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Study of various Approaches used for Speech Tagging and Parsing

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Abstract: *Speech tagging and parsing are fundamental components of Natural Language Processing (NLP) for extracting meaning from spoken language. This survey explores recent advancements in NLP methodologies that enhance speech tagging and parsing. It delves into the challenges posed by disfluencies, spontaneous speech, and diverse intonations in spoken language. The survey reviews state-of-the-art machine learning algorithms and annotated datasets used for training and evaluation. It highlights the development of robust models capable of handling various linguistic environments. Deep learning architectures and attention mechanisms are emphasized for their role in capturing complex relationships, thereby improving speech tagging and parsing systems. Furthermore, this paper discusses the significance of speech tagging and parsing in applications such as automated speech recognition, voice-activated assistants, and conversational bots. Real-world case studies illustrate the practical implications and potential future advancements in human-computer interaction and voice-driven command systems. By presenting novel approaches to managing the dynamic nature of spoken language, this survey contributes to the advancement of NLP techniques for speech processing. It aims to enhance human-machine communication across diverse linguistic contexts through the development of more sophisticated and accurate systems.*

Keywords: *Speech Tagging, Part-of-speech (POS), Parsing, NLP.*

1. INTRODUCTION

In the subject of Natural Language Processing (NLP) [1], which focuses on enabling machines to comprehend and interact with human languages, speech tagging and parsing are essential components that are essential to the field. This field of research is essential for a wide range of applications, including voice-activated assistants, machine translation, sentiment analysis, and an assortment of other applications.

1.1 ***Speech Tagging:*** Speech tagging [2], also known as part-of-speech tagging or POS tagging, is the process of recognizing and classifying each word in a phrase according to the part of speech that it belongs to. The process of categorizing words into categories like as nouns, verbs, adjectives, adverbs, and so on is carried out here. Since it gives context that a computer can comprehend, the procedure is vital for comprehending the structure and meaning of phrases. Tense, number (single or multiple), and case are some of the more difficult components that may be identified by advanced point-of-sale (POS) tagging solutions.

1.2 Parsing: The technique of parsing [3] progresses this procedure to the next level. An examination of the grammatical structure of a sentence, the dissection of the phrase into its constituent parts, and a knowledge of the many connections that exist between these constituent parts are all required. An example of this would be the process of parsing, which helps to identify whether words in a phrase function as subjects, objects, or modifiers. As a result of the fact that this is essential for comprehending the meaning and intention behind a statement, it is an essential instrument for the comprehension and reaction of machines shown in figure 1.

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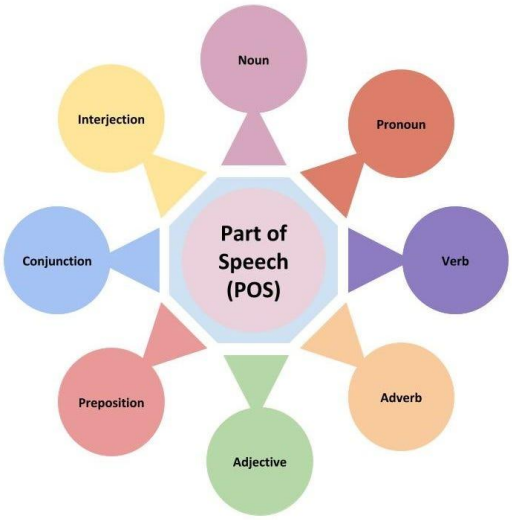

Figure 1: **Speech Tagging and Parsing in NLP**

Using algorithms and machine learning models that have been trained on massive datasets of human language, voice tagging and parsing are both methods that are utilized. These models acquire the ability to detect patterns and structures in language, which results in them being able to evaluate new phrases with an increasing degree of sophistication.

Through the incorporation of voice tagging and parsing into natural language processing (NLP) systems, substantial breakthroughs have been made in human-computer interaction, resulting in a more natural and intuitive experience. These procedures will grow much more complex as natural language processing (NLP) technology continues to advance, further bridging the gap between human communication and computer comprehension.

2. LITERATURE REVIEW

The Part-of-speech (POS) tagging is a crucial task in natural language processing (NLP) that involves labeling words with their corresponding parts of speech, such as nouns, verbs, adjectives, etc. This literature review examines recent advancements in POS tagging, focusing on code-switched texts, low-resource languages, deep learning techniques, and multilingual approaches.

