form of algorithms, Pseudocode, or other, and how to test and data acquisition. The description of the course of research should be supported references, so the explanation can be accepted scientifically. Research of sarcasm detection are scattered across journals of various disciplines such as social sciences, computer science, psychology medicine, etc. The journal articles and conference articles that we collected in this research taken from the Scopus website (<https://www.scopus.com>). The articles were obtained using a keyword "sarcasm" and were limited to the area of Computer Science. The following section will explain the procedures performed in extracting the articles used for this literature review study.

A. Data Resources and Filtering Procedures

We started outreaching the articles for this literature study from the publication database website, Scopus, since this site is one of the databases used by most researchers. We took all the articles published from 2008 until 2018, with the keyword "sarcasm." However, in 2018 and above, the research on this subject became a trending topic, and the number of articles increased sharply. Table I shows the article filtering criterias that are used in this review.

For the first filtering, articles were selected if they met the keyword "sarcasm," and we found 832 items from the Scopus website. In the second stage of the filtering, we found 670 documents limited only for journal and conference articles from practitioners and academics often use journals and conferences to acquire

and publish research discovery. For our third stage of the document selection process, we selected only documents originating from the field of research in computer science. From this filtering stage, 230 articles were obtained and used for this literature review. Finally, on the fourth filtering, we select the articles that published only since the year 2008 until 2018 to limit the screening. The last screening process is selecting the articles using a keyword "sarcasm" that contained titles, abstracts, keywords, and conclusions and found 68 articles as the final documents to study in this review. Thus, as the last process, we analyzed the contents of each document based on a predetermined classification scheme that will be explained in the next section. Fig.1 shows the sequence of the process that we used to filter the articles that met all specified criteria.

B. Statistical Analysis

From the documents screening stages, it is shown that research on sarcasm detection was mostly carried out by researchers from the field of computer science, and then followed by social sciences, art and humanities, mathematics, neuroscience, engineering, medicine, business management, and others. This fact is shown in Fig. 2. Computer science researchers may write computer algorithms that mathematically shows what peoples write on social media. The algorithm enables the detection of sarcastic statement by using a combination of some features and recognize the sarcasm sentences from some variation of platforms such as online news, Twitter, Instagram, or Tumblr.

TABLE I
ARTICLE FILTERING CRITERIAS

Criteria	Description
Time frame	2008 - 2018
Keywords	"Sarcasm"
Document type	Journal article and conference
Search in	Article title and abstract and
Search databases	SCOPUS research database
Type of	Peer-reviewed
Field	Computer science

