The Data Cards Playbook

pair-code.github.io/datacardsplaybook
Data Cards Template (Beta) | Updated November 2022

MAN TruckScenes

MAN TruckScenes is the first large-scale multimodal dataset for autonomous trucking. It consists of 747 scenes from typical long-haul truck environments and provides multimodal data with long-range annotations. The dataset comprises data from a state-of-the-art sensor suite, including multiple high-resolution cameras, lidar, and radar sensors to provide full coverage of the surrounding area, along with a high-precision GNSS and two IMU units to support a multitude of applications. MAN TruckScenes covers a large geographical area, three seasons of the year, day and nighttime driving, as well as numerous different weather conditions, including fog, rain, and snow. The dataset includes scenes in logistics terminals and recordings of vehicles with high relative velocities on the German Autobahn to promote the unique challenges of long-haul trucks.

DATASET LINK	DATA CARD AUTHOR(S)
www.man.eu/truckscenes	Fent, Felix
	Kuttenreich, Fabian
	Ruch, Florian
	Rizwin, Farija
	Juergens, Stefan
LICENSE TYPE	**CC BY-NC-SA 4.0**

Authorship

Publishers

PUBLISHING ORGANIZATION(S)	INDUSTRY TYPE(S)	CONTACT DETAIL(S)	
MAN Truck & Bus SE	Corporate - Tech	**Contact:**	MAN Truck & Bus SE Dachauer Straße 667 80995 München
		Mail:	truckscenes@man.eu
		Website:	www.man.eu
Technical University of Munich	Academic - Tech	**Affiliation:**	Institute of Automotive Technology School of Engineering & Design
		Contact:	Technical University of Munich Boltzmannstr. 15 85748 Garching
		Website:	www.mos.ed.tum.de/ftm

Dataset Owners

CONTACT DETAIL(S)	AUTHOR(S)
Dataset Owner: MAN Truck & Bus SE **Contact:** MAN Truck & Bus SE Dachauer Straße 667 80995 München **E-Mail:** truckscenes@man.eu **Website:** www.man.eu	Fent, Felix – Technical University of Munich Kuttenreich, Fabian – MAN Truck & Bus SE Ruch, Florian – MAN Truck & Bus SE Rizwin, Farija – MAN Truck & Bus SE Juergens, Stefan – MAN Truck & Bus SE Lechermann, Lorenz – MAN Truck & Bus SE Nissler, Christian – MAN Truck & Bus SE Perl, Andrea – MAN Truck & Bus SE Voll, Ulrich – MAN Truck & Bus SE Yan, Min – MAN Truck & Bus SE Lienkamp, Markus – Technical University of Munich

Funding Sources

INSTITUTION(S)	FUNDING OR GRANT SUMMARY(IES)
Federal Ministry for Economic Affairs and Climate Action	*Partially funded by the government-supported ATLAS-L4 project with grand no. 19A21048I.*

Dataset Overview

DATA SUBJECT	DATASET SNAPSHOT		CONTENT DESCRIPTION
Data about places and objects	Size of Dataset	784 GB	MAN TruckScenes is the first large-scale dataset for autonomous trucking. It comprises data from a state-of-the-art sensor suite, including 4 high-resolution cameras, 6 lidar, and 6 radar sensors to provide full coverage of the surrounding area. In addition, the data of a high-precision GNSS and 2 IMU units are included. The sensor data is provided as JPEG, PCD, and JSON files. The dataset provides high-quality annotations for 747 scenes. These annotations consist of manually annotated 3D bounding boxes with unique instance identifiers for object tracking, standardized scene tags, and attribute labels to indicate the object's state. The data and annotation format are based on the nuScenes format.
	Number of Scenes	747	
	Number of Sample	29862	
	Number of Sample Data	6230622	
	Number of Sample Annotation	1013090	
	Number of Instances	53866	
	Number of Sensors	18	
	Number of Calibrated Sensors	18	
	Number of Categories	27	
	Number of Attributes	15	
	Number of Visibilities	4	
	Number of Tags	34	
	Average Annotations Per Sample	33.93	
	Average Annotations Per Instance	18.81	
	Algorithmic Annotations	0	
	Human Annotations	1013090	

Sensitivity of Data

SENSITIVITY TYPE(S)	FIELD(S) WITH SENSITIVE DATA		SECURITY AND PRIVACY HANDLING
Anonymous Data	**Anonymized Sensitive Data**		**Blurring:** All human faces and vehicle registration plates have been blurred in all camera images. The anonymization was done automatically and has been checked manually. This process was subject to a dual control cycle. **Randomization:** All timestamps were randomly changed, but temporal consistency was ensured. **Additional Notes:** All sensitive data has been anonymized.

