

PROTOTYPE OF NEURAL NETWORK FOR ECG DIAGNOSIS

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Cardiovascular disease is the leading cause of death in the world. Therefore, it is important to timely and qualitative diagnose the state of the heart. ECG allows you to record the electrical potential of the conductive system of the heart on the surface of the skin. Diagnosis of ECG is a non-trivial task and requires high qualification. Consequently, the issue of automating the ECG diagnostic process is acute. Some hopes for solving this problem are related to artificial neural networks [1]. The prototype of one of these is presented in this work.

We took the technique of rapid ECG interpretation as a basis for building own neural network. Diagnosis is made based on the indicators of heart rate and presence of certain signs in individual ECG leads [2]. Based on this, we present a composition of 12 CRNN for analysis of individual leads and separate CNN to monitor heart rate properties. Networks for analysis of individual leads are a combination of CNN and LSTM and have the same structure. Each of these 12 networks generates a vector of 10 features for each lead, and a separate network – 20 features. Then vector of 140 features is fed to a MLP, which determines the ECG class.

For research, a dataset was created on the basis of open datasets and databases: CODE-15%, Chapman-Shaoxing, Ningbo, Georgia 12-Lead ECG Challenge, PTB-XL, CPSC 2018. For further work, they were compiled into a single set, after which it was preprocessed. The result is a dataset of 70 thousand records of 10 classes: normal sinus rhythm and nine classes of cardiovascular disease. At the same time, classes are unbalanced by the number of records.

High-level programming language Python was used for development in the study. The neural network was created using the PyTorch library. Google Colaboratory (Colab) was used as a development environment which allows you to run interactive Python code through a browser. For training needs, the created dataset was divided into three parts: for training, validation and for test. It was decided to use the Focal Loss to solve the class imbalance problem. In general, the quality of the network is satisfactory, but it classifies only a part of the classes well. Therefore, it is necessary to continue work to finalize it.

In the future, we plan to increase the efficiency of the network. To do this, it is necessary to solve the problem of imbalance of the dataset. It is also necessary to replace the MLP with a decision tree or gradient boosting algorithm for a human-friendly interpretation of the diagnosis based on the features generated by network. Because now the diagnostic algorithm is a black box at all stages.

References (translated):

1. Hong S. et al. Opportunities and challenges of deep learning methods for electrocardiogram data: A systematic review //Computers in biology and medicine. – 2020. – T. 122. – C. 103801.
2. Khan M. G. (ed.). Rapid ECG interpretation. – Totowa, NJ: Humana Press, 2008.