

A stochastic approach to model traffic in a road network

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Traffic congestion in the urban areas has become an unremitting problem faced by city planners. This phenomenon could result in adverse situations such as excessive fuel consumption, escalation in vehicle operating costs, time waste etc. Thus, it emphasizes the need for an efficient solution for the traffic scenario. Traffic scenarios have been extensively studied under diverse methodologies to predict when and where the traffic would appear. Stochastic methods such as Markov chains and Monte Carlo simulation produced fruitful results and are proven to be highly effective in terms of predictions along a segment of highway, freeway etc. However, a major drawback of these methods is the lack of feasibility when applied to the road networks in its entirety, due to the high complexity. This study attempted to introduce a new concept based on Markov models to overcome these drawbacks by mainly focusing on striking a balance between the route capacity and total surface area of vehicles of different vehicle types (motorcycles, cars, three-wheelers, buses and heavy vehicles). A road system with multiple junctions and lanes was considered and represented in matrix form. A separate matrix was assigned to each vehicle type to record the counts of each vehicle type that enters a road segment within short intervals of time. Thereafter, the total surface area of vehicles occupying each road segment was expressed as a proportion of road capacity. By repeating these steps several times on a given day, the traffic state transition for the given segment was estimated. Given the state of traffic for a road segment, these transition matrices can be used to identify the converging traffic state in the future. A road network with 7 junctions having 10 connecting two-way road segments was considered for the simulation study. For each vehicle type, the flow of traffic was assumed to follow a Poisson distribution with varying rates. Results showed that the proposed method worked as expected for different initial conditions of the traffic flow. Future studies would extend the proposed method by considering other criteria such as vehicles parked on either sides of the roadway, vehicle speed and weather conditions.