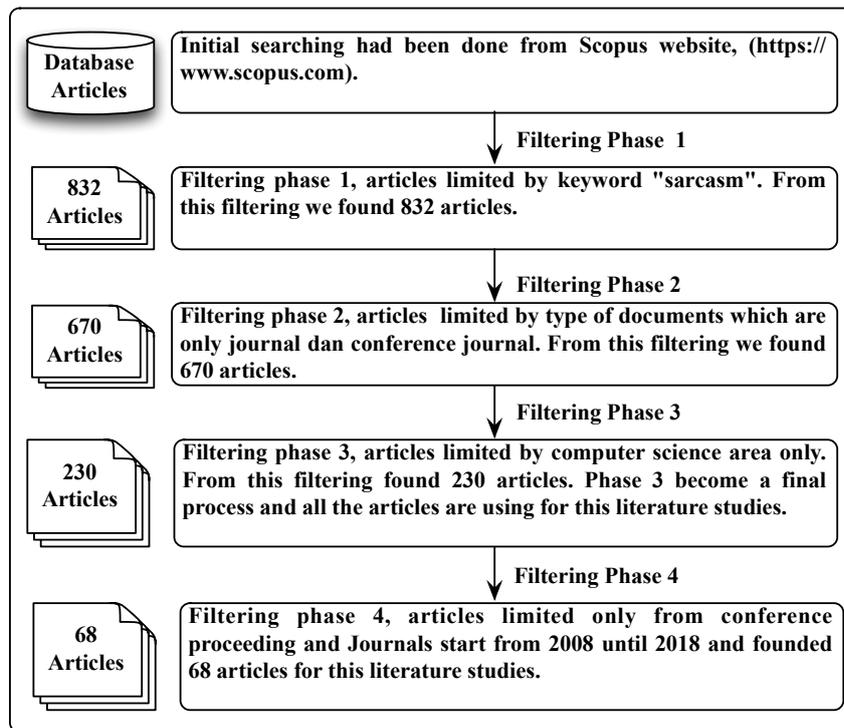


Fig. 1 Articles filtering procedure

The distribution of articles with a total of 68 articles written by researchers from 2008 to 2018 taken from the Scopus website, with the search keyword "sarcasm," type of articles is restricted to journal and conference articles, and the area of research is in computer science. Meanwhile Fig. 3 shows that the number of studies has increased significantly over the last five years. The dataset used by these studies were taken from social media, such as Twitter, WhatsApp, Amazon's sales media, and news media. The most productive country that has been doing sarcasm research, namely India and followed by the USA, Spain, and the UK. Sarcasm detection on Indian languages is one of the most challenging tasks of Natural Language Processing because Indian words are ambiguous in nature and rich in morphology [10].

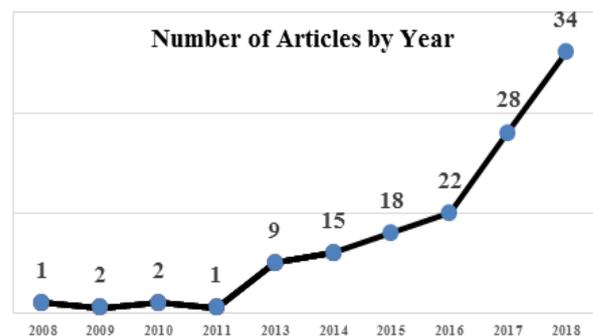


Fig. 3 Increasing of sarcasm research by year

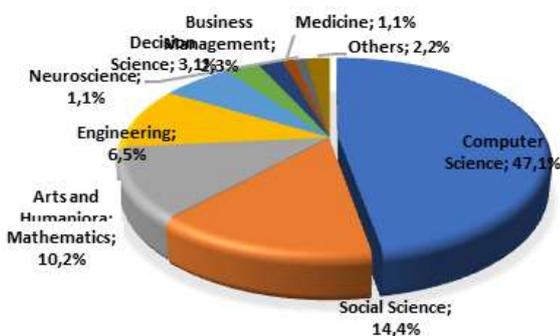


Fig. 2 Statistical analysis of articles filtering procedure

III. RESULT AND DISCUSSION

To be more systematic in expressing research on sarcasm where a study of classification outline was expanded. This scheme of classification was categorized with focuses on 68 chosen articles from filtration processes, as we have seen in Fig. 4.

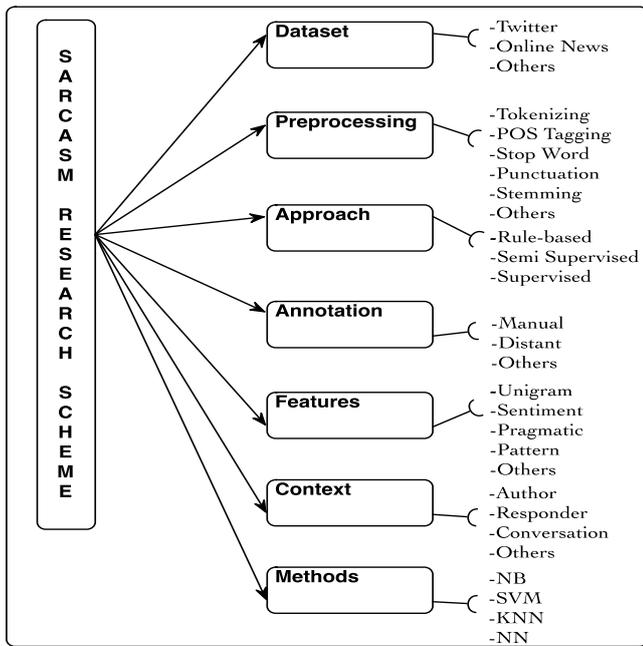


Fig. 4 Classification scheme of sarcasm research

We grouped the all articles into several schemes, which were; the dataset, the pre-processing, the

approaches, the annotations, the features, the context, and the methods as we can see in Table II with an explanation of each scheme as follow:

