Literature Review

Prediction and Control of Traffic Jams
In City of Windsor

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INTRODUCTION

In current times, there is an increase in demand for mobility and transportation means which has led to an increase in traffic and the possibility of jams in the rush hours. So, it has become necessary to develop tools and technologies that can deal with traffic and transportation problems, including traffic control, optimal use of existing road networks, efficient handling of signals at intersections, and so on. Now more than ever, we need interdisciplinary approaches to find a good solution.

As a solution to this problem, we propose simulating an agent-based system that will take three types of Agents into consideration: Location specific (location of vehicle on the road), Vehicle specific (speed of vehicle, type of vehicle, etc.), and Driver specific (Perception, style of driving, etc.). Special rules for all the different agents will be defined based on which the model will make the predictions on the flow of traffic. Apart from that, the conditions at the intersection, i.e. traffic lights, will also be taken into consideration.

RELATED WORKS

A. *Hierarchical Agent-Based Modeling for Improved Traffic Routing* [1]
   It has been proposed to provide an integrated platform for modelling a wide range of real-world traffic challenges. The challenge of achieving system-optimal traffic flow has been solved. The minimization of total vehicle travel time in a network by affecting traffic allocation over open roads in a network is one feasible criterion for evaluating our approach. When a large number of cars are participating at the same time, it is difficult to direct specific vehicles to specified lanes in real time to minimise congestion or traffic jams. Using principles of static and dynamic floor fields, the proposed model was developed for mass traffic congestion scenarios.

B. *Multi-agent model predictive control of signaling split in urban traffic networks* [2]
   For signalling split, the TUC method employs a feedback control law, in which a static feedback matrix is generated off-line using the LQR methodology and a quadratic programme is solved on-line to determine split feasibility. Model predictive control, on the other hand, uses a finite-time rolling horizon and solves optimization problems on-line to address constraints in a systematic way. This research presented a deconstruction of the MPC issue into a collection of locally connected sub-problems that are iteratively solved by a network of distributed agents to cope with huge networks and allow distributed reconfiguration

C. *Tourism, transport, and land use: a dynamic impact assessment for Kaohsiung's Asia New Bay Area* [3]
   This paper describes a hybrid method for analyzing relations between public transports, tourism and land use. The agent-based model combines the information from System Dynamics (SD) and Geographical Information Systems (GIS) to analyze these relations. The model was developed to evaluate the quantitative and spatial effect of the two phase LRT (Light Rain Transit) Development. The paper has further explored stock-flow model of ABM for interactive spatial information. The simulation results from the model determined that the second phase of LRT development will increase the tourism significantly by alleviating the problem of road traffic congestion. This model is developed

to help the policymakers decide the strategies for future LRT developments and its impact on the traffic conditions in general.

D. *The impact of different obstacles on crowd dynamics* [4]

When a person encounters obstacle in his path, they make adjustments in their path and movement to avoid it. Based on this fact, we can say that presence of an obstacle changes/affects the movement of an individual. This paper discusses how different types and shapes of obstacles affect the movements of pedestrians. For this study, four different crowd dynamics are taken into consideration: unidirectional, bi-directional, intersecting, and merging. Also, the three shape areas studied: Straight corridor, T-junction, and an Intersection. Apart from this, various combinations and columns of barriers are taken into consideration. To simulate the pedestrian movement, we have used the PULSE simulator. In the research, it is determined that we can enhance the pedestrian flow by using line barriers, a column, and sometimes by narrowing space of movement of the pathways. It is also concluded that we can decrease the pedestrian velocity by using zig-zag barriers. This model provides insight on installations of barriers to regulate proper pedestrian flow in an environment of mass gatherings.

E. *Optimal design of low computational burden model predictive control based on SSDA towards autonomous vehicle under vision dynamics* [5]

In the development of self-driving intelligent vehicles, the main issue that we encounter is predicting the steering angle of the vehicle. The Model Predictive Control (MPC) strategy is devoted to provide control of steering to the AVs. However, developing a simple model of MPC with few parameters that can accurately predict the angle is a difficult problem to resolve. This paper describes the approach to resolve this issue. This is done by applying hybrid solution between discrete-time Laguerre Function (DTLF) and MPC. This method takes fewer parameters but it is important to fine-tune this model to appropriate accurate results. This can be done using Social Ski Driver Algorithm.

