IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 10 Issue 01, January 2023
ISSN (Online) 2348 – 7968 | Impact Factor – 6.72
www.ijiset.com

Citation Function Classification Schemes and Techniques: A survey

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January 22, 2023

Abstract

Citation function classification is a new and emerging research area in citation analysis, machine learning, and information science. It has been developed to identify the citation purposes in scholarly publications and improve classical bibliometric measures for research quality assessment. This paper introduces this topic and reviews its schemes and techniques for addressing automated citation function classification. The literature reviews focuses on citation function/purpose classification and explored the primary schemes and the techniques used to detect the purpose of citing the literature. This paper reviewed the schemes and identified the existing approaches' advantages and disadvantages. The review concludes that early citation detectors founded on machine learning employed fewer annotated datasets that subject-matter experts often labeled. Techniques for categorization may be divided into three groups. The feature-centered machine learning categorizers use the contextual and non-contextual characteristics retrieved from the citing set. The dependence linkages and cue terms associated with the dissertation structure are common contextual elements scholars utilize to understand better the long-term relationships between terms in the citation set

Function Classification Schemes and Techniques: A survey

The reason an author cites a paper may be established through the utilization of citation classification; this can be achieved through analysis of the context of the cited works. A citation is defined as the manner an author tells the readers that particular material is obtained from a different source (Nazir et al., 2020). Similarly, it offers the readers the information essential to get to the location specifics of that source on the Works Cited page. Citation context describes the text which bears the author's reason for citing anything from another paper. Classification of citation context might offer additional information concerning the author's reason behind citing information from another paper (Nazir et al., 2020).

Furthermore, present bibliometric procedures for evaluating the popularity and influence of published articles offer quantitative pointers of the eminence of a published paper. This, in most cases, fails to show the work quality presented in the paper. Consequently, this type of analysis is supposedly beneficial if the qualitative features were incorporated into the standard bibliometric actions like an Impact Factor of journals using Citation Function Classification (CFC) (Nazir et al., 2020).

This paper evaluates the literature on Citation Function Classification Schemes and Techniques with a specific emphasis on deep learning and neural network techniques. The purpose citations could be helpful for citation summarization and automated survey generation. This paper uses the terms' purpose' and 'function' interchangeably. The research examines the various categorization systems, data repositories, preprocessing techniques, and ways of extracting contextual and non-contextual characteristics, classification classes, and assessment approaches. The study emphasizes the significance of determining the reference kinds for research assessment, the difficulties encountered by scientists throughout the procedure, and the areas for further research that still need to be filled.

Citation Purpose Schemes

The motivation of researchers for citing the works of other scholars is different. For instance, a scholar might cite existing work to obtain help regarding background material, tools, and concepts. It could similarly be for reviewing approaches, critiques, or disproving the preceding work to improve numerous citation-centered applications like automatic survey generation and citation summary (Alshamari et al., 2020). This precise illustration of citation functions might accurately depict the effect or influence of publication. The existing works have proven that various citation function schemes have been formed to answer an essential question as to why the authors quote the

literature review with several functions as well as the levels of granularity.

Different pieces of literature have records of Manual citation function classification processes with varying granular levels ranging from 35 to 3 functions, as cited by Alshammari et al. (2021). Consequently, automated classification is unavoidable owing to the numerous publications published daily. Cui et al. (2022) proposed a citation scheme that might categorize citation functions into six functions focused on: stockpile, advantageous, drawbacks, distinction, recognition, and boundaries. A clear definition of a conceptualization is what is meant by ontology. It has several notions, including characteristics, units, and characteristics. Even though these ideas share scope with their relationships and meanings, scholars can manually and automatically construct subject taxonomies and incorporate them, incorporating various web mining technologies (Mariko et al., 2020). Various ontologies have been built using ontological expression languages like Web Ontology Language (OWL) and Resource Description Framework. Keep in mind that the taxonomies make it possible to repurpose domain information. Due to its adaptability, researchers have commonly used taxonomy to transfer knowledge to solve the problem of citation role classification (Mariko et al., 2020).

