ALY 6980:

CAPSTONE

Week 2: Survey on Big Data Techniques in Intelligent Transportation System (ITS)

Submitted To:
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Article 1: Survey on Big Data Techniques in Intelligent Transportation System (ITS)

I. APA Citation:

Mohandu, A., & Kubendiran, M. (2021). Survey on Big Data Techniques in Intelligent Transportation System (ITS). Materials Today: Proceedings, 47, 8–17. https://doi.org/10.1016/j.matpr.2021.03.479

II. Summary:

This article explores the role of Big Data analytics in the field of Intelligent Transportation Systems (ITS). It highlights the significance of Big Data in efficiently managing information for secure, clean, and reliable transportation, contributing to the transformation of urban environments into smart cities. The paper discusses various ITS technologies deployed over the last two decades, such as traffic control, smart parking, transport information assistance, and traffic speed measurement. The authors emphasize the need for Data Analytics insights in the transport and mobility industry, examining areas such as routing, planning, infrastructure tracking, platform architecture, and more. Additionally, the article addresses open problems in ITS and proposes leveraging Big Data analytics to overcome these challenges.

III. Findings:

The findings of the research emphasize the exponential growth of data in Intelligent Transportation Systems, ranging from Trillions to Petabytes. Conventional database frameworks are deemed inadequate for handling this massive volume of data, and the article proposes Big Data analytics as a modern technological approach for ITS. The integration of large data systems, such as Hadoop Distributed File System (HDFS) and Spark, is highlighted as a capable solution for processing extensive amounts of data generated by various sources, including social networks and smartphones.

IV. Relevance to Business Question:

This article is highly relevant to the business question of implementing analytical tools for the capstone project. It provides insights into the challenges faced by the transportation industry, emphasizes the role of Big Data analytics in addressing these challenges, and

discusses the potential solutions and technologies that can be applied. The findings of the article align with the broader goal of developing analytical tools for the transportation sector.

Article 2: Big Data Analytics for Transportation: Problems and Prospects for its Application in China

Authors: Robert P. Biuk-Aghai, Weng Tat Kou, Simon Fong
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Abstract:

Transportation, as a crucial aspect of modern society, involves the movement of goods and people between different locations. This paper explores the integration of big data technology infrastructure into China's current development and provides suggestions for improvement. The authors discuss China's transportation system, outline relevant big data technologies in the transportation domain, and propose opportunities for enhancement through standardization and the integration of big data analytics in a national framework.

I. Introduction:

Transportation is vital for economic development, and this paper focuses on the application of big data analytics to address challenges in China's transportation system. The lack of empirical data on road conditions poses difficulties in formulating effective transportation strategies. The paper emphasizes the impact of transportation on safety, environmental pollution, and the economic costs associated with traffic-related issues.

II. China's Transportation System:

The authors discuss the growth of China's transportation infrastructure, including railways, highways, and expressways, over the years. The significant increase in privately owned vehicles has led to issues like traffic congestion. The paper highlights the unequal growth between highways and the number of vehicles, leading to the challenge of managing traffic. Intelligent transportation technologies are being deployed to address these

challenges, but there is limited use of big data analytics.

III. Big Data Technology for Transportation:

The paper introduces big data analytics as a solution for transportation challenges. It describes the application of big data analytics in transportation, including data analysis, modeling, mining, and visualization. The authors emphasize the potential of big data analytics to create more intelligent transportation systems. However, the development of big data technology in China faces challenges related to data volume and initial investment in surveillance tools and traffic sensors.

IV. Opportunities for Improvement:

The authors identify opportunities for improving big data practices in China's transportation sector:

A. Big Data Standards:

The paper suggests the need for standards in big data technology to address the existing differences in intelligent transportation technology among different regions in China. Standardization efforts are seen as essential for guiding technology providers and ensuring compatibility.

B. Standardized Software Systems:

Once component-based, modular big data standards are defined, the authors propose the development of standardized software systems. This approach aims to foster competition among vendors, encourage adherence to established standards, and provide users with interchangeable and interoperable software components.

