Case study

We performed a case study using our proposed framework. Initially, this experiment was designed to be used to compare human data to a novel human-human interaction model. This new model is ongoing work and a separate publication about this model is currently being prepared. Here we describe the methods of the experiment in an extended discussion compared to the paper.

Methods

Eighteen drivers volunteered to participate in our experiment (6 female, 12 male, mean age: 25, std: 2.6). All participants were in possession of a valid driver's license. They were divided into 9 pairs of two and executed the experiment in these pairs. A photograph of the used experimental setup can be seen in Figure 1. Each participant observed the simulation on a 4:3 computer screen, the software randomly mirrored the participant's view such that the participant approached the merge point from the left or the right. Participants controlled their vehicle using the pedals of a Logitech Driving Force GT steering wheel. This steering wheel also provided vibration feedback to the participants when they deviated from their initial velocity. Each participant got Sony WH-1000XM3 noise-canceling headphones to prevent them from hearing (the vibration feedback of) the other participant. A playlist of openly available background music was played on the headphones, this playlist can be found on GitHub. The participants were seated at separate tables and divided by a black screen to prevent them from seeing each other. The experimenter could observe both participants and control the simulation from a single laptop. The software used for the experiment can be found on GitHub.

Participants were instructed to maintain their initial velocity, but to avoid collisions. When the vehicles did collide, the participants got a time penalty of 20 seconds. This is longer than the duration of a trial, which takes approximately 16 seconds. Furthermore, participants were instructed to remain seated, use one foot on the gas or brake pedal, keep both hands on the steering wheel, and not to communicate by making sounds or noise. Finally, participants were told that this is a scientific experiment, not a game or a race, and that no vehicle had the right of way.

The experiment consisted of 11 experimental conditions. Two variables were varied: the initial velocities of the vehicles (where the average was always 10 m/s), and the projected headway when the first vehicle reaches the merge point (assuming that the vehicles will maintain their initial velocity). Given these two parameters, the starting positions of the vehicles can be calculated.

Figure 1: The used experimental setup as seen from the view of one of the participants.
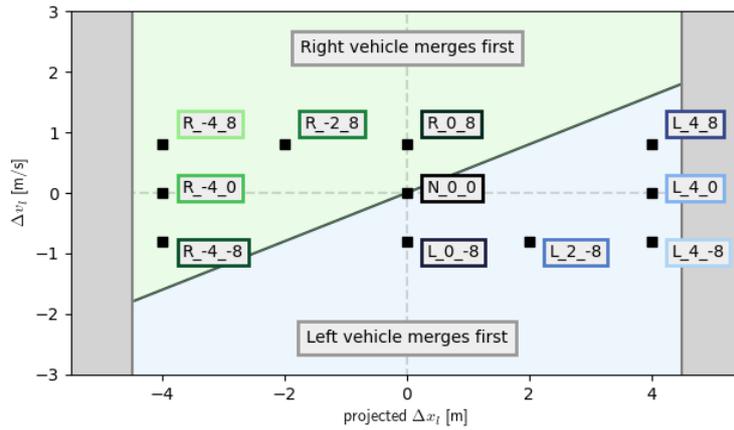
Figure 1: a visualization of the condition-space. The y-axis shows the relative velocity of the vehicles where a positive number indicates the left vehicle has a higher velocity. The x-axis shows the projected headway at the merge point assuming that both vehicles maintain their velocity. A positive number indicates the left vehicle is going first. The grey areas on the left and right sides represent the conditions space where no conflict is present because the headway at the merge point is larger than the vehicle length. The deviation of the plane into the green (right first) and blue (left first) areas is based on pilot experiments. The black markers indicate the used conditions with their names. These are placed symmetrically around the estimated threshold line.

This two-dimensional condition space can be visualized to obtain insight into the relationship between conditions (see Figure 2). Based on a pilot experiment, we estimated the regions of the condition-space where the left and right vehicles merge first most of the time. These regions are indicated in green and blue in Figure 3. The 11 conditions are placed symmetrically around the estimated threshold between these regions. The conditions are named with three characters. The letter corresponds to the expected vehicle to merge first (R for right, L for left, and N for neutral). The first number denotes the projected headway at the merge point in meters (positive means left is ahead). The second number denotes the relative velocity between the vehicles in decimals (dm/s). All conditions were repeated 10 times in random order for every pair of participants. 5 additional trials from random conditions were used at the start of the experiment as training runs.