Ball and Garrette (2020) tackle the challenge of POS tagging for code-switched and transliterated texts without explicit language identification [4]. Their work, presented at EMNLP 2018, proposes a novel method that does not rely on language identification, which is typically a prerequisite for tagging code-switched texts. This approach is particularly beneficial for texts where language boundaries are not clearly defined, allowing for more accurate tagging across mixed-language datasets.

Tesfagergish and Kapočiūtė-Dzikienė (2020) focus on POS tagging for northern-Ethiopic languages using deep neural networks [5]. Their research, published in Information Technology Control, highlights the challenges posed by the scarcity of annotated data for these languages. They demonstrate that deep learning models, particularly those trained on small datasets, can significantly improve the accuracy of POS tagging in under-resourced linguistic contexts.

Wu et al. (2020) present a method for automatic movie tagging by exploiting user reviews [6]. Published in Multimedia Tools and Applications, their work demonstrates how user-generated content can be leveraged to improve tagging systems.

Deshmukh and Kiwelekar (2020) discuss various deep learning techniques for POS tagging in their work presented at the 2nd International Conference on Innovative Mechanisms for Industry Applications [7]. Their study provides a comprehensive overview of how deep learning models, such as recurrent neural networks (RNNs) and convolutional neural networks (CNNs), can be applied to POS tagging tasks. They emphasize the advantages of these models in handling complex language structures and improving tagging accuracy.

Priyadarshi and Saha (2020) develop the first POS tagger for the Maithili language, a low-resource language spoken in parts of India and Nepal [8]. Their study, published in Computer Speech and Language, emphasizes the importance of creating linguistic resources and customized NLP systems for lesser-studied languages. By compiling a Maithili corpus and developing a corresponding tagger, they lay the groundwork for future research and applications in this language.

Suppa and Jariabka (2021) benchmark pre-trained language models for multilingual named entity recognition (NER) in the BSNLP 2021 shared task [9]. Their research, published in the proceedings of the 8th Workshop on Balto-Slavic Natural Language Processing, highlights the potential of pre-trained models in enhancing the performance of POS tagging across multiple languages.

Van Nguyen et al. (2021) introduced Trankit at the 16th Conference of the European Chapter of the Association for Computational Linguistics (EACL) [10]. Trankit is a transformer-based toolkit designed for multilingual natural language processing (NLP), aiming to provide robust performance across diverse languages. Leveraging

transformer models, Trankit achieves state-of-the-art results in a range of NLP tasks, prominently including part-of-speech (POS) tagging. The toolkit addresses the challenge of linguistic diversity by offering efficient and effective solutions for tasks such as syntactic parsing and named entity recognition (NER). Its lightweight architecture makes it particularly suitable for applications requiring resource-efficient NLP solutions without compromising performance. Van Nguyen et al. showcase Trankit's versatility and effectiveness through empirical evaluations, demonstrating its applicability in both research and practical NLP applications across various linguistic contexts.

This paper [11] presents innovative techniques for parts of speech (POS) tagging and extractive summarization specifically for Kannada documents. The authors address the unique challenges posed an under-resourced language with complex morphology and syntax, which requires tailored NLP solutions.

This paper by Junaida and Babu (2021) investigates the application of deep learning techniques to parts of speech (POS) tagging for the Malayalam language [12]. Malayalam, a Dravidian language spoken in the Indian state of Kerala, presents specific linguistic challenges due to its rich morphology and complex syntactic structures.

Lin et al. (2021) propose ASRNN, a recurrent neural network with an attention model for sequence labeling [13]. Published in Knowledge-Based Systems, their research demonstrates how the attention mechanism can be integrated with RNNs to improve the accuracy and efficiency of POS tagging. The attention model helps the network focus on relevant parts of the input sequence, leading to better tagging performance.

Pan and Saha (2021) conducted an evaluation focused on part-of-speech (POS) tagging for Bengali text [14]. Presented in their study are insights into the challenges and effectiveness of various tagging methodologies tailored to the linguistic nuances of Bengali. The research underscores the complexities inherent in accurately tagging Bengali language structures, addressing issues such as morphological richness and syntactic diversity. Pan and Saha's findings emphasize the importance of context-aware tagging strategies and the adaptation of existing NLP techniques to suit the specific characteristics of Bengali. Through empirical assessments, they assess the performance of different POS tagging approaches, providing comparative analyses and recommendations for optimizing tagging accuracy and efficiency in Bengali NLP applications. Their study contributes valuable insights into advancing POS tagging methodologies tailored for Bengali, aiming to enhance the precision and applicability of linguistic analysis tools in this language domain.

