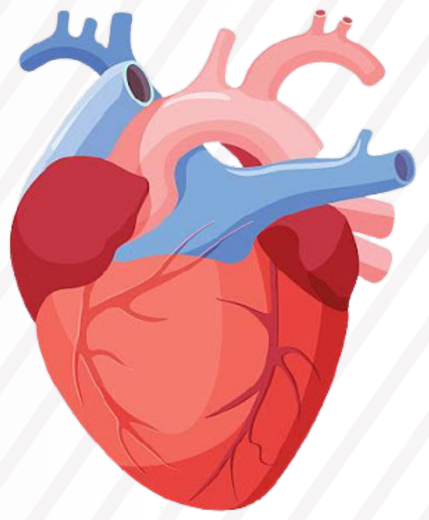
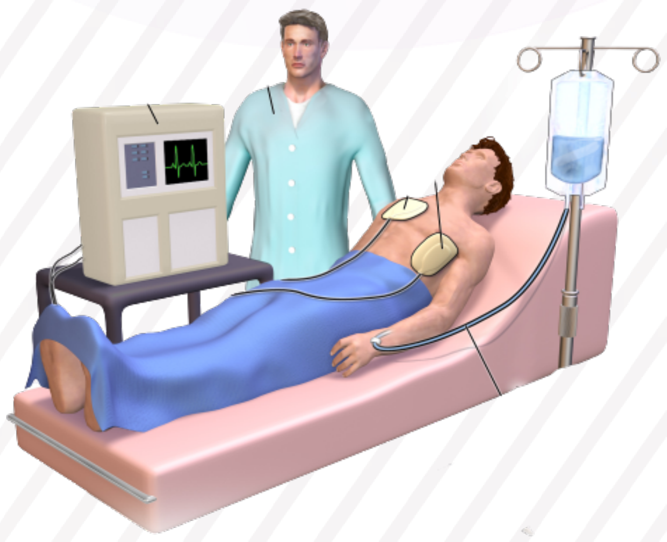
Prediction of short-term success of electrical cardioversion

Lazar Vasović, Ana Jakovljević
{mi16099, mi16021}@alas.matf.bg.ac.rs
Faculty of Mathematics, University of Belgrade

Introduction

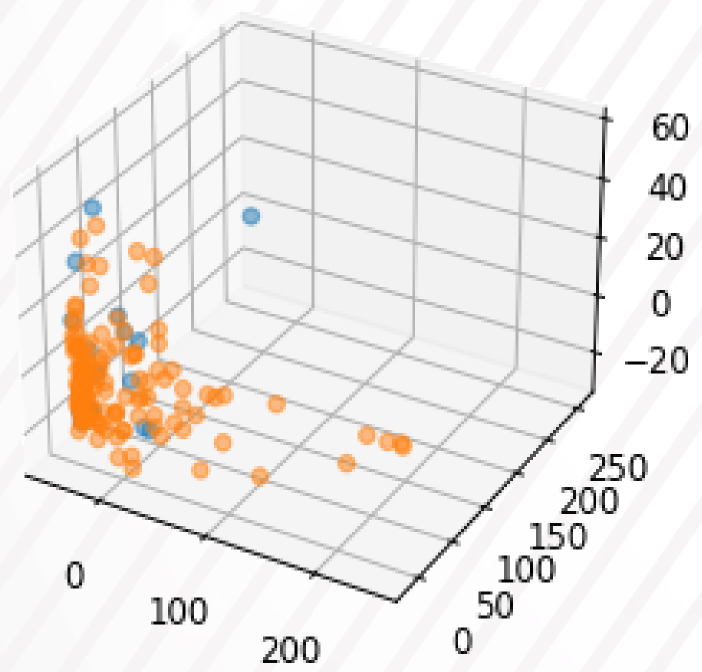
Electrical cardioversion is a medical technique that uses synchronized electrical shocks to restore normal sinus heart rhythm in people with persistent arrhythmia (tachycardia, very fast irregular heartbeats). We aimed to create a classi-fication model that accurately predicts whether the procedu-re will be successful in the short term (immediate outcome), based on data on the clinical picture, other indications, and drug therapy prescribed to patients undergoing it.

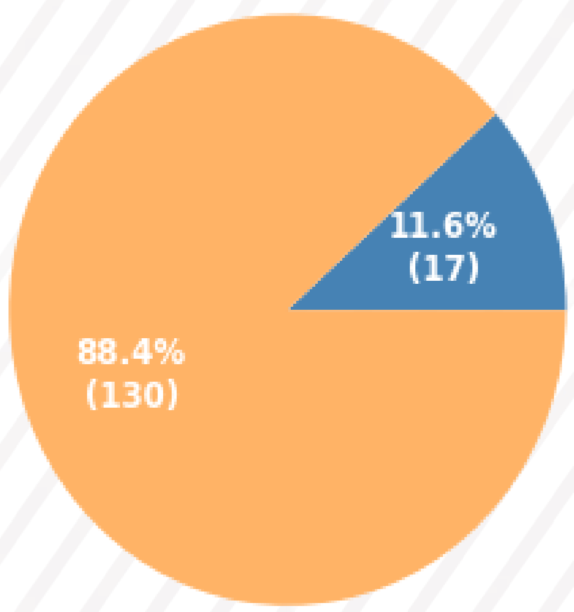




Dataset

Dataset was obtained from the Pacemaker Center of the Clinical Center of Serbia. It consists of 147 unique instances representing patients. Most procedures are initially successful. Such cardioversions make up 88.4 % of the dataset and are marked as class True. Unsuccessful ones are marked as class False. Accordingly, the dataset is imbalanced with concern to the target class, so we used the stratified train-test split with balanced augmented oversampled train partition. We used PCA and UMAP for visualization, which made us notice that the classes are inseparable and that there will be the need for compromise.





