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Exploring the Intricate Relationship between Semantics and Computational Linguistics

[1]Azhar Ahmad, [2]Dr. Ishfaque Ahmed Abbasi, [3]Rashid Hussain Abbasi, [4]Bushra Rasheed

[1]M. Phil English (Linguistics) Lahore Leads University, Lahore, Punjab, Pakistan. Email: azharscholar313@gmail.com

[2]Assistant Professor, Department of Maths, Basic Sciences and Humanities, Sukkur IBA University, Sindh, Pakistan. Email: ishfaque@iba-suk.edu.pk

[3]Lecturer department of maths, basic sciences and humanities, Sukkur IBA university Sindh, Pakistan. Email: rashidhussain@iba-suk.edu.pk

[4]MPhil English (Linguistics), Institute of Humanities and Arts, KFUEIT, Rahim Yar Khan, Punjab, Pakistan. Email: bushrarasheed23@gmail.com

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Abstract

The main objective of the present study was to explore the intricate relationships between the two subfields of linguistics known as semantics and computational linguistics. For this purpose, researcher employed content analysis approach for congregating information from different written sources available on social media books, articles and newspapers. The findings of the research unveiled different type of relationships between these two as both are related as subfields of linguistics; different aspects and functions are also common; relationships through disciplines of computer science; theory of computation expressing relationship; semantic analysis expressing relationships; applications of computational linguistics (Automatic hyphenation, grammar, spelling and style checking, references to words and words to combinations, information retrieval) are expressing relationships; semantic computing expressing relationships; and Human Language Technology (HLT). On the bases of these findings' researchers presented some recommendations for the future scholars and researchers.

Keywords: Linguistics, Semantics, Computational linguistics.

Introduction

Before exploring the intricate relationships between semantics and computational linguistics it is necessary to understand the meanings and worth of both terms known as semantics and computational linguistics, it is necessary to understand its accurate meaning. Therefore, the both terms are presented blew concisely to familiarize with these terms.

Semantics

Defining semantics, we can say that the study of the linguistic meaning of morphemes, words, phrases, and sentences is called semantics. While focusing on its terminology we find that the noun semantics and adjective semantic are derived from Greek word semantikos meaning signify (Green et al., 2002; Zhuge, 2010; Ahmad et al., 2021). The renowned French linguist Michel Boreal is considered as the founder of modern semantics and first of all the term semantics was used by him in (1833). Semantics is a sub-discipline of linguistics which emphases on the study of meaning. It attempts to understand meaning of a word or element language; moreover, it also tries to understand that by what means it is created by language; likewise, it interpreted, obscured and negotiated by speakers and listeners of a language

(Green et al., 2002). Semantics has also close linkage with one more sub discipline of linguistics known as pragmatics which is study of meaning in context. On the other hand, unlike pragmatics, semantics is an extremely theoretic research perspective, and lonely looks at meaning in language but pragmatics is additionally more applied subject focusing on the meaning in the usage of language. In the field of linguistics semantics looks that just how meaning is created which is significant to understand that how language works as a whole. The study of semantic originated during ancient times but it was not acknowledged as an independent field until nineteenth century (Nerbonne, 1995; Gliozzo & Strapparava, 2009).

Computational Linguistics

Computational linguistics is a field ranges between linguistics and computer science with the help of psychology and logic. It uses computers to simplify treating with linguistic issues. It is considered as a branch of computer science as well as of linguistics (Muslim, 2007). Farhat, 2019). Computational linguistics originated in late 1950s but the roots of this field goes back to the early days of computing. The term Computational linguistics was coined and first time used by David Hayes in 1970s decade. Computational linguistics is an interdisciplinary field of linguistics that applies computers while analyzing and comprehending verbal and written language. It combines linguistics, computer science and artificial intelligence to comprehend language from a computational perspective. It aids in simplifying our communication with the help of technological software (Maitlo, Abbasi & Ali, 2024). 2024; Zou, 2024). Computational linguistics focuses on the system or concept that machine can be computed to understand, learn or output languages. Whereas Natural Language Processing which is abbreviated as NLP is the application of processing language which enables a computer program to understand human language in both written and spoken forms (Smith, 1982; Delmonte, 2007; Zhuge, 2010).