Pradhan and Yajnik (2021) conducted a comparative study focusing on part-of-speech (POS) tagging for ambiguous Nepali text [15]. Their research highlights the effectiveness of neural network models in addressing ambiguity, contrasting them with traditional probabilistic methods. The study emphasizes the challenges posed by ambiguity in Nepali language processing, attributed to its rich morphological and syntactic variations. Pradhan and Yajnik's findings underscore how neural network-based approaches, such as Bidirectional LSTMs and Conditional Random Fields, outperform probabilistic models by leveraging contextual dependencies and learning intricate patterns in the data. Through empirical evaluations, they demonstrate the superior performance of neural networks in achieving higher accuracy and robustness in POS tagging tasks for Nepali. Their research contributes insights into advancing NLP techniques tailored for Nepali, advocating for the adoption of neural network architectures to enhance the precision and reliability of linguistic analysis in complex and ambiguous language contexts.

Chiche, Alebachew, and Yitagesu (2022) provided a systematic review of deep learning and machine learning approaches in POS tagging [16]. They synthesized the advancements, challenges, and future directions in utilizing these techniques across different languages.

Kaushal and Chadha (2022) reviewed the state-of-the-art developments and future directions in applying deep learning to POS tagging [17]. Their work highlighted recent innovations and discussed potential avenues for improving tagging accuracy and efficiency.

Mishra et al. (2022) proposed a context-based NLP framework for textual tagging in low-resource languages [18]. Their framework aimed to enhance tagging accuracy by leveraging contextual information tailored to languages with limited linguistic resources.

Gómez-Olmos (2022) explored algorithms and applications of POS tagging across various domains [19]. His study focused on the practical applications and algorithmic enhancements that contribute to more accurate and efficient tagging systems.

Li et al. (2022) begin by discussing the foundational concepts of discourse parsing, emphasizing its importance in tasks such as text summarization, sentiment analysis, and question answering [20]. They categorize discourse parsing approaches into several types, including rule-based, supervised machine learning, and more recently, deep learning methods. The survey highlights the shift towards neural network architectures, such as graph-based models

and transformer-based approaches, which have shown significant improvements in discourse parsing accuracy.

The integration of cutting-edge technologies like fog computing and the Internet of Things (IoT) into healthcare systems has garnered significant attention due to its potential to enhance disease prediction, healthcare delivery and patient outcomes. This literature review examines key studies focusing on the application of fog computing, IoT and predictive analytics in healthcare settings, along with recent advancements in machine reading comprehension (MRC) and question-answering (QA) systems.

Wan et al. (2023) integrated part-of-speech (POS) tagging into a grammar-supervised end-to-end speech recognition system, emphasizing the synergistic benefits across multiple natural language processing (NLP) tasks [21]. Their study showcases the integration of POS tagging with dependency parsing to improve the accuracy and efficiency of speech recognition systems. By incorporating POS information, the system enhances syntactic analysis and semantic understanding, thereby refining the interpretation of spoken language inputs. Wan et al. illustrate how POS tagging acts as a foundational component, facilitating more precise parsing of linguistic structures and aiding in error correction during speech recognition. The research underscores the importance of integrating POS tagging with broader NLP frameworks, demonstrating significant advancements in handling complex language phenomena and improving overall system robustness. Their findings advocate for the incorporation of grammar-aware approaches in speech recognition systems, highlighting the potential for enhanced performance through seamless integration of POS tagging with dependency parsing mechanisms.

Dalai et al. (2023) concentrated on part-of-speech (POS) tagging for the Odia language, employing a blend of statistical and deep learning methodologies [22]. Their study aimed to tackle unique challenges inherent to Odia, such as its rich morphological diversity and syntactic intricacies. By integrating statistical techniques with advanced deep learning models, Dalai et al. demonstrated enhanced accuracy in POS tagging tasks specific to Odia. Their research underscores the efficacy of combining diverse methodological approaches to optimize tagging precision, accommodating the linguistic complexities of Odia effectively. Through empirical evaluations, they highlight the benefits of leveraging both statistical and deep learning frameworks to achieve robust performance in linguistic analysis and application development tailored for the Odia language domain.

Hirpassa and Lehal (2023) improved POS tagging in Amharic using deep neural networks [23]. Their study contributed to enhancing NLP capabilities in languages with complex morphological structures, showcasing advancements in deep learning applications.