Ciancarini et al. (2013) introduced CiTo1 (Citation Typing Ontology) and CiTaLo functions to recover the type of citation function and utilized semantic relatedness to determine the citation purpose objective. They have utilized a variety of tools. In order to construct CiTaLo software, Kontonatsios et al. (2020) used 18 papers and combined ontological modeling with NLP methods to assess the citings. Ciancarini et al. (2013) established the CiTo framework to study an existent source for categorizing citations. They annotated academic publications using semantic innovation under two different circumstances the entire set of Cito attributes and a particular subset. However, researchers may have various features, including author data and level of publication, which might outshine citation function strategies that do not integrate scholarly ontology. The techniques above do not consider these extra details about scholars in the system. These techniques also utilize rule-centered and controlled machine learning methods, which call for the manual categorization of citation functions by subject-matter professionals. The monitored training techniques have two problems: first, the training images utilized by the algorithms that are supervised to train on are labeled using unequal citation systems, and second, physical annotation of human training is frequently expensive.

For text categorization models, several scholars have used neural networks, and they have produced satisfactory results. Embedding of a word is a model that Mariko et al. (2020) used to design characteristics from word representations in neural networks. The categorization of citation functions has grown as a novel and important study area. It is a means to determine the author's justifications for citing the work.

Published papers are not stand-alone things; they are solitary literary works that reference earlier studies. Citations, which serve as a link between the referencing as well as quoted documents, are used to establish this relationship between the study articles. Information researchers and anthropologists of technology have already conducted substantial research on the rationale or driving force behind mentioning an article. In their innovative research, Sula et al. (2014) list 15 justifications for mentioning a publication, some of which include "Honoring founders, paying tribute for related tasks, defining technique, gear and so on., Giving background research" and other similar phrases. To shed light on researchers' citing habits, this research created ontologies for categorizing citations to discover the social purposes that citations fulfill and gauge how significant they are to the quoting writer. To decipher the latent elements of references from the language enclosing the source, previous techniques employed case studies of established writers or the researchers' knowledge (Sula et al., 2014). Nevertheless, analysis of the citation setting's scientific substance received little focus.

This review presents a unique strategy for CFC by merging writers and citing taxonomies as parameters to the convolutional neural network (CNN) decoder to solve human attribute selection concerns and enhance classification efficiency. The scholar classification will comprise the features of authors, like author data like name, organization, and level of publication, as well as individual demographic information.

The creation of automated algorithms for analyzing citation settings and extracting linguistic and non-textual properties, accompanied by the categorization of references, is a consequence of advancements in studies in the domains of machine learning as well as natural language processing (NLP). This literature review will look at the research on citation categorization qualitative elements, including its purpose and significance. This meta-analysis examines earlier research connected to every one of the above phases and looks at the various methodologies employed. The terms related to citation categorization are discussed in the section in the setting of a discourse relation between the content referenced and the text referencing it. Then, the

subheadings, difficulties, and uses of automatic reference categorization systems are covered.

Importance of Citations

Past studies on classification emphasized differentiating citations centered on their purposes or the researcher's motive for the article citing. Nevertheless, fresher classification approaches portraying citations centered on their significance and impact were not presented prior to 2015. Prevailing studies in citation significance classification utilizes feature-centered binary cataloging methods. The works of Zhu et al. (2015) are the most highlighted studies in this field. Even though the previously identified 40 varied components for noticing some references from the list that are significant to the citing text, the latter incorporated 12 somewhat overlying aspects for describing both direct citations as supplementary or significant. Another study assessed the components from the studies mentioned to classify the most significant forecasters for citation impact cataloging. The quantification of the connection between the initial aspects and the actual label they get intangible resemblance to be the most prognostic aspect.

Table 1 below provides examples of a few critical works categorizing citation significance. The binomial categorization schemes Incidental and significant are used in all of the material analyzed in this work to identify citation significance. Valenzuela et al. (2015) created a scheme that treats historical and comparison-linked citations as coincidental while classifying those within the subcategories of utilizing and progressing the work. The Below 15% of citing settings for each of the studies are found to be in a Significant category, according to the distributions of category occurrences. Logistic Regression (LR) is a straightforward machine learning-based model employed in each study described in this analysis. Random Forest consistently outperformed all other classifiers in these experiments (RF). The sum of occasions a journal mentions in the paper is the most significant predictor in each situation.

Referance	Number of Functions	Categories	Comments
Zhu et al. (2015	65	Influential	Using Auther's annotations to highlight essential references
Qayyum and Afzal (2019)	69	Incidental	Only 69 occurrences of the overall annotated annotations fell in the crucial group
Valenzuela et al (2015)	465	Important	When compared to techniques using content-based characteristics the utilization of metadata alone yields good results

Table 1: *Table 1:Citation function*

Citation Purpose Techniques

Features For Citation Classification

Machine-learning-based automatic citation classification methods utilize aspects that assist in capturing the relationship between the cited and the citing texts. The characteristics are manually established then the text-founded citation background gets examined for extracting enlightening signs. Tables 2 and 3 show the characteristics utilized by a couple of the texts linked to the citation purpose and significance classification. The citation classification in the prevailing literature considers the following varied feature scopes.

