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Title: Data-driven approach based on hidden Markov model for detecting the status of bikes in Bike-Sharing systems

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Abstract: Detecting unusable bikes remains a significant challenge within the supply chain of bike-sharing systems (BSS). While bad riding experiences negatively affect users' satisfaction, uncollected broken bikes harm the environment. Although some studies have addressed the issue of detecting unusable bikes, the methods used have specific assumptions (or limitations) that make them inapplicable in some other cases. This is the first study to apply the Hidden Markov Model (HMM) in detecting the bikes' status. The applied method tracks the gradual changes in bike status and takes into account that the maintenance process could improve the status of the bike. The proposed method demonstrated its ability to detect the hidden state of bikes in both dock-less and station-based BSSs, where it predicted the status of more than 94% of the bikes and detected most of the unusable bikes in a timely manner. The study also analyzed the relationship between trip features (speed, distance, and waiting duration) and the status of bikes and offered a better understanding of users' behavior toward unusable bikes. Based on the quantitative results, this research proposed a paradigm for improving user-company communication. Finally, the study recommends using HMM as an explainable AI model for detecting the hidden status of bikes.

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