Cheragui et al. (2023) investigated the application of BERT models for part-of-speech (POS) tagging in the Algerian dialect, focusing on the adaptability and effectiveness of transformer-based approaches in handling dialectal variations [24]. Their study underscored the significance of adapting advanced language models like BERT to suit regional linguistic nuances, crucial for accurate and context-aware POS tagging in Algerian Arabic. By leveraging BERT's pre-trained representations and fine-tuning techniques, Cheragui et al. demonstrated improved performance in capturing dialect-specific syntactic patterns and linguistic features. The research highlights the transformative impact of transformer models in enhancing the accuracy and applicability of NLP tasks across diverse linguistic contexts, particularly for underrepresented dialects. Their findings advocate for further exploration and customization of transformer-based architectures to address the unique challenges posed by dialectal variations, paving the way for more effective language processing solutions tailored to regional linguistic diversity.

Reinforcement learning (RL) has gained traction in language processing tasks due to its ability to optimize sequential decision-making processes. Uc-Cetina et al. (2023) conduct a survey focusing on RL applications specifically within the domain of language processing [25].

The survey by Uc-Cetina et al. starts by explaining the fundamental concepts of RL and its adaptation to NLP tasks, highlighting its advantages in scenarios where sequential decision-making and long-term dependencies are crucial. The paper reviews RL techniques applied to various language processing tasks, such as machine translation, dialogue systems, and text generation.

The authors categorize RL approaches into model-free and model-based methods, discussing their respective strengths and limitations in different NLP applications. They emphasize recent advancements, including hybrid approaches that combine RL with supervised and unsupervised learning techniques to enhance performance and stability.

He and Choi (2023) explore advancements in sequence-to-sequence (Seq2Seq) models for sequence tagging and structure parsing [26]. They discuss enhancements in model architectures and training techniques that have improved performance across various NLP tasks, including named entity recognition, syntactic parsing, and semantic role labeling. The paper emphasizes the integration of attention mechanisms and transformer architectures to handle long-range dependencies and improve the accuracy of sequence tagging tasks.

Nunsanga (2023) conducts a detailed analysis of part-of-speech tagging specifically for the Mizo language [27]. The study investigates challenges unique to less-resourced languages and proposes language-specific adaptations to existing tagging models. Nunsanga's work contributes insights into improving accuracy and applicability of NLP tools for underrepresented languages.

Rudrappa et al. (2023) present HiTEK, a preprocessing framework tailored for speech and text in natural language processing [28]. The paper discusses techniques for noise reduction, feature extraction, and data normalization, enhancing the robustness and efficiency of NLP systems operating in diverse linguistic environments.

Jahan and Oussalah (2023) provide a systematic review of automatic hate speech detection methods employing NLP techniques 29]. They analyze current approaches, including supervised and unsupervised learning models, and highlight challenges such as data bias and cultural context sensitivity. The review outlines directions for future research aimed at improving the effectiveness and fairness of hate speech detection systems.

Srivastava et al. (2023) introduce an AI-powered voice bot for Sanskrit based on natural language processing techniques [30]. The paper details the development of voice interaction capabilities, semantic understanding, and contextual processing tailored for the Sanskrit language, demonstrating applications of NLP in preserving and promoting linguistic heritage.

Prajna et al. (2024) present methods for visualizing parts-of-speech tags through the analysis of English language texts [31]. Their study explores techniques to extract and visualize syntactic structures, aiding linguistic analysis and facilitating insights into language usage patterns across different textual genres.

Smidt et al. (2024) address the intricacies of fine-grained part-of-speech tagging, focusing on the challenges posed by ancient languages encoded in cuneiform scripts [32]. Their paper underscores the complexities involved in linguistic annotation and the adaptation of contemporary natural language processing (NLP) methodologies to effectively preserve and interpret ancient textual artifacts.

The study emphasizes the unique linguistic features and syntactic structures inherent in cuneiform texts, presenting hurdles such as sparse linguistic resources and ambiguous lexical forms. Smidt et al. explore how modern NLP techniques, including deep learning models and computational linguistics approaches, can be tailored to handle these challenges and extract meaningful linguistic insights from ancient scripts.

Their research highlights the importance of developing specialized tools and methodologies for fine-grained part-of-speech tagging in historical linguistics, contributing to the broader effort of preserving and understanding ancient languages through advanced computational techniques.

Woldemariam (2024) investigates NLP methods to enhance user rating systems in crowdsourcing forums and improve speech recognition for less-resourced languages [33]. The study proposes adaptive learning approaches and data augmentation strategies to mitigate challenges related to data scarcity and linguistic diversity.