Contextual Features

According to how the citations are specified in the setting, the situational features are further divided into syntactic and semantic categories. Next, the semantic characteristic is divided into textual, similarity-based, and polarity-centered categories.

Semantic features

The use of Meta discourse for automatic citation categorization is very widely researched. Various studies (Jurgens et al., 2018; Xu et al., 2013). Mercer and Di Marco (2003) recognize the significance of sign terms as a "connective that helps in the construction of the rationality and consistency of a text ...." The researchers researched the existence of cue expressions

within the full-text IMRaD (chapters as well as citing phrases and in the citation setting and concluded on the noteworthy incidence of dissertation signals in the citation setting, which renders these profound determinants for classifying citations centered on their characters. According to Jurgens et al. (2018), the citation incidence in context topics and term vectors in the upper 100 uppermost weighted characteristics offer precise information.

The contextual factors focused on polarity are used in reference categorization techniques, with classes separating the study's opinion of the publications referenced. The importance of cue phrases relating to partiality in citation neutrality categorization, as per Jha et al. (2017). Jochim et al. conducted a study on the use of a vocabulary built around consistently polar concepts (2012). Additionally, the taxonomy researchers employed lexicons and general-role polarization in their investigation, finding improvements in the different classifiers.

Automatic Citation Methods

Evaluating the citation background by hand was a primary component of earlier classification systems. There have been initiatives to automate the procedure to overcome earlier methods' drawbacks. The various automatic citation categorization techniques are discussed in the subsections that follow.

Rule-Based Techniques

Sellak et al. (2015) conducted a study on Machine Learning (ML) algorithms used in citations; the study contributed to the citation line of works by providing an alternate method not yet verified in the domain-centered semantic rule-centered classifiers. This method used a novel Hybrid Feature Selection Method (HFSM) in a Class Association Rules (CARs) procedure. Tests were carried out on a corpus culminating from a definite systematic review. The study's findings demonstrate that the algorithm outdoes the prevailing literature algorithms. Sellak et al. (2015) provided proof that the prevailing method might suggestively diminish false negatives as well as the rates of error while implementing a text classifier to back the decision-making when conducting systematic reviews.

The usage of automatic cue terms or expressions for automatic citation classification has been extensively researched. Jurgens et al. (2018) and Xu et al. (2013) appreciate the significance of cue terms as a "... combination or conjunction that helps in the creation of the consistency and coherence

of a writing ....” The researchers evaluated the incidence of cue expressions in the entirety of text IMRaD segments as well as citing statements as well as in the citation setting and concluded on the significant incidence of dissertation signs in citation background, which renders these vital determining factors for classifying citations centered on the roles they play. By Marco et al., it was demonstrated that the incidence of equivocation cue terms or expressions, such as ”While,” ”may,” ”could,” and ”is steady with,” and moving ahead, captures the absence of inevitability in citation situation (2006). Jurgens et al. (2018) established the incidence of citation background subjects and term paths in the 100 peak-weighted components offering precise information. Additional commonly utilized semantic components comprise similarity-based signs.

Additional commonly utilized semantic components comprise similarity-based signs. Hassan et al. (2018) and Pride et al. (2017) engage these by gauging the similarity in semantics between the abstract cited and the text used in citing with cosine similarity. They see this as the best edifying component for citation significance classification. Correspondingly, the Pearson correlation coefficient between the components and the gold tag for Zhu et al. (2015) shows the efficiency of the similarity-centered components calculated between the subject of the cited article with the various features of the citing article. Prevalent deep learning citation methods for classification depend on word depictions like Global Vectors for Word Representation (GloVe) and Bidirectional Encoder Representations from Transformers (BERT) for apprehending the citation contexts semantics (Beltagy et al., 2019; Cohan et al., 2019).

The classification systems with classes differentiating the writer’s sentiment regarding the cited text similarly utilize contextual aspects centered on polarity. Jha et al. (2017) established the significance of the cue expressions relating to partiality in citation polarity classification. Jochim et al. (2012) researched using a lexicon centered on systematically polar terms. Jochim et al. (2012) similarly utilized overall-purpose polarity along with positive and negative dictionaries in their experimentations, discovering enhancement in the classifier performance in the identification of the facades, juxtaposition vs. evolution, and confirmation vs. negation.

