

AI CUP 2023 春季賽

多模態病理嗓音分類競賽報告 (TEAM_3037)

隊伍：TEAM_3037

隊員：陳在民（隊長）、龐力元

Private leaderboard：0.600346 / Rank 9

壹、環境

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貳、演算方法與模型架構

We hypothesize that our previous network architecture, MetforNet, can be generalized to predict pathological voices using sound. The backbone architecture of MetforNet is based on our works [1], where we demonstrated that the backbone architecture of MetforNet can extract and predict the patterns of biomedical signals of electrocardiography (ECG), which brings us the world championship of The China Physiological Signal Challenge 2018. In our following studies, we further showed that the backbone architecture of MetforNet is strong with transferability in other applications of ECG, such as long-term monitoring for portable/wearable devices and prediction of cardiovascular mortality [2, 3].

參、創新性

Our preliminary result suggests the MetforNet could also be applied to different biomedical signals, such as DNA sequences [4], rather than just ECG signals. Therefore, we hypothesized that MetforNet could also be applied to learn the patterns of pathological voices from sound signals. The motivation of our approach is to prove that our MetforNet could be a general end-to-end solution to predict patterns from all kinds of biomedical signals.

肆、資料處理

To utilize the sound records, our previous network architecture, MetforNet, was selected as the backbone model to predict the patterns of pathological voices. It was built on a combined architecture of five CNN blocks, followed by a bidirectional gated recurrent unit (GRU), an attention layer [5, 6], and a fully connected layer. In our architecture, each CNN block contained two convolution layers that were followed by a convolution-pooling layer, which is a convolution-based pooling layer, to reduce the number of parameters and computation in the network and to control overfitting [7]. All convolution layers share the same kernel number of 12 and kernel size of three, except for the five convolution-pooling layers with kernel sizes of 24, 24, 24, 24, and 48, sequentially. Furthermore, between these CNN blocks and other independent layers, including the one between the last CNN block and the bidirectional GRU layer, 20% of their connections were randomly dropped. Batch normalization was also used to adjust and rescale the results from the attention layer, which is a special mechanism proposed to generate importance-weighting vectors [8]. LeakyReLU activation functions were used in each layer other than the fully connected layer, where a sigmoid activation function was used for predicting five classes of pathological voices [9]. This architecture was built using the Keras package supported by TensorFlow in GPUs [10, 11].

To utilize the additional demographic and clinical data, the categorical and numerical data of them were processed by one-hot encoding and Z-score normalization, respectively. The processed additional demographic and clinical data then concatenate with the output vector of the attention layer above to go through another path of dense, batch normalization, LeakyReLU, and dropout layers to produce five additive values by a dense layer with a hyperbolic tangent activation function on the five output values of the sigmoid activation functions to generate another model output. The sound records were subjected to Z-score normalization. They were randomly divided into 60 equal parts to set up an 58-1-1 training, validation, and test scheme for machine learning.

