Medical Prescription using NLP Approaches: A Literature Review

Denis Goh Ee Kin
MSc in Artificial Intelligence
Asia Pacific University of Technology & Innovation
Kuala Lumpur, Malaysia
TP048456@mail.apu.edu.my

Mafas Raheem
Senior Lecturer
Asia Pacific University of Technology & Innovation
Kuala Lumpur, Malaysia
raheem@apu.edu.my

Nirase Fathima Abubacker
Associate Professor
Asia Pacific University of Technology & Innovation
Kuala Lumpur, Malaysia
nfathima.abubacker@apu.edu.my

***Abstract*—Natural Language Processing (NLP) is revolutionizing medical prescription technology within the healthcare industry. This research endeavors to underscore the pivotal role of NLP, elucidating the methodologies employed to convert unstructured textual medical prescription data into structured information. This transformation facilitates personalized medication recommendations and enhances patient outcomes. The study delves into the challenges inherent in medical prescription contexts, examining existing literature and NLP applications aimed at mitigating these challenges. Additionally, it evaluates current systems for medical prescription to identify areas for improvement in healthcare operations. Highlighted in this paper are potential issues such as prescription errors and misuse, alongside the discussion of NLP's significance and its primary techniques in medical contexts. While NLP solutions have addressed some prescription challenges, further enhancements are warranted, as suggested by scholars advocating for advanced NLP techniques. In conclusion, this study emphasizes the techniques and applications of NLP in medical prescriptions, underscoring the need for continued research to refine NLP methodologies and optimize healthcare practices.**

Keywords—Medical Prescription, Natural Language Processing

I. INTRODUCTION

In today's rapidly advancing technological era, medical prescriptions stand at the forefront of innovation, driven by data for healthcare. Accurately identifying a patient's diagnosis relies on understanding their symptoms and signs. Once diagnosed, the process of prescribing the appropriate medications can commence. Prescriptions play a crucial role, containing vital information such as medication names, dosages, administration instructions, and more (Al Garadi et al., 2021). This information is essential for patient care, as doctors rely on it to provide accurate treatment. However, the complexity and variability of prescription contexts pose challenges for effective examination and comprehension, leading to potential inadequacies and inconsistencies in healthcare operations (Corny et al., 2020).

As the volume of healthcare information diversifies rapidly and the demand for personalized medications rises, analyzing medical prescriptions is becoming increasingly complex. Moreover, Al Garadi et al. (2021) highlighted that the misuse and abuse of medical prescriptions have become national concerns in the US, posing challenges for automating monitoring systems. Thus, integrating Natural Language Processing (NLP) approaches into various applications shows promise in revolutionizing the comprehension of medical prescriptions. This allows healthcare industries to systematically identify, categorize, and extract vast amounts of information from these texts (Corny et al., 2020).

The main objective of this study is to explore the techniques and practical applications of Natural Language Processing (NLP) in addressing the challenges posed by the intricate and inconsistent nature of prescription language, particularly aiming to mitigate the risk of medical prescription errors. Furthermore, this review seeks to assess the implications of these findings for both future research endeavours and practical implementations within the realm of medical prescription. By synthesizing insights gleaned from various studies, this literature review delves into how NLP techniques are reshaping the landscape of medical prescriptions, offering potential avenues for actionable insights for healthcare professionals and researchers. The subsequent sections of this paper will delve deeper into these topics, beginning with Section 2 providing an overview of medical prescriptions, their significance in healthcare, limitations, and existing systems pertaining to this domain. Following that, Section 3 will elucidate Natural Language Processing, highlighting its significance and associated techniques. Section 4 will present research findings and future directions of NLP in healthcare. Finally, Section 5 will offer concluding remarks on the entire literature review, along with suggestions for future research endeavours to build upon the insights provided in this paper.

II. OVERVIEW OF MEDICAL PRESCRIPTION

In contemporary times, the medical prescription process has undergone significant evolution due to technological advancements and the digitalization of healthcare systems. A proper medical prescription is crucial for promoting a healthier lifestyle and managing illnesses effectively. It contains essential information such as the medication's name, dosage instructions, and other pertinent details provided by healthcare professionals. Yet, traditional paper-based prescriptions, once prevalent, are being supplanted by electronic prescription systems. These digital solutions offer numerous advantages including enhanced efficiency, accuracy, and accessibility (Mahatpure et al., 2019).