F. *Incorporating individual preference and network influence on choice behavior of electric vehicle sharing using agent-based model* [6]

The concept of Electric Vehicle Sharing (EVS) is fairly new in today's time and has not yet gained as much popularity even though the benefits of the strategy are many. This paper describes an agent-based model that is developed to evaluate EVS choice behavior diffusion which determines an individual's willingness to adopt new innovations. It is done based on the social network influence and consumer's choice behaviour. The final evaluation of the model determines that although the choice behaviour spreads faster in the worker group, the final choice proportion is higher in the student group. This model is helpful to the government in determining and developing strategies to promote the use of EVS to reduce the traffic congestion issues.

G. *Grey models for short-term queue length predictions for adaptive traffic signal control* [7]

This paper discusses the Adaptive Signal Control System (ASCS) strategies applied in real-time to reduce the wait time at signaled intersections and reduce the congestion at those points. Such technology greatly increases the travel-time reliability, especially in the urban areas where traffic is a common issue. This is done by predicting the queue length based on the timings and signal phasings. The accuracy of the queue length prediction model

varies based on various factors like the arrival time of vehicles, driver characteristics, vehicle arrival rates, time of the day, and so on. Thus, the objective of this study is to develop a short-term queue prediction model and this is done by implementing variations of Grey systems. This is because Gray models do not require a large amount of data to make predictions like statistical models and they have fast processing speed. Based on the final evaluation, it was determined that Grey models perform better than LSTM and NN models in this case.

H. *Regional flow control in peak travel period based on fuzzy algorithm* [8]

This paper describes the issue of not having efficient models tat can accurately output the state of traffic lights at multiple moments, which leads to congestion at the intersections during peak traffic hours. So they have proposed a method based on fuzzy logic that can be used for regional flow control. Following are the steps performed: multi-scale prediction model to predict the flow of traffic, two-level fuzzy controller for regional coordination, traffic flow information between adjacent intersections as well as the predicted wait time at each intersection, Green light phase output to adjust the traffic flow managed by the controller, and finally, the regional coordinated flow control was realized. The simulation results show significant reduction in the waiting time at signaled intersections.

I. *Exploring the behavior of self-organized queuing for pedestrian flow through a non-service bottleneck* [9]

When it comes to pedestrian traffic flow, it is necessary to regulate the crowd flow, and for that purpose, how the others queue and the level of social order are vital concerns. This paper describes an agent-based cellular automata that allows the agents to perceive and act on the order of social environment. The results of the simulation show that it is not favorable to have crowds in a high-ordered environment due to the unfairness of queueing process as well as the extreme decrease I speed of pedestrians due to the whole process. Instead, a moderately ordered environment is better to alleviate the local jams and enhance the outflow rate at the exits. The simulation is also able to generate flow-density, flow-velocity relationships as well as time varied perceptions of the group order.

J. *BIM-based traffic analysis and simulation at road intersection design* [10]

This paper deals with the road intersection traffic analysis. Analysing traffic at intersections plays a vital role in project design and planning phases by providing important insights on suitable traffic requirements and site characteristics. The Building Information Modeling (BIM) framework has been used for traffic simulation in this case study. The proposed framework has following five steps: i) BIM models and traffic information collection, ii) Model configuration, iii) simulation, analysis and calibration, iv) cost analysis and documentation, and v) comparisons and recommendations. The final results prove that the use of BIM simulation models improves the performance of traffic analysis. Some of the major advantages of this approach are better understanding of the design, improved project quality, efficient communication, scope clarification, and efficient design process.

K. *Using agent-based modelling for investigating modal shift: The case of university travel* [11]

This paper investigates the factors that affects an individual's choice of commutation and how we can simulate alternative modes of transport in current system. In the study, seven

themes were identified as metrics for the case: Journey time, Reliability, Cost and Value for Money, Security, Comfort, Convenience, and Personal Mobility. After evaluating surveyed data, they applied simulation over the said metrics using agent-based social simulation approach. The results of study help us understand how the decision factors and their interconnections influence the decisions of populations' choice of transportation, which in turn provides insight on what factors to concentrate on when making strategies for mode shift. The results state that strategies developed will work better when applied to a targeted group of travellers.

L. *An extended dynamic model for pedestrian traffic considering individual preference* [12]
Most vehicle traffic assignment methods cannot be utilized efficiently to tackle the dynamic pedestrian flow assignment problem due to the network's unique topology structure. Although some prior researches have been able to identify pedestrian dynamics, individual pedestrian preferences are rarely included. The cell transmission concept makes pedestrian evacuation simple to simulate (CTM). In addition, several decision field theory (DFT) ideas are introduced to illustrate various pedestrian preferences. Pedestrian route choices alter over time as people make decisions.

