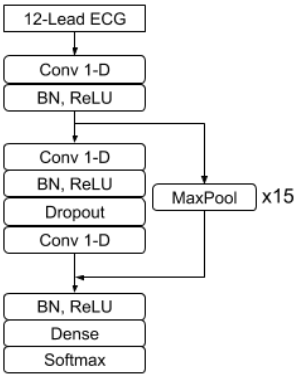
Automatic Concurrent Arrhythmia Classification using Deep Residual Neural Networks

Deepankar Nankani, Pallabi Saikia, Rashmi Dutta Baruah
Indian Institute of Technology Guwahati
Guwahati, Assam, India

Introduction: Early diagnosis of concurrent cardiac arrhythmias helps in a timely treatment to reduce the mortality rate. The standard 12-lead electrocardiogram (ECG) interpretation is performed over the ECG signals by expert cardiologists to detect concurrent arrhythmias.

Method: We developed a Deep Residual Neural Network (ResNet) that includes Batch Normalization, Dropout, Convolution, Max Pooling, and Fully connected layer. Our model consists of fifteen layers. We also tried using a ten layer convolution neural network (CNN) but the ResNet provided better results on both the training and testing data. We divided the signals into the segments of six seconds each. Segmentation was performed for two reasons, firstly, the neural network ingests a constant sized input, and secondly, the minimum ECG duration present in the dataset was 6 seconds.



ResNet Architecture

Result: The fifteen layer ResNet model produced an F_β score of 0.628 and a G_β score of 0.426 on the testing data, where F_β assigns more weight to recall than precision and G_β, the Jaccard measure, provides missed diagnoses twice as much weight as correct diagnoses. The results on training data are provided in Table 1. The reduction on F_β score and Jaccard measure on the testing data might be due to the overfitting of the model.

Table 1. Results on Training Data

	AUROC	AUPRC	Accuracy	F1	F_β	G_β
CNN	0.5	0.119	0.831	0.045	0.07	0.028
ResNet	0.701	0.674	0.994	0.961	0.942	0.872

Conclusion: ResNet significantly improves the generalization ability of the model and improves the performance of the model on different evaluation metrics. The reason might be the presence of residual connections that allow the gradient of last layers to backpropagate to the initial layers so that they are able to learn the data distribution by mitigating the problem of vanishing and exploding gradient.