A. Importance of medical prescription in healthchare

Medical prescriptions are the cornerstone of healthcare, playing a vital role in ensuring patients receive appropriate treatment and care. They are not just pieces of paper with instructions; rather, they are essential tools that promote patient safety and facilitate seamless communication among healthcare professionals, pharmacists, and patients. Carchiolo et al. (2019) underscored their significance in the healthcare ecosystem, emphasizing how they serve as a conduit for

accurate information exchange and coordinated care. Precision and specificity are paramount in medical prescriptions to mitigate potential risks such as medication errors and adverse drug interactions, which can compromise patient safety. By meticulously detailing the medication regimen, dosage, frequency, and route of administration, prescriptions help prevent misunderstandings and ensure patients receive the right treatment tailored to their individual needs.

However, prescribing medications is far from a simple task. As highlighted by Hijazi et al. (2020), it demands not only medical expertise but also an understanding of current medical insights and best practices. The landscape of healthcare is constantly evolving with new medications, treatment guidelines, and research findings emerging regularly. Thus, doctors must stay informed and continuously update their knowledge to make informed prescription decisions that align with the latest evidence-based practices. Moreover, the complexity of medical conditions and individual patient histories adds another layer of challenge to the prescription process. Each patient is unique, presenting with different medical histories, underlying conditions, and medication sensitivities. Doctors must carefully assess these factors and tailor their prescriptions accordingly to optimize treatment outcomes while minimizing risks.

In essence, medical prescriptions are more than just written instructions; they are a product of careful consideration, medical expertise, and ongoing education. By crafting precise, well-informed prescriptions, doctors can enhance patient safety, improve treatment efficacy, and ultimately contribute to better patient outcomes and overall healthcare quality.

B. Maintaining the integrity of the specifications

Medical prescriptions play a crucial role in healthcare, guiding patients and healthcare providers in administering the correct medications for various conditions. However, despite their significance, it's important to acknowledge the limitations inherent in the prescription process. These limitations can lead to medication errors, which pose significant risks to patient safety and can have detrimental effects on healthcare outcomes. One primary limitation is the potential for errors stemming from inadequate writing. Illegible handwriting can result in misinterpretation of instructions by pharmacists or other healthcare professionals, leading to the wrong medication being dispensed or incorrect dosages being administered to patients. Additionally, abbreviations and medical jargon used in prescriptions may not be universally understood, further increasing the risk of errors.

Another common limitation is the possibility of miscommunication between healthcare providers, patients, and pharmacists. This can occur due to unclear instructions, incomplete patient information, or a lack of effective communication channels. Misunderstandings or incomplete information can lead to mistakes in medication administration or failure to recognize potential drug interactions or contraindications. Moreover, technological limitations or deficiencies in prescribing systems can also contribute to errors. Electronic prescribing systems, while designed to enhance efficiency and accuracy, can still be prone to glitches, software errors, or user interface issues that may inadvertently result in medication errors.

The consequences of medication errors can be severe, ranging from adverse drug reactions and ineffective treatments to serious harm or even fatalities. Therefore, it's imperative for healthcare professionals to recognize and address the constraints associated with medical prescriptions. This may involve implementing standardized prescribing practices, enhancing communication protocols, improving the legibility of prescriptions, and leveraging technology to minimize errors. By proactively addressing these limitations and implementing appropriate safeguards, healthcare providers can help ensure patient safety, enhance the quality of care, and optimize healthcare operations. This underscores the critical importance of continuous vigilance and improvement in the prescribing process within the healthcare industry.

C. Medical prescription error

One of the critical limitations within medical practice is the occurrence of medical prescription errors, often stemming from human fallibility in various aspects. These errors manifest through inadequate handwriting, misinterpretation of abbreviations, and a lack of effective communication among healthcare professionals (Suclupe et al., 2020). In daily practice, the persistent issue of illegible handwriting significantly heightens the risk of misinterpretation and subsequent errors.

Consequently, the likelihood of errors in medical prescriptions is substantially influenced by the intricacies of treatment protocols, potential drug interactions, and individual patient responses to symptoms and medications (Manias et al., 2020). This limitation poses a significant threat, potentially resulting in harm to patients and compromising the fundamental principles of effective treatment delivery. Such detrimental outcomes can lead to fatal consequences, exacerbation of existing symptoms, and other adverse effects.

Moreover, the presence of medical prescription errors profoundly impacts patients' well-being, extending beyond their immediate medical conditions to engender additional challenges for healthcare institutions. These challenges include increased hospitalization rates, prolonged recovery times for patients, and escalated costs of medical care (Manias et al., 2020). Thus, it becomes imperative to address the complexities underlying the occurrence of medical prescription errors during the prescribing process, thereby ensuring the overall quality and safety of healthcare services.

