



Envisioning the future of transportation: Inspiration of ChatGPT and large models

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Editorial

Envisioning the future of transportation: Inspiration of ChatGPT and large models



1. Introduction

Traditional artificial intelligence (AI) strategies, reliant on manually crafted patterns or task-specific feature representations, often suffer from overfitting and struggle with the dynamic nature of real-world scenarios. In contrast, the current AI landscape is witnessing a significant departure from conventional methods, exemplified by the rise of generative and large models like Chat Generative Pre-Trained Transformer (ChatGPT). They not only offer broad functionalities for diverse applications but are also designed for intuitive interpretation, application, and adaptability to emerging tasks and domains.

These GPT-style models have the potential to fundamentally reshape the landscape of AI-based tasks. In the transportation domain, the adaptability and multifaceted learning capability allow large models to handle complex traffic scenarios more effectively than traditional methods. Specifically, their application can significantly enhance the efficiency and reliability of services such as signal control, traffic prediction, and bus scheduling, which could assist in improving traffic management, reducing congestion, and enhancing road safety. Furthermore, with the ability to learn from large amounts of data, these models could potentially revolutionize traffic modeling and prediction, bringing us closer to the vision of intelligent transportation systems (ITS) (Lin et al., 2023).

2. ChatGPT and large models

ChatGPT is an advanced language processing AI that utilizes the power of machine learning, specifically the Transformer, to generate human-like text based on the given input. Built upon the GPT framework, ChatGPT is trained on a vast amount of text data and can carry on a conversation, write essays, answer questions, and even generate creative content such as poetry and stories. Its ability to understand and generate contextually relevant responses makes it a powerful tool across various fields, especially customer service, education, and content creation.

Indeed, the origins of large models can be traced back to the development of large-scale pre-training models such as the Bidirectional Encoder Representations from Transformers (BERT) and GPT-3. Distinguished by the characteristic of homogenization, these models serve as the backbone of intelligent systems, and their progress and limitations significantly influence the entire AI community. This trend, initially

prominent in natural language processing (NLP), is gradually proliferating into various domains, signaling a shift towards a unified AI approach. In a substantial report, a Stanford team named these entities "Foundation Models," exploring their capabilities, applications, technological ties, and societal impacts, which further deepens the understanding of large models (Bommasani et al., 2021).

Typically, large models are categorized into three types: Large Language Models (LLMs) such as BERT and GPT; Large Vision Models (LVMs) including models like Variational Inference with adversarial learning for end-to-end Text-to-Speech (VITS); and Vision Language Models (VLMs), which are multi-modal models akin to Masked Language Model (MLM) (Bommasani et al., 2021). These models, known for their pre-training on extensive data followed by fine-tuning for specific downstream tasks, offer several benefits, such as reduced training costs and the ability to remedy precision defects of model structures. However, they also present challenges like deployment difficulties, data privacy and security issues, and significant computational resource consumption.

The inherent flexibility of large models allows for their modification or fine-tuning to suit a wide array of downstream applications, generally focusing on universally defined targets such as language, text, or images. This adaptability has spurred the development of several domain-specific models optimized for particular fields, thereby achieving unparalleled performance in specialized tasks. For example, OpenAI's DALL-E, a multimodal model, can transform the text into images when integrated with pre-trained models like CLIP. Other notable applications include the 3D-Transformer model, which excels in global weather forecasting within meteorology, ChemBERTa that is adept at predicting chemical structures and properties in the field of chemistry, and Lawformer, which is tailored for legal case judgments and question-answering in the legal domain. The rapid progress in large models and their underlying technologies has also piqued interest in the exploration of large models for transportation applications.

3. Applications in transportation

In the domain of ITS, there are some applications of ChatGPT and large models, most notably in traffic flow prediction, traffic data generation, traffic management, and intelligent vehicles. These models theoretically consolidate all information to handle diverse traffic tasks, as depicted in Fig. 1.

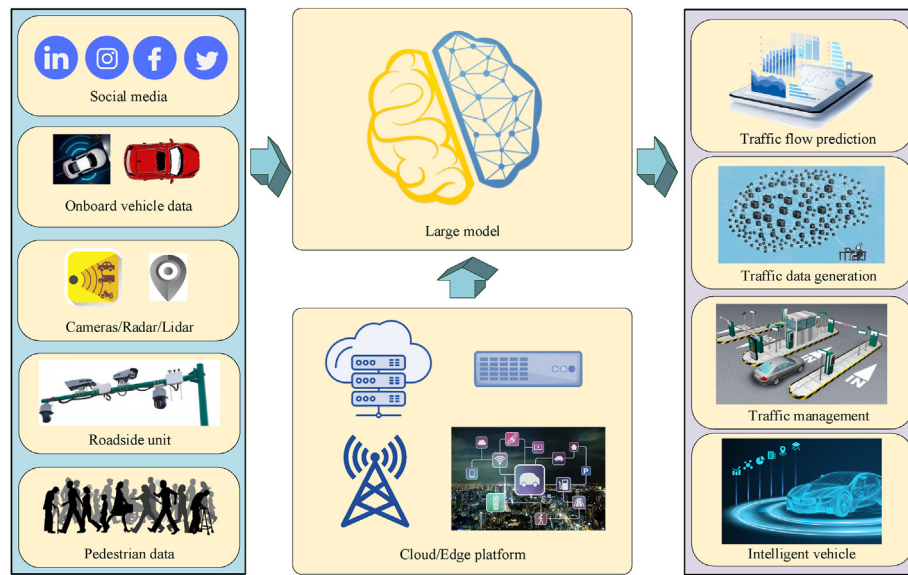


Fig. 1. Structure and process of large models in transportation tasks.

