CS 410: Technology Review

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Natural language processing (NLP) is a machine learning methodology that evaluates textual narratives on a word, sentence, and document level in order to model the human language. Its application is wide-reaching and have led to many transformative advances in many industries. This review will focus on the recent applications of NLP in the healthcare sector.

There have been many recent applications of NLP in the healthcare sector, including clinical decision support, improving point of care, general health surveillance, and even predicting a patient's quality of life. Electronic medical records (EMRs) are systems used by healthcare institutions to store a patient's medical records and health history. The clinically-relevant information though, such as the severity of a symptom, is often entered into the system as narrative text by a clinician. NLP is therefore a useful tool that can extract medical insights from EMR systems. In 2000, Fiszman et al compared the performance of a NLP system, which extracted acute bacterial pneumonia-related data in chest x-ray free-text reports from the hospital information system, to that of physicians and found the results to be similar.[1] This suggests that a NLP system could be a valuable aid in clinical decision support to physicians and prevent errors in clinical diagnoses. Similarly, Doan et al in 2010 had combined several NLP tools (MedEx for extraction of information, SecTag for identifying sections in clinical notes, a sentence splitter, and a drug name spellchecker) developed at Vanderbilt University Medical Center and tested its performance at extracting medication-related information from discharge summaries with good results.[2] This suggests that even general-purpose NLP tools can be used to improve point of care, ensure medication compliance, and support medication quality assurance. A relatively new application for NLP is seen in wearable devices, like smartwatches. LeBaron et al have developed a NLP algorithm called CommSense that aims to bridge the communication gap between patient and clinician using sentiment

analysis.[3] The novelty of the software is that it will be used in smartwatches and mobile devices to leverage the embedded sensors for physiological and gesture metrics, as well as the embedded microphone for textual data.[3] The results from the study may be useful for training staff in empathy and improving patient care and the patient-clinician relationship. Furthermore, NLP can be used in prediction analysis for general health surveillance. Parkhomov et al in 2008 explored the prediction of a patient's response to standardized health-related quality of life (HRQOL) assessments from the physician's notes in the EMR by using a general-purpose NLP system (Metamap) and support vector machines.[4] They found that the "pain" feature had the best agreement between the HRQOL assessments and the automated NLP algorithm.[4] Whether it's to aid a physician's clinical diagnosis, improving point of care, or predicting a patient's health-related quality of life, NLP's usage in healthcare is far-reaching and its application is steadily increasing, including integration with smartphones and wearable devices.

Even though it seems easy to use out-of-box NLP solutions applied to healthcare issues, there are also some special challenges. According to Velupillai et al, tight government restrictions, ethical regulations, and privacy concerns around using patient data from an EMR are all hurdles that must be addressed in order to allow NLP research in healthcare to be more adopted.[5] With these challenges, there are limits in data availability for clinical trials.

In conclusion, natural language processing techniques are widely used in healthcare research. Many of the NLP applications in healthcare center around the exploration of how the narrative notes in the EMR can be leveraged to provide better point of care to patients, to improve clinical decision support, and to predict a patient's quality of life.

References

1. Fiszman, Marcelo, et al. "Automatic detection of acute bacterial pneumonia from chest X-ray reports." Journal of the American Medical Informatics Association 7.6 (2000): 593-604.

2. Doan, Son, et al. "Integrating existing natural language processing tools for medication extraction from discharge summaries." Journal of the American Medical Informatics Association 17.5 (2010): 528-531.

3. LeBaron, V., et al. "Exploring the Use of Wearable Sensors and Natural Language Processing Technology to Improve Patient-Clinician Communication: Protocol for a Feasibility Study." JMIR Research Protocols 11.5 (2022): e37975-e37975.

4. Pakhomov, Serguei, et al. "Automatic quality of life prediction using electronic medical records." AMIA Annual Symposium Proceedings. Vol. 2008. American Medical Informatics Association, 2008.

5. Velupillai, Sumithra, et al. "Using clinical natural language processing for health outcomes research: overview and actionable suggestions for future advances." Journal of biomedical informatics 88 (2018): 11-19.