D. Medical prescription abuse

Another limitation lies in the misuse and overuse of medical prescriptions, a practice that exacerbates patients' health issues through various means. This misuse often occurs during the prescribing process, where inexperienced doctors or prescribers inadvertently recommend medications, leading to unintended abuse (Sarker et al., 2020). Moreover, inadequate communication between patients and healthcare professionals can result in disjointed medication regimens, wherein patients receive the same drugs from different sources, each with disparate prescriptions. Consequently, this fragmentation amplifies the risks associated with medical prescription abuse/misuse, posing significant challenges to healthcare systems and public health. In addition, there are instances where patients exploit medical prescriptions, concealing their actions from their healthcare providers. Some individuals exaggerate symptoms or medical conditions to

manipulate healthcare providers into prescribing certain medications. Such manipulative behavior can result in a plethora of adverse consequences, including the development of addictive habits, increased risk of overdosing, and elevated mortality rates (Sarker et al., 2020).

Moreover, patients may resort to fraudulent means to counterfeit or tamper with medical prescriptions for medications lacking a legitimate medical necessity. Healthcare providers employ tactics like doctor shopping, a prevalent strategy wherein they monitor patients seeking multiple prescriptions for the same medication from various healthcare sources, as documented in (Soeiro et al., 2021). Nonetheless, this study also highlights that prescribers or doctors might remain unaware of the deception, as patients often go to great lengths to conceal their abusive behaviors. These insights underscore the pitfalls of relying solely on interactions between prescribers and patients, underscoring the value of leveraging claims databases to impartially assess doctor shopping. Consequently, overcoming this challenge necessitates technological interventions, such as integrating machine learning within the healthcare system.

III. EXISITING SYSTEM IN MEDICAL PRESCRIPTION

In prior investigations, a plethora of researchers have delved into the realm of medical prescription systems, exploring avenues ranging from machine learning to natural language processing, among other methodologies. Each researcher has contributed distinctive viewpoints aimed at addressing diverse challenges within the healthcare sector. This segment elucidates the groundwork for scrutinizing extant systems, drawing insights from a multitude of research papers dedicated to enhancing medical prescription practices.

The ground-breaking study by Carchiolo et al. (2019) pioneered a novel medical prescription classification system, seamlessly integrating advanced machine learning and Natural Language Processing (NLP) techniques. Their innovative approach revolutionizes the classification of medical prescriptions by automating text extraction from scanned documents, employing sophisticated NLP methodologies, and implementing spelling correction algorithms. Moreover, they employ state-of-the-art machine learning algorithms for precise classification.

Furthermore, the paper introduces a cutting-edge RESTful Web Service, empowering users to engage with the proposed classification system effortlessly. This platform enables users to access classification results across a broad spectrum of diagnostic statements, enhancing accessibility and usability. Through the demonstration of the immense potential of NLP and machine learning methodologies in refining the accuracy and efficiency of medical prescription classification, this study emerges as a cornerstone in advancing healthcare services and their myriad applications.

Hijazi et al. (2020) introduced a personalized knowledge base system aimed at facilitating medical prescriptions, even when faced with incomplete knowledge, inconsistent information, and exceptional scenarios. While the paper lacks systematic guidelines for verifying compatibility and prescribing the correct medication, as well as a framework for describing knowledge pertinent to alternative treatment options, the authors undertook a thorough evaluation of prior similar endeavours to deepen their understanding of medication prescription processes. To tackle these challenges, the authors employed the description logic system ALC (Attributive Language with Complements) to construct an ontology for their proposed knowledge representation system. Consequently, the comprehensive system outlined in the paper showcases its efficacy in handling conflicting information and incomplete knowledge, ultimately enabling informed medical prescription decisions. Furthermore, the study highlighted the potential for further advancements by considering additional requirements, such as integrating real-world medical data or refining defeasible logic systems, to enhance the personalized medical prescription system.

In Wang's (2020) study, a recommendation system for Traditional Chinese Medicine (TCM) prescriptions employing a knowledge graph is proposed. The study focuses on four key entities: prescriptions, symptoms, Chinese medical herbs, and diseases, extracted from a semi-structured dataset sourced from TCM medical records. The entity data is utilized to construct a comprehensive knowledge graph of TCM, comprising 1709 prescriptions and 451 diseases in the training set. Subsequently, Node2vec is employed to transform this TCM knowledge graph into a set of vectors. Additionally, the study utilizes the K-Nearest Neighbour (KNN) algorithm within the realm of machine learning to classify traditional Chinese medicine prescriptions. Specifically, it leverages the top 10 vectors with the shortest distances, which are deemed most compatible with the patient's diseases. Consequently, the recommendation system demonstrates promising performance, achieving an 80% Hit Ratio in classifying Chinese medicine prescriptions based on the TCM knowledge graph. Nonetheless, the study underscores the limitation of only targeting four unique entities and suggests potential improvements by exploring and incorporating additional types of entities.

