exiD Dataset Format

The exiD dataset includes data extracted from 7 recording sites. In total four files are provided for each recording:

- An image of the recorded road section (XX_background.png)
- A csv file describing the recording location (XX_recordingsMeta.csv)
- A csv file containing an overview of recorded vehicle and VRU tracks (XX_tracksMeta.csv)
- A csv file for the tracks' trajectories (XX_tracks.csv)

These files are created for each recording to ensure easy handling of the data. In the following, the dataset format and especially the meaning of every column is explained in detail.

In addition to these four files per recording, maps for the 7 recording locations are also provided:

- Lanelet2 maps (.osm)
- OpenDrive maps (.xodr)

Image of the Road Section (XX_background.png)

For each recording an georeferenced image of the road section is added. The image was created from the used recording itself by removing all moving vehicles through a filter. Additionally the resolution of the image was reduced.
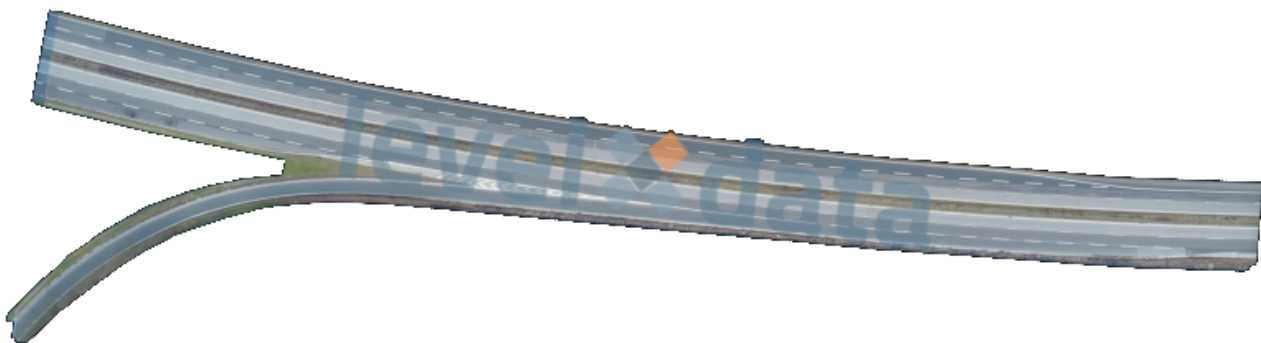
Recording Meta Information (XX_recordingMeta.csv)

This file contains metadata for each recording. The metadata provides a general overview, e.g. of the time of recording, the road section considered and the total number of objects tracked.

Name	Description	Unit
recordingId	The ID of the recording. Every recording has a unique ID.	[-]
locationId	The ID of the recording location.	[-]
frameRate	The frame rate which was used to record the video.	[Hz]
speedLimit	The speed limit of the driving lanes.	[m/s]
weekday	The weekday the recording was done.	[-]
startTime	The hour at which the recording was started.	[hh]
duration	The duration of the recording.	[s]
numTracks	The number of objects tracked.	[-]
numVehicles	The number of vehicles tracked.	[-]
numVRUs	The number of vulnerable road users (VRUs) tracked.	[-]
latLocation	Rough latitude coordinates of recording location. **Not the same point as the UTM coordinates below!**	[deg]
lonLocation	Rough longitude coordinates of recording location. **Not the same point as the UTM coordinates below!**	[deg]
xUtmOrigin	X value of UTM coordinate of origin of the local coordinate system for this recording location. Add this to xCenter to get UTM coordinates. See below for more information on the coordinate system.	[m]
yUtmOrigin	Y value of UTM coordinate of origin of the local coordinate system for this recording location. Add this to yCenter to get UTM coordinates. See below for more information on the coordinate system.	[m]
orthoPxToMeter	Scale factor from ortho image pixels to UTM meters. This value is needed for visualization.	[m/px]

Track Meta Information (XX_tracksMeta.csv)

This file contains an overview of all tracks. The purpose of this file is to allow to filter tracks e.g. by class.