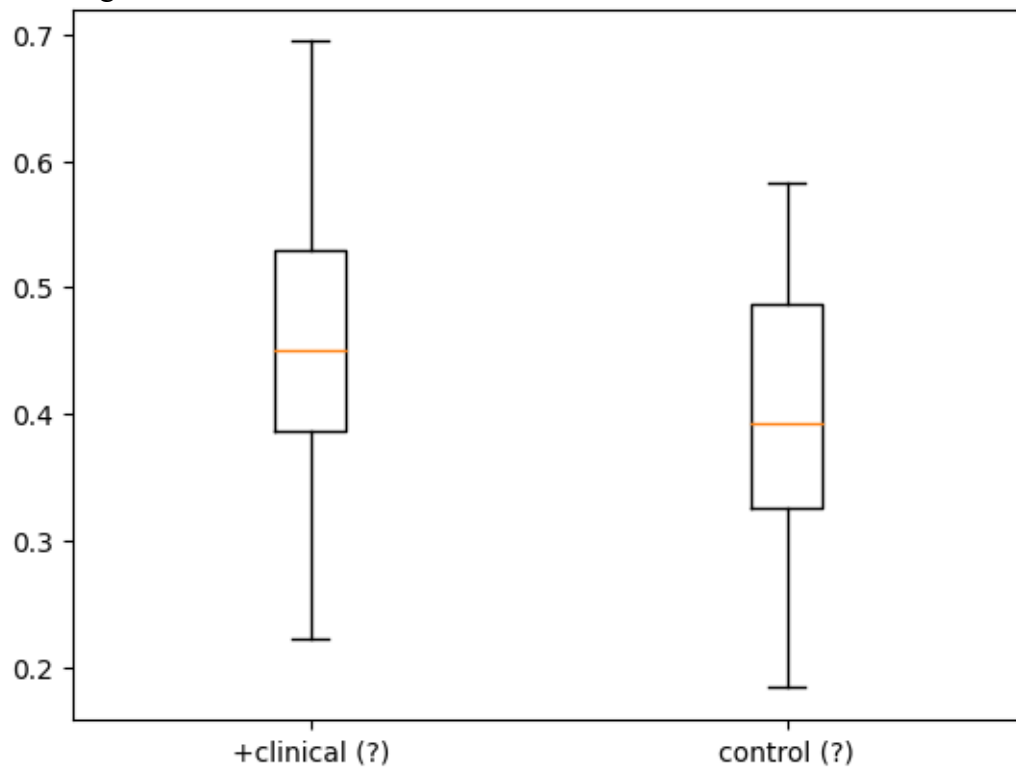
伍、訓練方式

Under such data splitting, the model was trained for 100 epochs (which refers to one complete cycle feeding training dataset) to generate 100 models (one model at each epoch), and the model with the best performance on the validation set was selected as the best model for this training process. Subsequently, the best model was used to compute the Unweighted Average Recall (UAR) score on the test set. The procedure was repeated 60 times to complete a 60-fold training; thus, the 60 best models were selected for each fold. The training process was implemented using the ADAM optimizer with a mean-square error loss function [12]. Finally, the 60 best models were merged into a model ensemble by simply averaging their output probability. Each record was predicted by the model ensemble separately to make the final decision for each patient. The model output with additive values was selected for this task.

陸、分析與結論

The proposed end-to-end solution, MetforNet, can predict pathological voices from sound records. It suggests that a method to learn features of pathological voices from

sounds is possible. Besides, the result shows that the additional demographic and clinical data could improve the performance of pathological voices prediction shown in the figure below.



The left boxplot indicates the 60-fold result with demographic and clinical data (+clinical) in comparison to the right boxplot without demographic and clinical data (control).

RecallScores +clinical:

Median Recall: 0.4506944444444444

Mean Recall: 0.4579166666666666

RecallScores control:

Median Recall: 0.3923611111111111

Mean Recall: 0.3966898148148148

柒、程式碼

Github 連結：<https://github.com/chentsaimin/AI-CUP-2023-Multimodal-Pathological-Voice-Classification-Competition-Metformin-121/>

捌、使用的外部資源與參考文獻

[1] T.-M. Chen, et al., "Detection and classification of cardiac arrhythmias by a challenge-best deep learning neural network model." *Iscience* 23.3 (2020): 100886.

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- [12] D. P. Kingma and J. Ba, "Adam: A Method for Stochastic Optimization." ArXiv e-prints 1412.

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★註 1：請確認上述資料與 AI CUP 報名系統中填寫之內容相同。自 2023 年起，獎狀製作將依據報名系統中填寫內容為準，有特殊狀況需修正者，請主動於報告繳交期限內來信 moe.ai.ncu@gmail.com。報告繳交截止時間後將不予修改。

★註 2：繳交程式碼檔案與報告，請 Email 至：aicenter@g.yzu.edu.tw，並同時副本至：
t_brain@trendmicro.com 與 moe.ai.ncu@gmail.com。缺一不可。