Field Name	Description
Sample Data	Camera sensor data contains human faces and vehicle registration plates
Ego Pose	GNSS data contains position and timestamp information
Ego Motion Cabin	IMU data contains timestamp information
Ego Motion Chassis	IMU data contains timestamp information

Dataset Version and Maintenance

MAINTENANCE STATUS	VERSION DETAILS	MAINTENANCE PLAN
Actively Maintained (No new versions will be made available, but this dataset will be actively maintained, including but not limited to updates to the data.)	**Current Version:** 1.0 **Release Date:** 06/2024	**Versioning:** New versions will be made available if significantly new features are added to the dataset. **Errors:** Errors will be eliminated and result in a minor version update. **Feedback:** Feedback can be given as issues in the devkit.

Data Points

PRIMARY DATA MODALITY	DATA FIELDS	
Multimodal (Camera, Lidar, Radar)	**File Name**	**Description**
	attribute.json	An attribute is a property of an instance that can change while the category remains the same.
	calibrated_sensor.json	Definition of a particular sensor as calibrated on a particular vehicle. All extrinsic parameters are given with respect to the ego vehicle body frame. All camera images come undistorted and rectified.
	category.json	Taxonomy of object categories. Subcategories are delineated by a period
	ego_motion_cabin.json	Ego vehicle cabin motion at a particular timestamp. Given with respect to vehicle coordinate system.
	ego_motion_chassis.json	Ego vehicle chassis motion at a particular timestamp. Given with respect to vehicle coordinate system.
	ego_pose.json	Ego vehicle pose at a particular timestamp. Given with respect to global coordinate system.
	instance.json	An object instance tracked across sample.
	sample.json	A sample is an annotated keyframe at 2 Hz.
	sample_annotation.json	A bounding box defining the position of an object seen in a sample. All location data is given with respect to the global coordinate system.
	sample_data.json	A sensor data object.
	scene.json	A scene is a 20s long sequence of consecutive frames extracted from a measurement drive.
	sensor.json	A specific sensor type.
	visibility.json	The visibility of an instance is the fraction of annotation visible in all 4 images. Binned into 4 bins.

DATA FIELD DEFINITION(S)

attribute

```
attribute {
    "token":                <str> -- Unique record identifier.
    "name":                 <str> -- Attribute name.
    "description":          <str> -- Attribute description.
}
```

calibrated_sensor

```
calibrated_sensor {
   "token":                  <str> -- Unique record identifier.
   "sensor_token":           <str> -- Foreign key pointing to the sensor type.
   "translation":            <float> [3] -- Coordinate system origin in meters: x, y, z.
   "rotation":               <float> [4] -- Coordinate system orientation as quaternion:
                             w, x, y, z.
   "camera_intrinsic":       <float> [3, 3] -- Intrinsic camera calibration. Empty for
                             sensors that are not cameras.
}
```

category

```
category {
   "token":                  <str> -- Unique record identifier.
   "name":                   <str> -- Category name. Subcategories indicated by period.
   "description":            <str> -- Category description.
   "index":                  <int> -- The index of the label used for efficiency
                             reasons.
}
```

ego_motion_cabin

```
ego_motion_cabin {
   "token":                  <str> -- Unique record identifier.
   "timestamp":              <int> -- Unix time stamp.
   "vx":                     <float> -- Velocity in x direction given in meters per
                             second (m/s).
   "vy":                     <float> -- Velocity in y direction given in meters per
                             second (m/s).
   "vz":                     <float> -- Velocity in z direction given in meters per
                             second (m/s).
   "ax":                     <float> -- Acceleration in x direction given in meters per
                             second squared (m/s^2).
   "ay":                     <float> -- Acceleration in y direction given in meters per
                             second squared (m/s^2).
   "az":                     <float> -- Acceleration in z direction given in meters per
                             second squared (m/s^2).
   "yaw":                    <float> -- Yaw angle around the z axis given in rad.
   "pitch":                  <float> -- Pitch angle around the y axis given in rad.
   "roll":                   <float> -- Roll angle around the x axis given in rad.
   "yaw_rate":               <float> -- Yaw rate around the z axis given in rad per
                             second.
   "pitch_rate":             <float> -- Pitch rate around the z axis given in rad per
                             second.
   "roll_rate":              <float> -- Roll rate around the z axis given in rad per
                             second.
}
```

