A Survey of Natural Language Processing Applications in Healthcare System

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Abstract
Natural language processing (NLP) has the potential to revolutionize healthcare delivery by providing clinicians with valuable insights into patient health and improving patient engagement. The researchers used a serious literature review for a comprehensive and critical evaluation of existing research and scholarly works, particularly on NLP applications. Methodical search methodology was also used as a systematic and structured approach to conducting literature search. In this survey, the researchers analyzed 71 studies to provide an overview of the most cutting-edge NLP applications in healthcare. The findings show that NLP is being used for clinical decision support, patient monitoring, medical information retrieval, and medical chatbots. These applications have demonstrated the potential to assist clinicians in making more accurate diagnoses and treatment plans, provide valuable insights into patient health outside of the clinical setting, improve patient engagement, and provide more efficient access to medical information. However, significant challenges must be addressed before these applications can be widely adopted, including ensuring patient privacy and confidentiality and ensuring the accuracy and reliability of NLP applications. Further research is needed to validate these findings and ensure that NLP applications are effective, safe, and protect patient privacy and confidentiality.
Keywords: NLP, Healthcare, Electronic Health Records, Clinical Decision Support, Patient Monitoring, Medical Chatbots, Medical Information Retrieval

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I. INTRODUCTION

The discipline of natural language processing (NLP), which is expanding quickly, has demonstrated tremendous promise in a number of sectors, including healthcare [1]. In order to enhance patient care, clinical decision-making, and overall healthcare outcomes, academics have demonstrated a growing interest in investigating the uses of NLP in the healthcare sector [2]. In order to analyze huge amounts of unstructured data from sources like medical records, patient forums, social media, and other sources, NLP is the technology that enables machines to comprehend human language and provide responses [3].

The purpose of this survey is to present a summary of the most cutting-edge NLP applications currently being used in healthcare [4]. The researchers concentrated on the possible applications of NLP in clinical decision support, patient monitoring, electronic health records (EHRs), information retrieval for the medical industry, and medical chatbots [5]. They also go over the advantages and restrictions of NLP use in healthcare, as well as any potential ethical and privacy issues [6].

The structure of this survey is as follows. First, an introduction to NLP and its fundamental ideas is given [3]. The potential uses of NLP in healthcare, along with the advantages and disadvantages of each strategy, are then covered [5]. After that, gaps and potential areas for further research in the fields of NLP and healthcare are identified [7]. Finally, the main conclusions are outlined and closing remarks are given [8].

Overall, this serious literature review offers insightful information on the potential of NLP in healthcare and its present uses, as well as areas that require more study to properly tap into their potential [4].

II. LITERATURE REVIEW

The discipline of natural language processing (NLP), which is expanding quickly, has demonstrated tremendous promise in a number of sectors, including healthcare [1]. In order to enhance patient care, clinical decision-making, and overall healthcare outcomes, there has been an increase in interest in researching the uses of NLP in the healthcare industry in recent years. In order to analyze huge amounts of unstructured data from

sources like medical records, patient forums, social media, and other sources, NLP is the technology that enables machines to comprehend human language and provide responses [1].

Electronic Health Records (EHRs)

The analysis of electronic health records (EHRs) is one of the most promising applications of NLP in the healthcare industry [9]. Physician notes in EHRs are an example of unstructured data that NLP algorithms may examine to find patterns and insights that can enhance patient care. Healthcare practitioners can take action before issues arise, for instance, by using NLP algorithms to examine clinical records to identify patients who are at risk for readmission [8]. In order to enhance clinical decision-making, NLP can be used to extract crucial data from EHRs, such as patient demographics and medical histories [10].

Clinical Decision Support

With NLP, healthcare professionals can receive clinical decision support. NLP algorithms can offer suggestions for a diagnosis and possible courses of treatment by examining patient data, including EHRs and test results [8]. Clinical practice guidelines can be analyzed by NLP algorithms in order to give pertinent information to healthcare professionals at the point of care [8].

Patient Monitoring

In particular, NLP can be utilized to analyze social media data for patient monitoring [11]. NLP algorithms are capable of identifying potential mental health problems and delivering the right remedies by examining patient discussions on social media. NLP algorithms, for instance, can be used to spot suicide intent in social media messages and notify medical professionals [8].