1) *Dataset*: The most employed dataset that studies by many researchers are Twitter because of its distinguishable properties comparing to another kind of dataset. Twitter data contain various kinds of characters, texts, or emoticon, and it is essential to process the data before applying to feature extraction. Data pre-processing includes cleaning, tokenization, POS-tagging, stop word, punctuation, stemming, etc. [11]. Other datasets that are not widely used by a researcher are online news and WhatsApp group [10], [12].

2) *Pre-Processing*: The best classifiers are chosen and paired with various pre-processing provide the best possible accuracy [13]. The most widely used by researchers for pre-processing, among others, is tokenization, POS-tagging, stop word, punctuation, and stemming. After the pre-processing steps are completed, the data should be ready for the sarcasm classification phase.

TABLE II
CLASSIFICATION SCHEME OF SARCASM RESEARCH

Scheme	Criteria	References
Dataset	Twitter	[6], [14], [15]
	Online News	[14]
	Other	[16]–[18]
Pre-processing	Tokenization	[15], [11]
	POS Tagging	[19], [20], [9]
	Stop Word	[21]
	Punctuation	[20], [19]
	Stemming	[10], [21], [22]
	Approach	Rule-based
Approach	Semi-Supervised	[23], [6]
	Supervised	[20], [22]
Annotation	Manual	[20], [26], [27], [28], [29]
	Distant	[30], [31]
Feature	N-gram	[31], [20]
	Sentiment	[25], [15], [32], [33], [34], [33], [35]
	Pragmatic	[33], [26], [36], [16]
	Pattern	[20], [27], [27], [27]
Context	Author	[37], [38], [39]
	Conversation	[40], [41], [39], [42], [18]
Method	Naive Bayes	[43], [36], [44], [35], [45], [46], [47]
	SVM	[40], [44], [35], [48], [49], [50], [51], [52]
	KNN	[53], [49]
	CNN	[54], [55], [56]

3) *Approach*: A variety of methods have been done with many varieties of techniques, including statistical models, sentiment analysis, pattern recognition, supervised or unsupervised machine learning [57]. The supervised and semi-supervised approach is used for building a model to classify data through a statistical and logical process. Meanwhile, the pattern-based method uses semantic, syntactic, and stylistic properties of sentences in any language such as phrase pattern, lexical, and structural properties to analyse the value of the sentence.

4) *Annotation*: Manual annotation means each tweet is labelled by the annotators to decide whether the statement of the tweet is recognized as sarcasm sentences or not. The distant technique to create datasets is the use of hashtag-based supervision. Many approaches use hashtags in tweets as indicators of sarcasm, such as #sarcasm or #sarcastic. Sarcasm sentences found within those hashtags can be detected more efficiently [58].

5) *Feature*: The lexical feature is based on n-grams that occur more than twice in the training data, while the pragmatic feature determines when the sentiment of the sentence differs from the emoticons or smiles [59]. N-Gram model is probabilistic of words to predict the next item in a sequence with (n-1) order Markov Model. The prediction could be made based on a single preceding item N-gram. Items that are a part of the speech of the words used in the sentences then classified using trigrams as features for the model and not suggest the higher n-grams, because its ineffectively in classification [60].

6) *Context*: The existing work currently focuses on utilizing contextual information in the sentences (e.g., a conversation or the history of the target author). Context-augmented neural models can effectively decode sarcastic clues from contextual information, and give a relative improvement in the detection performance. Including the contextual features will significantly improve the performance, and that the most significant gains are attributable to features encoding information about the authors of tweets [56].