ego_motion_chassis

```
ego_motion_chassis {
   "token":                    <str> -- Unique record identifier.
   "timestamp":                <int> -- Unix time stamp.
   "vx":                       <float> -- Velocity in x direction given in meters per
                               second (m/s).
   "vy":                       <float> -- Velocity in y direction given in meters per
                               second (m/s).
   "vz":                       <float> -- Velocity in z direction given in meters per
                               second (m/s).
   "ax":                       <float> -- Acceleration in x direction given in meters per
                               second squared (m/s^2).
   "ay":                       <float> -- Acceleration in y direction given in meters per
                               second squared (m/s^2).
   "az":                       <float> -- Acceleration in z direction given in meters per
                               second squared (m/s^2).
   "yaw":                      <float> -- Yaw angle around the z axis given in rad.
   "pitch":                    <float> -- Pitch angle around the y axis given in rad.
   "roll":                     <float> -- Roll angle around the x axis given in rad.
   "yaw_rate":                 <float> -- Yaw rate around the z axis given in rad per
                               second.
   "pitch_rate":               <float> -- Pitch rate around the z axis given in rad per
                               second.
   "roll_rate":                <float> -- Roll rate around the z axis given in rad per
                               second.
}
```

ego_pose

```
ego_pose {
   "token":                    <str> -- Unique record identifier.
   "translation":              <float> [3] -- Coordinate system origin in meters: x, y, z.
                               Note that z is always 0.
   "rotation":                 <float> [4] -- Coordinate system orientation as quaternion:
                               w, x, y, z.
   "timestamp":                <int> -- Unix time stamp.
}
```

instance

```
instance {
   "token":                    <str> -- Unique record identifier.
   "category_token":           <str> -- Foreign key pointing to the object category.
   "nbr_annotations":          <int> -- Number of annotations of this instance.
   "first_annotation_token":   <str> -- Foreign key. Points to the first annotation of
                               this instance.
   "last_annotation_token":    <str> -- Foreign key. Points to the last annotation of this
                               instance.
}
```

sample

```
sample {
   "token":                 <str> -- Unique record identifier.
   "timestamp":             <int> -- Unix time stamp.
   "scene_token":           <str> -- Foreign key pointing to the scene.
   "next":                  <str> -- Foreign key. Sample that follows this in time.
                            Empty if end of scene.
   "prev":                  <str> -- Foreign key. Sample that precedes this in time.
                            Empty if start of scene.
}
```

sample_annotation

```
sample_annotation {
   "token":                 <str> -- Unique record identifier.
   "sample_token":          <str> -- Foreign key. NOTE: this points to a sample NOT a
                            sample_data since annotations are done on the sample level
                            taking all relevant sample_data into account.
   "instance_token":        <str> -- Foreign key. Which object instance is this
                            annotating. An instance can have multiple annotations over
                            time.
   "attribute_tokens":      <str> [n] -- Foreign keys. List of attributes for this
                            annotation. Attributes can change over time, so they belong
                            here, not in the instance table.
   "visibility_token":      <str> -- Foreign key. Visibility may also change over time.
                            If no visibility is annotated, the token is an empty
                            string.
   "translation":           <float> [3] -- Bounding box location in meters as center_x,
                            center_y, center_z.
   "size":                  <float> [3] -- Bounding box size in meters as width,
                            length, height.
   "rotation":              <float> [4] -- Bounding box orientation as quaternion: w,
                            x, y, z.
   "num_lidar_pts":         <int> -- Number of lidar points in this box. Points are
                            counted during the lidar sweep identified with this sample.
   "num_radar_pts":         <int> -- Number of radar points in this box. Points are
                            counted during the radar sweep identified with this sample.
                            This number is summed across all radar sensors without any
                            invalid point filtering.
   "next":                  <str> -- Foreign key. Sample annotation from the same
                            object instance that follows this in time. Empty if this is
                            the last annotation for this object.
   "prev":                  <str> -- Foreign key. Sample annotation from the same
                            object instance that precedes this in time. Empty if this
                            is the first annotation for this object.
}
```

