Chapter 17
Comparing Conventional Methods With Fuzzy Logic for Quantifying Road Congestion: Evidence From Central Kolkata, India

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ABSTRACT

Congestion, in India, is generally defined using volume-capacity (V/C) ratio. The passenger car unit (PCU) measures the volume, and capacity here is subjective. In such circumstances, volume and capacity cannot be directly measured. Hence, the determination of the actual capacity of any road remains debatable. As a result, the measure of the degree of congestion becomes subjective. This paper discusses conventional techniques for quantifying congestion and describes congestion using fuzzy tools and techniques. This paper uses two input variables that give direct and precise measures such as speed and inter vehicular distance (IVD) in the fuzzy model and volume and capacity as two input parameters for conventional methods. The congestions were calculated using conventional and fuzzy techniques on the roads of Central Kolkata and compared those quantified congestions on each road to find out the more reliable techniques among themselves.

INTRODUCTION

Transportation planning is a wide human-oriented field with diverse and challenging problems waiting to be solved. Characteristics and performances of transport systems – services, costs, infrastructures,

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vehicles, and control systems are usually defined based on a quantitative evaluation of their main effects (Sarkar et al., 2012; Kapadia et al., 2022). Globally traffic scenario has experienced a vast change over the years as traffic volumes on urban roads have increased by leaps and bounds (Sarkar and Sarkar, 2020). One of the most undesirable consequences of urbanization is traffic congestion. With the increased urbanization, especially in third-world countries, traffic congestion has become a significant issue for commuters in the everyday world. The affected seems to have submitted to the ever-increasing problems of Congestion hence making the magnitude of the consequences grow to an unmanageable extent. Traffic congestion is a global phenomenon predicted to worsen in the future (Jain et al., 2010; Kiunsi, 2023). Various authors have described Congestion in the different scientific spectrum. Usually, it is the consequence when the number of vehicles occupying a road space exceeds its carry capacity, leading to unintended and unplanned waste of time, energy, and resources. Humanity faces the loss of work opportunities, environmental degradation, time, fuel, mental health, and social commitments and submits them to high congestion pricing (Remi et al., 2009; Mahmud et al., 2012). In the ever-increasing urbanized world, commuters often sacrifice to the venom of Congestion resulting from avoidable additional vehicles, causing delays to other vehicles that lead to a slower and less productive journey. Traffic congestion is a non-linear function (Sinha et al., 2022; Sinha et al., 2018). There are different ways to classify and predict Congestion on the road. One of the most emerging fields is the Machine Learning Approach, which can be applied to classify and predict Congestion on the road.

MACHINE LEARNING APPROACH

Machine learning techniques are divided into four branches:

- **Supervised Learning:** It works on the set of unlabeled data. The various algorithms like Artificial Neural Networks (ANN), K-Means, and Bayesian Belief Networks (BBN) are working on the supervised learning technique. These algorithms are used to train the standard data, and while adjusting the parameters, the data classification is performed.
- **Unsupervised Learning:** The unsupervised learning method characterizes the data structure. It is not dependent on previously labeled data. An algorithm like clustering and outlier detection works well in unsupervised machine learning techniques (Sinha et al., 2019).
- **Semi-Supervised Learning:** Semi-Supervised learning technique is a mixture of supervised and unsupervised learning methodology. The training process required both labeled and unlabeled datasets (Sinha et al., 2016).
- **Self-Training Learning:** Self-Training is also a kind of self-machine learning technique, where the wrapper algorithm will use for both self-labeling and decision-directed learning. In starting, the unlabeled data is labeled based on the model. The unlabeled points are labeled and retrain the occurrences that a new model is learned. This process is repeated for the entire dataset until the model accuracy is not achieved (Sinha et al., 2021).

The machine learning technique consists of different types of classifiers. This technique is generally used for the classification of data.