

# Sentiments behind citations: Tracking the need, current work and future directions of Citation Sentiment Analysis.

Dr. Sarabjeet Kaur<sup>1</sup>, Uma Ojha<sup>2</sup>, Urvashi Choudhary<sup>3</sup>, Vasundhra Dahiya<sup>3</sup>

<sup>1</sup>Assistant Professor, Department Of Computer Science, Indraprastha College For Women,  
University of Delhi, New Delhi, India.  
sarabjeet.kochhar@gmail.com

<sup>2</sup>Assistant Professor, Department Of Computer Science, Atma Ram Sanatan Dharma College,  
University of Delhi, New Delhi, India.  
ojha.uma@gmail.com

<sup>3</sup>Department of Computer Science, Indraprastha College for Women, University of Delhi  
New Delhi, India  
{urvashi0801, vasundhra.dahiya} @ gmail.com

**Abstract.** Citations have always been an integral part of academic writing and have given proof of thorough research from time immemorial. Researchers cite their references to show how meticulously the research has been conducted and also to avoid plagiarism. Analysis of these citations brings out information about the quality of papers, research, and institutes. Tracking the frequency of citation of a paper has been a useful means of its analysis over the years. Although citation count gives a fair idea about the popularity of the paper, it is persistent to note that the use of citations by various researchers could also be made to highlight the imperfection or infirmities. Moreover, it also does not recognize the assert opinion of the researcher about the citations. This new form of sentiment detection of citations helps to summarize paper by observing significant achievements, shortcomings and drawbacks in a particular research problem. This helps a researcher in understanding the true impact of the paper. This is where opinion mining meets citation analysis. Algorithms to automatically detect and infer sentiments from a context around citations are need of the hour. As a research community, we are poised far behind a human reader for whom the task of sentiment detection from context is both natural and trivial. So in this paper, we choose to survey various studies conducted for finding the context of citation and analyze sentiments there in. Some conclusions from the survey are also presented at the end.

**Keywords:** Citation Analysis, Sentiment Analysis, Citation Context detection.

# 1 INTRODUCTION

Citation analysis is an emerging and challenging area at the confluence of fields such as bibliometrics and computational linguistics. Analyzing the citations helps to detect the impact of the research, summarize papers, study co-authorships among researchers and discover research transfer across different domains [1][11].

Citations have been looked at from various perspectives. Some researchers have tried to fit these citations into categories to better understand them [1]. Some have tried to place papers as nodes and connect them by citations using the graph theory [4] [8].

Many methods have been used to make sense out of these citations, however nowadays much stress is laid on fetching the context behind them [2]. It is important to study the context of a citation in order to understand the author's underlying sentiment for it. When looked at individually, the citation sentences may appear completely neutral but when the bunch of sentences around it is examined, its sentiment becomes visible. This is the reason why there is an increasing focus on studying the sentiment behind particular citations.

Algorithms and methods to automatically detect and infer sentiments from a context around citations are need of the hour. Only a handful of works have so far attempted to address this problem [2] [4] [8] [15] [16]. As a research community, this positions us far behind a human reader to whom the task of sentiment detection from context is natural and trivial.

This paper discusses various methods that have been devised till now to perform sentiment analysis of citations. Also, the levels at which it is performed is discussed.

## 1.1 BASIC TERMINOLOGIES

A mention or reference of another paper in a text is known as a citation. The paper in which the reference is made about the source paper is called the citing paper. The paper being cited is the target paper. Citations are divided into a number of categories, but the two basic categories are explicit citations and implicit citations [2] [4] [8].

Explicit citations refer to the sentences where the citations have been mentioned explicitly i.e. referenced specifically, e.g.: "While SCL has been successfully applied to POS tagging and Sentiment Analysis (*Blitzer et al., 2006*), its effectiveness for parsing was rather unexplored."

Implicit citations involve mentions of other research papers and authors with informal or indirect references and no proper explicit reference. In most cases, citations are mentioned in one sentence and are further implicitly used and elaborated with the help of determiners, pronouns, and certain other fixers, e.g.: "Exploring more lexical features in a later work, Wiebe and Riloff (2005) developed a Naive Bayes classifier using data extracted by a pattern learner. *This* pattern learner was seeded with known

subjective data. Additional features for this Naive Bayes classifier included strong and weak subjective.” In this example, the second sentence makes an implicit reference to the explicit reference in the first sentence (Wiebe and Riloff (2005)) by using the pronoun "this".