In their 2019 study, Mahatpure et al. introduced an innovative concept harnessing speech recognition, blockchain technology, and natural language processing to bolster the functionality of electronic prescription systems within mobile applications. This ground breaking approach targets key challenges in healthcare operations, such as cumbersome patient data management and the inefficiencies of handwritten prescriptions by doctors. The paper proposes a cohesive integration of technologies, incorporating elements like the Hyperledger Composer Blockchain Network, a Node.js server for REST API functionality and text processing, a React JS-powered admin panel, and React-Native for mobile application development. Consequently, this integrated system promises significant time and cost savings for both patients and doctors. Patients gain control over their personal information and prescription details, while doctors enjoy streamlined record management, prescription creation, and reference handling for their patients.

Nayak et al. (2023) conducted an exhaustive literature review focusing on the application of machine learning in recognizing medical prescriptions. Their study analysed eight research publications, delving into the systems proposed and identifying potential limitations. Building upon this analysis, the authors proposed their own solutions to enhance the interpretation of handwritten prescriptions, aiming to facilitate clear understanding for both patients and doctors and minimize errors. They also developed a mobile application that employs machine learning and text recognition technologies to accurately classify prescribed medications. This application enables the convenient digitalization of

prescriptions, ensuring readability and ease of understanding for patients and healthcare providers alike.

In Garg's (2021) study, a drug recommendation system is introduced, employing sentiment analysis on patient reviews alongside machine learning to suggest the most suitable drug for a given disease. The author extensively reviews related literature to grasp the nuances of machine learning and sentiment analysis applied in medical prescription contexts. What sets this study apart is its diverse methodology, which incorporates various vectorization techniques such as Bag of Words, Word2Vec, TF-IDF, and manual feature engineering. Each technique generates distinct datasets, subsequently divided into 75% training and 25% test sets for model implementation. Across these datasets, a range of machine learning algorithms is employed for training and testing. The models are then evaluated and compared based on performance metrics like accuracy, precision, F1-score, and recall. Results indicate that the LinearSVC classifier with TF-IDF vectorization achieves the highest accuracy at 93%, surpassing other models. In summary, this research not only enhances drug recommendation systems but also holds promise for improving decision-making capabilities for both patients and healthcare providers.

IV. NATURAL LANGUAGE PROCESSING

In recent years, the field of Natural Language Processing (NLP) has undergone significant advancements, allowing machines to comprehensively understand and interact with human languages. NLP, a subset of computer science, focuses on equipping machines with the ability to comprehend, interpret, and assess human languages (Torfi et al., 2021). Researchers in NLP have utilized these advancements to gather insights, developing tools and methodologies that enable machines to grasp and execute crucial tasks (Casey et al., 2021). According to Khurana et al. (2022), the inception of machine translation (MT), dating back to the late 1940s, preceded the formal establishment of NLP. During this nascent stage, researchers pioneered efforts in automating translation processes, conducting MT experiments primarily between English and Russian. Consequently, the term NLP has garnered increased attention in recent times, recognized for its transformative potential in fostering the creation of effective applications across various domains, bolstered by advancements in technology.

The creation of Natural Language Processing (NLP) applications spans across a multitude of domains, including machine translation, artificial intelligence, text pre-processing, speech recognition, and beyond (Casey et al., 2021). Moreover, the development of NLP techniques poses considerable challenges, as it heavily relies on the nuances of natural language data for accomplishing fundamental objectives such as interpretation, analysis, and manipulation (Khurana et al., 2022). The increasing reliance on data-driven methodologies in NLP development has fostered the emergence of more robust and innovative models, thereby propelling advancements in NLP domains, bolstered by optimized access to big data and enhanced computational capabilities (Torfi et al., 2021). Nevertheless, as NLP technologies become increasingly ingrained in everyday life, the specter of bias and ethical concerns looms over the development and deployment processes. Hence, to mitigate potential biases and ethical dilemmas, it is imperative to incorporate ethical considerations, enabling researchers to gain a comprehensive understanding of societal implications (Hovy & Prabhumoye, 2021). This section delves into the significant impact of Natural Language Processing on the healthcare industry, exploring various NLP techniques and related works that have been instrumental in medical applications.

A. Significance of NLP in healthchare industry

While Natural Language Processing (NLP) holds promise across various domains, effectively managing vast quantities of sensitive personal data in healthcare remains a formidable challenge. Consequently, there are numerous critical considerations when it comes to handling and leveraging biomedical information, much of which is in textual format. These considerations encompass advancing health research, enhancing quality of care, and reducing costs (Houssein et al., 2021). In this context, NLP plays a pivotal role by facilitating the conversion of unstructured medical text into structured data. For example, by comprehensively understanding patient needs, automating medical prescriptions using NLP can significantly aid in recommending tailored treatments. Thus, NLP has emerged as a disruptive force in healthcare, promising substantial benefits such as improved opportunities, better patient outcomes, and enhanced administrative efficiency.

