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Contents

Abstract

Public bus transport is a key component of modern urban mobility. Society and the environment benefit from the reduced congestion, pollution, and energy consumption in cities. However, bus transport systems are complex and require careful planning and management to ensure their efficiency and sustainability. Moreover, if provided services are sub-optimal, people tend to abandon the public transport and return to more individual mobility measures. This paper presents a review of ideas on how to improve the efficiency of bus dispatching and scheduling by employing deep learning models.

1 Introduction

Transport is the key enabler of economic growth and social development of countries around the World. European Union (EU) is one of the most developed regions in the World, and it is a good example on how the development of logistics improves quality of life.

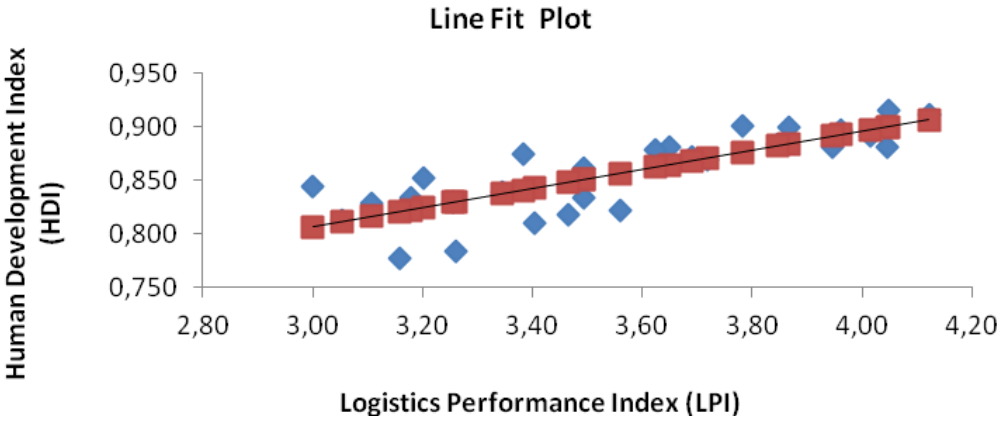

Figure 1. The correlation between the Logistics Performance Index (LPI) and the Human Development[1]

As shown in in figure 1 the relationship between European Union country logistics performance and quality of life is strong. However, transportation is also a net emmiter of CO_2 in EU. According to the European Environment Agency (EEA) report domestic transport is responsible for 29.17% of total CO_2 emissions in 2022[2]. And yet the trend of domestic transport utilisation is still increasing.This is a clear indicator that transportation is sub-optimal and requires improvements in order to reduce the impact on environment.

Public transport is seen a solution on how to tackle the problem of increasing CO_2 emissions. Efficient and reliable public transport systems can reduce the number of cars used, thus reducing the load on public roads and mitigating unnecessary accident risks. However, to acheive that it there are some dificult challenges that need to be addressed. SOme of the most important aspects that keep people in their car are: unreliable schedules, long waiting times, inconvenient routes, high ticket prices, overloaded buses

In the scope of this research some of the most important hurdles for public transport will be addressed. The main focus of this paper will be put on increasing the efficiency of bus dispatching and scheduling. By optimising the route and schedule, the number of buses utilised in the fleet can be reduced and the size of bus sent on route can be adjusted to the number of passengers expected. By doing so, the costs of operations should decrease thus, making public transportation services more affordable and attractive to the society.

To optimise the dispatching and scheduling neural network models will be used. The models will be trained on historical data on sales of tickets in bus stops. The developed model will be used to predict the number of passengers in bus stops in the future. The decision on the size of the bus to dispatch and stations to include in the route will be made by the dispatcher, but with real time advice from the neural network model.

2 Related work overview

The technologies for aggregating passenger flow data have had significant advancements in the last decade. With the development of the Internet of Things (IoT) devices, Intelligent Transport Systems (ITS) have become widely available for public transportation fleet operators. Smart ticket composters, GPS tracking devices, automated passenger counters (APC) and data transmission technologies such as 5G networks became common with monitoring and managing public transport. The collected data can be used not only for tracking Key Performance Indicators (KPIs), but also to model passenger flow and predict future demand.

The passenger flow prediction could be divided in terms of prediction time scale: short-term forecasting (minutes to hours), medium-term forecasting (hours to days) and long-term (months, seasons of the year). For short term passenger flow forecasting, short term traffic flow forecasts have an effect. Moreover, short term flow prediction could be divided in parametric and non-parametric models. Parametric models

Parametric models is the standard approach for short-term flow forecasting. Models such as Seasonal Autoregresive Integrated Moving Average (SARIMA) and Autoregressive Integrated Moving Average (ARIMA) have been used to predict demands for fleet[3]. These models are well suited for time series predictions and widely used in the field of transportation management. However, due to linear nature of these models, they are not well suited to capture the non-linear patterns in the data.

Non-parametric approach such as Long Short-Term Memory (LSTM) reccurent neural networks (RNN) have been used to predict passenger flow[4]. However RNN models have a flaw of vanishing gradient problem, which makes it difficult to train the model for long sequences of data. To overcome this problem, LSTM models were introduced. LSTM models have a memory cell that can store information for long periods of time.

References

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