Name	Description	Unit
recordingId	The ID of the recording. Every recording has a unique ID.	[-]
trackId	The ID of the track. The IDs are assigned in ascending order for each recording.	[-]
initialFrame	The frame in which the track starts.	[-]
finalFrame	The frame in which the track ends.	[-]
numFrames	The total lifetime in frames.	[-]
width	The width of the tracked object. This property is set to zero for VRUs.	[m]
length	The length of the tracked object. This property is set to zero for VRUs.	[m]
class	The class of the tracked object.	[-]

Tracks (XX_tracks.csv)

This file contains all time dependent values for each track. Information such as current position, velocity and acceleration.

| Name	Description	Unit
recordingId	The ID of the recording. Every recording has a unique ID.	[-]
trackId	The ID of the track. The IDs are assigned in ascending order for each recording.	[-]
frame	The frame for which the information are given.	[-]
trackLifetime	The current age of the track at this frame.	[-]
xCenter	The x position of the object's centroid in the local coordinate system. Add xUtmOrigin to get UTM coordinates.	[m]
yCenter	The y position of the object's centroid in the local coordinate system. Add yUtmOrigin to get UTM coordinates.	[m]
heading	The heading in the local coordinate system.	[deg]
width	The width of the tracked object (0 for VRUs).	[m]
length	The length of the tracked object (0 for VRUs).	[m]
xVelocity	The velocity in x-axis direction in the local coordinate system.	[m/s]
yVelocity	The velocity in y-axis direction in the local coordinate system.	[m/s]
xAcceleration	The acceleration in x-axis direction in the local coordinate system.	[m/s²]
yAcceleration	The acceleration in y-axis direction in the local coordinate system.	[m/s²]
lonVelocity	The longitudinal velocity.	[m/s]
latVelocity	The lateral velocity.	[m/s]
lonAcceleration	The longitudinal acceleration.	[m/s²]
latAcceleration	The lateral acceleration.	[m/s²]
traveledDistance (since v2.0)	The accumulated distance covered by the track up to this point in time.	[m]
latLaneCenterOffset (since v2.0)	Lateral offset of the vehicle's centroid to the closest point on the centerline of the lanelet the vehicle is currently driving in. Semicolon-separated list with values for each lanelet the vehicle is currently in. (*)	[m]
laneWidth (since v2.0)	Width of the lane at the current centroid position of the vehicle. Semicolon-separated list with values for each lanelet the vehicle is currently in. (*)	[m]
laneletId (since v2.0)	Semicolon-separated list of the IDs of the lanelets the vehicle is currently driving in according to the Lanelet2 map. Determined by the vehicle's centroid position. (*)	[-]
laneChange (since v2.0)	Whether the lane was changed in lateral direction. First frame, in which the centroid is in the new lane.	{0,1}
lonLaneletPos (since v2.0)	Length of the segments of the centerline from the start of the lanelet to the closest point on the centerline from the vehicle's centroid. Semicolon-separated list with values for each lanelet the vehicle is currently in. (*)	[m]
laneletLength (since v2.0)	Length of the complete centerline of the lanelet the vehicle is currently driving in. Semicolon-separated list with values for each lanelet the vehicle	[m]

	is currently in. **(*)**	
leadDHW (since v2.0)	Distance Headway from the front bumper of the current vehicle to the rear bumper of its lead vehicle (default value: -1).	[m]
leadDV (since v2.0)	Relative velocity between the current vehicle and its lead vehicle. Positive if the current vehicle is faster than lead (default value: -1000).	[m/s]
leadTHW (since v2.0)	Time Headway from the front bumper of the current vehicle to the rear bumper of its lead vehicle (default value: -1).	[s]
leadTTC (since v2.0)	Time-to-Collision from the front bumper of the current vehicle to the rear bumper of its lead vehicle (default value: -1).	[s]
leadId (precedingId before v2.0)	The ID of the lead vehicle in the same lane (default value: -1). **(**)** This and the following *surrounding vehicle IDs* are best visualized using the drone-dataset-tools.	[-]
rearId (followingId before v2.0)	The ID of the rear vehicle in the same lane (default value: -1). **(**)**	[-]
leftLeadId (leftPrecedingId before v2.0)	The ID of the lead vehicle in the left adjacent lane in travel direction or in one of its further left adjacent lanes (default value: -1). **(*)**	[-]
leftAlongsideId	Semicolon-separated list of the IDs of the alongside vehicles (with longitudinal overlap) to the left of the vehicle in travel direction or in one of its further left adjacent lanes (default value: empty). **(**)**	[-]
leftRearId (leftFollowingId before v2.0)	The ID of the rear vehicle in the left adjacent lane in travel direction or in one of its further left adjacent lanes (default value: -1). **(*)**	[-]
rightLeadId (rightPrecedingId before v2.0)	The ID of the lead vehicle in the right adjacent lane in travel direction or in one of its further right adjacent lanes (default value: -1). **(*)**	[-]
rightAlongsideId	Semicolon-separated list of the IDs of the alongside vehicles (with longitudinal overlap) to the right of the vehicle in travel direction or in one of its further left adjacent lanes (default value: empty). **(**)**	[-]
rightRearId (rightFollowingId before v2.0)	The ID of the rear vehicle in the right adjacent lane in travel direction or in on of its further right adjacent lanes (default value: -1). **(*)**	[-]
odrRoadId (roadId before v2.0)	The ID of the road the vehicle is currently driving on according to the OpenDRIVE map.	[-]
odrSectionNo (section before v1.2)	The number of the section of the road the vehicle is currently driving on according to the OpenDRIVE map (1-based index). (Deprecated and removed since v1.2, reintroduced in v2.0)	[-]
odrLaneId (laneId before v2.0)	The ID of the lane the vehicle is currently driving on according to the OpenDRIVE map.	[-]
simpleLaneId (before v1.2)	(Deprecated and removed since v1.2)	[-]
distToLeftLaneMarking (before v2.0)	Closest distance from a bounding box corner of the tracked object to the left lane marking of the lane the object is currently driving on.	[-]