## **2 SENTIMENT ANALYSIS OF CITATIONS**

The sentiment analysis of citations can be carried out mainly on two different levels, namely, the sentence level and the context level, which are explained in the following subsections.

### **2.1 SENTENCE LEVEL CITATION SENTIMENT ANALYSIS**

Sentence-Based citation sentiment classification is the method of identifying the sentiments behind the citation sentences. When working with explicit citations, sentences are categorized as positive (p), negative (n) and neutral (o) [3] [4] [7] [13]. Teufel et al. [15] has classified the citations into 12 different citation functions based on the sentiments mentioned in the cited text. Using the machine learning methods and natural language processing (NLP) algorithms, many classifiers have been trained for annotating the polarity of a citation sentiment. This includes assigning a polarity label, such as positive/ negative/ neutral, from an existing set of labels to a new observation [5]. Classifiers like Naive Bayes, Maximum Entropy and Support Vector Machines have been applied efficiently in sentiment classification of sentences [2]. Some of the features affecting sentiments of a given sentence are adjectives, adverbs, subjectivity clues, negation words and polarity shifters (like although etc) [2] [7].

It is observed that classifiers behave differently with different domains, for e.g. it may vary according to the lexical items that are chosen to convey the sentiments. Thus, for scientific literature, different features and classifiers are needed than for a movie review [17]. This observation is strongly supported by the work of Awais [2] [5], who used the Naive Bayes and Support Vector Machine Classifiers, to experiment on annotated citation dataset obtained from ACL Anthology Network to predict the polarity of citation sentences using the Weka toolkit [14]. The work clearly shows that because of difference in domains, macro F-score was better for trigrams than unigrams and bigrams for scientific literature as compared to the movie reviews. This is because words in scientific text do not clearly convey the intention of their usage due to covert scientific writing style, which was not so in the movie reviews.

To detect sentiments of explicit citation, Athar used trigrams as baseline and added different combinations of features with it. A significant improvement in the score (macro-F=0.764) was found, when dependency triplet and window-based negations with window length 15 were added to the trigrams. He also demonstrated that SVM

performed better than the Naive Bayes Classifier, which is generally considered to be more robust and efficient algorithm.

## 2.2 CONTEXT LEVEL CITATION SENTIMENT ANALYSIS

There is more to a citation than just a pointer between the publications [4]. The citation may just be mentioned in a single sentence, but its respective sentiment may have been spanned in several following sentences. Detection of sentiment from the text surrounding the citation (explicit) which generally includes implicit citations, forms a part of the process known as the Context Level Citation Sentiment Detection.

Context level citation sentiment detection has two main things to work on. First, the detection of citation context and second, the sentiment classification of the citation context. Sentiment classification can be a relatively easier task than the detection of citation context and many machine-learning algorithms have proved to be effective for citation sentiment detection [2][4][16].

Citation context detection can be an exhausting task because it depends on how efficiently a function can span the surroundings of citation, such that nothing important is left out. Over the years, many automatic citation functions have been created for the same [2] [15]. From their results, it has been revealed that the factors to be taken into consideration have to be intelligently selected for proper detection. Some of the common features that can be used for context detection are anaphora (words like this, these, he, she, etc), Author name, acronyms, method names, work nouns (words like method, techniques, etc), connectors, etc. The following paragraphs will discuss the methodology and results of some recent significant works in this area.

Butt et al. [13] classified the citation as positive or negative polarity using a window of five sentences enclosing the cited text using Sentiment Lexicon. To classify sentiment analysis, Naïve Bayes classifier was used on manually annotated corpus and 80% accuracy was achieved. It is interesting to note that this process is trivial and natural for a human reader, but is very complex for machine learning algorithms. Abu-Jbara et al. [16] used supervised learning methods on citation context to analyze the impact of research qualitatively by measuring the purpose and polarity of citations. For detection of citation context, window size of 4 sentences is considered. The accuracy for detection of sentiments was improved by 12.1% when citation context is used as compared to explicit citations with the SVM classifier.

Athar and Teufel [3] also use classes for citation context as Positive (p), Negative (n), Objective/Neutral (o) and 'x' for the context, which refers to no citation and has to be excluded. For detection of citation context, a window of 4 sentences was considered which was inspired by work of Qazvinian and Radev [8]. He, then used SVM classifier with features such as author name, acronyms, work nouns, connectors and lexical hooks in the sentence and observed 8% improvement as compared to n-gram (1-3 grams) baseline. Among all features, Lexical hooks and acronyms played the

major role in predicting implicit citations. On this citation context, Sentiment analysis was performed and an improvement of 48% was noticed with explicit citation as baseline.

