Traffic flow problem

Based on Game Theory

BAKING π TEAM

كلية الهندسة جامعة القاهرة FOUNDED IN 1816 تأسست عام ١٨١٦م

Introduction

Have you ever thought about how they are arranged? Those red, yellow, and green traffic lights with their unique timing for each square and street; those bumps and zebra crossing here and there; and even the number of lanes for each road across the city. How things work and how to make them more and more efficient, that's exactly what engineers are interested in; in fact, one of the most known problems that engineers have to deal with is traffic flow optimization. Over decades, as a result of the development that mankind has reached in industry, paired with the increasing population, the number of cars has been increasing, and traffic problems have appeared.

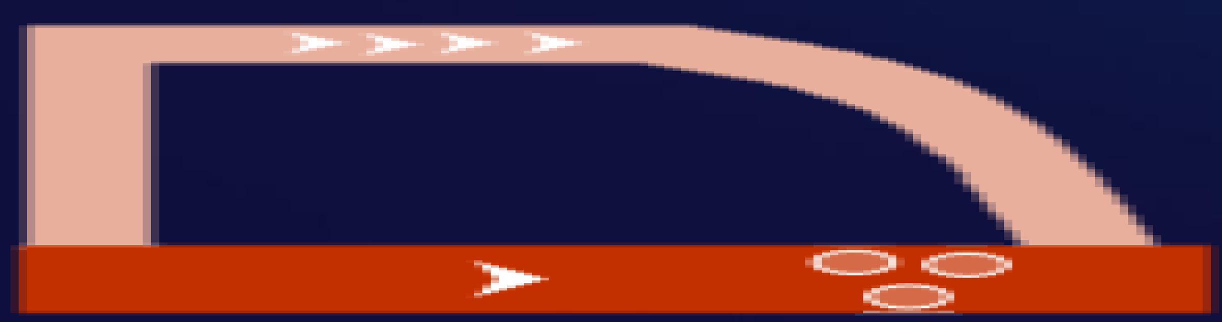
Abstract

A truth that cannot be denied is that traffic networks are the backbone for modern cities and localities. Therefore, the scientific research done by engineers and modeled by mathematicians is looking forward to establish a complete description of traffic flow characteristics that would help figuring out serious issues. the Lighthill – Whitham–Richards Model (LWR) is considered a basic model that expresses the flow of traffic. The final forms of equations from this model appear the relationship between speed and flow. Furthermore, we integrated some basic principles from game theory with the established model to show its effectiveness in studying drivers' behaviors. The results produced by equations were proved using simulations in addition to comparing them with real data from other modern sources.

Models

1. Lighthill-Whitham-Richards (LWR)
2. Mixed Strategy Game Theory

Mixed Strategy Game Theory



1st player \ 2nd player	shortcut	impedance
shortcut	$\Delta t0,\Delta t0$	$\Delta t0$, f (ρ)
impedance	f(ρ),$\Delta t0$	f(ρ+dρ),f (ρ+dρ)

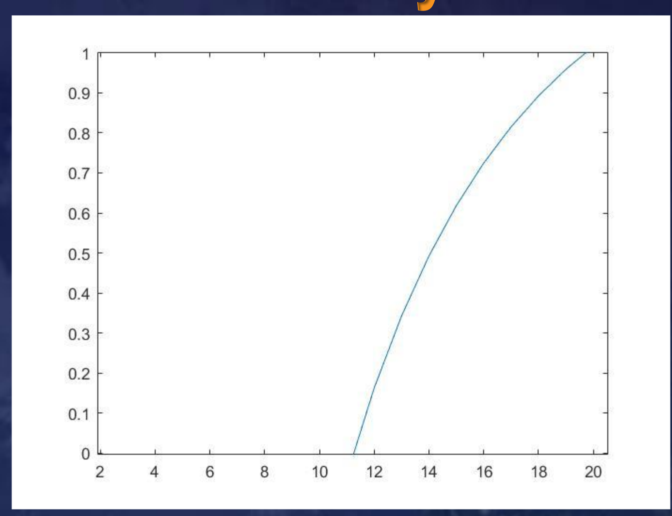
$$us = \Delta t_0 *(h + (1 - h)) = \Delta t_0$$

