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Statistical Travel Time Inference Under Incomplete Data: A Queueing-Theoretic Approach

Travel time reliability (TTR) is an important issue in transportation systems, significantly influencing individual decision-making and aggregate travel demand. The inherent uncertainty in travel time is crucial for various applications, which requires the estimation of entire travel time distribution instead of merely the expected travel time. This work proposes a statistical framework for estimating travel time distributions using the Mt/G/∞ queueing model, specifically tailored for scenarios where only interval-censored data are available. A comprehensive joint likelihood function is derived for incomplete data that considers the observed arrival counts and departure counts within each time interval. The model assumes a log-normal distribution for travel times, which effectively captures the characteristic right-skewness and non-negativity of empirical traffic data. The performance of the proposed framework is validated using the NGSIM US101 dataset, a high-fidelity trajectory database from a southbound freeway segment in Los Angeles. Our results demonstrate that the Queueing-Theoretic method can estimate the travel time distribution effectively for incomplete datasets. The findings suggest that the proposed methodology offers a powerful, cost-effective approach for estimating travel time distributions.
Similar approach could be applied for the recovery time inference as well, when the transportation systems operation is interrupted by natural disasters, traffic accidents, or failure of critical equipment, which would be helpful to assess the resilience of the transportation systems.

Special/ Invited session

Classification

Both methodology and application

Keywords

Travel Time Reliability; Mt/G/∞ Queue; Interval-censored Data.

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