Predictive Diagnosis Based on Continuous Heart Monitoring

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Introduction
- Sudden cardiac death causes more than 300,000 deaths annually in the United States
- Although there is research on the prediction of heart failures (HF), there is not yet a working operational model
- New wearable technology enables continuous monitoring with cloud-based data processing

Approach
Architecture of the planned data-driven cardiac monitoring, predictive diagnosis, and treatment planning system:

Prediction of heart failure is based on a Two-Tier machine learning algorithm with combined regression/classification, using the continuous heart-rate (HR) data stream:
In Tier 1, the HR data is divided into short-range packets, which are tagged with regressive features using multiple regression models.
In Tier 2, blocks of packets are categorized with a classification model.

Population groups with high risk:
- Elderly
- Athletes
- Military

Scheme of the two-tier (two-level) machine learning training system:

Tier 1:
- HR data is divided into one-minute long overlapping packets
- 139 features are calculated for each packet:
  - statistics (20),
  - info theory (6),
  - signal processing (4),
  - multidimensional analytics (109) features
- Multiple gradient boosting regression models are applied: XGB Regressor and Light GBM Regressor
- The training target function is linearly increasing in the pre-HF time domain
- 5-fold cross validation is used

Tier 2:
- 5-12 packets are grouped into blocks
- Block features are the ones calculated in Tier 1 for each packet
- Single gradient boosting classifier model is applied: XGBM
- Training target function is binary: data is pre HF or not
- 5-fold cross validation is used

Results
Prediction of heart failure 1-5 minutes before onset was carried out on a model trained on clinical data of 460 cases containing HR data on 5 minutes before the onset of heart failure. Failures included Asystole, Bradycardia, Ventricular Flutter Fibrillation, Tachycardia, Ventricular Tachycardia. (Physionet Challenge 2015)
The figures below show results on the differentiation between pre-HF and non pre-HF data:

Accuracy: 91.6 %

AUC = 0. 966

References
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