M. *A neural network approach for traffic prediction and routing with missing data imputation for intelligent transportation system* [13]
In traffic management, a reliable traffic rerouting system is essential, as is an accurate traffic simulation model. Missing data, on the other hand, continues to be an issue because it will undoubtedly lead to inaccuracies in anticipating congestion levels, resulting in less efficient rerouting. The absence of a realistic traffic simulation also stymies the development of a more effective traffic management system. As the world's population grows, so does the number of vehicles driven by that population. As the number of vehicles increases, traffic congestion increases, resulting in an increase in CO2 emissions. To cut vehicle travel time, a lot of effort has gone into figuring out how to predict traffic congestion and give drivers a more efficient path. Data is continuously acquired in real-time from multiple sources as ITS advances, resulting in a tremendous volume of data. When faced with such conditions, neural networks would face scaling issues. This study presents an online deep neural network that uses a sliding window technique to learn a specific period's worth of data in a small batch and adjust accordingly. As a result, the following are the paper's primary contributions: To achieve realistic traffic initialization, the traffic simulation is first modelled with a current traffic condition using data received from traffic APIs and benchmarked against Google Maps. Second, a pheromone-based, multifactor online deep neural network traffic congestion prediction system is developed, which uses a weighted average of current and past traffic data to accommodate missing data. The viability of the missing data processing approach would be determined using this traffic forecast system. The constructed traffic simulation is used to test the resulting rerouting system in three different scenarios: no rerouting, standard rerouting, and rerouting with missing data handling. When compared to Google Maps, the simulation's real-traffic situation model yields promising results, demonstrating that a more realistic traffic simulation may be achieved with a basic Traffic API. These figures are frequently inaccurate and do not adequately reflect current traffic. As a result, the proposed

technology would produce a more realistic traffic simulation that could be used in traffic studies or driving simulators, advancing the ITS sector. The online multi-factor deep neural network has demonstrated that it can work with little to no traffic data history, learning on-the-fly in small batches and using only traffic data collected from the simulation. The relevance of an advanced intelligent transportation system grows in tandem with the number of vehicles on the road (ITS). This necessitates more realistic traffic simulations to evaluate novel traffic control technologies that will reduce dangerous substance emissions from automobiles while also increasing public productivity by cutting travel time. Future study could add non-recurring situations such as events and accidents, as these cases were not considered when the simulation was created, and so the neural network's performance for such scenarios is unknown.

N. BIGSEA: A Big Data analytics platform for public transportation information [14]

EUBra-BIGSEA is a platform for constructing data analysis processes on top of elastic cloud services without requiring programming or cloud-related knowledge. The method combines cloud orchestration, Quality of Service, and automatic parallelisation on a platform that also includes a toolbox for implementing privacy guarantees and data quality enhancements, as well as advanced services like sentiment analysis, traffic jam estimation, and trip recommendation based on estimated crowdedness.

O. Hierarchical traffic signal optimization using reinforcement learning and traffic prediction with long-short term memory [15]

In vast traffic networks, hierarchical multi-agent systems can be employed to operate traffic signals. Because the agents in charge of network control have a local perspective, supplying more global information can help the system operate better. A hierarchical multi-agent system for traffic signal control is proposed in this study, with two different types of agents organised in two layers. To determine the best control policy, the agents at the first level use reinforcement learning. For traffic status prediction, the agents in the second level employ a deep neural network, which is also used to make decisions regarding joint actions for the agents in the first level

P. Simulating a transition to autonomous mobility [16]

When CC0, CC1, and CC2 are evaluated as 0.38, 0.45, and 2, respectively, an examination in the optimization of driving behaviours found that they can deliver the highest overall improvement in traffic quality. Changes to CC3-CC9 did not improve the optimum situation linked with CC0, CC1, and CC2; in fact, most of those parameters had negative consequences. Except for CC0, CC1, and CC2, the rest of the Wiedemann parameters analyzed in this study should not be changed. This conclusion is based on the optimization results. Among the rest three features, the impact of CC1 was found to be the highest.