Pradhan and Yajnik (2024) conduct a comparative study on various models for part-of-speech (POS) tagging tailored for Nepali texts [34]. Their research evaluates the performance of Bidirectional LSTM, Conditional Random Fields (CRF), and Hidden Markov Models (HMM) in handling the morphological complexities of the Nepali language.

The study addresses the challenges posed by Nepali's rich morphology, which includes diverse inflectional patterns and syntactic structures. Pradhan and Yajnik highlight how each model excels in capturing different aspects of Nepali linguistic features: Bidirectional LSTM for its ability to model contextual dependencies effectively, CRF for its sequential labeling capabilities, and HMM for its probabilistic framework suited for tagging sequences.

Through empirical evaluations, they provide nuanced insights into the strengths and limitations of each model, offering recommendations to enhance tagging accuracy and efficiency in Nepali NLP applications. Their findings underscore the importance of selecting appropriate modeling techniques that align with the linguistic characteristics of morphologically complex languages like Nepali, aiming to advance the development of robust and adaptable POS tagging systems tailored for diverse linguistic contexts.

Jatta (2024) delves into the forefront of automatic speech recognition (ASR) tailored for maritime settings, employing artificial intelligence (AI) techniques to bolster transcription precision and operational utility amidst formidable acoustic challenges [35]. His study underscores the critical need for robust ASR solutions capable of navigating the complex acoustic environments inherent to maritime operations.

By harnessing AI methodologies, Jatta enhances transcription accuracy, ensuring clearer communication and operational efficiency in maritime contexts where ambient noise and variable acoustic conditions pose significant hurdles. His research contributes insights into optimizing ASR systems, emphasizing adaptive algorithms and noise suppression techniques that enhance speech signal clarity amidst challenging maritime acoustic landscapes.

Jatta's work highlights the transformative potential of AI-driven ASR advancements in maritime domains, offering practical applications in navigation, communication, and operational safety. His findings advocate for ongoing innovation in ASR technologies tailored for specific environmental contexts, aiming to elevate performance standards and expand the scope of automated speech recognition across diverse operational settings.

Li et al. (2024) undertake a bibliometric analysis aimed at comprehensively mapping the landscape of part-of-speech (POS) tagging research [36]. Their study offers a systematic exploration of methodologies, applications, and emerging trends within the field, providing a detailed overview of recent advancements and future trajectories.

Through their bibliometric approach, Li et al. identify and analyze key themes and research methodologies employed in POS tagging studies. They highlight the evolution from traditional rule-based approaches to modern machine learning and deep learning techniques, emphasizing the shift towards neural network architectures like Bidirectional LSTMs and transformer models.

The study also delves into diverse applications of POS tagging across various domains, including machine translation, sentiment analysis, and information retrieval. Li et al. explore how POS tagging methodologies are adapted and optimized to meet specific task requirements and linguistic challenges in different languages and contexts.

Furthermore, Li et al. outline emerging topics and research directions within POS tagging, such as fine-grained tagging, domain adaptation, and multilingual tagging frameworks. Their comprehensive analysis not only synthesizes current knowledge but also informs future research agendas aimed at advancing the accuracy, efficiency, and applicability of POS tagging technologies across diverse NLP applications.

3. CONCLUSION

In this paper, speech tagging and parsing play pivotal roles in Natural Language Processing (NLP), enabling the extraction of meaning from spoken language. This survey has explored recent advancements in NLP methodologies specifically designed to enhance these critical components. It has addressed challenges such as disfluencies, spontaneous speech, and diverse intonations inherent in spoken language, underscoring the necessity for robust models capable of navigating varied linguistic environments.

State-of-the-art machine learning algorithms and annotated datasets have been reviewed, highlighting their pivotal role in training and evaluating advanced models. Deep learning architectures and attention mechanisms have emerged as particularly effective in capturing intricate linguistic relationships, thereby elevating the accuracy and efficiency of speech tagging and parsing systems.

Moreover, the significance of these advancements extends to practical applications such as automated speech recognition, voice-activated assistants, and conversational bots. Real-world case studies have demonstrated the tangible benefits of these technologies in enhancing human-computer interaction and enabling more intuitive voice-driven command systems.

By presenting innovative approaches to address the dynamic nature of spoken language, this survey contributes to the ongoing evolution of NLP techniques for speech processing. It aims to foster enhanced human-machine communication across diverse linguistic contexts, paving the way for more sophisticated and responsive NLP systems in the future.

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