sample_data

```
sample_data {
   "token":                  <str> -- Unique record identifier.
   "sample_token":           <str> -- Foreign key. Associated Sample of this sample_data
   "ego_pose_token":         <str> -- Foreign key.
   "calibrated_sensor_token": <str> -- Foreign key.
   "filename":               <str> -- Relative path to data-blob on disk.
   "fileformat":             <str> -- Data file format.
   "width":                  <int> -- If the sample data is an image, this is the image
                                      width in pixels.
   "height":                 <int> -- If the sample data is an image, this is the image
                                      height in pixels.
   "timestamp":              <int> -- Unix time stamp.
   "is_key_frame":           <bool> -- True if sample_data is part of key_frame.
   "next":                   <str> -- Foreign key. Sample data from the same sensor that
                                      follows this in time. Empty if end of scene.
   "prev":                   <str> -- Foreign key. Sample data from the same sensor that
                                      precedes this in time. Empty if start of scene.
}
```

scene

```
scene {
   "token":                  <str> -- Unique record identifier.
   "name":                   <str> -- Short string identifier.
   "description":            <str> -- List of scene tags according to seven distinct
                                      categories separated by semicolon.
   "log_token":              <str> -- Foreign key. Always empty.
   "nbr_samples":            <int> -- Number of samples in this scene.
   "first_sample_token":     <str> -- Foreign key. Points to the first sample in scene.
   "last_sample_token":      <str> -- Foreign key. Points to the last sample in scene.
}
```

sensor

```
sensor {
   "token":                  <str> -- Unique record identifier.
   "channel":                <str> -- Sensor channel name.
   "modality":               <str> {camera, lidar, radar} -- Sensor modality.
}
```

visibility

```
visibility {
   "token":                  <str> -- Unique record identifier.
   "level":                  <int> -- Visibility level.
   "description":            <str> -- Description of visibility level.
}
```

Motivations & Intentions

Motivations

PURPOSE(S)	DOMAIN(S) OF APPLICATION	MOTIVATING FACTOR(S)
Research	Autonomous Driving, Perception, Machine Learning, Computer Vision, Object Detection, Object Tracking, Prediction.	- Providing the first multimodal dataset for autonomous trucking. - Allow the research community to come into contact with truck-specific challenges, such as trailer occlusions, novel sensor perspectives, and terminal environments for the first time. - Providing the first dataset with 4D radar data with 360° coverage.

Intended Use

DATASET USE(S)	SUITABLE USE CASE(S)	UNSUITABLE USE CASE(S)
Safe for research use	**Object Detection**: Localization and classification of objects in 3D space. **Object Tracking**: Tracking of 3D objects across time. **Object Prediction**: Prediction of object tracks in 3D space. **Scene Classification**: Classification of environmental conditions. **Additional Notes:** The dataset can also be used for localization, mapping, ego-trailer detection, and articulation angle estimation, even if it was not specifically designed for these use cases.	**Additional Notes:** Currently not known.
	RESEARCH AND PROBLEM SPACE(S)	**CITATION GUIDELINES**

	Autonomous driving perception	``` @article{fent2024,
		  title={ MAN TruckScenes: A multimodal dataset for autonomous trucking in diverse conditions},
		  author={Fent, Felix and Kuttenreich, Fabian and Ruch, Florian and Rizwin, Farija and Juergens, Stefan and Lechermann, Lorenz and Nissler, Christian and Perl, Andrea and Voll, Ulrich and Yan, Min and Lienkamp, Markus},
		  journal={ Proceedings of the Neural Information Processing Systems Track on Datasets and Benchmark},
		  year={2024}
		} ```

Access, Retention, & Wipeout

Access

ACCESS TYPE	DOCUMENTATION LINK(S)	PREREQUISITE(S)
External - Open Access	www.man.eu/truckscenes [Github URL]	None
	POLICY LINK(S)	**ACCESS CONTROL LIST(S)**
	MAN TruckScenes is part of the AWS Open Data Sponsorship Program. The Terms and Conditions of the program apply.	Unrestricted access. Access control and compliance with sanctions and embargos is handled by AWS.

Retention

	DURATION	POLICY SUMMARY
	The dataset availability is guaranteed for at least two years. We aim for a permanent provision of the dataset.	Data retention is subject to the AWS Open Data policies.

Provenance

Collection

METHOD(S) USED	METHODOLOGY DETAIL(S)	SOURCE DESCRIPTION(S)
OEM Collection Efforts	**OEM Collection Efforts** **Platform:** MAN autonomous test truck **Is this source considered sensitive or high-risk?** No **Dates of Collection:** [08 2023- 01 2024] **Primary modality of collected data:** Multimodal (Camera, Lidar, Radar) **Update Frequency for collected data:** Static	**MAN:** Recorded the sensor data and selected the scenes. **b-plus:** Handled the data annotation and quality assurance.

