Collective Intelligence: Driving Lessons From Ants

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Traffic is a universal phenomenon for humans leading to casualties, economic losses, and health problems. Interestingly, traffic has been observed in other species as well. For example, ants form trails to forage and return to their nests, yet they do not experience traffic jams. Motivated by collective intelligence, defined as an ability of a group to solve a problem or achieve the goal without centralized control, exhibited by species such as ants, bees, fish, and birds, I compare two traffic systems of ants' and human vehicles. In this project, I simulated both ants' and human vehicular traffic using a simple, unified microscopic model to find out why traffic jams occur in the latter. I hypothesize that delayed overreaction is the main cause and perform parameter sensitivity study to test this idea. Humans experience a delay in visual perception and often compensate by overreacting, whereas ants adjust their speeds more gradually, even when they could move faster. Using density, velocity, and flow, I compare two traffic systems and observe the emerging traffic patterns. Based on the insights from the study of ants' and human-driven traffic, I propose a self-driving car algorithm that incorporates physical parameters such as maximum speed, acceleration, same as cars; behavioral parameters such as gap sensitivity, reaction delay, same as ants. My simulations show that even a small fraction of self-driven cars improves the overall traffic. While human behavior is difficult to control, traffic systems can be optimized through self-driving vehicles with programmable behavior. Creating safer and more efficient traffic environments has the potential to improve quality of life for all.

Awards Won:
Third Award of $1,200