CC0: Standstill Distance, **CC1:** Headway Time, **CC2:** "Following" Variation, **CC3:** The Threshold for entering "Following" phase, **CC4:** Negative "Following" Threshold, **CC5:** Positive "Following" Threshold, **CC6:** Speed Dependency of Oscillation, **CC7:** Oscillation Acceleration, **CC8:** Standstill Acceleration, **CC9:** Acceleration at 80 kmph

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Q. Time-dependent stochastic vehicle routing problem with random requests: Application to online police patrol management in Brussels [17]

As a practical modelling framework for the real-world problem of police unit management in Brussels, the SS-VRP-R was developed. We demonstrated how to reduce the projected

average response time using data from intervention requests from 2013 to 2016. Experiments are carried out with 2017's observations serving as a validation baseline. In comparison to a basic wait-and-serve policy in which the vehicles are never relocated, the first-stage solutions obtained under the SS-VRP-R framework cut average response times by more than 60% on average when combined with a simple recourse strategy. We also compared those solutions to nontrivial clustering-based rules.

R. *A review on agent-based technology for traffic and transportation* [18]

The quantity of articles devoted to agent-based technologies' applications in traffic and transportation engineering has exploded in recent years. As a result, it appears to be a suitable time to reflect on the accomplishments of the previous decade, as well as the questions that have been successfully handled as well as the challenges that remain challenging. We evaluate the literature in the domains of agent-based traffic modelling and simulation, as well as agent-based traffic control and management, in this study. Later, we'll talk about and outline the major accomplishments and challenges. The cross-fertilization of traffic, transportation, and artificial intelligence, which dates back to the 1980s and 1990s, has shown to be a beneficial experience. Because of the employment of agent technology, there has been considerable development in transportation and traffic engineering during the previous decade. In summary, given the geographical, functional, and temporal distribution of data and control, as well as the frequent and flexible interaction between participants and their environment, it is widely known that agent-based techniques are ideally suited to traffic and transportation management. As a result, agent-based techniques can help with the overall effort of designing and controlling intelligent transportation systems (ITS) and, in the end, making our cities really smart. One of the most compelling reasons for distributed artificial intelligence and multiagent systems is to manage interactions among autonomous entities with ever-increasing interdependencies. These are aimed at creating and analysing models drawn from social interactions in human civilizations, as well as applying them to computational systems to resolve disputes in various types of organisational structures. The underlying model conceptualization in agent-based simulation is autonomous agents and multiagent systems. A model is made up of interacting agents that are placed in a simulated environment. The modelling and regulation of traffic becomes increasingly challenging as societies and economies become more complex and interconnected. Traffic and transportation engineering now necessitates information technology and control engineering solutions. Technologies connected to autonomous agents and multiagent systems provide a significant contribution to the former. In the context of smart cities, these technologies are becoming more popular in a variety of traffic-related applications.

The purpose of this paper was to provide an overview of numerous publications that address cross-fertilization between the aforementioned topics. Modeling and simulation, as well as control and management, are the two key categories in which we have categorised the works we have studied. We concentrate on automotive traffic in these categories, leaving pedestrian and crowd simulation, public transit, air traffic management, maritime traffic simulation, and all logistics-related topics for future research. This is something we've decided to do in order to keep the focus on an already large area. We've

attempted to describe the fundamental principles, paradigms, and approaches. Following that, we talked over the accomplishments made thus far as well as the obstacles ahead. These issues affect not only computer science, information technology, and engineering subfields, but also ITS-related domains.

To address the majority of these issues, it appears self-evident that researchers from many fields of computer science, computer engineering, traffic and transportation engineering must collaborate and work in multidisciplinary teams.

S. *Identification of walking human model using agent-based modelling* [19]

Simulations on a computer help you to learn more about a subject. Make sense of astronomical observations by studying the interactions of physical particles. Offices, administrations, and bureaucracies are all used in today's world, financial trading, economic exchange, and financial control are all terms that are used to describe how money is exchanged. Infrastructural networks, and a significant portion of our workforce. Without the usage of technology, communication would be impossible. Computers are no longer used. We addressed the prospects of computer simulation and the features of agent-based modelling and multi-agent simulation with statistical analysis of data and data-driven efforts to disclose the prototype of transport traffic model (MAS). Because of its capacity to provide comprehensive insights into the social behaviours and interdependencies that characterise transportation systems, agent-based modelling has been largely acknowledged as a viable tool for urban planning. Agent-based modelling (ABM) allows dynamic objects like vehicles to be described separately and have control over their behaviour, which is useful for traffic simulation. In doing so, we investigated and presented a number of challenges related to agent-based simulation, as well as a method for doing them correctly from a scientific standpoint. The purpose of this paper is to discuss how traffic simulation can assist traffic engineers in reducing congestion. Its goal is to assist in the development of a one-of-a-kind traffic simulation system that may be used to research traffic theory, network infrastructure, and control adjustments. This research focuses on how traffic simulation can aid traffic engineers in reducing congestion, specifically through the usage of high occupancy vehicle (HOV) lanes. Congestion is a big issue, and it is only going to become worse as the number of traffic continues to rise.