Collection Criteria

DATA SELECTION	DATA INCLUSION	DATA EXCLUSION
Measurement Drives: Measurement drives are part of a dedicated measurement campaign with specially trained test drivers in diverse conditions.	**Novel Category:** Recording of an object category that was previously not included in the dataset. **Novel Tag:** Recording of a scene tag (environmental condition) that was previously not included in the dataset. **Novel Attribute:** Recording of an object attribute that was previously not included in the dataset. **Anormal Scene:** Anormal situation due to the present objects, maneuver, or environment. **Additional Notes:** The selected data should represent long-haul trucks' operational design domain.	**Corrupted Data:** All data that contains dropouts, invariant sampling frequencies, drifts, or synchronization errors are excluded. **Additional Notes:** Data quality is checked automatically and manually.

Extended Use

Use with Other Data

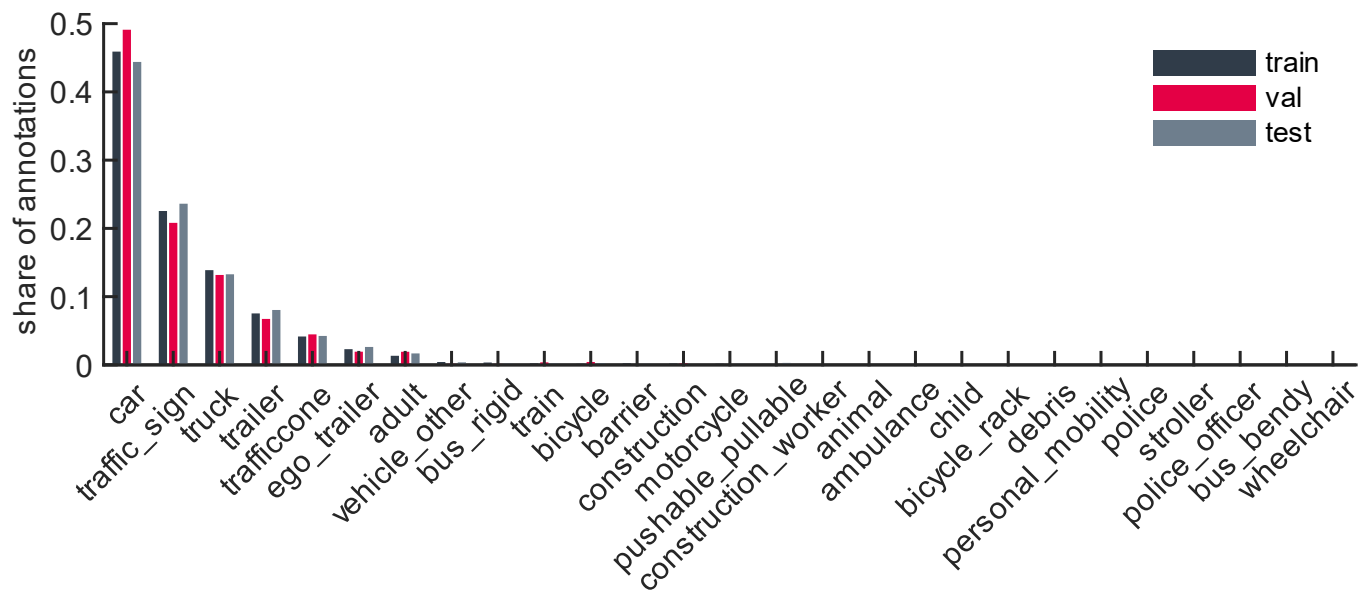
SAFETY LEVEL	KNOWN SAFE DATASET(S) OR DATA TYPE(S)	BEST PRACTICES
Safe to use with other data	**Autonomous Driving Datasets:** Safe to use with other autonomous driving datasets (like nuScenes, Waymo Open Dataset, etc.) for benchmarking, pretraining, or domain adaptation. **Computer Vision Datasets:** Safe to use with other computer vision datasets (like COCO, ImageNet, etc.) for pretraining.	Note that different datasets use different metrics or different configurations of the same metrics.

Use in ML or AI Systems

DATASET USE(S)	NOTABLE FEATURE(S)	USAGE GUIDELINE(S)
Training Validation Testing	**Tutorial:** [Link to Tutorial]	**Usage Guidelines:** The dataset is provided for training and validation purposes. The annotations of the test data are not published.