"Computational linguistics is a field ranges between linguistics and computer science with the help of psychology and logic. It uses computers to simplify treating with linguistic issues. It is considered as a branch of computer science as well as of linguistics" (Muslim, 2007, p.29). Computational linguistics appeared from the amalgamation of classic linguistics with computer science field; that makes it purely an innovative discipline (Jeevan et al., 2023; Younus et al., 2023). But as we go through the pages of history, we find that its early form of this field was totally abstract (Maitlo et al., 2024; Sadaf et al., 2024) The linguists belong to the earlier ages often imagined that in the future computer possibly will be able to evaluate language practically and this idea has been changed in practicality. In the modern age linguists

are using computer science, artificial intelligence, and in the science of neurology to create prototypes and models which are making easy for computer devices to progress language (Blackburn & Bos, 2003; Fox, 2010; Boleda, 2020; Maitlo, Shah & Ahmed, 2024).

Aim of the Study

The present study aims to exploring the intricate relationship between semantics and computational linguistics. Previously there are some works done to finds different types of relationships between the different subfields of linguistics. But there is no study conducted to explore the relationships between these two sub fields of linguistics. Therefore, this study will pave way for the future researchers and scholars to consider on this topic which was ignored from a long time.

Significance of the Study

The present study is significant in this regard because earlier no one has made attempt to explore the relations between these two sub fields. But the in my assignment work I have tried to find the relationships between these sub field of linguistics known as semantics and computational linguistics. The study is also valuable in aspect as it will pave way for the future researchers to work in these areas of linguistics in their contexts.

Limitations of the Study

- The present study has some limitations as it comprises only two subfields of linguistics disregarding other areas and fields of linguistics; whereas syntax, morphology, pragmatics and other macro level sub fields are totally overlooked.
- In the present study writer have only attempted to explore the relationships between two sub fields, while it can be extended to the other areas as features, significance, functions, purposes etc. these are totally sidestepped in this work.
- The present study is also limited to a particular setting and particular subject.

But instead of all these limitations this study is significant and valuable masterpiece work for the reason that this is newfangled theme and insignificant work is done on this topic, so the author made this arduous mission possible and explored many kinds of complex relationships between these two subfields of linguistics. This is also significant in itself.

Theoretical Framework

“The structure that can support a theory is called theoretical framework; it not only encompasses the theory, but narrative explanation about how the researcher engages in using the theory and its underlying assumptions to investigate the research problem” (Ahmad,

Farhat & Abbas, 2024, p.302). the present study follows the study conducted by Abdullayev & Kholbekova, (2023) examined the relationships between syntax and semantics in the context of Uzbekistan State World Languages University, he conducted study to explore the complex connection concerning semantics and syntax both are important subfields of linguistics earlier preform vital part in transfer meaning while later manages the organization of words to make sentence. These both fields related to the micro level of linguistics. In the same way in the present study is conducted to explore the intricate relationships between semantics and computational linguistics in Pakistani context and these both are subfields of linguistics. But in the present study semantic belongs to micro level and computational linguistics is related to macro level sub field of linguistics.

Literature Review

A literature review discusses published information in a particular subject area, and sometimes information in a particular subject area within a certain time period (Ahmad et al., 2025; Jalbani et al., 2023). A literature review can be just a simple summary of the sources, but it usually has an organizational pattern and combines both summary and synthesis (Rao et al., 2023; Amin et al., 2024). The literature review of the present study contains on semantics in computer Science, followed by some previous related research works to the present study.

Semantics in Computer Science

In programming language theory, semantics is the difficult scientific study of the meanings of programming languages. The semantics gives computational meaning to effective sequences in programming linguistic composition. That is narrowly connected to and frequently signs over the semantics of scientific evidences. Semantics refer to the procedures which computer monitors during performing a database in a particular linguistic set. It might be performed by defining the linkage among the contribution and production of a database, while providing clarification that how database will be performed on a definite stage, thus generating models on a computer (Simmons, 1972).