There are a variety of strategies for alleviating traffic congestion, including the usage of HOV lanes, which are now being implemented on crowded highways. Every day, the economic significance of traffic management expands. Highway networks that are well-designed and well-managed lower the cost of delivering goods, minimize energy usage, and save countless person-hours of driving time. Many countries have invested considerably in road construction and traffic control systems in order to decrease traffic congestion. However, once a computer environment for social phenomena is built, the cost of research will be significantly lower than traditional research methodologies. Agent-based modelling, which allows dynamic objects like vehicles to be described independently and have control over their behaviour, can be used to implement traffic simulation. Congestion is a big issue in densely populated urban areas, especially in the morning and evening. Despite government attempts to improve road infrastructure and promote public vehicle transportation systems, the traffic density on the roadways will continue to increase

over time. Countries with excellent road infrastructure and the usage of navigators in every vehicle, such as South Korea, have significantly reduced traffic congestion. However, it is unreliable in densely populated nations such as India and China.

This is due to the high latency, satellite overload, and the cost of deployment, which may cause more harm than good. The goal of this work is to demonstrate that traffic simulation is a valuable tool for traffic engineers when analysing alternating systems, as well as to investigate the consequences of changes introduced through graphs. The goal of this project is to create a realistic traffic condition by simulating driver behaviour. These drivers engage with one another, and the traffic that results is an emergent outcome of those interactions. However, traffic is mimicked with only one lane in each direction and no traffic lights at intersections. This results in chaotic traffic, with traffic patterns determined by the aggregate behaviour of diverse agents rather than by traffic laws. The user can also set his own psychology and see himself as a part of the overall simulation.

T. Agent-Based Approaches in Economic and Social Complex Systems [20]

Modeling is a powerful tool that allows a designer to observe cause-and-effect relationships in events that occur too slowly or quickly to see; involve danger or safety concerns; occur on a scale too large or small for study; are not a common occurrence; or simply cannot be realised in a real environment with real entities. In this research, we develop a multi-agent based traffic simulator by treating traffic flows as emergent phenomena. At both the macroscopic and microscopic levels, replicating realistic traffic flow patterns is a major difficulty in agent-based traffic modelling. The purpose of simulation is to produce a traffic situation that is generated by the model and seems like a genuine road situation. The study of how traffic moves is critical for better road network planning. If traffic movement could be fully comprehended, traffic volumes could be predicted, and congestion could be anticipated and avoided. For many drivers, traffic congestion is a serious concern; it causes delays, wasted time, and increased stress, and it can lead people to be late or lose business. Vehicles, road segments, intersections, and traffic lights are the major components in the traffic simulator implemented in this work, which are modelled as agents and objects. Reactive agents are used in the suggested paradigm. Making innovative traffic-control tactics necessitates the use of computer traffic simulation. Microscopic traffic simulators are ideal for agent-based vehicle control because they can mimic traffic flow in a realistic manner. We describe a reactive agent model that is utilised to control a simulated vehicle in this paper. The agent's driving task is separated into numerous competing and reactive behaviour rules to achieve quick reaction times. The simulator features a cityscape with two-lane streets, crossroads, traffic lights, and automobiles. A single driving agent controls each car, and each agent has its own set of behaviour settings. Agent-based microscopic traffic simulation has a number of advantages over traditional macroscopic traffic simulation, the most important of which is that it is more realistic. Rather of utilising general traffic-flow models, traffic emerges as a result of the interaction of agents. Another benefit of agent-based simulation is that it is more adaptable. Changing agent parameters allows for quick changes to traffic scenarios.

Preliminary tests have revealed that our driving agent has human-like driving behaviour and can represent a variety of driving styles. Busses, trucks, emergency vehicles, pedestrian

crossings, bicycles, traffic signs, trees, and buildings should all be added to the simulation environment to make it more realistic. The agent's functionality must be enhanced to cope with these items after the simulator is improved with the additional objects.