DISTRIBUTION(S)

Train	523 Scenes
Validation	75 Scenes
Test	149 Scenes

SPLIT STATISTICS

Transformations

Synopsis

TRANSFORMATION(S) APPLIED	FIELD(S) TRANSFORMED	LIBRARY(IES) AND METHOD(S) USED
Converting Data Types Anonymization	**Converting Data Types** | Field Name	Data | |---|---| | Sample Data | Camera images Lidar point clouds Radar point clouds | | Ego Pose | GNSS data | **Anonymization** | Field Name | Data | |---|---| | Sample | Meta data | | Sample Data | Camera images Lidar point clouds | | Ego Pose | GNSS data | | Ego Motion Cabin | IMU data | | Ego Motion Chassis | IMU data |	**Converting Data Types** **Method:** Convert image data to a pinhole camera model and JPEG image compression. **Platforms, tools, or libraries:** Open Computer Vision Library (OpenCV) **Method:** Point cloud data compression. **Platforms, tools, or libraries:** Point Cloud Library (PCL) **Method:** GNSS coordinate system transformation. **Platforms, tools, or libraries:** utm **Anonymization** **Method:** Blurring of human faces and vehicle registration plates in camera image data. **Platforms, tools, or libraries:** Open Computer Vision Library (OpenCV) **Method:** Randomization of timestamp information in meta and sensor data.

Breakdown of Transformations

CONVERTING DATA TYPES	METHOD(S) USED
Camera image data conversion and compression	The camera data of the four camera sensors undergo an undistortion process using a pinhole camera model and a Lanczos interpolation scheme with an 8 x 8 kernel and constant padding values. The resulting image is cropped to a 1980 x 943 pixel size and stored as a compressed JPEG image.
Lidar point cloud data compression	The point cloud data is stored as binary (Marc Lehmann's LZF) compressed data in the point cloud data (pcd) format.
GNSS coordinate system transformation	The GNSS data is transformed to a UTM-WGS84 coordinate system and mapped to cell U32.

ANONYMIZATION	METHOD(S) USED
Blurring of human faces and vehicle registration plates	Human faces and vehicle registration plates are blurred using a polynomial blurring method, which is not further specified to avoid reverse engineering.
Randomization of timestamp information	All timestamps within the meta and sensor data are anonymized randomly. However, temporal consistency is guaranteed for all samples and sensor data.

ANONYMIZATION	METHOD(S) USED

Annotations & Labeling

ANNOTATION WORKFORCE TYPE	ANNOTATION CHARACTERISTIC(S)	ANNOTATION DESCRIPTION(S)
Human Annotations (Expert)	Annotations are made in the form of 3D bounding boxes, object attributes, tracking IDs, and scene tags.	**Instance:** An object instance tracked across samples.

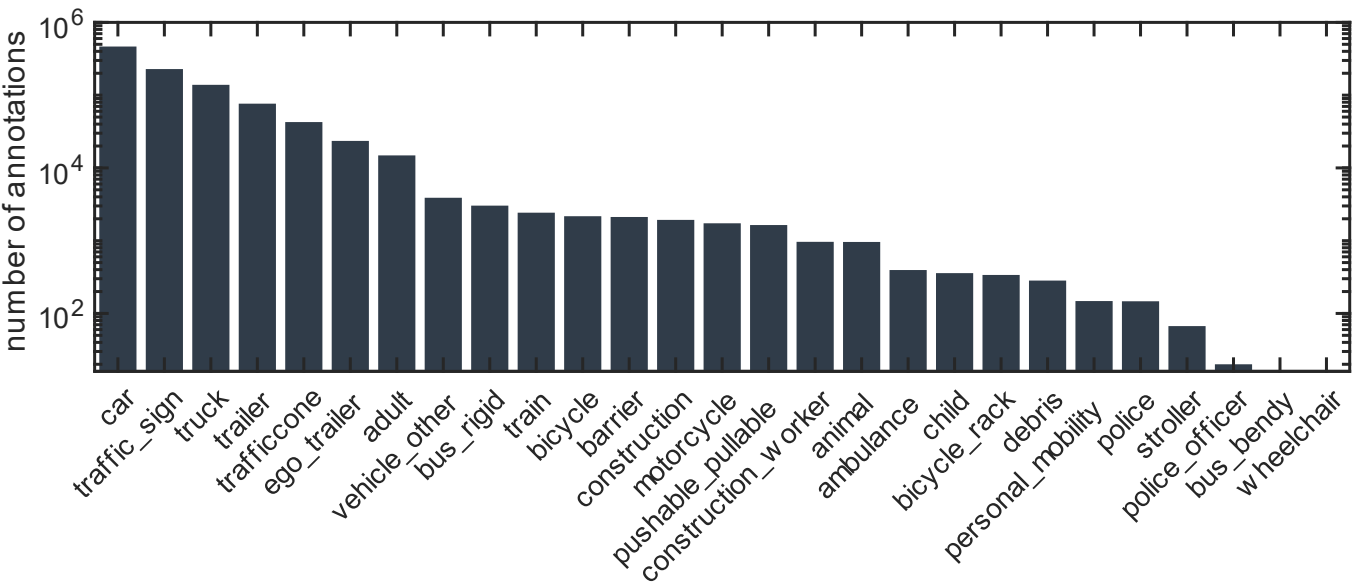
Number of Annotations	1013090
Number of Instances	53866
Average Annotations Per Sample	33.93
Average Annotations Per Instance	18.81