	This value is negative if a part of the bounding box is reaching over the left lane marking of the current lane. (Deprecated and removed since v2.0, use *latLaneCenterOffset* and *laneWidth* instead.)	
distToRightLaneMarking (before v2.0)	Closest distance from a bounding box corner of the tracked object to the right lane marking of the lane the object is currently driving on. This value is negative if a part of the bounding box is reaching over the right lane marking of the current lane. (Deprecated and removed since v2.0, use *latLaneCenterOffset* and *laneWidth* instead.)	[-]

(*) For more details on how these values are calculated, check the separate section below.
(**) For more details on how the surrounding vehicle IDs are calculated, check the separate section below.

Coordinate System
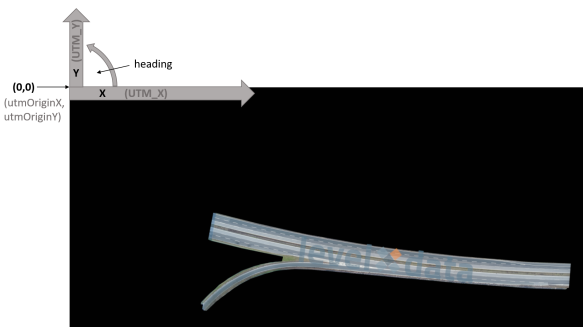
The global coordinate system used is the UTM coordinate system, as we geo-referenced our data. For easier handling of data of the same intersection in different recordings, we introduced a local UTM-like coordinate system. The only difference is, that the origin (0, 0) is very close to the recorded road section and the same for all recordings at each location. To transform positions into the global UTM coordinate system, just add xUtmOrigin and yUtmOrigin to all positions. The local coordinate system looks as follows: The horizontal axis is the x-axis, which grows to the right. The vertical axis is the y-axis, which grows upwards. The heading is calcuated as in the UTM coordinate system. Finally, we use SI units only.

Lane-related Values

The lane-related values are calculated using the Lanelet2 maps. The values are calculated for the bounding box centroid of each vehicle. The following picture visualizes the different values. In constrast to the map in the picture, the width of a lanelet (and especially of following lanelets) is **not** necessarily constant over the complete lanenet. Therefore, the lane width-related values (laneWidth, latLaneCenterOffset) are calculated for each vehicle position individually.
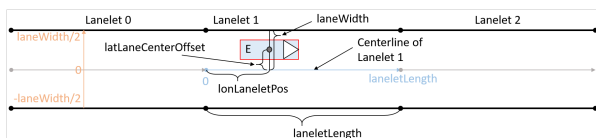

Surrounding Vehicle IDs

The surrounding vehicles are calculated using the Lanelet2 maps. The bounding box centroid of each vehicle is used to determine, in which lanelet it is currently driving. Lanelets with an *lxd_virtual* tag are ignored. The following images

present the concepts of the search algorithms for the surrouding vehicle IDs of an ego vehicle (E). The surrounding vehicle IDs can also be visualized using the drone-dataset-tools.

The lead and rear IDs are calculated as depicted below.
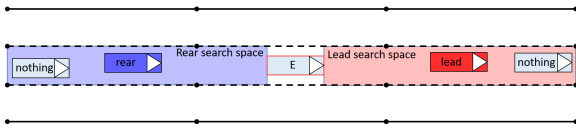
The leftAlongside and rightAlongside IDs are calculated as depicted below.
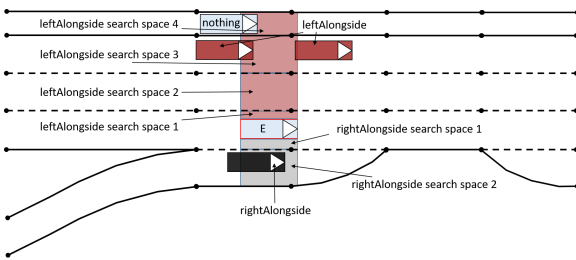
The leftRear, leftLead, rightRear and rightLead IDs are calculated as depicted below.