7) *Method*: The method is the approach that is used for sarcasm detection through specific evidence. The used models vary, such as Naive Bayes, SVM, KNN, and CNN. CNN has been a target of attention in social media because has shown excellent capabilities for modelling complex word composition in a sentence [54]. CNN is generally used in computer vision, however recently

CNN has been applied to various NLP tasks such as sarcasm detection and the results were promising, as we can see in Table III. The accuracy using skip-gram and sentiment until character level gives over than 92% and 92% for F-score using bag-of-words classification method. The range of accuracy values is wide enough, between 54% until 90%. These results can be a challenge in finding the most appropriate features and classification techniques for the best way to detect sarcasm. The features performance for various machine learning algorithms that have been used as classifiers, as well as SVM, K-NN, random forest, NB, and CNN. The classification techniques are still dominated by SVM and KNN models, giving the highest performance accuracy value for sarcasm detection, above 80%. The highest precision values above 72% are generated using SVM and KNN.

The classification methods are chosen depending on the task or a particular problem to be solved. It has been recommended to consider as many algorithms as possible to determine the validity of the proposed process, include pre-processing. The language most widely used by researchers in English and others that are used, but not many are Portuguese, Dutch, Chinese, India, and Indonesian. Sarcasm detection studies involving Indonesian-language social media have been carried out [7] using negative word count information and the number of interjection words. This study uses SentiWordNet for the sentiment classification process and produces an accuracy value under 60%. A review study conducted in 2010 said that the value of accuracy and precision obtained when detecting sarcasm, which is higher than 90%, was carried out using the Supervised Sarcasm Identification feature. This research was conducted for Twitter and Amazon data with English-language texts [51].

Table IV shows the most relevant studies regarding sarcasm detection with the highest number of citations and the most topics discussed in the articles. Detection of sarcasm is indeed a topic that closely concerned with machine learning; therefore, most of the articles discussing the use of machine learning to solve the problems of sarcasm detection. The other issues are still dominated by sentiment analysis, features, social media, and the algorithm. Meanwhile, natural language processing, neural network, and deep learning for sarcasm detection research are most discussed in the last three years, as mention by [9].

TABLE III
FEATURES PERFORMANCE

Ref.	Features	Accuracy (%)	Classification Technique	Language
[61]	Emoticon, Lexicon, Syntactic, Semantic, Unigram	60	Multi-Class	English
[43]	N-gram, Skip-gram.	65	NB	English
[62]	Lexical, Pragmatic, Emoticon.	71	SVM	Dutch
[7]	Unigram, Negativity, Interjection	53	NB	Indonesia
[63]	Semantic, Expression, Emoticon.	54	SVM	Indonesia
[64]	N-gram, Emoticon, Interjection	83	SVM	English
[20]	Emoticon, Interjection, Syntactic-Semantic.	86	SVM	English
[65]	Skip-gram (word2vec)	60	SVM	English
[39]	Conversation context	80	KNN	English
[66]	Sentiment (+) (-) Character level	90	CNN	English
[67]	Positive Verbs & Negative Situation	54	CNN	English
		95	CNN	English
		81	SVM	English

TABLE IV
SARCASM DETECTION RESEARCH CHALLENGES

Ref.	State of the Art	Future Research Challenges
[60]	Hashtag #sarcasm using true-positive and false-positive rate	Different language and more subtle variants like understatements, euphemisms, and litotes
[36]	SVM and Decision Tree modelling for context incongruity	Use other data type, dialogue systems, or review ranking systems
[34]	The context-based pattern in Hindi Tweets	Sufficient dataset and language for training and testing
[46]	Classifier model with some features	A large number of data compare human annotator with machine annotator and emoticon processing
[41]	Conversation context modelling using LSTM	Full thread context and utilize external background knowledge to model the sentiment
[39]	Context-augmented CNN	Improve the model with more context
[23]	Context2Vec using Bidirectional LSTM	Incorporating the current method as a set of features for a statistical classifier
[49]	Simile classification with CNN	Expand the dataset and the method
[68]	Word similarity score as an augmented feature with a deep learning model	RNN model, other features, word intensifier, punctuations, and deep learning hyper-parameter optimizing

Fig. 5 presents a maps of keywords which is calculated based on co-occurrence data that collect from title and abstract of all the articles. There are two visualizations shown, that are: network visualization and density visualization. The network visualization, the colors indicate by a label and, by a circle. The more important an item, the larger its label and its circle. The network visualization shows the cluster to which an article was assigned by the clustering technique used by

VOSviewer. There is a strong connection between the word “sarcasm” with “sarcasm detection”, “approach”, “tweet”, and “feature”. Meanwhile, density visualization can be used to see parts of research that are still rarely done. There are strong similarities that result between the clustering obtained from VOSviewer and our classification technique above. The three clusters that correspond strongly with our manual classification are sarcasm detection, approach, and context.