Previous Related Studies

Pulman, (2007) Formal and computational semantics: a case study. Muslim, (2007) not only presented an introduction of computational linguistics but also highlighted its advantages and disadvantages. Fox, (2010) in his book computational semantics the handbook of computational linguistics and natural language processing. The present study is inclusive exertion that offers an outline of the ideas, approaches, and presentations in computational

linguistics and natural language processing (NLP). Jabeen, Gao and Andreae (2020), in the article entitled "Semantic association computation: a comprehensive survey". The study analysed semantic linkage with computer. The findings of this survey research revealed that semantics has some relations with computational linguistics. Some more researches are conducted in different contexts which are related to this present topic to some extent as Scott & Strachey, (1971) studied mathematical semantics for computer languages Jurafsky, (2006) in his book analysed pragmatics and computational linguistics. Hausser, (2011) analysed computational linguistics and talking robots in processing content in database semantics.

Research Methodology

"The research methodology is the procedure which is used by the researchers to gather data for resolving problems of investigation" (Ahmad, Farhat & Choudhary, 2022). The content analysis approach was employed for congregating information from different written sources available on social media books, articles and newspapers.

Research Findings

This part of my article contains on relationship as sub-fields of linguistics, computational linguistics aspects expressing relations, functions of computational semantics expressing relationships, relationships through disciplines of computer science, theory of computation expressing relationship, and semantic analysis expressing relationships.

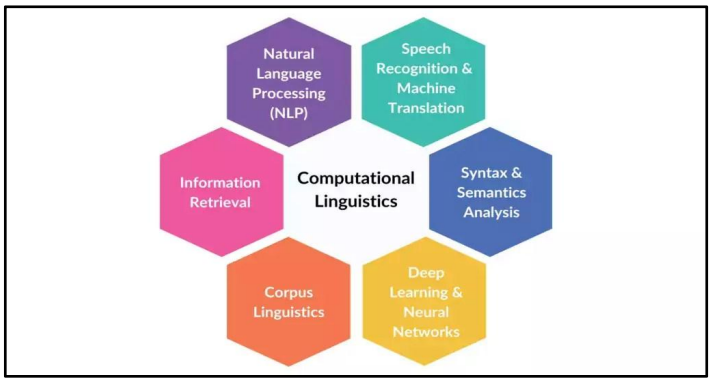
Relationship as Sub-Fields of Linguistics

Semantics is a micro level branch of linguistics which studies language in the abstract without regard to its meaning. But the computational is macro level field of linguistics that studies how machines process human language. Here I want to make clear the difference between micro level and macro level fields of linguistics; the former refers to a narrower field of linguistics which studies language internally, and it includes phonetics, phonology, morphology, syntax, semantics and pragmatics; while the later refers to a border field and its function is to study that how machine process in human language. The study of how machines can understand, learn, and output human language is closely linked to Natural Language Processing NLP. Although there is difference in the levels of semantics and computational linguistics but in spite of these level differences both are subfield of linguistics therefore both fields are related with each other (Smith, 1982; Fox 2010).

Semantics and computational linguistics are related fields; computational semantics is subfield of computational linguistics that studies how to automatically analyze meaning of

natural language. Semantics refers to study meaning and how it's linguistically encoded; but computational linguistics is study of preforming computations on linguistic objects while its subfield which is known as computational linguistics study that how meaning of a natural language is analyzed automatically by using computers (Liu et al., 2017; Maruthi et al., 2021; Aladakatti et al., 2023).

The figure number one blew is highlighting the functions of computational linguistics:



Source: (https://spotintelligence.com/2024/01/25/computational-linguistics)

Computational linguistics comprises, Natural Language Processing (NLP), search recognition and machine translation, syntax and semantics analysis, deep language and natural language networks, corpus linguistics, and information retrieval. These are part of computational linguistics as showed in the above figure number one.

Computational Linguistics Aspects Expressing Relations

There are some key aspects of computational linguistics expressing relations of computational linguistics with semantics.

- First aspect is known as Natural Language Processing (NLP) which is a subcategory of computational linguistics which focuses on the interaction between computers and human language. It includes set of rules and models which enables computers in understanding, interpreting and generating human language.

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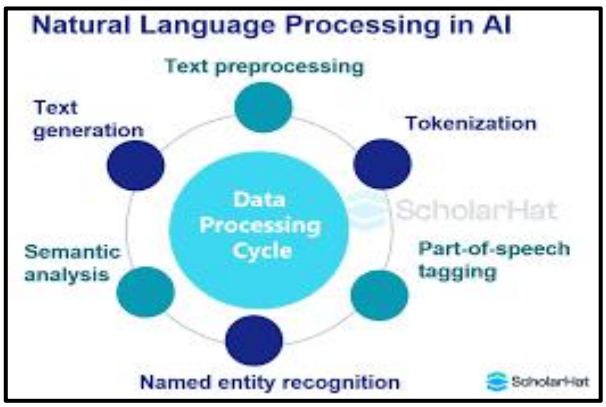
The figure number two below is presenting the function of natural language processing:



(Source: https://www.scholarhat.com).

