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From Waves to Wisdom: Leveraging Transformers and CNNs for ECG Signal Classification

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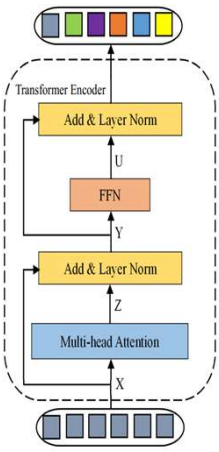
INTRODUCTION & AIM

Diagnosing heart disease is a complex and critical task that requires extracting meaningful patterns from large electrocardiogram (ECG) datasets. As the demand for faster and more reliable diagnostic tools increases, deep learning has emerged as a transformative solution, enabling automated ECG interpretation and reducing the risk of human error. However, traditional models often face challenges such as high computational complexity and limited adaptability to the dynamic nature of ECG signals.

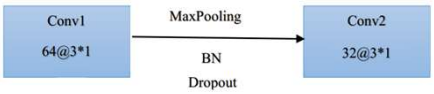
In this study, we investigate the potential of transformer-based architectures to overcome these limitations and enhance classification performance.

METHOD

Transformer encoder



CNN layer

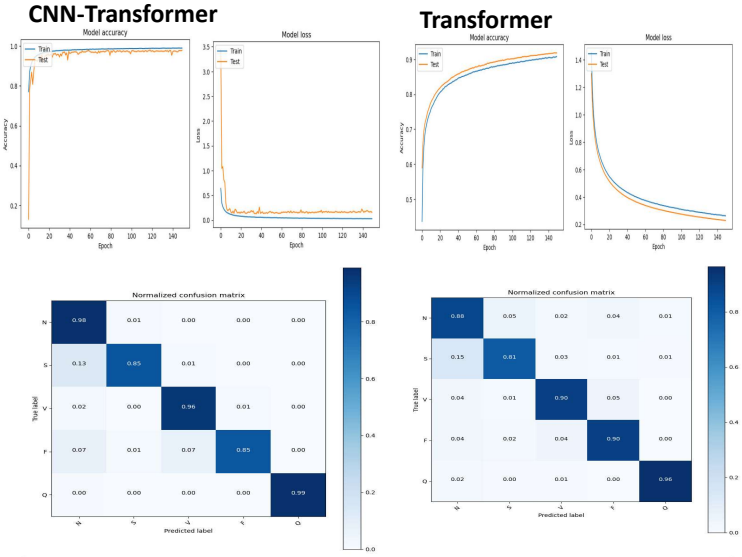


Experimental parameters setting

	Transformer-encoder	CNN-Transformer encoder
Epochs	150	200
Batch-size	1000	1000
Num_head	2	2
Head_size	32	32
Ff_dim	2	2
transformer_bloks	1	1
MLP_units	200	128
Dropout	0.2	0.2
MLP_Dropout	0.4	0.4

RESULTS & DISCUSSION

CNN-Transformer **Transformer**



Methods	Normal	Q	V	S	F	Overall (Acc)
Transformer-encoder	Pre: 0.99 Re: 0.88 F1: 0.93	Pre: 0.32 Re: 0.81 F1: 0.46	Pre: 0.77 Re: 0.90 F1: 0.83	Pre: 0.16 Re: 0.90 F1: 0.27	Pre: 0.87 Re: 0.96 F1: 0.91	**0.89**
CNN-transformer encoder	Pre: 0.99 Re: 0.98 F1: 0.99	Pre: 0.74 Re: 0.85 F1: 0.79	Pre: 0.94 Re: 0.96 F1: 0.95	Pre: 0.75 Re: 0.85 F1: 0.79	Pre: 0.98 Re: 0.99 F1: 0.98	**0.98**

The findings demonstrate that the model not only successfully captures useful features from the training data but also effectively extracts these same hidden features from the unknown test data, enabling accurate classification. These results provide strong evidence supporting the generalizability of the proposed algorithm.

CONCLUSION

We can observe that the results obtained in our study are promising, although they may not surpass the state-of-the-art performance achieved by other works in literature. However, it is worth noting that our model is relatively simpler, consisting of only one transformer block and two layers of CNN. In summary, while our current results show promise, we recognize the need to further explore different datasets and combinations of deep learning techniques to improve the performance of our model and achieve state-of-the-art results in ECG classification.