Hao et al. (2021) elucidated their groundbreaking research on the development of Health NLP, encompassing a diverse array of methodological innovations and practical applications. Within the framework of Health NLP, the methodology spans a broad spectrum of domains such as machine learning, health information retrieval and extraction, and NLP models tailored for medical contexts. Furthermore, Health NLP showcases an array of sophisticated applications leveraging advanced NLP techniques for clinical settings, including question-answering technology for guidance and NLP-based approaches for medical personalization. These achievements are underpinned by adept utilization of medical information extraction, as demonstrated in their study, underscoring its pivotal role in facilitating the deployment of medical informatics. Noteworthy features integrated into Health NLP encompass Health Text Mining, which amalgamates cutting-edge machine learning models with specialized NLP techniques, and Health Knowledge Graph, facilitating textual representation mapping (Hao et al., 2021).

In the realm of healthcare, the burgeoning significance of Natural Language Processing (NLP) cannot be overstated. However, amidst its rise, challenges loom large, stemming from various factors such as linguistic intricacies, ethical dilemmas, unstructured data, and the critical issue of data privacy. Yet, these challenges present opportunities for leveraging NLP to augment healthcare operations, particularly in managing vast swathes of unstructured textual data (Elbattah et al., 2021). Therefore, the full potential of NLP can be realized through a dual focus on innovation and ethical considerations, thereby propelling advancements in the medical field alongside emerging technologies.

B. NLP techniques in medical prescription classification

The deployment of various applications harnessing NLP techniques has sparked growing enthusiasm within healthcare sectors for the classification of medical prescriptions. The advent of NLP technology has played a significant role in this burgeoning interest. NLP techniques function to extract

invaluable insights from the medical contexts of prescriptions, facilitating evaluation processes to gauge their semantic nuances before embarking on classification tasks using machine learning algorithms within the NLP domain (Carchiolo et al., 2019). By leveraging NLP techniques, these prescriptions' textual details undergo a transformation into more structured and comprehensive information, aiding healthcare professionals in their decision-making processes. Typically, these details encompass crucial elements such as prescription names, dosages, administration instructions, and more, all of which can be deciphered and interpreted with the assistance of NLP techniques prior to the development of a classification model for medical prescriptions (Raza et al., 2023). Furthermore, the synergy between NLP techniques and both machine learning and deep learning methodologies has been instrumental in enhancing accuracy levels in the classification of medical prescriptions, showcasing their utility across a spectrum of applications where extracting pertinent information and achieving precise classification are paramount (Houssein et al., 2021).

Houssein et al. (2021) posit that while NLP techniques, notably machine learning, have demonstrated optimal performance within the healthcare industry, a deeper understanding of clinical text analysis necessitates further experience. Consequently, this presents a burgeoning opportunity for researchers to tackle the challenges associated with extracting insights from clinical narratives through forthcoming investigations. It can be inferred that the trajectory of medication management and healthcare administration will be significantly shaped by the adoption of NLP techniques to glean invaluable insights from medical prescriptions, particularly given the healthcare sector's increasing emphasis on data-driven decision-making and personalized treatment paradigms. As such, ongoing research into NLP methodologies should be duly acknowledged, enabling researchers to concentrate on devising novel approaches with tangible applications in real-world healthcare settings. Moreover, ethical considerations and evidence supporting enhanced model interpretability are imperative in addressing the complexities inherent in medical prescription analysis (Carchiolo et al., 2019).

1. Tokenization

Tokenization, a foundational technique in Natural Language Processing (NLP), involves the art of dissecting a sentence or paragraph into its constituent units, known as tokens. This process is akin to breaking down a complex structure into its elemental building blocks, thereby facilitating subsequent analysis and manipulation. By segregating unstructured text into manageable segments during the preprocessing phase, tokenization lays the groundwork for enhanced processing and deeper insights (Park et al., 2020). The significance of tokenization reverberates across numerous domains within NLP, spanning from sentiment analysis to information retrieval and beyond. Its versatility renders it indispensable in diverse applications, underpinning the very fabric of language modelling and analysis. In the realm of medical practice, tokenization assumes a particularly pivotal role, offering invaluable support for healthcare providers. By meticulously parsing medical prescription descriptions, tokenization enables the extraction of crucial details, including but not limited to prescription names, drug dosages, and administration instructions (Mielke et al., 2021). This refined approach holds immense promise in augmenting healthcare services, facilitating precise identification and utilization of pertinent information for optimal patient care.