The above figure number two is showing that there are six main functions of Natural Language Processing (NLP), as the text generation, text preprocessing, and tokenization, part of speech tagging, and named entity recognition, followed by semantic analysis. That is expressing the intricate relationship between semantics and computational linguistics.

- The second aspect is known as Speech Recognition which allows computers to convert verbal language in written text. Speech recognition is a technology which permits computers to translate verbal arguments in to writing. This is a cross-disciplinary field that combining computer science, linguistics, acoustics, digital signal processing, artificial intelligence, and mathematical statistics.
- The third aspect of computational linguistics is recognized as Information Retrieval which is essential in developing search engines and Information Retrieval system can cognize the operator's enquiry and provides related outcomes. It includes evaluating the meaning and structure of language to develop the accurateness of search systems.
- The fourth aspect of computational linguistics is identified as Machine Translation which emphases on developing systems that translate text or speech from one language to another language automatically. It is principally significant in this globalized circle, easing communication from corner to corner of language borders.
- The fifth aspect of computational linguistics is identified as corpus linguistics which often works with wide-ranging collections of texts or bodies for the purpose of analyze the its forms in the use of language. It aids in increasing set of rules and modals for a number of tasks linked to language.
- Sixth aspect of computational linguistics is identified as Syntax and Semantics Analysis.

Computational linguistics comprises generating models to analyze grammatical structure of sentences (syntax) and meaning (semantics). It aids in extracting significant information a text and develop the context of understanding.

From the above aspects it becomes clear that the computational linguistics is deeply related to the field of linguistics. The aim of my study is find more and more relationships between these two fields of linguistics known as semantics and computational linguistics. Consequently, while probing these relationships between both fields I find that the sub field of computational linguistics termed as computational semantics which is study of how to automate the procedure of creating and thinking with meaning demonstrations of natural language expressing is possible. Computational semantics therefore preform a significant part in natural language processing and computational linguistics (Saint-Dizier & Viegas, 1995; Fox, 2010).

Functions of Computational Semantics Expressing Relationships

There are some functions of computational semantics which expresses the complex relationships between the semantics and computational linguists. Firstly, computational semantics preforms automatic meaning analysis of natural language. Secondly, research in computational semantics designs meaning signs and develops tools for transmission automatically. Lastly, computational semantics is not merely preforming particularly undertaking monumental tasks but it comprises numerous sub-tasks containing sense of words, constructions of words, disambiguation, multi-word expression analysis, semantic role classification, syntax and sematic structures, co-reference resolution, and the automatic induction of semantic evidence from data. Moreover computational semantics not only studies that just how the meaning of natural language words can be signified and proceeded on computers but it frequently depend on the understandings of formal semantics and put on them to problems that can be solved by using computer devices (Green et al., 2002). Some of its key problems include computing the meaning of complex expressions by analyzing their parts, holding vagueness, ambiguity, and context-dependence, and using the extracted information in automatic reasoning (Green et al., 2002). It forms part of computational linguistics, artificial intelligence, and cognitive science. Its applications include machine learning and machine-translation. These functions of the computational semantics are expressing relationships between semantics and computational linguistics. (Simmons, 1972; Blackburn & Bos, 2003; Fox, 2010; Abdullayev & Kholbekova, 2023).

Relationships through Disciplines of Computer Science

Semantics and computational linguistics is also related by the discipline of computer science. In disciplines of computer science the semantics of a program is how it works as a computer device works. Semantics differ from syntax that is the specific formula in it directions are transported. The similar behavior can usually be referred with dissimilar formulas of syntax. In java script it is the case for commands i+ = 1 and i = i + 1, these are not the same in syntax way and these terms are increasing the value of the variable by i by one. This variance is similarly reflecting in diverse programs of linguistic sciences relying on dissimilar syntax however can be generally engaged to generate databases with similar behaviors on semantic level. In this regard the semantic is also related to computational linguistics (Rosner & Johnson, 1992; Rapaport, 1995).

