



An exhaustive method to iteratively discover & mine traffic scenarios from large Trajectory Data

¹*Imanol Irizar Da Silva, Germany, ²Fin Malte Heuer

*lead presenter

¹ Imanol.IrizarDaSilva@dlr.de, DLR (German Aerospace Center), Institute for Transportation Systems

² DLR (German Aerospace Center), Institute for Transportation Systems

Traffic on freeways is generally very safe and represents a large proportion of the total traffic mileage in each year. Its characteristics make it an easier target than an urban environment for developing and testing automated cars (SAE level 3-5) which is currently cutting-edge research and development in the automotive branch. In this context our motivation is to generate a catalogue of the traffic scenarios found on the German Autobahn (freeway without speed limits) using the naturalistic vehicle trajectory data from the Testbed Lower Saxony (TFNDS), and to develop methods for the mining of the different scenarios from large trajectory data sources.

First, a smaller amount of interactions is extracted from the large trajectory data, by using an automated algorithm in order to be able to manually label the scenarios. The algorithm should therefore be simple and fast but produce no false negatives, because missing valid scenarios will prevent the catalogue from being complete. We used an algorithm that considered a pair of trajectories as a valid interaction when they were closer than 100m over 3 seconds because the UNECE 157 standard for automated driving systems defines an interaction with a Time Headway (THW) of 2 seconds (around 70m) whereas research shows that trajectories can interact up to a distance of 100 to 150 meters (3 to 4.5 seconds of THW).

Second, the found interactions are manually labeled & counted to outline the scenarios that occur in our dataset, as well as gain other insights from this process. A previous feasibility analysis with 30 minutes of data returned 122 valid interactions that were labeled as in Table 1. Two insights were gained: that there is an inherent hierarchy from more abstract to more concrete scenarios and that the scenarios very rarely happen isolated from other interactions.

Cut in	Cut out	Passing	Platoon	Full overtakes	Overtake start	Overtake end	Parallel driving trucks	Overtake after being overtaken
2	1	74	29	2	10	6	14	12

Table 1

Third, methods are developed to automatically mine each one of the scenarios from large data with the least amount possible of false positives and negatives. The previously manually labeled scenarios are used as ground truth.

Finally, the first simple step of mining of traffic interactions will be repeated over a new batch of data. The previous scenarios will be automatically added to the database and the rest are



new scenarios whose mining will be automatized too. This process can be iterated ad infinitum and because the researcher manually labels and automatizes the new scenarios from each batch of data, this is an exhaustive method of discovering scenarios. The process can be seen in Diagram 1.

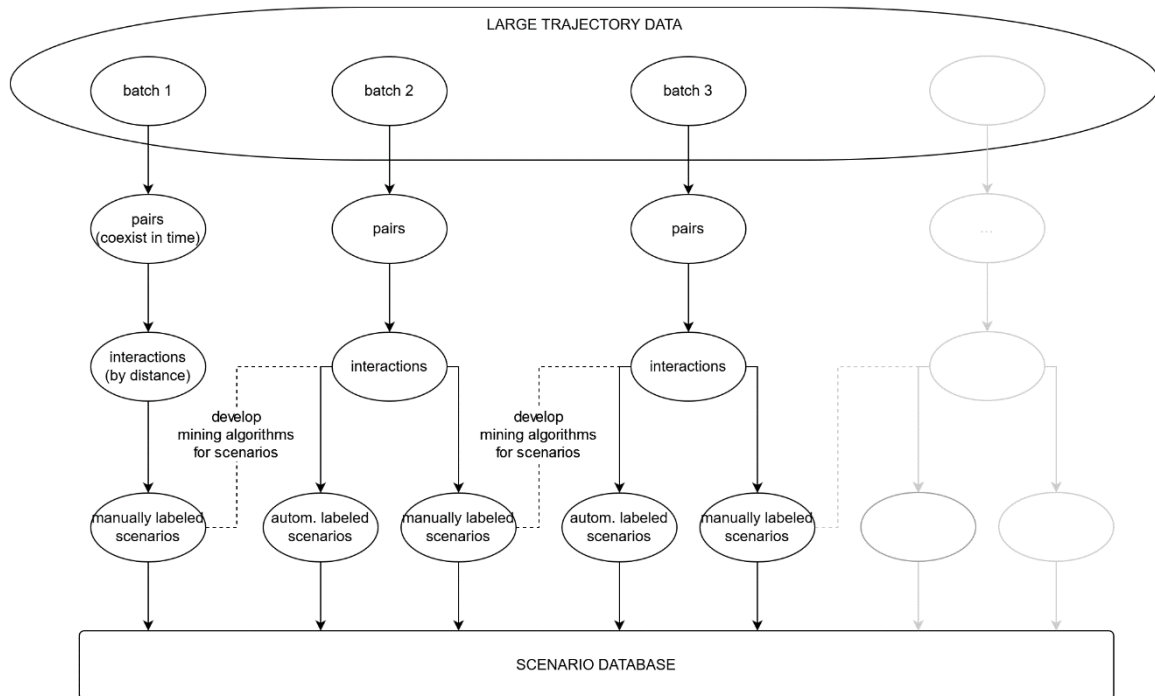


Diagram 1

The results of the study are:

- A simple method to find traffic interactions in large trajectory data.
- A catalogue of the scenarios found in naturalistic vehicle trajectory data from the German Autobahn.
- The prevalence of each scenario in the catalogue.
- The co-occurrence of the scenarios in the catalogue.
- Methods to automatically mine these scenarios from large trajectory data.
- An exhaustive method to iteratively discover and mine new scenarios from large trajectory data.

In conclusion, an extensive catalogue of the scenarios found in naturalistic trajectory data from a German Autobahn (TFNDS) was generated, as well as the algorithms to mine each one. Furthermore, an exhaustive method to iteratively discover and mine new scenarios from any large trajectory data source was developed and tested with real data. This is currently one of the leading topics in the traffic safety research and our method is a simple and effective way for researchers to make the jump from the trajectory level of analysis to the interaction level without missing valuable scenarios.