According to Kumar & Hittalamani (2022), the utilization of tokenization methods significantly enhances the capabilities of automated medical prescription systems. This contribution facilitates the development of applications capable of discerning the diversity and intricacy inherent in medical prescriptions. Additionally, these authors pioneered the development of a pharmaceutical prescription system by employing sentiment analysis on medical reviews. Preceding the sentiment analysis process, they conducted thorough text pre-processing to cleanse the medical reviews, including lowercasing the cleansed texts. By leveraging tokenization to extract features from textual data and construct a sentiment classifier, their system proficiently categorizes each medical review as positive or negative based on user ratings. In summary, tokenization plays a pivotal role in the text pre-processing phase of sentiment analysis, empowering these authors to extract pertinent insights from medical reviews.

2. Named Entity Recognition (NER)

Named Entity Recognition (NER) stands as a fundamental technique in Natural Language Processing (NLP), typically deployed post tokenization, with its aim set on extracting and categorizing valuable information from tokens (Li & Zheng, 2023). With a primary focus on medical textual data, NER emerges as a pivotal tool in addressing myriad medical classification challenges. Moreover, NER boasts a suite of pre-trained models tailored to the medical domain. Illustratively, a study by Raza et al. (2023) showcases the utilization of a Bidirectional Long Short-Term Memory (BiLSTM)-Convolutional Neural Networks (CNN)—Conditional Random Field (CRF) model, incorporating BERT-based embeddings at the character level in the model's initial layer to generate vectors. These vectors serve as inputs, enabling the discernment of contextual features and thus facilitating the extraction of nuanced semantic information from texts. Subsequently, the CRF layer is invoked to yield named entities as model output, elucidating the interdependencies of named tags and refining them into the ultimate predicted labels (Raza et al., 2023).

In the realm of medical prescriptions, Named Entity Recognition (NER) plays a pivotal role in identifying and categorizing various entities within the prescription context. These entities typically encompass prescription names, dosages, frequencies, and other pertinent details. The crucial process of discerning essential medical entities from patient posts, as facilitated by text classification models, underscores the importance of NER (Dreyfus et al., 2021). An illustrative study by Li & Zheng (2023) delved into the development of a recognition system tailored for ancient Chinese medicine prescriptions. This research harnessed NER to extract and categorize Chinese characters from prescription texts, laying the groundwork for training Support Vector Machine (SVM) algorithms. The bulk of ancient Chinese medicine prescriptions stem from Song Dynasty medical literature, embodying a rich array of vital ingredients, predominantly various Chinese herbs utilized in medicinal concoctions.

Consequently, NER has demonstrated its efficacy in classifying medical prescriptions by distilling pertinent information from unstructured prescription data. This contribution is instrumental in fostering the evolution of

precise and efficient medicine prescription recognition systems within the healthcare industry. Moreover, amidst the healthcare sector's escalating adoption of data-driven methodologies, NER emerges as a cornerstone in safeguarding the accuracy and efficacy of healthcare information systems (Dreyfus et al., 2021).

3. Semantic Analysis

Semantic Analysis is a pivotal NLP technique, characterized by its systematic approach to extracting and deciphering the essence of words and phrases within a given context. Its significance reverberates throughout language comprehension, enriching processes like information retrieval, contextual comprehension, machine translation, and question-answering applications (Wang, 2020). In the realm of medical prescriptions, Semantic Analysis emerges as a valuable tool, adept at unravelling the intricate relationships embedded within crucial prescription details such as medication names, dosages, and administration instructions. By employing Semantic Analysis, healthcare professionals can unveil nuanced dependencies among various elements, facilitating a deeper understanding of prescription nuances. This capability extends to medical prescription classification, enabling the discernment of semantic contexts and the extraction of pertinent information with precision.

A study conducted by Kocabiyikoglu et al. (2019) discussed how researchers discovered new semantic web ontologies whenever scientists from the National Library of Medicine developed a new drug. Consequently, this discovery completely impacts their development and post-marketing surveillance (PMS) requirements. To meet the demands of PMS, the researchers employed semantic analysis methods to further categorize high-level slots into more detailed slots. This enabled them to analyze the information of new drugs and collaborate with medical professionals for examination (Hope et al., 2021).

Thus, with a clearer understanding of new drug prescriptions, not only can the efficiency of medical operations be enhanced, but healthcare centers can also make well-informed decisions for patients. It's crucial to note that medical prescription heavily relies on semantic analysis for classification purposes, aiming to improve the precision of information retrieval from unstructured medical text data. This enhancement empowers healthcare professionals to engage in better clinical decision-making (Kocabiyikoglu et al., 2019). Bose et al. (2021) discovered in their research that while their topic modelling framework effectively pinpointed four primary topics concerning COVID-19, it fell short in capturing the broader spectrum of issues surrounding the disease, such as its social, economic, cultural, and psychological impacts. Despite implementing NLP techniques to extract relevant topics based on document relationships, their framework struggled to encompass these multifaceted dimensions. Consequently, they emphasized the need for additional research into NLP methodologies tailored to address various aspects of the COVID-19 crisis. They proposed that integrating advancements in technology could propel NLP to new heights, offering innovative solutions to enhance topic modelling systems.

