Adaptive Behavioral Biometrics in Evolving Environments

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KEYWORDS	ABSTRACT
Concept Drift, Data Stream Mining, Behavioral Biometrics, Extreme Verification Latency.	Behavioral biometrics, particularly keystroke dynamics, offer a promising layer of continuous and user-specific authentication to enhance conventional password-based security systems. However, real-world deployments face significant challenges due to the evolving nature of user behavior and the presence of unlabeled, high-velocity data streams. Traditional data stream mining approaches fall short, as they often rely on static, labelled, and balanced datasets. Moreover, Extreme Verification Latency (EVL) the delay between prediction and ground-truth feedback—further limits the adaptability of models in dynamic environments. To address these challenges, this paper proposes an adaptive learning framework for keystroke-based behavioral biometrics that leverages online semi-supervised learning, concept drift detection, and progressive model updates without requiring continuous labelled data. The framework dynamically adapts to changes in user behavior over time while maintaining real-time responsiveness and robustness against spoofing attempts. Experimental results demonstrate that our solution significantly improves authentication accuracy and resilience in evolving, latency-prone environments, offering a viable pathway for next-generation secure password systems.
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