Abstract

Natural Language Processing of Medical Alert Service Notes Reveals Reasons for Emergency Admissions

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Abstract

Background: A Personal Emergency Response Service (PERS) enables an aging population to receive help quickly when an emergency situation occurs. The reasons that trigger a PERS alert are varied, including a sudden worsening of a chronic condition, a fall, or other injury. Every PERS case is documented by the response center using a combination of structured variables and free text notes. The text notes, in particular, contain a wealth of information in case of an incident such as contextual information, details about the situation, symptoms and more. Analysis of these notes at a population level could provide insight into the various situations that cause PERS medical alerts.

Objective: The objectives of this study were to (1) develop methods to enable the large-scale analysis of text notes from a PERS response center, and (2) to apply these methods to a large dataset and gain insight into the different situations that cause medical alerts.

Methods: More than 2.5 million deidentified PERS case text notes were used to train a document embedding model (ie, a deep learning Recurrent Neural Network [RNN] that takes the medical alert text note as input and produces a corresponding fixed length vector representation as output). We applied this model to 100,000 PERS text notes related to medical incidents that resulted in emergency department admission. Finally, we used t-SNE, a nonlinear dimensionality reduction method, to visualize the vector representation of the text notes in 2D as part of a graphical user interface that enabled interactive exploration of the dataset and visual analytics.

Results: Visual analysis of the vectors revealed the existence of several well-separated clusters of incidents such as fall, stroke/numbness, seizure, breathing problems, chest pain, and nausea, each of them related to the emergency situation encountered by the patient as recorded in an existing structured variable. In addition, subclusters were identified within each cluster which grouped cases based on additional features extracted from the PERS text notes and not available in the existing structured variables. For example, the incidents labeled as falls (n=37,842) were split into several subclusters corresponding to falls with bone fracture (n=1437), falls with bleeding (n=4137), falls caused by dizziness (n=519), etc.

Conclusions: The combination of state-of-the-art natural language processing, deep learning, and visualization techniques enables the large-scale analysis of medical alert text notes. This analysis demonstrates that, in addition to falls alerts, the PERS service is broadly used to signal for help in situations often related to underlying chronic conditions and acute symptoms such as respiratory distress, chest pain, diabetic reaction, etc. Moreover, the proposed techniques enable the extraction of structured information related to the medical alert from unstructured text with minimal human supervision. This structured information could be used, for example, to track trends over time, to generate concise medical alert summaries, and to create predictive models for desired outcomes.

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KEYWORDS

data visualization; natural language processing; text data mining

Multimedia Appendix 1

Poster.
[PDF File (Adobe PDF File) 1 MB-Multimedia Appendix 1]

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