$$ui = f(\rho) * h + f(\rho + d\rho) * (1 - h))$$

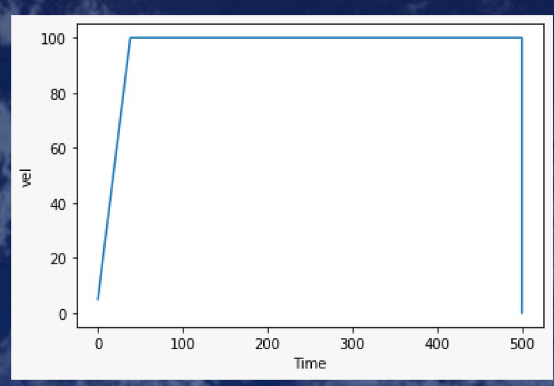
$$us = ui$$

$$h = \Delta t_0 - f(\rho+d\rho) / (f(\rho) - f(\rho+d\rho))$$

Probability H



$$q = v * \rho c * (\ln Vf - \ln v)$$



Methodology

LWR

$$q = \rho \cdot v$$

$$\rho(t) + q(x) = 0$$

Underwood

$$v = Vf * \exp(\frac{\rho}{\rho c})$$

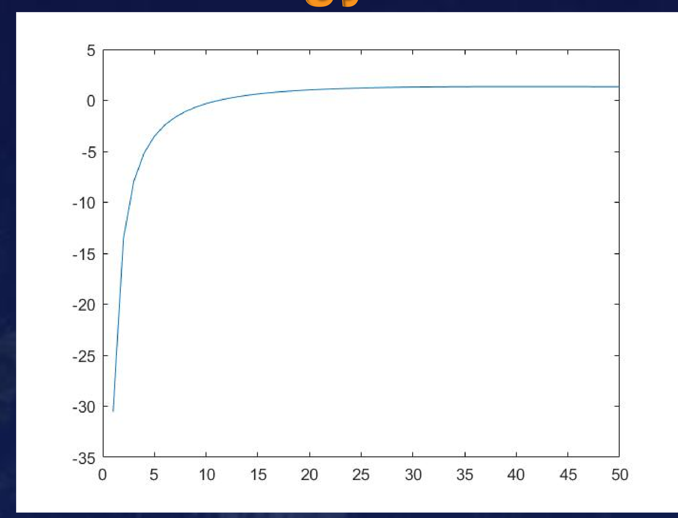
$$q = \rho * vf * \exp(\frac{\rho}{\rho c})$$