Medical Information Retrieval

In order to offer healthcare professionals pertinent information at the point of care, NLP techniques can also be employed for medical information retrieval. NLP algorithms, for instance, can be used to assess medical literature and give healthcare providers pertinent information [12]. In order to give healthcare providers insights into patient experiences and concerns, NLP can also be utilized to evaluate patient forums [13].

Medical Chatbots

Lastly, medical chatbots that can offer patients individualized healthcare suggestions and support can be created using NLP algorithms. NLP algorithms can be used by medical chatbots to analyze patient symptoms and make relevant suggestions for self-care or additional medical care [14].

NLP has a wide range of possible applications in healthcare, but there are also significant restrictions and ethical issues to be mindful of. The following portions of this manuscript will go over these restrictions and ethical issues. Overall, the cutting-edge NLP applications currently being used in healthcare show how this technology has a huge potential to enhance patient care and healthcare outcomes.

III. RESEARCH METHODOLOGY

An overview of the most cutting-edge NLP applications in healthcare was the goal of this survey. To find relevant literature, a methodical search methodology and a serious literature review were used to perform the survey. The following databases were looked up: IEEE Xplore, Google Scholar, and PubMed. Natural language processing, healthcare, clinical decision support, patient monitoring, electronic health records, medical information retrieval, and medical chatbots were the search terms utilized, and the search was restricted to articles published between 2016 and 2022.

The following criteria were used to determine whether an article should be included: (1) it must be written in English; (2) it must discuss the application of NLP in healthcare; (3) it must have undergone peer review; and (4) it must have been published in a journal or conference proceeding. The following were the exclusion criteria: (1) the article is a book or book chapter; (2) it is a thesis or dissertation; (3) it is a white paper; (4) it has no connection to healthcare; and (5) it has no connection to NLP.

A total of 352 articles were found in the search results. To find pertinent studies, two researchers independently reviewed the publication titles and abstracts. After then, the complete texts of the chosen articles were examined to determine whether they qualified for inclusion in the survey. Discussion between the researchers was used to settle any disagreements.

71 studies made up the final list of publications for the survey. The research was examined to determine the many NLP applications in healthcare, their advantages, and disadvantages, as well as any privacy or ethical issues that might have been raised. The next section is a presentation of the survey's findings.

Data Extraction and Analysis

Data extraction was done to gather information on the uses of natural language processing (NLP) in healthcare after the pertinent literature was found. Two impartial reviewers extracted the data, and any discrepancies were settled through discussion and agreement. The title, authors, publication year, study design, NLP application, data source, and key conclusions were all taken out of each study.

Figure 1 Data Extraction and Analysis Process

The data was then combined and examined to find recurring themes and trends in research. The study was undertaken to utilize a qualitative technique, where themes were uncovered through a process of inductive reasoning, allowing for the emergence of new insights from the data. The same two independent reviewers carried out the synthesis and analysis, and any differences were settled through discussion and consensus.

The findings and discussion parts of this survey were created using the findings of the data synthesis and analysis. The process of data synthesis and analysis made it possible to find similar themes and patterns among studies, giving insights into the most cutting-edge NLP applications being used in healthcare today.

IV. RESULT

The survey's findings demonstrate that NLP has numerous healthcare applications. The most common uses included patient monitoring, clinical decision assistance, medical information retrieval, electronic health records, and medical chatbots. We'll go over the survey's main conclusions in this part.

Patient Monitoring

In hospitals and other medical facilities, real-time patient monitoring is done using NLP technology. This strategy may lead to better patient care and shorter hospital stays. In order to help doctors make better treatment choices, NLP can also be used to analyze patient data and provide reports for them.

Clinical Decision Support

Physicians are using NLP to help them make wise clinical decisions. To help doctors make better judgments about a patient's care, NLP technology may be used to assess and extract data from clinical notes, electronic health records, and medical literature.

Medical Information Retrieval

NLP has the ability to help with the search for medical data. This is crucial since the amount of medical data that is now available is expanding quickly. From medical journals, novels, and other sources, useful information may be extracted using NLP technology.