Methodology

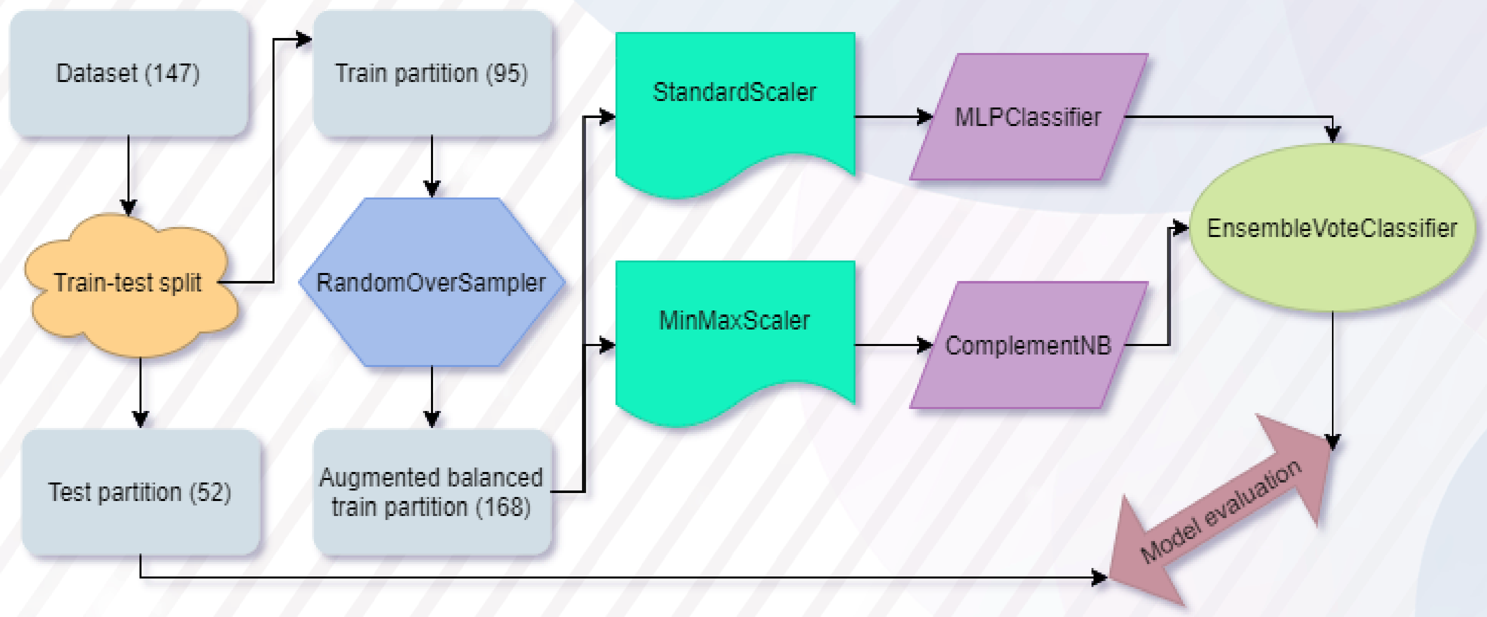
The focus was initially on the Bayesian networks, a well-known probabilistic graphical model. They, however, proved inferior to other methods of classification and, extended, machine learning, which we used extensively afterward.

The decision tree was overfitted, and pruning didn't help obtain a better model. Random forest, complement naïve Bayes, and support vector classifier were mutually similar. They had better performance in comparison to the first results. Multilayer perceptron singly performed the best.

We finally chose to combine models to get more robust results. One way to do so was by using voting ensembles, namely duos, where one model is picked up to overcome the weaknesses of the other. We broke eventual ties by favoring the important unsuccessful procedures; only if both members vote True, an instance was labeled as so.

Results

The short-term success of electrical cardioversion wasn't the easiest thing to predict. We, however, managed to get some acceptable results. The voting ensemble made of multilayer perceptron and complement naïve Bayes turned out the best, with full 100% specificity, recall of the important class False. It also maintained a relatively high F_1 score of 63% on the same class. Accuracy was 87%, while balanced (macro-average) accuracy was 92%. Precision on class False was not that good 46%, but it was still the best compromise when it comes to the precision-recall rate.



Future work

Even though we managed to create a fully specific model, we believe more data could help boost precision on the important class False. In the future, we would like to experiment on a bigger dataset and with more columns.

References:

1. Draeger T, Wright S, Meenakshisundaram R, et al. A Five Year Audit of DC Cardioversion for Patients with Atrial Fibrillation in East London. J Univer Surg. 2016, 4:3.
2. Kuppahally SS, Foster E, Shoor S, Steimle AE. Short-term and long-term success of electrical cardioversion in atrial fibrillation in managed care system. Int Arch Med. 2009, 2:39.
3. Van Gelder IC, Crijns HJ, Van Gilst WH, Verwer R, Lie KI. Prediction of uneventful cardioversion and maintenance of sinus rhythm from direct-current electrical cardioversion of chronic atrial fibrillation and flutter. Am J Cardiol. 1991 Jul 1;68(1):41-6.