Theory of Computation Expressing Relationship

Computer science is the study of precise descriptions of finite processes; and semantics is study of meaning in language. In this regard computational semantics embraces any project which approaches the phenomena of meaning. Therefore, theory of computation or computational also becomes a source of relationship between semantics and computational linguistics.

Semantic Analysis Expressing Relationships

Semantic analysis often referred to as meaning analysis is a process used in linguistics, data analytics, and computer science for the purpose of understanding the meaning of given text or set of texts. In computer science it is extensively used in compiler design where it ensures that the code written follows the correct syntax and semantics of the programming language. In the context of natural language processing and big data analytics it delves in to understanding the contextual meaning of individual words used not only in the sentences but also in the entire documents (Simmons, 1972; Muslim, 2007). By breaking down the linguistic constructs and relationships semantic analysis helps machine to grasp the underlying significance, themes, emotions carried by the text. In a nutshell, semantics analysis is a procedure which helps computers in understanding the meanings of the words and phrases in context. Its key part of natural language processing that allows computers to understand language. Semantic analysis can understand meaning of words; it can also understand the meanings of the individual words and the relationship between these words. Semantic analysis also can analyse meaning of sentences and examines the meaning of the

words that comes together in the sentence (Simmons, 1972; Muslim, 2007). Moreover, semantic analysis can interpret tone, feeling and emotion in a text. Furthermore, it can not only determine connotation whether tone is positive or negative or neutral, but it also help search engines to understand intent behind a search query. Consequently, it becomes clear that there is relationship between semantics and computational linguistics (Simmons, 1972; Rapaport, 1995; Muslim, 2007; Pulman, 2007).

Applications of Computational Linguistics Expressing Relationships

There are some applications of computational linguistics that are expressing relationships between both fields of linguistics named semantics and computational linguistics. These are application of automatic hyphenation, application of spelling checking, application of grammar checking, application of style checking, and application of references to words and words to combinations followed by application of information retrieval. These applications are briefly analysed through their functions to explore the relationship between semantics and computational linguistics.

Automatic Hyphenation

Automatic hyphenation is used to join two elements of compound words or single word at the end of line. It fits long words in a suitable form by means of computer device.

Spelling Checking

This is a method used in computer to correct typo mistakes in written texts. This application not only checks spellings but also suggests some word from which the operator can select correct word. For instance, if user has type presen incorrectly the spelling checker will provide full form of words by suggesting words present and preset from these suggested words the user can select required word.

Grammar Checking

This is a method used in computer not merely to check grammar but it also corrects the grammar. It is useful tool and used for various purposes in the modern times. Written works and documents are corrected by the grammar checker soft wares. Muslim (2007) pointed out that a “useful grammar checker should bear a complete syntactic analysis (parsing) system of a text in order to be an active assistant to the user” (p.36).

Style Checking

“Each literary category has its own style of writing. In official writing; one should choose constructions far from slang language. The style checker provides the user with the correct

choice. It also parses the text automatically in order to find out the wrong syntactic constructions" (Muslim, 2007, p.36).

References to Words and Words to Combinations

The operator can easily get find a combination of words "semantically related to a certain one. This is achieved by autonomous on-line dictionaries and other which are built in. The user can get benefit from such references to choose the most appropriate word for text" Muslim, 2007, p.36).

Information Retrieval

This program was planned for searching related evidence that can be finding in several types of documentation. Dissimilar research approaches are used for the reason that to fulfil the excessive aspiration of searching for systematic objects existed in documentation.

The above analysed six applications showed that the semantics and computational linguistics are related fields. Muslim, (2007) also pointed the functions of these applications of computational linguistics but in the present study these applications of computational linguistics are analysed regarding the relationship between semantics and computational linguistics which makes it a valuable work.

Semantic Computing Expressing Relationships

Semantic computing is a field of computing that combines elements of semantic analysis, elements of natural language processing, elements of data mining, elements of knowledge graphics, and elements of related fields. Semantic computing discusses three main complications as firstly, understanding the objectives of semantics that users are communicating computer machine translation; secondly, understanding the semantics of computational contents; thirdly, planning the semantics of operators with purpose of content recovery, organization, creation etc. The name of this field is semantic computing which is expressing the relationship between semantics and computational linguistics.

