The flow of liquids and gasses is well explained through physical laws and theories. However, in terms of mathematical theories and predictions, traffic flow is not understood to the same extent as the physics of matter flow. In this project, we establish and evaluate assumptions that allow traffic to be treated as a fluid. Then, following the law of conservation of mass for fluids, we derive a conservation law for traffic flow. Finally, we seek to loosen the assumptions and improve the model.

Initially, we make the following assumptions: (i) there is only one lane and no overtaking is allowed; (ii) there are no “sources” or “sinks” for cars – that is, no cars may enter or exit the system under consideration; (iii) the average speed of traffic is not constant and depends solely on the density of the traffic. While the first assumption is not directly involved in the derivation of a conservation law, it allows for simplicity in our model. The latter two, however, are fundamental assumptions in the derivation.

Most traffic phenomena of interest occur with multiple parallel lanes, similar to laminar flow in fluid dynamics. We now hope to remove the first assumption, thereby enabling a model of multiple lanes of traffic. We preserve assumptions (ii) and (iii), and establish the following new assumptions: (iv) given two parallel lanes, fix a lane $L$ such that the density of $L$ never exceeds that of its adjacent lane, $L'$; (v) cars will flow from $L'$ to $L$ until their densities are equal; assume these lane changes occur instantaneously.

Assumption (iv) simplifies our model, and assumption (v) permits a relationship between $L$ and $L'$. By formalizing a relationship between these adjacent densities, a linked system of differential equations can be generated to model this two-lane system and, by extension, traffic systems with arbitrarily many adjacent lanes. Due to assumption (ii), the total number of vehicles in the system must remain constant. The density of the entire traffic system over a given interval must therefore remain constant as well.

As of yet, we have not found a closed solution to this higher-order problem. Our proposed differential equations used to relate the densities of $L$ and $L'$ are not readily solvable. A possible topic for further research is to address this problem. Once a solvable relation is established, we can derive a new conservation law for the two-lane model and study ensuing model behaviors, such as equilibrium between the adjacent lanes.