References	Year	Number of Functions	Features Used		Semantic-based	
			Syntactic	*Text-based*	*Similarity-based*	*Polarity-Based*
Joshim et al.	2012	12	Consistent citation Dependency relations	Negation Cue words		General polarity lexicon General negative lexicon
Xu et al.	2013	2	Whether citation are used parenthesis	Cue patterns		
Hassan et al.	2017	12				
Ather et al	2011	10	Post tags Dependancy Relations	Subjectivity cues Sentence splitting Negation		Scientific polarity lexicon
Jurgens et al	2018	65	Sentence and clause lenth Verb tens	Citation context subjects Extended cue expressions	Topical similarity with cited text	-

Machine Learning Techniques

Deep-learning methods

Deep learning approaches have been used to classify citations in recent years due to advancements in dealing with NLP-related issues. Even though complex, neural networks' capability to recognize components automatically eliminates the laborious process of establishing handmade characteristics prior to categorization. On the ACL-ARC set of data, Perier-Camby et al. (2019) contrast the performance of the feature-centered machine learning strategy with that of the Bi-attentive Classification Network (BCN) as well as Elmo. The researchers stress the necessity of more extensive sets of data for deep learning techniques to handle classification tasks more effectively. Yousif et al. (2019) suggested a mixed model utilizing LSTM and Convolutional Neural Networks (CNN) to capture n-grams, long-term relationships for multifunctional citation function, and sentiment classification. With the aid of a bidirectional LSTM, attentiveness process, and Elmo matrices, Cohan et al. (2019) 's multimodal differentiated instruction successfully detected the citation purpose from the architectural data gathered using two additional tasks: citation quality and chapter heading. SciBERT is a novel transformer-centered form created by Beltagy et al. (2019) utilizing the BERT design, then educated on 1.14 million science articles. A more extensive SciBERT system known as S2ORC-SciBERT (Lo et al., 2020) is developed using a new corpus of 8.1 million full-text academic articles that are freely available online.

Knowledge-Based Techniques

Vlachidis et al. (2016) study hascritical contributions to the semantic indexing attempt; this comprises CIDOC-CRM unit recognition with the use of shallow construing NLP techniques motivated by a helpful utilization of ontological as well as word field resources as well as utilization of context-motivated data extraction guidelines for the recognition of the semantic relation from expressions of unstructured text. According to Vlachidis et al. (2016), the Gold Standard assessment remains at least viable with linked work, even though, as discoursed, direct contrasts of performance measures may be ambiguous owing to application field aspects of single system features. The assessment demonstrates direct benefit in the utilization of supportive NLP units linking to WSD, as well as Noun Phrase Authentication, which improves the precision performance of the NER result (Vlachidis et al., 2016). The study's outcomes similarly show the capability and nimbleness of the

measured thesaurus development to allow a scalable NER conduct favoring either accuracy or recollection. Additionally, the performance of RE gains from a syntactic-centered description of RE outlines resulting from domain-adapted corpus examination as contrasted to an automatic description of offset extent outlines (Vlachidis et al., 2016).

Because field dividers differ, automatic citation retrieval is challenging. For instance, one may use spaces to divide the publisher and headline variables and brackets to divide the quantity and problem fields. Punctuation errors inside sections lead to additional separator problems. Several citation standards are wildly dissimilar, which makes matters worse (that is, varied field orders). Several technologies try to retrieve citation data from citations in digital records. A program that automatically indexes academic articles in digital methods is called CiteSeer. It employs machine learning algorithms to distinguish between different references for a single work. Lehmann et al. (2014) also retrieve citations from digital texts using a prototype mining technique.