Electronic Health Records (EHRs)

Moreover, NLP technology can be used to extract important data from electronic health records (EHRs). This strategy might let doctors quickly access patient data from EHRs, leading to quicker and more effective therapy.

Medical Chatbots

Conversational chatbots are being developed for use in medical applications using NLP technology. The purpose of these chatbots is to help people access medical information and provide answers to health-related concerns. By giving knowledge on health-related issues and responding to frequently asked queries, chatbots could help ease the workload of medical personnel.

The survey also uncovered several difficulties with the application of NLP in the healthcare industry. Among the most significant were worrying about privacy and morality. When using NLP technology, patient privacy must be protected, and ethical issues must be taken into account.

Overall, the survey's findings show that NLP technology has the ability to enhance patient care and help doctors choose treatments with more knowledge. When using this technology in healthcare, however, privacy and ethical issues must be carefully taken into account.

V. DISCUSSION

The goal of this research was to look into potential NLP uses in the healthcare sector. Following a review of the literature, several significant conclusions were drawn.

Clinical decision support is one of the most prominent uses of NLP in the healthcare industry. Clinical choices involving patient care can be made more intelligently by clinicians with the use of NLP algorithms. NLP

can help clinicians by extracting and analyzing data from clinical notes and electronic health records to help them identify individuals at risk for various diseases and ailments. The results of this study are in line with earlier studies that have shown how NLP can increase the precision of diagnosis and treatment recommendations.

Patient monitoring is an important area where NLP is used in medicine. NLP can offer important insights into patient health outside of the clinical setting by evaluating patient-generated text data, such as symptoms and treatment outcomes. Remote patient monitoring has the potential to raise the standard of care and lessen the likelihood of negative outcomes.

Additionally, the creation of medical chatbots and NLP apps for information retrieval can increase patient involvement and facilitate more effective access to medical data. NLP can assist patients in managing their medical issues more effectively by offering them individualized information and support.

The use of NLP applications in healthcare, however, confronts a number of difficulties. Making sure patients' privacy and confidentiality is one major concern. It is critical to build effective procedures for safeguarding patient privacy and guaranteeing data security because many of the studies analyzed in this study featured sensitive patient data.

Making sure NLP applications are accurate and reliable is another difficulty. Although the papers examined in this analysis showed that NLP has the potential to enhance healthcare outcomes, more research is required to confirm these results and make sure that NLP applications are secure and reliable.

The overall findings of this study indicate that NLP has enormous potential to transform healthcare delivery by giving clinicians insightful information about patient health and enhancing patient participation. However, before NLP applications are widely used in healthcare, it is essential to overcome the issues stated above. Future studies should concentrate on creating reliable procedures for safeguarding patient privacy and making sure NLP applications are accurate and reliable.

VI. CONCLUSION

In summary, this study has offered a thorough analysis of the state of natural language processing (NLP) applications in the healthcare industry. Our findings suggest that by giving clinicians insightful information about patient health and enhancing patient participation, NLP has a significant potential to enhance healthcare outcomes.

The application of NLP for clinical decision assistance, patient monitoring, medical information retrieval, and medical chatbots were found to be the most common topics in the study of 71 articles. These use highlight the potential of NLP to increase patient involvement and access to medical information, support physicians in developing more precise diagnoses and treatment plans, offer insightful information about patients' health outside of the clinical context, and more.

Before NLP applications may be extensively used, a number of issues must be resolved. While evaluating sensitive patient data, patient privacy and confidentiality are crucial factors to take into account. To preserve patient privacy and guarantee data security, effective approaches are required. Further study is also required to confirm the efficiency and security of NLP applications and to guarantee their accuracy and dependability.

Overall, NLP has the potential to completely transform the way that healthcare is delivered, but for this to happen, it will take a concerted effort on the part of healthcare institutions, researchers, and decision-makers to address the issues and encourage the ethical and safe application of this technology. We anticipate that this work will advance knowledge of NLP's potential applications in healthcare and encourage additional investigation in this fascinating and quickly developing area.

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