Category: A category is a property of an instance that cannot change over time.

Attribute: An attribute is a property of an instance that can change over time.

Scene Tag: Property of a scene that describes the current environment.

ANNOTATION DISTRIBUTION(S)

Category Distribution

Attribute Distribution

Pedestrian

sitting lying down (2%)
standing (30%)
moving (68%)

Cycle

without rider (26%)
with rider (74%)

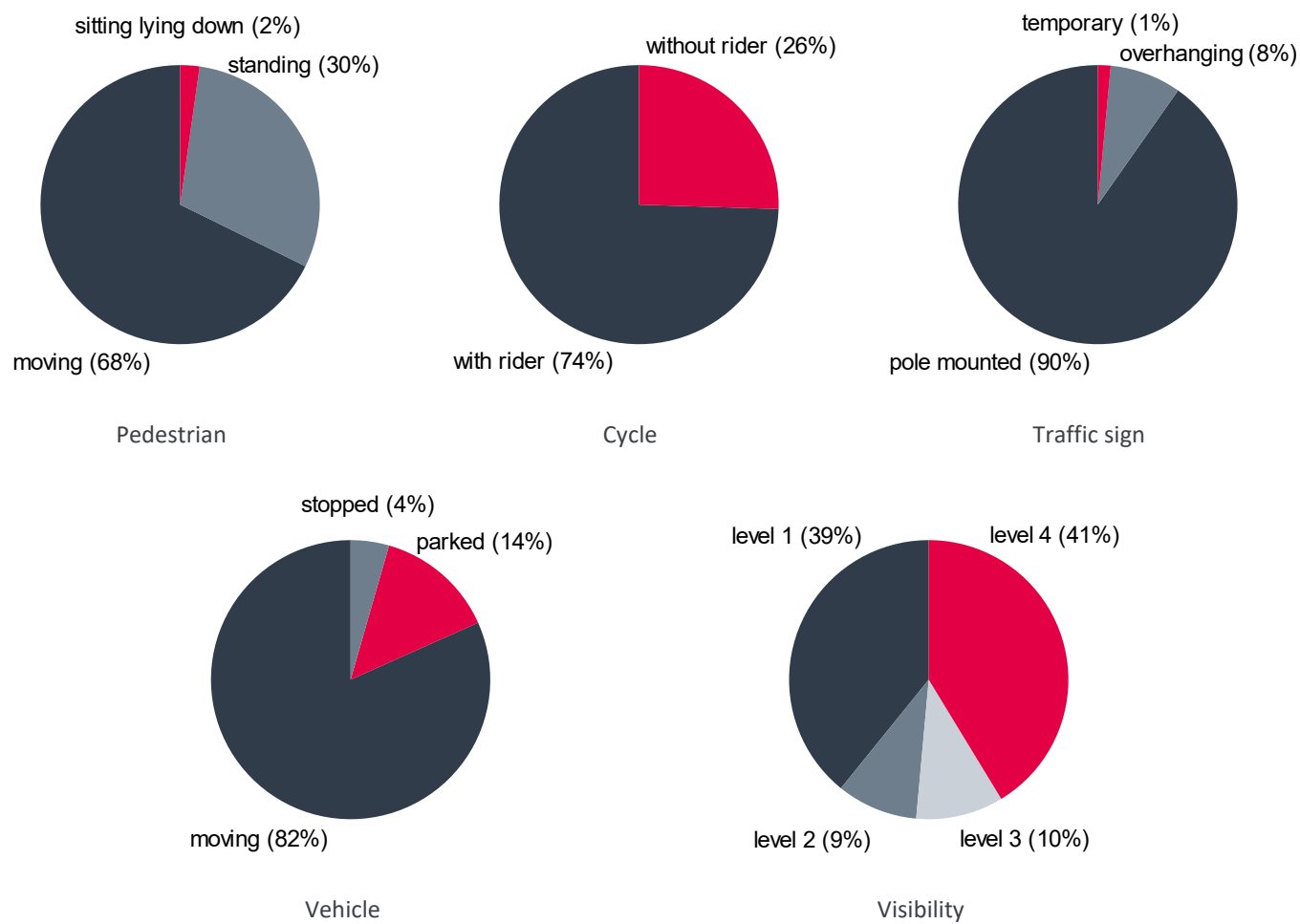
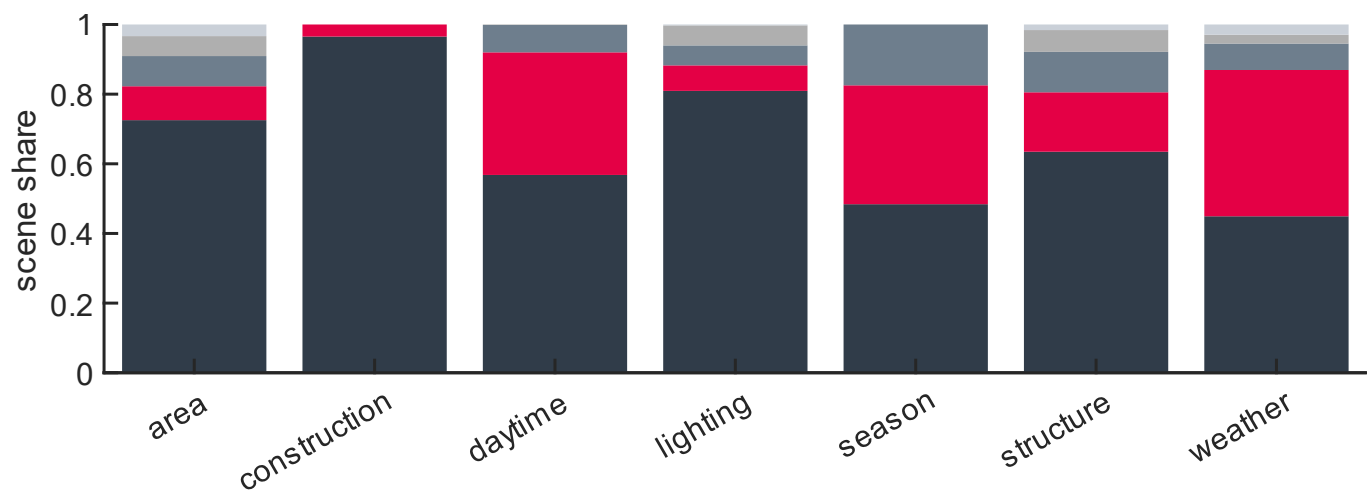
Traffic sign

temporary (1%)
overhanging (8%)
pole mounted (90%)

Vehicle

stopped (4%)
parked (14%)
moving (82%)

Visibility

level 1 (39%)
level 4 (41%)
level 2 (9%)
level 3 (10%)

Scene Tag Distribution

Validation Types

METHOD(S)	BREAKDOWN(S)	DESCRIPTION(S)
Consistency Validation Annotation Validation Anonymization Validation	**Consistency Validation** **Number of Data Points Validated:** 7732152 **Annotation Validation** **Number of Data Points Validated:** 1013090 **Anonymization Validation** **Number of Data Points Validated:** 600848	**Consistency Validation** **Method:** Automated validation of the sensor capturing frequency, sampling frequency, data dropouts, and data integrity. **Annotation Validation** **Method:** Manual and automated validation of the annotation category, position, size, orientation, attributes, and tracking IDs. **Anonymization Validation** **Method:** Manual validation of the anonymization of human faces and vehicle registration plates.

Version	
1.0	Initial Release.

The Data Cards Playbook ↗ by Google Research is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

You are free to share and adapt this work under the appropriate license terms ↗.