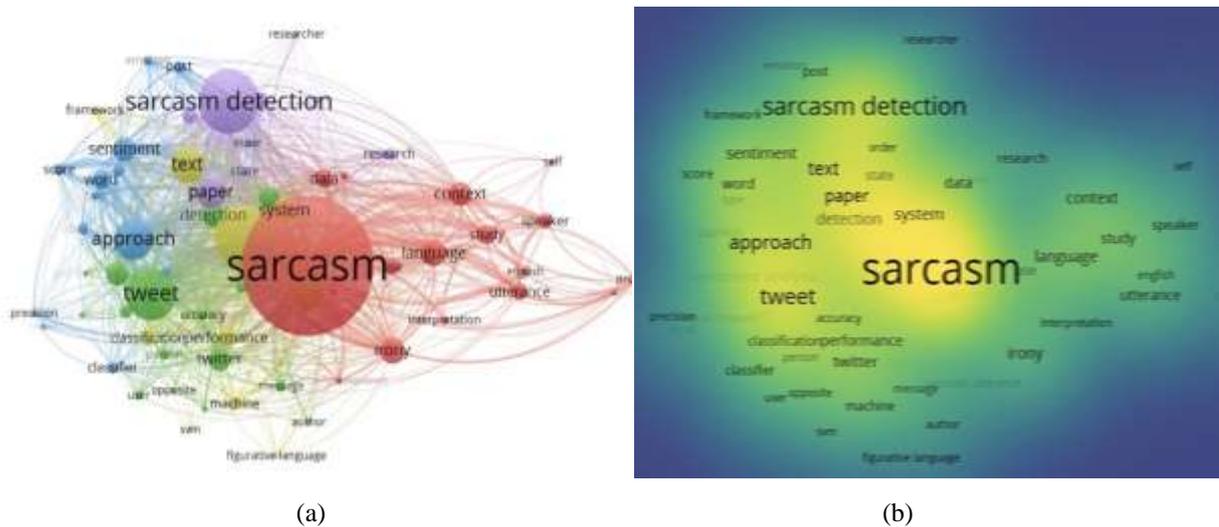


Fig. 5 Network (a) and density (b) visualization for sarcasm keyword

IV. CONCLUSIONS

Various machine learning algorithm has been used for sarcasm classifiers, such as SVM, K-NN, NB, and NN. In general, there are extensive choices of which classification method can be used when designing a sarcasm with large and unstructured data. Text dataset, with noisy and unstructured data, can be successfully classified using a deep learning approach such as CNN or RNN. CNN uses a variation of multilayer perceptron designed to reduce pre-processing. RNN with LSTM (Long Short Term Memory) and GRU (Gated Recurrent Unit) can be used for prediction to the sequence of texts. LSTM method with an attention mechanism model to detect English ironic sentences from Twitter shows a better performance with a combination of CNN, LSTM, and Deep Neural Network.

This classification scheme study reveals extensive guidance for other academics, researchers, and practitioners that are researching the field of sarcasm detection and recognition. This review will give a further understanding of various concepts about sarcasm detection in social media. The results showed explosive growth in the number of sarcasm detection articles published. This study describes the increase of research benefit in sarcasm detection as necessary and legitimate research topics. The most important aspect of future work in sarcasm detection is dataset usage with various languages and contextual information that effectively detect sarcasm and give an improvement in the detection performance. Furthermore, we believe that there are some prospective hybrid approaches for classification and feature extraction to identify the sarcasm sentence using deep learning with big data. Combining different methods between machine learning and deep learning to

facilitate sarcasm patterns and recognition is possible to do and developing contextual information of dataset to improve the performance of sarcasm detection.

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