The Potential of Artificial Intelligence in Detecting Cognitive Load

Abstract:

Recognizing and effectively managing cognitive load plays a pivotal role in optimizing learning and working environments, ensuring appropriate workload allocation tailored to individual capabilities. This study investigates the potential of artificial intelligence (AI) in detecting cognitive load by analyzing individuals' pupil responses. A total of 58 volunteer subjects participated in four distinct tasks: DPT, MA, PVT, and VWM. The study employed five training iterations, with the initial four focused on individual task training and the final iteration involving training on all four tasks collectively. The problem was framed as a binary classification task, with samples collected after the onset of cognitive load. The first sample following the onset was labeled as "1," indicating high cognitive load, while subsequent samples were labeled as "0," representing lower load levels. All samples have 1 second interval. The objective was to develop an AI model capable of accurately predicting high cognitive load. A Convolutional Neural Network (CNN) architecture was employed as the model for training the tasks, and the model's performance was evaluated using the F1 score metric. Among the individual tasks, the DPT task demonstrated the highest F1 score of 0.87, followed by the MA task with a score of 0.70, and the PVT task with a score of 0.66. The VWM task exhibited the lowest performance, yielding an F1 score of 0.38, slightly better than random guessing but falling short of reliable predictive capability. When training all four tasks together, the model achieved an F1 score of 0.54, indicating limited generalization ability. Although the model underperformed compared to the individual DPT, MA, and PVT tasks, it displayed promising results beyond random guessing. These preliminary findings underscore the potential of AI in detecting cognitive load and lay the foundation for further advancements in this domain. Refining AI models to attain a reliable level of accuracy holds immense potential for applications such as personalized learning. AI-based systems that detect cognitive load can continuously monitor and analyze individuals' cognitive load levels, enabling the adaptation of educational materials in terms of content, pace, and difficulty. This personalized approach enhances knowledge retention, engagement, and overall learning efficiency. By harnessing the capabilities of AI, optimizing learning experiences becomes a viable avenue for improving educational outcomes and facilitating individual growth.