U. *An agent-based approach for modeling traffic flow* [21]

Because of the large number of active players and the tension between the individual driver's self-interest and the total public utility of the system, traffic systems are difficult to study, control, and optimise. A lot of variables contribute to traffic congestion, one of which is driving behaviour. In this study, we use agent-based modelling (ABM) to simulate a traffic system. We built a model of four different types of car drivers to see how their actions affect the performance of the traffic system. We employed a genetic algorithm to optimise the traffic light schedule to maximise total network throughput and increase traffic system performance. Because of the large number of active players and the tension between the individual driver's self-interest and the total public utility of the system, traffic systems are difficult to study, control, and optimise. To better grasp the prominent features of such a complicated system, we use simulation. Taking the traffic system's flow without considering the drivers' needs. Finding a very efficient approach to tackle one problem is like finding a very efficient way to solve another.

A more serious issue than the one harming the system, such as driver behaviour is one of the most important causes of traffic congestion. In this research, we focus on the impact of drivers' actions on the environment. employing an agent-based modelling approach to model the traffic system and integrating it with a traffic light optimization layer scheduling. We have presented an agent-based approach for modelling traffic simulation in this research. The suggested framework is very adaptable and can be used to represent any type of transportation system. This research demonstrated a more realistic agent-based interaction, making the results more applicable to real-world applications. Using Blender as an open-source 3D environment and Python scripts, we were able to get near to the genuine motion of cars in this research. In Giza, Egypt, the model is used to simulate traffic flow. We have demonstrated through the results that driver conduct is a big role in traffic congestion; it is apparent that when we explored the scenarios of removing Minibuses (worst behaviour) while maintaining the same volume of cars, the results were drastically different. What we've discovered is a new technique to create strong simulation models from the ground up. This model could serve as a foundation for future research into traffic system modelling. We've created a genetic algorithm-based optimization model for the traffic signal schedule, with the goal of achieving a near-optimal throughput. The model is beneficial for transportation planning as well as the construction and upgrading of traffic networks. We encountered several computational challenges that constitute a significant concern with our model, but we were able to overcome most of them. However, all agents-based traffic simulation models that have been developed have required a significant amount of computational work, most likely on supercomputers or employing parallel processing.

V. *An agent-based negotiation scheme for the distribution of electric vehicles across a set of charging stations* [22]

The increasingly severe effects of climate change on society have compelled numerous countries to implement national carbon emission reduction strategies. Customers' acceptance of the new type of car, on the other hand, is critical to the successful introduction of EVs (Electronic Vehicles) into the market. Currently, three major issues are impeding the spread of electric vehicles. We look at the topic of EV charging scheduling across a network of various charging stations. The goal of each station is to maximise the amount of charged energy and the number of charged electric vehicles. We propose an agent-based simulation approach in which the EVs broadcast their requests to the stations, and each station uses Integer Linear Programming (ILP) techniques to find the best solution. The Offline Mode and the Online Mode are two variants of the problem that we offer. In the first, all of the EVs send charging requests at the same time at the start of the simulation, and the stations compute their charging schedules at the same time, whereas in the second, each EV can send a charging request at any time, and the stations compute their charging schedules incrementally. Finally, in the Online Mode, we include delays, allowing an EV that has reached an agreement with a station to cancel that arrangement and request charging again. We put our scheme to the test for both offline and online variations for a broad collection of stations and EVs, and illustrate the results of the various situations in the system. A number of charging stations with limited chargers and accessible energy exist in our setting. EVs need to charge and send requests to charging stations in this domain. The stations respond to the EVs' requests by accepting or denying them. Integer Linear Programming (ILP) approaches are being used to schedule EVs to recharge stations. If the ILP problem is initially insoluble because to a lack of resources at some stations, the EVs and the station engage in a negotiating process. The stations then make revisions (i.e., offers) to the EVs' initial preferences, which the EVs might accept or reject. In our scenario, a