3.1. Traffic flow prediction

Large models have shown significant potential in traffic flow prediction. Amygdala labs, for example, have effectively utilized time-series large models for intricate traffic prediction tasks, thereby enhancing transportation services. These models have facilitated accurate and timely predictions for various aspects including traffic conditions, Origin-Destination (OD) flow, regional flow, bus arrival times, and driving times (Zhao et al., 2023). Notably, the ability of these large models to handle time-series data has enabled more granular, precise predictions, allowing for better anticipation of traffic patterns and therefore more efficient route planning. As exemplified, with improved OD flow prediction, transportation services can optimize routes in real time to avoid congestion and reduce travel times.

3.2. Traffic data generation

The execution of traffic tasks requires abundant data from various modalities. These data sources not only encompass conventional static, fixed location sources but also diverse mobile sources like floating cars and social media. Nonetheless, actual data often lack comprehensiveness, are contradictory, and are unevenly distributed, making them challenging to employ directly for model training. It is imperative to establish reliable and trustworthy traffic scenarios for computational experiments through calibration and certification (C&C) methods and verification and validation (V&V), also known as scene engineering. Fortunately, with the appearance of large models, generating traffic data and building traffic scenarios become much easier.

3.3. Traffic management

Large models are now spearheading the convergence of ITS in TransVerse, as they process data from vehicle, roadside, and pedestrian perspectives, including images, text, point clouds, and dynamic data. The integration of large models in traffic management has brought about revolutionary changes, particularly in the realm of traffic signal control. By leveraging multi-modal, multi-perspective data, large models can

better comprehend complex traffic scenarios and dynamically adjust signal timings. This intelligent decision-making process leads to enhanced traffic flow, reduced congestion, and improved road safety. Specifically, large models can predict and respond to peak traffic volumes in real time, dynamically optimizing signal timings to ease traffic flow and reduce waiting times at intersections.

3.4. Intelligent vehicles

As one of the most direct applications in intelligent vehicles, ChatGPT serves as an intelligent voice interaction system between the vehicle and the driver. It can clearly understand the driver's intentions and take action accordingly. Furthermore, Open-TransMind presents a novel baseline and benchmark for the first large model challenge of intelligent transportation. Focused on computer vision tasks in intelligent driving, it integrates multiple data sources with text and image data models as the core (Gao et al., 2023). As vehicular interconnection and intelligence continue to advance, intelligent cockpits, featuring on-board vehicle systems as the main selling point, are becoming a major factor influencing consumer vehicle purchases. Large models like ChatGPT, with the ability of robust learning, NLP, and interactive capacities, are increasingly being adopted.

4. Conclusions and prospects

The proliferation and sophistication of the ITS have been seen to rely heavily on the amalgamation of diverse artificial intelligence technologies. Computer vision, machine learning, NLP, human-computer interaction, reinforcement learning, and big data analysis are all pivotal components in this digital landscape. They all work in concert to enhance aspects such as traffic flow prediction, vehicle recognition, user interaction, autonomous vehicle decision-making, and in-depth traffic data analysis. This fusion of AI technologies paves the way for a more safe, efficient, and user-friendly transportation experience.

Despite the promising strides in AI application to transportation, the development of large models in the transportation domain still poses significant challenges. Unlike ChatGPT, which has abundant training

data, the transportation domain faces obstacles in data acquisition and standardization. Key challenges include “data islands”, inconsistent data formats, and issues of data ownership and privacy, while information about transportation models’ internal frameworks is also less publicly accessible. Despite these challenges, there are untapped opportunities in specific scenarios with available large, multi-source data. Selection of the right model for specialized tasks remains an open research area for large models.

Looking to the future, the potential for large models like ChatGPT in the ITS is expansive. From intelligent communication assistance, unmanned intelligent parking solutions, and real-time traffic monitoring, to its applications in autonomous vehicle development, urban-delivery route optimization, and vehicle safety and energy management, the scope for ChatGPT’s integration is expansive (Liu et al., 2023). The model’s capability to combine natural language processing and human feedback reinforcement learning could considerably enhance user interaction, safety, energy efficiency, and the overall transportation experience. As we delve deeper into the era of AI, the prospect of a more connected, intelligent, and efficient transportation network becomes increasingly within reach.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Xiaobo Qu reports financial support was provided by the National Natural Science Foundation of China. Prof. Xiaobo Qu is the co-editor-in-chief of Communications in Transportation Research.

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