Mining Observation and Cognitive Behavior Process Patterns of Bridge Inspectors

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ABSTRACT

In bridge inspection, engineers should diagnose the observed bridge defects by identifying factors underlying those defects. Traditionally, engineers search and organize structural condition-related information based on visual inspections and multiple data sources. Even following the same qualitative inspection standards, experienced engineers tend to find the critical defects and predict the underlying reasons more reliably than less experienced ones. Unique bridge and site conditions, quality of available data, and personal skills and knowledge collectively influence such a "subjective" nature of data-driven bridge diagnosis. Unfortunately, the lack of detailed data about how experienced engineers observe bridge defects and identify failure modes from multi-source data makes it hard to comprehend what engineers' behaviors form the best practice of producing reliable bridge inspection. Besides, even experienced engineers could sometimes fail in noticing critical defects, thereby producing inconsistent, conflicting condition assessments and biased maintenance plans. Therefore, detailed cognitive behavior analysis of bridge inspectors is critical for enabling a proactive inspector coaching system that uses many inspectors' behavior histories to complement personal limitations. This paper presents a computational framework for revealing engineers' observation and cognitive-behavioral processes to identify bridge defects and produce diagnosis conclusions based on observed defects. The authors designed a bridge inspection game consisting of FEM simulation data (stress and displacements) and inspection reports (basic bridge information and possible defect types) to capture and analyze experienced and inexperienced engineers' diagnosis behaviors. Mining these behavioral logs have revealed reusable behavioral process patterns that map critical bridge defects and diagnosis conclusions. The results indicate that the proposed method can proactively share inspection experiences and improve inspection processes' explainability and reliability.