For citation context detection, Murray [4] used Qazvinian and Radev's graphical model [8] and Athar and Teufel's machine learning methods [2]. He also combined these methods to evaluate the efficiency score on an annotated dataset of Athar and Teufel's work. Murray, however, performs the detection of citation context with the categorization of sentences as 'not citation' and 'implicit'. He assumed that 'explicit' cited part has already been annotated and aims at identifying just the implicitly cited part. His research experiment was as follows:

1. He performed detection of implicit citations by adding certain features like the inclusion of text just around explicit citations, similarities in sentences, titles, and content using 20-cross validation method. He implemented Qazvinian and Radev's work [8] of graphical approach with Athar and Teufel's sentence-features.
2. From this combination, he discovered an increase of 132% as compared to macro F-score of Athar and Teufel's work and 88 % improvement with macro-F score of Qazvinian and Radev's work.
3. He also compared these two approaches separately and concluded that Machine learning is better than the graphical approach in classifying sentences positively. He also showed that the performance of the classifier improves if the distance to the closest previous citation is taken into consideration whereas extending the graphical algorithm with text similarity measure proved to be a failure.

Studies have proved that analysis of context around the explicit citations is more helpful in an accurate understanding of the citation sentiment, which takes us to why we need context level sentiment analysis.

### **3 CHALLENGES**

At the crossroads of bibliometrics and sentiment analysis, the area of detecting sentiment behind citations is brimming with challenges. Some of them are enumerated below.

1. Amongst sentence level citation sentiment analysis and context level citation sentiment analysis, of course the latter is more efficient and accurate. But existing algorithms, classifiers, sentence features and lexicons are still not performing that well on citation context, which is why many improvements are needed. For e.g., the techniques results vary for a large corpus which needs immediate work if citation sentiment analysis has to be implemented in a wide research domain [2].
2. Recent studies have not placed enough importance on the researcher's viewpoint i.e. why in the first place the papers are cited [9]. The validity of the claim made by

the researcher and the strength of cited paper should be focused upon rather than just the polarity [10].

3. Most of the inspiring research works are not cited or are rarely cited [6]. The scope of citation analysis can be extended to account for un-cited research work.
4. Even after detecting implicit citations, the problem of analyzing and identifying the true sentiments is yet to be accurately addressed, because in scholastic writing often citations may be made either out of softness or sympathy towards the researcher [3]. Moreover, negative citations are mentioned in subtle ways that may be detectable by humans, but may not be properly identified by algorithms. If identified, they may not be quantifiable.

## **4 FUTURE SCOPE**

Citation Sentiment analysis is an emerging field and some work has been done on it, but the field has not been fully explored. Following are some of the promising areas for further work.

1. We believe that annotation of data plays an important role in the citation sentiment analysis and better annotation of data can give better results. Researchers can work towards automation of the annotation mechanisms. [15]
2. For efficient detection of context, more features can be added such that they perform equally well on any corpus domain.
3. Although there are a few mentions of people trying to implement graphs [4][8], there is a lot of scope for work on exploring the confluence of areas such as graph theory and citation sentiment analysis.
4. There is a need to improvise the existing algorithms for detection of context windows sizes and finding all references to the cited work including that, which are outside the window [2].
5. Since all citations are not equally important, weights can be assigned to the important citations in citing articles, based on the strength and importance of the cited work [10]. This can lead to the development of recommender systems that can recommend papers based on the strength of its citation instead of just the citation count.
6. Limiting the citation boundaries in the running text of the research paper might be helpful in many citation-based analysis techniques [12]. For automatic summarization it is another promising avenue for further research.

## **5 CONCLUSION**

The paper is set at the confluence of areas namely citation analysis, context detection and sentiment analysis. Since the frequency of citations does not essentially imply the

quality of citations, the paper brings to fore the motivation behind analyzing sentiments behind citing a paper. Section 2 briefly presents the research work for sentiment and context level citation sentiment analysis, their methodology and their conclusions. Section 3 outlines the major challenges facing this emerging area. Section 4 discusses the areas to focus upon for the development of the field of citation sentiment analysis. Section 5 concludes the paper.

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