

Automatic Referral Classification for the Chilean Waiting List

Problem

In Chile, some health problems are covered by the Explicit Health Guarantees (GES in Spanish), which means that there is a time limit to diagnose and treat these problems. Moreover, by law, patients have the right to be treated in a prioritized way (1). Misclassification of patients covered by GES lead to be considered in a non-prioritized waiting list (WL), characterized by prolonged waiting times (2). Furthermore, hospitals get fines for this misclassification.

Solution

Design, construct, train and deploy an automatic system as a web service that receives a referral and then classify it as a prioritized WL case or not. This solution is based on machine learning algorithms that train models with human-coded historical data from healthcare services. Those models have the intelligence to classify a referral into GES or an urgency, with the remaining cases going to the non-prioritized WL. A demo of the model can be checked in ssmso.scian.cl/saci/.

Method

Natural languages processing (NLP) techniques were applied to the free-text of the referrals to code the information into a vectorial representation of words (3,4). These dense vector were inputted as features to train different machine learning models, with the ones with the best performance being selected (5).

Variable and Metrics

The performance of each model is measured based on the precision, recall, F1-score and receiver operating characteristics area under the curve. The deployment performance was tested using a survey to the final users assessing their satisfaction.

Hypothesis

A machine learning model trained over historical human-classified data can separate WL referrals into GES, urgency and non-prioritized classes with human classification performance, and this classification system is deployable in a real-world hospital context.

Objectives

1. Implement NLP techniques to analyze free-text diagnostic suspicions.
2. Classify referrals using ML models and compare their performance.

3. Compare the classification proposed by the model with a gold standard that combines the classifications made by healthcare experts.
4. Deploy the classification system into the workflow of a hospital.

Preliminary Results

The best performing algorithm was Multilayer Perceptron, reaching a F1-score of 0.89 in GES and 0.94 in urgency classification. The platform has been used 7 consecutive weeks in a hospital and 1663 referrals have been analyzed. Human-machine discrepancies were 84 cases, where in 42 cases the machine was right.

Outlook

The input for our ML models are the same than the information in the National Registry of WL (6), therefore our results are immediately scalable to the national level.

References

1. Ministerio de Salud de Chile. Ley Número 19.966 Establece un Régimen de Garantías en Salud [Internet]. 2004 [cited 2018 Nov 10]. Available from: <https://www.leychile.cl/Navegar?idNorma=229834>
2. Martinez DA, Zhang H, Bastias M, Feijoo F, Hinson J, Martinez R, et al. Prolonged wait time is associated with increased mortality for Chilean waiting list patients with non-prioritized conditions. *BMC Public Health*. 2019;1–11.
3. Mikolov T, Chen K, Corrado G, Dean J. Efficient Estimation of Word Representations in Vector Space. 2013;1–12. Available from: <http://arxiv.org/abs/1301.3781>
4. Bojanowski P, Grave E, Joulin A, Mikolov T. Enriching Word Vectors with Subword Information. 2017;
5. Pouransari, H. Deep learning for sentiment analysis of movie reviews. CS224N Proj [Internet]. 2014;1–8. Available from: <http://web.stanford.edu/class/cs224d/reports/PouransariHadi.pdf>
6. Ministerio de Salud de Chile. Norma Técnica Para El Registro De Las Listas De Espera [Internet]. 2011. Available from: [http://web.minsal.cl/sites/default/files/files/Nueva Norma de Listas de Espera 2011.pdf](http://web.minsal.cl/sites/default/files/files/Nueva%20Norma%20de%20Listas%20de%20Espera%202011.pdf)