Human Language Technology (HLT)

Language technology often called Human Language Technology abbreviated as HLT; it studies approaches of in which way computer programs or electronic devices such as laptop etc. can analyze, produce, modify, or respond to human texts and speech. But keep in mind that working with technology often requires broad knowledge not only about linguistics but also about computer science. Human Language Technology (HLT) is an interdisciplinary field that examines how computer programs and strategies can investigate, create transform,

and answer to human speech and writing. Word sense disambiguation that is abbreviated as WSD is the processes of analyzing the accurate meaning of an expression in a sentence or in other situation. It is a normal arrangement problem that is significant in various fields, including text analytics, information retrieval, and speech acknowledgement. Multi word expression analysis, semantic role labeling, the construction of sentence semantic structure, conference resolution, the automatic induction of semantic information from data, and manually constructed developmental resources in computational semantics. These resources hypothesize the linguistic constructions to be targeted in automatic analysis and these are facilitating high quality information organized by humans that can be used to teach machine learning systems. For instance, WordNet, ProbBank, FrameNet, VerbNet, TimeBank and many others.

Discussions

Computational linguistics deals with the applications of computers to work with language. There are number of things that human do with language that can be automated to degree of a computer translating from one language to another language, recognizing the speech, pronouncing these words, understanding sentence and large texts, and producing text that conveys meaning or information. As in computational linguistics, computers work with language aspects such as translation of languages from one language to another language. Consequently, in order for the computer to translate words, sentences, and large text to another language correctly, they should firstly be semantically as well as grammatically meaningful so as words or sentences in to the second language would also be meaningful. The wrongly constructed words, sentences, or large text in the first language leads to wrong translation in the second target language.

In a natural language performing meanings analysis automatically is main function of computational semantics. The study of computational semantics develops depictions of meaning and also advances appliances for the purpose of conveying it in automatic way. Moreover, computational semantics is not merely particular monumental mission but it entails several sub-tasks as well as word sense dis-ambiguities, investigating multi word communication, labelling semantic role, building sentence in semantic arrangement, reference purpose, and automatically generating semantic evidence from facts. The growth of created properties in manual way is massively significant in motivating and advancing this field. Instances consist of Word Net, Prop Bank, Frame Net, Verb Net, and Time Bank. These

properties insist on the language arrangements to be directed in programmed investigation, and these are providing extraordinary quality human made information which can be employed to sequence in machine learning systems. Administered machine learning based on manual way created properties that are generally employed procedures.

Second fundamental element is the generation of to become familiarize to vocabulary from written documents. For, instance, words can be signified from side to side the perspectives in which these appeared is named distributional directions and embedding's, as in semantic way comparable words have comparable signs. The semantic relations concerning words can be inferred from forms of words that connected these words. Wide coverage semantic analysis constantly wants additional information, together the knowledge of vocabulary and knowledge of the world, and programmed instruction at least relieves the problematic issues.

Compositionality is a third core theme: the systematic construction of structural meaning representations of larger expressions from the meaning representations of their parts. The representations typically use logics of varying expressivity, which makes them well suited to performing automatic inferences with theorem proverbs. Manual specification and automatic acquisition of knowledge are closely intertwined. Manually created resources are automatically extended or merged. The automatic induction of semantic information is guided and constrained by manually specified information, which is much more reliable. And for restricted domains, the construction of logical representations is learned from data. It is at the intersection of manual specification and machine learning that some of the current larger questions of computational semantics are located.

Conclusion and Recommendation

Concluded that semantic is deeply linked to the computational linguistics, but it is complex to explore the relations between both subfields of linguistics. The purpose of my study was to explore these complicated links between semantics and computational linguistics. By analysing both subfields of linguistics from different perspectives I find some connections between both as sub-fields of linguistics, computational linguistics aspects, functions of computational semantics, disciplines of computer science, theory of computation, and semantic analysis. The study finds that there is least work is done on this theme and it was severely ignored by the preceding scholars and researchers. Now the young researchers and scholars must take responsibility on their shoulders to work on this area of linguistics that

was continually overlooked. The present assignment work will pave way for the future researchers and scholars and it will become an evidence of masterpiece work in future. Moreover, it will instigate scholars and researchers to conduct more valuable works on current subject to benefit the realm of linguistics.

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