Greenshields

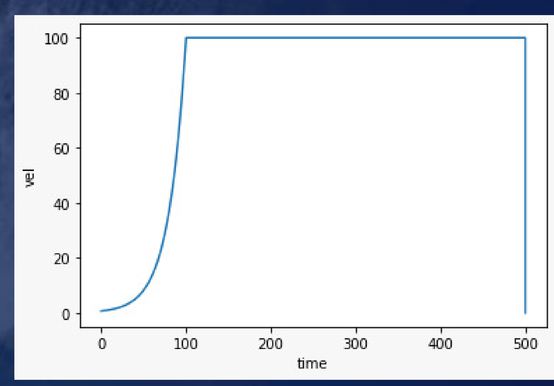
$$v = Vf\ (1 - \frac{\rho}{\rho j})$$

$$q = q * Vf\ (1 - \frac{\rho}{\rho j})$$

Mixed strategy Probability

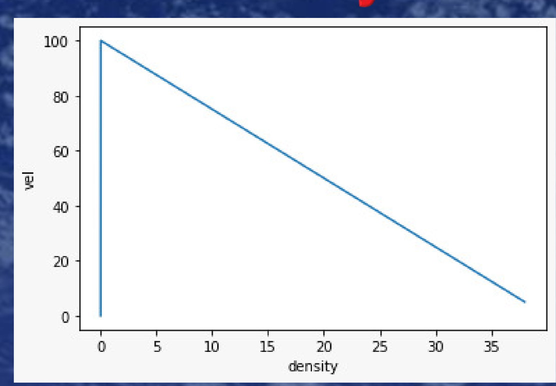


$$q = v * \rho j * (1 - \frac{v}{Vf})$$

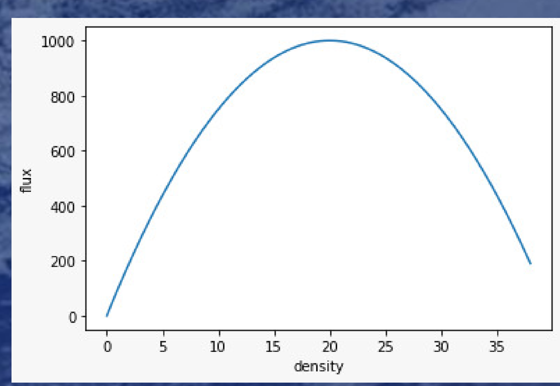


Greenshields

Velocity

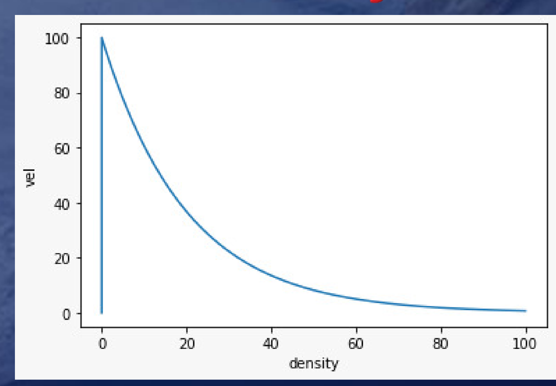


Flow

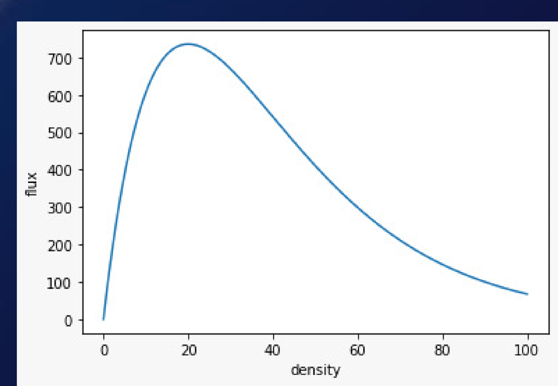


Underwood

Velocity

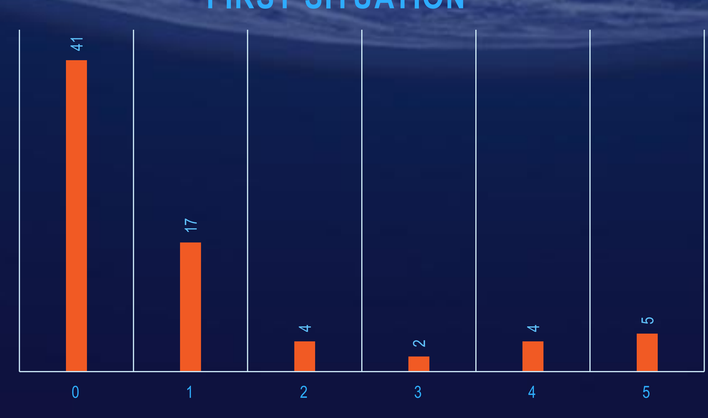


Flow

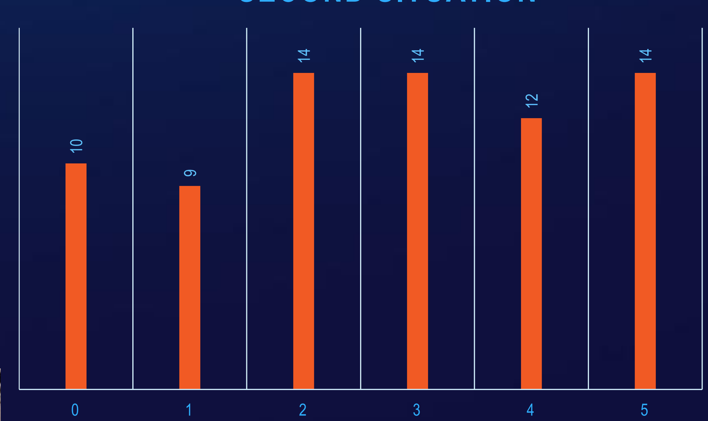


Results

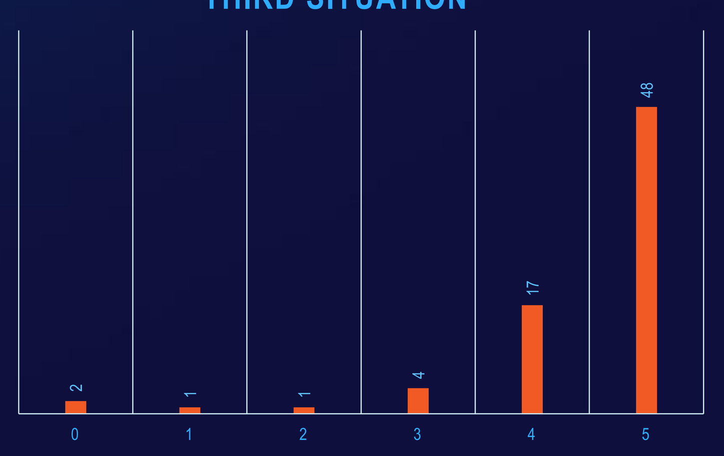
FIRST SITUATION

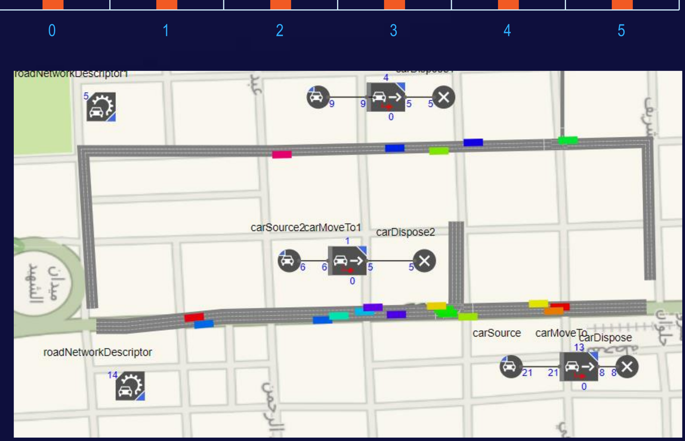


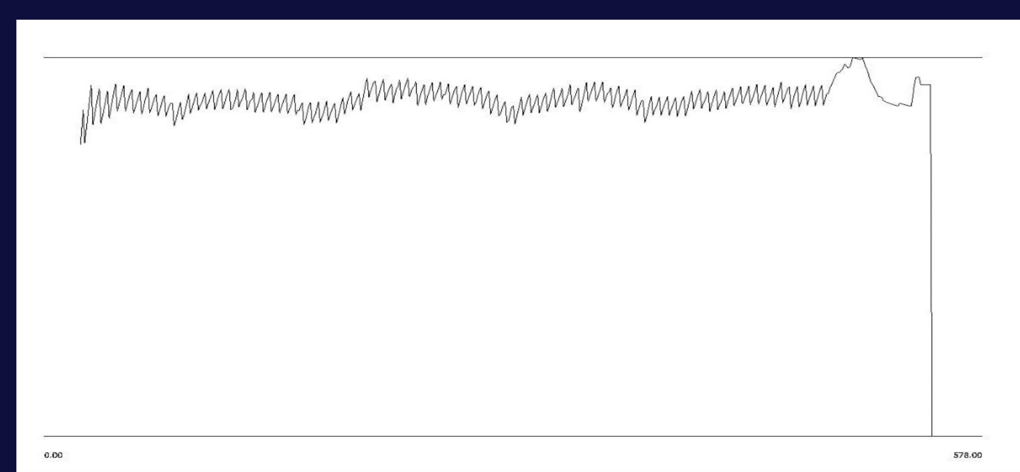
SECOND SITUATION



THIRD SITUATION







Analysis

In this study, the aim was to Compare the Greenshield, and the Underwood traffic flow models. We verified that the two models correctly describe the traffic flow by testing it on a road that has linear characteristics using the sumo simulation program, however, we noticed that due to the exponential nature of the underwood equation (equation number....), the error produced by it increases with the increase of pmax, and we observed that the linearity in the Greenshields equation (equation number....) it works fine with a road that has linear characteristics.

conclusion

Finally, it can be said that Based on road characteristics the suitable equation will be chosen to describe this road, where the Greenshields equation perfectly describes roads with linear characteristics, and the Underwood equation is associated with low density. At intersections all drivers seek to achieve maximum utility and accordingly, this will lead to a steady state (Nash equilibrium).so the more the driver is aware of the road, the more precisely he takes decisions.

Our Team

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Submitted to Dr. Samah Mohammed Al-Shafi'i

Course Code :: MTH1172

References

[1] Lighthill, M., and G. Whitham (1955), On kinematic waves. II: A theory of traffic flow on long crowded roads, Proceedings of the Royal Society of London

[2] Garber, N.J. and L.A. Hoel, Traffic and Highway Engineering. Second Edition ed1999,

[3] Umar, Khalil, Khan, Zawar Hussain, Waheed Imran, Salman Saeed, Khurram Shehzad Khattak, Khizar Azam, and Mushtaq Ahmad Khan. "Behavioral Analysis of LWR Model under Different Equilibrium Velocity Distributions." Pakistan Journal of Science 71, no. 4 (December 2019): 194-99.