Image-based analysis of the photoplethysmography signal for biological sex classification

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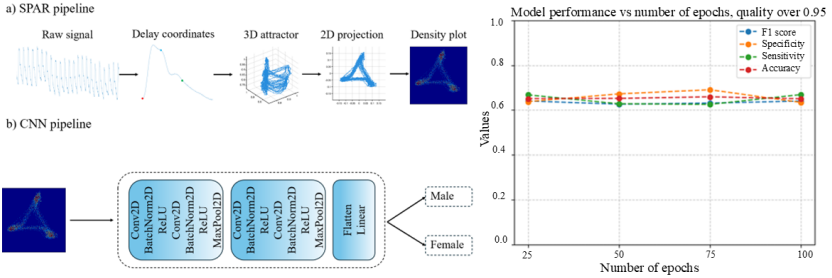
Introduction The development and application of data-driven models require careful assessment of potential sources of bias. While sex-related differences in the electrocardiogram (ECG) signals are well documented, those in photoplethysmography (PPG) remain less explored. This study examines whether a simple Convolutional Neural Network (CNN) captures sex-related features in Symmetric Projection Attractor Reconstruction (SPAR) images derived from PPG signals.

Methods The Aurora-BP dataset, which is balanced for sex, was selected for analysis. Data was stratified by "optical quality" (0.65, 0.75, 0.85, 0.95) and filtered prior to analysis. Each PPG recording was used to generate an image with the SPAR method, a novel method that quantifies pulse waveform morphology and variability. Images were given as input to the CNN for binary classification. The four quality thresholds and four training durations (25, 50, 75, 100 epochs) were tested to evaluate performance relative to data quality and training time. Accuracy, F1 score, sensitivity, and specificity were used for assessment.



Results Reasonable classification performance of around 70 % was observed for all settings considered, although model performance proved to be more constant when only high quality data (over 0.95) was considered. An increase in training time generally corresponded to an increase in model performance regardless of quality threshold.

Conclusion These findings indicate that biological sex may influence PPG-based AI model training and should be considered during dataset selection and model evaluation.