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# EchoVisuAL v1.16: An automated high-precision analysis workflow for mouse echocardiograms in preclinical cardiovascular research

Mice are a key model in cardiovascular research, yet manual analysis of only two consecutive heartbeats remains the standard for physiological assessment. This minimal approach may not fully reflect the complexities of cardiac function. AI-based analysis of M-Mode echocardiography is advancing; however, animal-specific algorithms remain rare and lack the ability to extract reliable cardiac parameters across complete recordings, which are essential for time-resolved functional assessment.

EchoVisuAL v1.16 is an automated, end-to-end analysis workflow that addresses this need by utilizing a heterogeneous dataset of 90973 echocardiograms from 18498 C57BL/6N mice provided by the International Mouse Phenotyping Consortium (IMPC). The architecture of EchoVisuAL v1.16 is founded on three core components: 1. segmentation of the left ventricular border using a Bayesian U-Net (Dice score: $0.97 \pm 0.02$), 2. estimation of key functional parameters, such as ejection fraction or cardiac output, alongside confidence metrics, and 3. metrics-based selection of high-quality segments for downstream analysis.

By automating segmentation, parameter estimation and downstream analysis, EchoVisuAL ensures consistent interpretation of echocardiographic data and enhances reproducibility across laboratories by standardizing analysis across diverse experimental settings. Independent expert validation has confirmed the high reliability of the segmentations (Randolph's kappa: $0.91 \pm 0.10$), supporting robust diagnostics and scalable cardiovascular research.

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