Knowledge-based Reference Metadata Extraction (RME) is a difficult challenge, given the variety of referencing styles. In this essay, we suggest a knowledge-based RME technique for research papers. According to the empirical results, researchers could precisely retrieve creator, subject, publication, issue, year, and page data from various reference formats utilizing INFO MAP. For different reference types, the average total domain consistency of citation retrieval is 97.87

Challenges and recommendations

The process of categorizing citations according to their nature is not simple. First off, it is possible that the citing phrase could not always include all of the required syntactic clues. Second, writers typically cite a source mentioned earlier in their paper without directly identifying it by employing named things, like the identities of the employed techniques, technologies, or data sources (Kaplan et al., 2016). When describing citations, ignoring these explicit citations causes the loss of data (Athar et al., 2012). Sometimes researchers dodge unfavorable citations by hiding judgment in overly high reviews and refuse to identify by utilizing a particular technique from earlier studies. Creating a categorization system that could effectively represent a broad array of citation purposes is a challenge. Classification systems frequently vary from the fine-grained to the relatively vague. Even though the conceptual ontologies are too broad to grasp all the detailed info, the authors have trouble deciding between comparable or overlapping classifications in

the event of fine-grained systems, which results in a significant reduction in the inter-annotator contract. Sometimes, the difficulties involved in these identification techniques cause the resolution of the fine-tuned systems to be lowered (Fisas et al., 2016). Furthermore, a majority of the data approaches adopted for manual citation categorization tagged by subject-matter specialists, which takes much time and may be arbitrary.

The absence of interpreted corpora big sufficient to simplify the job across domains has slowed advancement in this discipline. The proper Owing to the non-use of the existing data sets, annotation techniques, usage of distinctive picture characteristics, and utilization of diverse classifiers, comparing findings from the current state of the art is a pretty difficult problem. Additionally, the absence of formal methodologies for comparing and evaluating citation categorization methods renders it hard to determine how the state of the field has advanced (Kunnath Pride et al., 2020). The domain-definite character of current data sets makes it challenging to use the corpora in various fields. The significant variations in the corpus, categorizing schemes, and classifications used for the investigations make it challenging to replicate prior findings with a new corpus. The data sample used to classify citations is substantially skewed, with most instances falling into the category of brief background study. Assisted learning systems for classifying citations typically omit a few subcategories, which are more critical in our study. Advancement in this area has been delayed by the lack of labeled data that are sufficiently big and cross-domain to generalize the task (Hernández-Lvarez et al., 2016).
Owing to the underutilization of the available databases and labeling techniques, the correct comparison of findings from the current state of the art is a somewhat tricky problem (Jochim et al., 2012).

Additionally, the absence of formal methodologies for comparing and evaluating citation categorization systems render it challenging to determine how state-of-the-art has advanced (Kunnath., 2020). Implementing such corpora across many disciplines is a relatively challenging possibility due to the domain-definite character of current data sets. Owing to the profound changes in the amount, classification schemes, and classifiers utilized for the study, replicating earlier results with a novel corpus is similarly challenging. The vast datasets utilized to classify citations are highly prejudicial, with most instances falling into the preliminary work, cursory, or neutral categories (Fisas et al., 2016).

Conclusion

Citations are essential for convincing since they provide a source of support for the assertions made by authors. Understanding whether the writers concur or disagree with the assertions made in the referenced publication is crucial because not all references are represented equally. The purpose of citing work or the author's objectives has long been the research topic. This review examined studies that categorize citations according to their purposes, polarities, and centralities. This review emphasized analyzing methodologies that consider the conceptual relationships between the cited and referenced publications.

Low, moderate, and fine-grained classifications are used in the categorization methods for determining citation role and polarity. Some research uses a tiered classification, with the pro level including more abstract classifications and the low degree providing the complete annotation system. However, categorization approaches for citation significance employ a straightforward binary classification. Early citation detectors founded on machine learning employed fewer annotated datasets that subject-matter experts often labeled. Techniques for categorization may be divided into three groups. The feature-centered machine learning categorizers use the contextual and non-contextual characteristics retrieved from the citing set. The dependence linkages and cue terms associated with the dissertation structure are common contextual elements scholars utilize to understand better the long-term relationships between terms in the citation set. The placement of references concerning other parts and their regularity are non-contextual characteristics that are significant for recognizing essential references.

The efficiency ofisf recently formed deep learning techniques, which do not need to be fed with manually created features, has improved when offered a more significant data set. Nevertheless, techniques utilizing transducer designs, like BERT, have been exclusively evaluated on straightforward three-class categorization schemes. The effectiveness of such models has to be assessed using considerably more comprehensive taxonomies that discriminate citation roles. Academic publications' information-gathering systems mainly rely on semantic- and context-based elements in addition to text comparison. Today's readers are inquisitive about a study's significance, aim, and impact on subsequent research projects. Several approaches have been created to improve the extraction of the most important scientific publications utilizing machine learning and AI. This paper reviews and enhances four current cutting-edge algorithms for locating significant citations.

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