Harnessing active learning to fine-tune large language models on minimal training data for near real-time detection of vaccine adverse events from emergency department notes

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The rapid development and widespread distribution and administration of vaccines in recent years have showcased the international community's capacity to respond to global infectious disease threats. However, the limited window available for collecting vaccine safety data during clinical trials and potential early widespread implementation has made imperative the need for post-licensure surveillance systems. Such systems monitor Adverse Events Following Immunization (AEFI), which encompass a spectrum of untoward medical occurrences that may follow vaccination, ranging from mild symptoms to severe allergic reactions and seizures. Ensuring the safety of vaccines demands vigilance through the monitoring of adverse events and unexpected patterns from various data sources.

Emergency department triage notes, which are often collected at the first point of a patient's healthcare interaction, offer valuable insights into patients' health conditions and serve as a crucial resource for health surveillance. Natural Language Processing (NLP) techniques have shown promise in enhancing medical text classification performance but often face challenges related to acquiring annotated data particularly from ED notes. This research focuses on utilizing active learning as a key component of the use of NLP for rapid identification of potential vaccine AEFI from emergency department notes. Active learning offers a solution to the labelled data scarcity issue by intelligently selecting and prioritizing the most informative data for expert annotation.

The study's unique contribution lies in its application of sentence embedding-based clustering to generate an initial training dataset for active learning. The research evaluated common active learning approaches—diversity, uncertainty, and a hybrid approach—and demonstrated their efficacy in creating a well-performing model for detecting potential AEFI presentations in emergency department notes.

The findings indicate that the sentence embedding clustering technique efficiently established a balanced and representative initial dataset, achieving an F1 score of 0.85 with only 500 training records. Furthermore, by employing active learning to select an additional 200 records, the F1 score was boosted by 5 percentage points.

In conclusion, this research demonstrates that active learning techniques offer a practical approach to streamline the annotation process while maintaining effective classification performance. The integration of NLP and active learning holds great potential for enhancing vaccine safety surveillance towards responding to emerging public health threats efficiently.