There are a lot of studies in the literature that attempt to answer similar difficulties Bayram et al., for example, assume a huge number of charging terminals, each of which has pre-ordered a specific amount of energy. They employ a centralised mathematical programming method to allocate energy to EVs in the most efficient way possible, in order to service the greatest number of EVs. The authors test the method in a scenario that includes both selfish (wanting to charge at the nearest charging station) and cooperative EVs, and they verify the algorithms' performance. The majority of the work in this sector has in common that once communicated to the charging station(s), the EVs' preferences do not change. The primary distinction in our approach is that we propose an agent-based strategy in which a station can negotiate with an EV and propose a new charging plan if its preferences cannot be met. Unlike [18], the charging characteristics of all electric vehicles are not expected to be known. The evaluation begins with Offline and Online Mode simulations of a single-station system, with the difference between the two variations as well as the impact of various proposals and delays on the metrics being observed. Then a third station is added, with various parameters being tracked. Finally, a large-scale simulation using a four-station system takes place. We suggested a multiagent system for scheduling EV charging at many charging stations in this research. In greater detail, we describe an agent-based simulation system that comprises of an Offline Mode in which an

optimal charging schedule is determined, and an Online Mode in which the Offline Mode's scheduling algorithm is gradually called when EVs send requests to charging stations. Furthermore, between the charging stations and the EV-agents, we deployed agent-based bargaining strategies. We show that using alternative suggestions improves the metrics of a single station and puts them closer to those of the best scenario through an empirical examination. It has also been noted that as the number of stations in the system grows, the contribution of negotiations decreases, and the Online scenarios outperform the Offline scenarios. Furthermore, delays have been shown to have a detrimental impact on a station's metrics; however, alternate ideas alleviate this issue. Alternative approaches tend to raise the stations' collective metrics when there are multiple stations in the system. Finally, based on the execution timings, we conclude that using Offline Mode in systems with a large number of EVs is not recommended because it does not significantly improve a station's metrics while adding extra computation time. The Online Mode, on the other hand, produces superior outcomes and requires significantly less time.

W. Expressway Exit Station Short-Term Traffic Flow Prediction with Split Traffic Flows According Originating Entry Stations [23]

Short-term traffic flow prediction is a vital step in anticipating traffic congestion and is an important component of Intelligent Transportation Systems (ITS). Data-driven algorithms with a range of attributes have been widely used to improve traffic flow prediction due to the availability of large amounts of traffic data.China boasts the world's largest total length of expressways, and much data is available.Vehicles enter and exit the expressway at different times. We collect data at a highway exit station in this paper.Split the data into its original entrance stations and forecast the associated exit station in Shanghai. Using multi-split traffic flows, create a flow of traffic. China is becoming more urbanised, and one of the biggest concerns is traffic congestion. Severe traffic congestion, as well as the negative impact on traffic safety and environmental conditions, have gained a lot of attention. Intelligent Transportation Systems (ITS) have been studied extensively for decades and have emerged as a viable means of increasing transportation efficiency. One of the key research fields in ITS is short-term traffic flow prediction. Accurate real-time short-term traffic flow forecasts assist traffic participants in selecting acceptable travel routes and offer traffic managers with an effective management approach for reducing traffic congestion. In this work, we collect data at an expressway exit station in Shanghai, split it according to its source entrance stations, and use multi split traffic flows to estimate the associated departure station traffic flow. The records are first gathered, preprocessed, divided, aggregated, and standardised. Second, to anticipate the overall exit flow, the Long Short-Term Memory (LSTM) model is used to learn from the properties of the overall flow and split traffic flows. The baselines are models that just consider overall flow information. In comparison to the baselines, the split flows according to entrance stations are also taken into account for prediction in other models. Finally, the LSTM model is compared to Convolutional LSTM (ConvLSTM), K-Nearest Neighbor (KNN), and Support Vector Regression (SVR) models. The model prediction performs best when the overall flow and six separate traffic flows are employed, and the step is set to 11 (with 5-minute aggregation). The improvement in prediction accuracy is up to 5.48 percent by Mean

Absolute Error when compared to the best result of the LSTM baseline model (MAE). In this research, we employed the LSTM model to forecast the overall departure traffic flow using data collected at an expressway exit station in Shanghai. To forecast the overall flow at later periods, both the overall flow information and the split flow information from test data were employed. We ran tests to see how divided flow information affected baseline models that solely evaluated overall flow information. In the same way, we analysed different models. The split flow information improves the accuracy of model predictions, according to the prediction analysis.