V. CONCLUSION & FUTURE RESEARCH

In summary, this paper provides a literature review of the role of Natural Language Processing (NLP) in revolutionizing healthcare management by ensuring the proper handling of medical prescriptions to prevent any adverse events. It examines how NLP techniques can extract and categorize information from unstructured medical prescription data, as highlighted in previous research. Additionally, it underscores the importance of NLP techniques such as named entity recognition, tokenization, and semantic analysis in handling medical prescriptions effectively. These techniques aid in analysing and converting textual data from prescriptions, thereby supporting healthcare professionals in offering personalized treatment recommendations and enhancing operational efficiency. The paper also discusses the limitations of current medical prescription practices and suggests future directions for further improvements in NLP applications within the healthcare sector.

REFERENCES

Al-Garadi, M. A., Yang, Y. C., Cai, H., Ruan, Y., O'Connor, K., Graciela, G. H., Parrone, J., & Sarker, A. (2021). Text classification models for the automatic detection of nonmedical prescription medication use from social media. *BMC Medical Informatics and Decision Making*, 21(27), 1-13. https://doi.org/10.1186/s12911-021-01394-0

Bose, P., Roy, S., & Ghosh, P. (2021). A Comparative NLP-Based Study on the Current Trends and Future Directions in COVID-19 Research. *IEEE Access*, 9, 78341-78355. https://doi.org/10.1109/ACCESS.2021.3082108

Carchiolo, V., Longheu, A., Reitano, G., & Zagarella, L. (2019). Medical prescription classification: a NLP-based approach. *Proceedings of the Federated Conference on Computer Science and Information Systems*, 18, 605-609. https://doi.org/10.15439/2019F197

Casey, A., Davidson, E., Poon, M., Dong, H., Duma, D., Grivas, A., Grover, C., Suárez-Paniagua, V., Tobin, R., Whiteley, W., Wu, H., & Alex, B. (2021). A systematic review of natural language processing applied to radiology reports. *BMC Medical Informatics and Decision Making*, 21(179), 1-18. https://doi.org/10.1186/s12911-021-01533-7

Corny, J., Rajkumar, A., Martin, O., Dode, X., Lajonchere, J.-P., Billuart, O., Bézie, Y., & Buronfosse, A. (2020). A machine learning–based clinical decision support system to identify prescriptions with a high risk of medication error. *Journal of the American Medical Informatics Association*, 21(11), 1688-1694. https://doi.org/10.1093/jamia/ocaa154

Dreyfus, B., Chaudhary, A., Bhardwaj, P., & Shree, V. K. (2021). Application of natural language processing techniques to identify off-label drug usage from various online health communities. *Journal of the American Medical Informatics Association*, 28(10), 2147-2154. https://doi.org/10.1093/jamia/ocab124

Elbattah, M., Arnaud, E., Gignon, M., & Dequen, G. (2021). The Role of Text Analytics in Healthcare: A Review of Recent Developments and Applications. *14th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2021)*, 5, 825-832. https://doi.org/10.5220/0010414508250832

Garg, S. (2021). Drug Recommendation System based on Sentiment Analysis of Drug Reviews using Machine Learning. *11th International Conference on Cloud*

Computing, 175-181. https://doi.org/10.1109/Confluence51648.2021.9377188

Hao, T., Huang, Z., Liang, L., Weng, H., & Tang, B. (2021). Health Natural Language Processing: Methodology Development and Applications. *JMIR Publications*, 9(10). https://doi.org/10.2196/23898

Hijazi, S., Obeid, N., & Sabri, K. E. (2020). On the Logical Foundation of a Personalized Medical Prescription System. *IEEE Access*, 8, 6471-6483. https://doi.org/10.1109/ACCESS.2019.2963304

Hope, D., Rogers, G., Grant, G., & King, M. (2021). Experiential Learning in a Gamified Pharmacy Simulation: A Qualitative Exploration Guided by Semantic Analysis. *Pharmacy Education Development*, 9(2). https://doi.org/10.3390/pharmacy9020081

Houssein, E., Mohamed, R., & Ali, A. (2021). Machine Learning Techniques for Biomedical Natural Language Processing: A Comprehensive Review. *IEEE Access*, 9, 140628-140653. https://doi.org/10.1109/ACCESS.2021.3119621

Hovy, D., & Prabhumoye, S. (2021). Five sources of bias in natural language processing. *WILEY*, 1-19. https://doi.org/10.1111/lnc3.12432

Khurana, D., Koli, A., Khatter, K., & Singh, S. (2022). Natural language processing: state of the art, current trends and challenges. *Multimedia Tools and Applications*, 82, 3713-3744. https://doi.org/10.1007/s11042-022-13428-4

Kocabiyikoglu, A. C., Portet, F., Blanchon, H., & Babouchkine, J.-M. (2019). Towards Spoken Medical Prescription Understanding. *10th Conference on Speech Technology and Human-Computer*.

