English Summary of "Macroscopic Traffic Flow Simulation: Fundamental Mathematical Theory and Python Implementation" by Seo (2023)*

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1 Book Features

This book is a comprehensive and systematic compilation of theoretical model formulations and simulation methods for traffic flow, i.e., the flow of many vehicles on a road network. The book also includes an open-source Python implementation of a traffic flow simulator.

2 Contents

Chapter 1: "What is Macroscopic Traffic Flow Simulation": Explains what traffic flow is and what macroscopic traffic flow simulation is in relation to general topics such as traffic congestion.

Chapter 2: "Basic Elements of Traffic Flow": Mathematical definitions of the basic elements of traffic flow are given along with examples of real data and their roles in the simulation. For example, road users, networks, vehicle trajectories, time–space diagrams, and traffic states are described.

Chapter 3: "Theory of Macroscopic Traffic Flow Models": This chapter describes theoretical models of macroscopic traffic flow. A link model describing traffic flow on a single link as a one-dimensional fluid, a node model describing branching and merging between links, and a demand and route choice model describing traveler behavior on the entire network are formulated and their theoretical solutions are described in detail. In addition, certain micro-traffic flow models, which is equivalent to the macroscopic-traffic flow model, is explained.

Chapter 4 "Simulation Methods for Macroscopic Traffic Flow Models": This chapter describes several simulation methods that are numerical solutions of the theoretical models described in Chapter 3. For example, those based on the finite difference method, variational method, equivalent micro-model, and cellular automata are described with their formulas, algorithms, and calculation examples.

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Chapter 5 “Simulator Implementation”: The simulation methods described in Chapter 4 are implemented using the Python programming language. The program code is also described.

Chapter 6, “Simulation Examples”: This chapter presents computational examples of the simulator described in Chapter 5. The simulation is intended to deepen the understanding of not only the theory and simulation, but also the traffic phenomenon itself, by covering interesting examples such as gridlock.

3 Message to the Readers

Macroscopic traffic flow simulation is the culmination of research results from 1935 to the present day, mainly in the field of transportation research. In this book, we have consistently and logically (or, to put it bluntly, axiomatically) explained the fundamental principles of traffic flow, the macroscopic simulation methods, and even the equivalent cellular automata. Simulation is complex, but I hope you will understand that it is ultimately the logical embodiment of a simple principle: travelers want to travel as fast and safely as possible. I hope that the reader will find it interesting to apply abstract mathematical theory to solve real-world problems, and that it will be of help to people in all fields who are interested in this topic.

References

Seo, T., 2023. Macroscopic Traffic Flow Simulation: Fundamental Mathematical Theory and Python Implementation. Corona Publishing Co., Ltd., (in Japanese).