X. *Optimized and meta-optimized neural networks for short-term traffic flow prediction: A genetic approach* [24]

Modern Intelligent Transportation Systems research and practise include short-term forecasting of traffic factors such as flow and occupancy. Although many various approaches for short-term predictions have been employed, literature suggests that neural networks are one of the better options for modelling and predicting traffic metrics. However, due to a lack of understanding about the best structure of a network given a specific dataset, researchers must rely on time-consuming and inefficient rules-of-thumb while creating them. It also assesses the constructed network's performance using both univariate and multivariate traffic flow data from an urban signalised arterial. The results reveal that when modelling both univariate and multivariate traffic data, the capabilities of a simple static neural network with genetically tuned step size, momentum, and number of hidden units are quite adequate. Because they can approximate practically any function, regardless of its degree of nonlinearity or prior knowledge of its functional form, neural networks have been proved to be one of the best solutions for modelling and predicting traffic metrics in the literature. However, due to the developmental nature of neural networks, there is a great deal of ambiguity when trying to choose the best network topology, and researchers must rely on time-consuming and inefficient rules-of-thumb to overcome this. The goal is to develop a multilayered structural optimization method based on an advanced genetic algorithm that can help with both the proper representation of traffic flow data with temporal and geographical characteristics and the selection of the "most appropriate" neural network structure. Short-term traffic parameter prediction, such as flow, is a critical component of existing ITS designs, although it is difficult to define mathematically. Its difficulty stems from the fact that traffic flow is a constantly changing phenomenon in both time and space. The authors of this research suggested an optimization approach for simulating this dynamic behaviour using static MLP forms. The overall concept consists of two parts: first, ensuring the model's internal performance (in terms of learning technique and network hidden layer dimensions), and second, including the temporal and geographical aspects of traffic flow. Furthermore, the proposed optimization technique that was tested in this work demonstrated a good balance of local and global optimization procedures. It originally used gradient descent's local nature to find the minimum in the network performance surface, but it also used the power of genetic algorithms' global idea to search in a multivariate space of solutions with a combined optimization of learning parameters and number of hidden units.

Y. *A deep network with analogous self-attention for short-term traffic flow prediction* [25]

Short-term traffic flow prediction is critical in the development and implementation of intelligent transportation systems. In the extraction of traffic features, the neural network approach can leverage massive data for training and has more advantages than other prediction models. However, extracting the spatiotemporal aspects of traffic flow in a simple and sufficient approach to increase prediction accuracy remains an issue. An analogous self-attention (ASA) is designed to boost the network's ability to fit the traffic data while retaining the benefits of attention without rarely raising training costs. The simulation results of traffic flow prediction tasks in different prediction horizons show that the prediction performance of the proposed prediction model (ASA-RGCNN) is superior to that of other common prediction models, and that the proposed model can be applied to the predicting task under various traffic conditions. A huge number of academics have examined the above tasks from the prediction models for decades. The quality and quantity of obtained data have substantially improved as a result of enhanced traffic information collection and storage methods, making data-driven machine learning methods more accurate in traffic flow prediction jobs than classic statistical models. It is becoming easier to acquire significant amounts of historical traffic data as improved traffic-aware infrastructure develops. In the context of bigdata, these machine learning algorithms have limited feature extraction capacity, which leads to a decrease in model generalisation ability. In traffic flow prediction research, it is especially important to design a prediction model with stronger feature extraction ability and higher accuracy. The speedy and accurate traffic flow prediction approach is especially important since it may provide an advanced management and control plan for the traffic system. To anticipate traffic flow, we propose a dual-branch residual gated convolutional network with comparable self-attention. Using a dual-branch deep residual gated convolution module, the network captures deep temporal and spatial features and weights them using an analogous self-attention module. Meanwhile, to acquire multi-location traffic flow, a regression layer is used. Certainly, traffic flow prediction mixed with deep learning requires more investigation, particularly in the areas of sample treatment and network structure optimization. Meanwhile, a single section's forecasting assignment can be stretched to a network, allowing the network structure to handle more realistic tasks.

CONCLUSION

In order to predict and control the flow of traffic, we need a deeper insight on the general factors that affect the transportation, like day of the week, time of the day, road conditions, and so on along with individual factors like choice of transportation, speed of vehicles, etc. We have researched several agent-based models as well as some other approaches designed to solve this (or a similar) problem. After studying these models, we have a general idea of what parameters we are going to consider while developing the model.

One limitation common among various researches we have come across is the lack or real-time data using which we can analyze the conditions and make predictions. This is an issue because weather and road conditions are not a constant measure and gathering that type of real-time data

is a challenge. Also, we were unable to find a model that can address all the parameters found and discussed across the papers we have surveyed.

In this project, we will try and simulate the traffic flow prediction and develop strategies for better management using all the knowledge gathered from the models. The project scope will be limited to the City of Windsor, and we will use the data specific to the City of Windsor to train the model

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