

Deep Learning Classification of Connexin-43 Distribution Patterns in Rodent Ventricular Tissue

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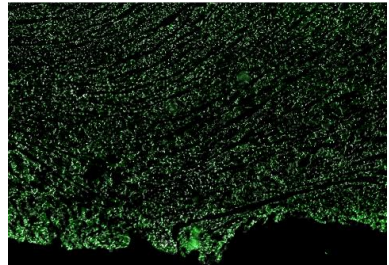
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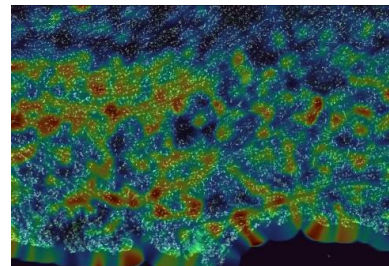
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Connexin-43 (CX43) lateralization in ventricular myocardium is associated with abnormal impulse propagation and arrhythmia susceptibility. Quantitative assessment of CX43 distribution from histological sections has been limited by the difficulty of segmenting individual cardiomyocytes and the reliance of existing methods on geometric rules applied to segmented cell profiles. This study presents a deep learning framework that classifies CX43-positive regions as terminal or lateralized directly from fluorescence images, without requiring cardiomyocyte segmentation.



An expert-annotated dataset was generated from left-ventricular cryosections of Wistar rat hearts, in which each CX43-positive region was labeled according to its distribution pattern (terminal/lateralized). A dual-stream convolutional classifier based on EfficientNetV2-S was trained to capture both local and contextual morphology of each region, processing two concentric image crops with a shared backbone. An inference module was developed to automatically detect and classify regions across whole tissue sections, generating spatial probability maps and a global percent lateralization estimate. The annotated dataset and complete codebase were made publicly available.

On the held-out test set, comprising CX43-positive regions extracted from two previously unseen tissue sections, the classifier reached a ROC-AUC of 0.904 and a PR-AUC of 0.808. In addition, the developed inference module was successfully applied to whole tissue sections, producing stable global lateralization estimates and spatial probability maps consistent with the per-region predictions.



The proposed framework achieved satisfactory classification performance on the evaluated dataset, suggesting that automated assessment of CX43 distribution patterns without explicit cardiomyocyte segmentation is feasible.