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A Time-Adaptive Ensemble Learning Algorithm for Detecting Arteriovenous Fistula Occlusion in Hemodialysis Patients

Wen-Hsien Ho[1], Yi-Wen Chiu[2,3], Yu-Jui Lien[1], Yen-Ming J. Chen[4], Jinn-Tsong Tsai[5] and Jyh-Horng Chou[6]

[1]Department of Healthcare Administration and Medical Informatics, Kaohsiung Medical University, Taiwan

[2]Division of Nephrology, Department of Internal Medicine, Kaohsiung Medical University Hospital, Kaohsiung Medical University, Taiwan

[3]The Master Program of AI Application in Health Industry, Kaohsiung Medical University, Taiwan

[4]Department of Information Management, National Kaohsiung University of Science and Technology, Taiwan

[5]Department of Computer Science and Artificial Intelligence, National Pingtung University, Taiwan

[6]Department of Mechanical and Computer-Aided Engineering, Feng-Chia University, Taiwan

Arteriovenous fistula obstruction is a common problem encountered by kidney dialysis patients. Currently, the assessment of Arteriovenous fistulaobstruction in clinical practice relies primarily on physical examination methods such as auscultation and palpation, which have limited accuracy due to their reliance on empirical observations. The objective of this study is to propose a self-made audio device and validate its feasibility using machine learning classification models and deep learning classification models. The study aims to train machine learning regression models and a proposed time-adaptive ensemble learning model using audio data collected during two instances of percutaneous transluminal angioplasty (PTA) procedures. The goal is to find the most suitable machine learning regression model to assist physicians in determining the degree of Arteriovenous fistulaobstruction. Among the machine learning regression models, the performance of the signal features was superior to that of acoustic features in the weak learners. Therefore, subsequent regression models were trained using signal features. Among the nine machine learning regression models, the time-adaptive ensemble learning model with the highest model interpretability (R-squared, R2) achieved R2 values above 0.85 for all three cases in the test set. This level of interpretability is trustworthy and can be utilized in clinical settings.

Key words: hemodialysis, arteriovenous fistula, acoustic feature analysis, time-adaptive ensemble learning algorithm

Figure 1: Position mark

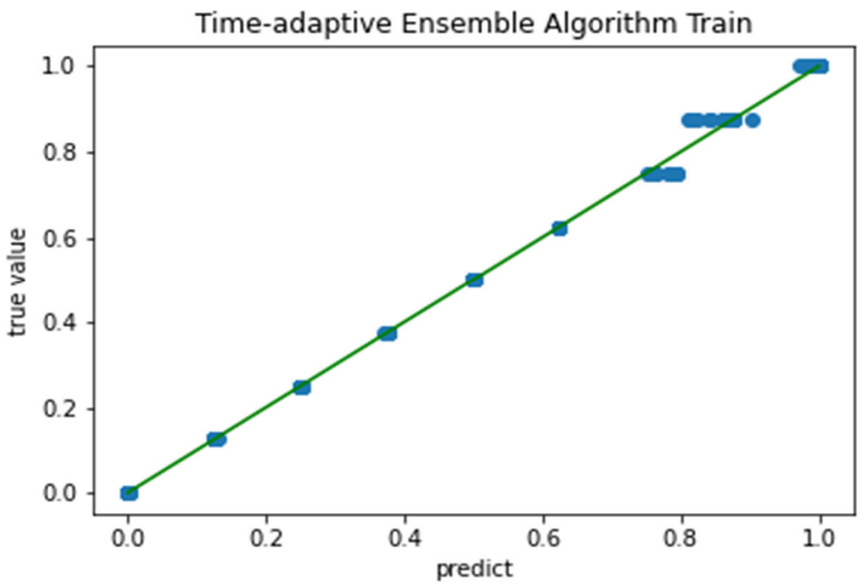

Figure 2: Training result for the proposed algorithm

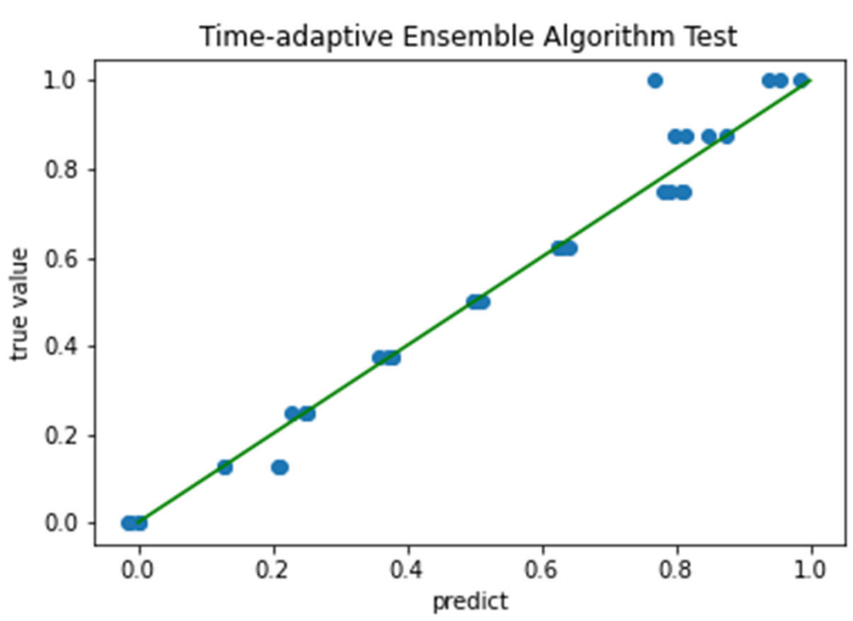

Figure 3: Testing result for the proposed algorithm