C. National Transportation Big Data Analytics Framework:

The paper proposes a multi-level framework for big data analytics at the municipal, provincial, and national levels. This framework involves the integration of traffic data from municipal systems to provincial and national systems, enabling adaptive decision-making at all levels.

D. The Future of Transportation:

The authors predict the future of transportation, envisioning trends such as driverless cars, electrically powered vehicles, and enhanced communication among vehicles. Big data is expected to play a crucial role in optimizing traffic control, providing individualized routing recommendations, and improving overall traffic management.

V. Conclusion:

The paper concludes by emphasizing the increasing role of big data analytics in managing transportation challenges. It highlights the potential for big data to contribute to better traffic management, increased efficiency, and the identification of future traffic needs. The authors acknowledge support from the University of Macau Research Committee.

References:

The paper includes references to sources cited in the text, covering topics such as Victorian technology, the cost of air pollution, road statistics in China, intelligent transportation market research, and cases of big data for transportation and logistics.

Article 3: A Reinforcement Learning-based Approach for Online Bus Scheduling

Authors: Yingzhuo Liu, Xingquan Zuo, Guanqun Ai, Yahong Liu

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Abstract

The Bus Scheduling Problem (BSP) plays a crucial role in minimizing operational costs and ensuring service quality. Traditional approaches generate bus scheduling schemes offline, leading to infeasibility when faced with uncertain events like traffic congestion. This paper introduces a novel Reinforcement Learning-based Bus Scheduling Approach (RL-BSA) for online bus scheduling. Departure times in the bus timetable are treated as decision points, where an agent, modeled as a Markov Decision Process (MDP), selects a vehicle to depart. The state features include real-time information on vehicles, and a reward function guides decision-making. RL-BSA is trained through interactions with a simulation environment, and experiments on real-world instances demonstrate its efficacy in reducing vehicle usage

compared to manual scheduling and Adaptive Large Neighborhood Search (ALNS).

1. Introduction

The Bus Scheduling Problem (BSP) focuses on efficiently arranging vehicles to perform planned trips in a bus timetable to minimize operational costs and ensure service quality. Traditional approaches often neglect uncertain events like traffic congestion, leading to infeasible scheduling schemes. This paper proposes RL-BSA, a Reinforcement Learning-based approach that treats BSP as a Markov Decision Process, allowing for real-time decision-making.

2. Related Works

2.1. Bus Scheduling Approaches under Static Environment

Under static environments, exact and heuristic approaches are employed. Exact approaches, such as linear programming and network flow models, aim to minimize operational costs. Heuristic approaches, like genetic algorithms and clonal selection algorithms, optimize driver and vehicle assignments. Numerous studies explore multi-depot scenarios and electric BSP, employing various optimization techniques.

2.2. Bus Scheduling Approaches under Uncertain Environment

Scheduling approaches under uncertain conditions fall into rescheduling and robust categories. Rescheduling involves frequent regeneration of schedules, responding to events like traffic congestion. Robust scheduling aims to generate schedules resistant to uncertainties, sacrificing optimality for reliability. Stochastic programming and network flow models are used to optimize robust bus scheduling.

3. Reinforcement Learning-based Bus Scheduling Approach (RL-BSA)

RL-BSA introduces a novel approach by modeling BSP as an MDP. Departure times become decision points, and a RL agent, employing Double Dueling Deep Q-learning (D3QN), selects vehicles based on real-time information. State features include remaining working time, driving time, rest time, trip count, and vehicle type. A reward function combines final and step-wise rewards, ensuring adherence to constraints through a mask layer.

4. Experimental Results

Experiments on real-world BSP instances reveal RL-BSA's superiority over manual scheduling and ALNS. Significant reductions in vehicle usage are observed, indicating RL-BSA's effectiveness in maintaining service quality without increasing operational costs under uncertain environments.

5. Conclusion

This paper presents RL-BSA, a pioneering Reinforcement Learning-based Bus Scheduling Approach, and demonstrates its application to real-world instances. RL-BSA's ability to handle uncertain events in online bus scheduling proves advantageous, outperforming traditional methods. The study contributes to the integration of RL in solving the BSP and opens avenues for further research in dynamic scheduling environments.