Kumar, R., & Hittalamani, V. (2022). Pharmaceutical Prescription System Based On Medication Review Sentiment Analysis. *International Research Journal of Modernization in Engineering Technology and Science*, 4(7), 572-582.

Li, M., & Zheng, X. (2023). Identification of Ancient Chinese Medical Prescriptions and Case Data Analysis Under Artificial Intelligence GPT Algorithm: A Case Study of Song Dynasty Medical Literature. *IEEE Access*, 11, 131453-131464. https://doi.org/10.1109/ACCESS.2023.3330212

Mahatpure, J., Motwani, D., & Shukla, D. K. (2019). An Electronic Prescription System powered by Speech Recognition, Natural Language Processing and Blockchain Technology. *International Journal Of Scientific & Technology Research*, 8(8), 1454-1462.

Manias, E., Kusljic, S., & Wu, A. (2020). Interventions to reduce medication errors in adult medical and surgical settings: a systematic review. *Therapeutic Advances in Drug Safety*, 11. https://doi.org/10.1177/2042098620968309

Mielke, S., Alyafeai, Z., Salesky, E., Raffel, C., Dey, M., Galle, M., Raja, A., Si, C., Lee, W. Y., Sagot, B., & Tan, S. (2021). Between words and characters: A Brief History of Open-Vocabulary Modeling and Tokenization in NLP. *Computation and Language*.

Nayak, N., T., P., Joshi, R., S., V., & K., D. (2023). MEDICAL PRESCRIPTION RECOGNITION USING MACHINE LEARNING: A SURVEY. *International Research Journal of Modernization in Engineering Technology and Science*, 5(4), 7279-7284.

Park, K., Lee, J., Jang, S., & Jung, D. (2020). An Empirical Study of Tokenization Strategies for Various Korean NLP Tasks. *Association for Computational Linguistics*, 133-142.

Raza, S., Schwartz, B., Lakamana, S., Ge, Y., & Sarker, A. (2023). A framework for multi-faceted content analysis of social media chatter regarding non-medical use of prescription medications. *BMC Digital Health*, 1(29). https://doi.org/10.1186/s44247-023-00029-w

Sarker, A., DeRoos, A., & Perrone, J. (2020). Mining social media for prescription medication abuse monitoring: a review and proposal for a data-centric framework. *Journal of the American Medical Informatics Association*, 27(2), 315-329. https://doi.org/10.1093/jamia/ocz162

Shastry, K., & Shastry, A. (2023). An integrated deep learning and natural language processing approach for continuous remote monitoring in digital health. *Decision Analytics Journal*, 8. https://doi.org/10.1016/j.dajour.2023.100301

Soeiro, T., Lacroix, C., Pradel, V., Lapeyre-Mestre, M., & Micallef, J. (2021). Early Detection of Prescription Drug Abuse Using Doctor Shopping Monitoring From Claims Databases: Illustration From the Experience of the French Addictovigilance Network. *Frontiers in psychiatry*, 12. https://doi.org/10.3389/fpsyt.2021.640120

Suclupe, S., Martinez-Zapata, M. J., Mancebo, J., Font-Vaquer, A., Castillo-Masa, A. M., Vinolas, I., . . . Robleda, G. (2020). Medication errors in prescription and administration in critically ill patients. *Journal of advanced nursing*, 76(5), 1192-1200. https://doi.org/10.1111/jan.14322

Torfi, A., Shirvani, R., Keneshloo, Y., Tavaf, N., & Fox, E. (2021). Natural Language Processing Advancements By Deep Learning: A Survey. *Computation and Language*, 1-23.

Wang, Y. (2020). A Novel Chinese Traditional Medicine Prescription Recommendation System based on Knowledge Graph. *Journal of Physics: Conference Series*, 1487, 1-10. https://doi.org/10.1088/1742-6596/1487/1/012019

Zhou, B., Yang, G., Shi, Z., & Ma, S. (2024). Natural language processing for smart healthcare. *IEEE Reviews in Biomedical Engineering*, 17, 4-18.