

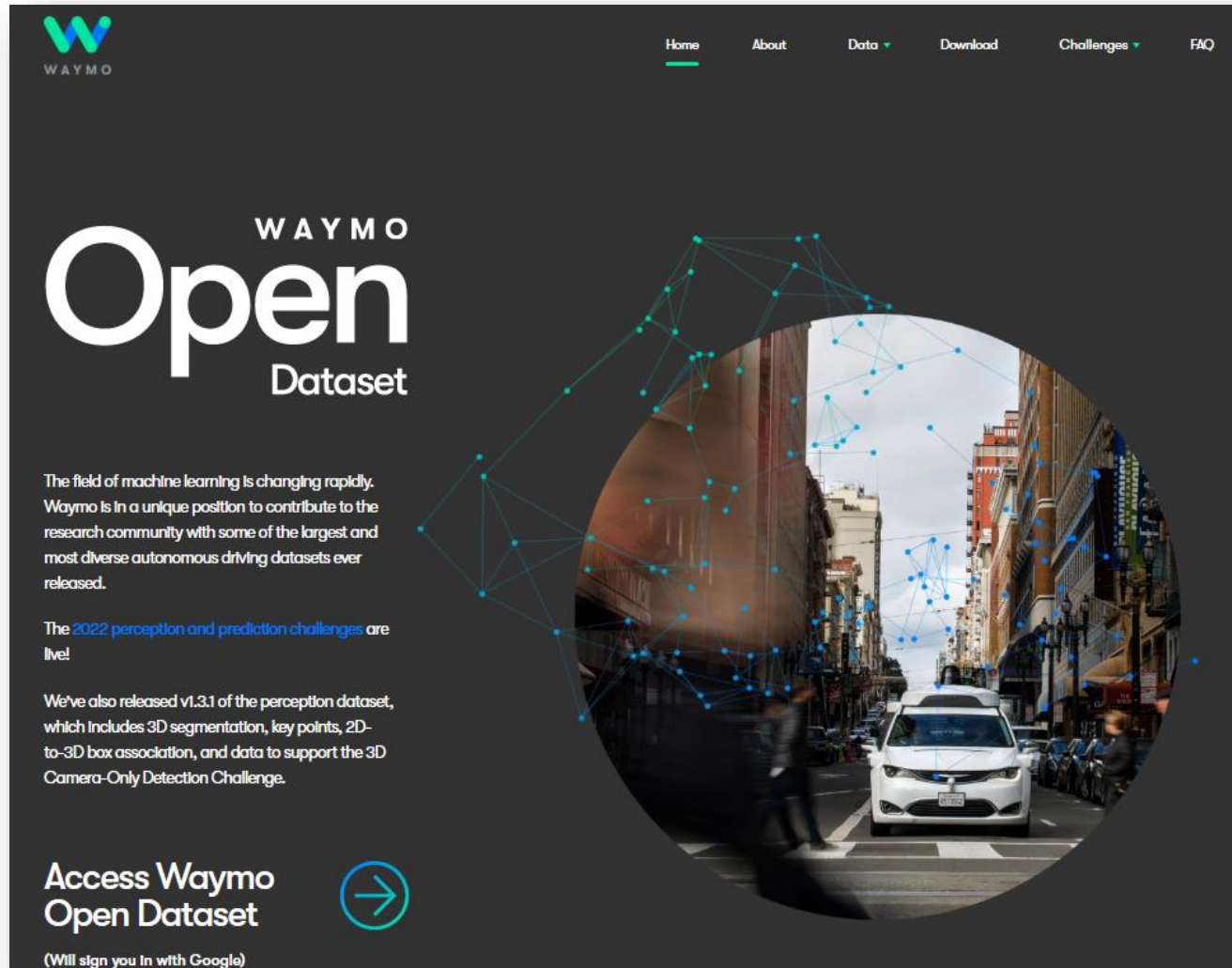
Waymo

Open Dataset *Challenges*

2022/05/10

WAYMO Open Dataset

<https://waymo.com/open>

The banner features the Waymo logo at the top left. The main heading "WAYMO Open Dataset" is prominently displayed. Below it, a paragraph states: "The field of machine learning is changing rapidly. Waymo is in a unique position to contribute to the research community with some of the largest and most diverse autonomous driving datasets ever released." Another paragraph follows: "The 2022 perception and prediction challenges are live!" A third paragraph mentions: "We've also released v1.3.1 of the perception dataset, which includes 3D segmentation, key points, 2D-to-3D box association, and data to support the 3D Camera-Only Detection Challenge." At the bottom left, there is a call to action "Access Waymo Open Dataset" with a right-pointing arrow icon and the text "(Will sign you in with Google)". The background of the banner is a circular image of a city street with a white car in the center, overlaid with a network of blue and green points and lines representing sensor data.

Sensor Specifications

	F	FL,FR	SL,SR
Size	1920x1280	1920x1280	1920x1040
HFOV	$\pm 25.2^\circ$	$\pm 25.2^\circ$	$\pm 25.2^\circ$

Table 3. Camera Specifications for Front (F), Front-Left (FL), Front-Right (FR), Side-Left (SL), Side-Right (SR) cameras. The image sizes reflect the results of both cropping and downsampling the original sensor data. The camera horizontal field of view (HFOV) is provided as an angle range in the x-axis in the x-y plane of camera sensor frame (Figure 1).

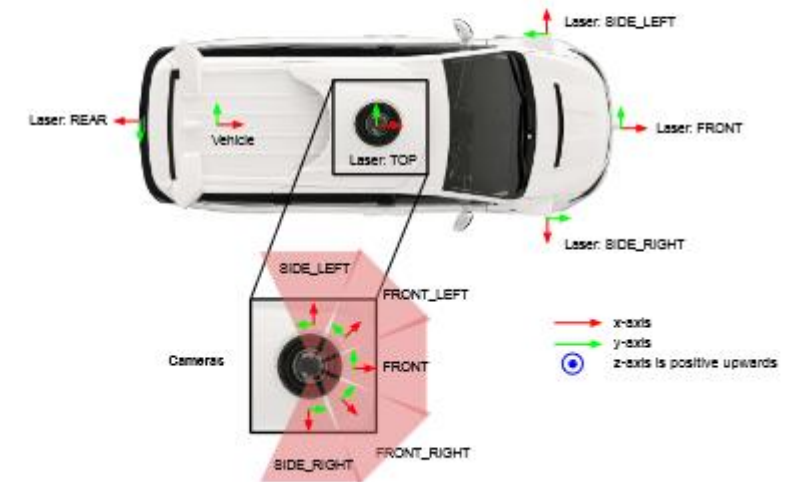


Figure 1. Sensor layout and coordinate systems.

<https://waymo.com/open/about/>

- We have released the Waymo Open Dataset publicly to aid the research community in investigating a wide range of interesting aspects of machine perception and autonomous driving technology.
- The Waymo Open Dataset is composed of two datasets - the perception dataset with high resolution sensor data and labels for 1,950 segments, and the motion dataset with object trajectories and corresponding 3D maps for 103,354 segments.
- In 2022, we expanded the perception dataset to include key points labels, 2D-to-3D association labels, and 3D semantic segmentation labels.



(a) Front-Left



(b) Front



(c) Front-Right

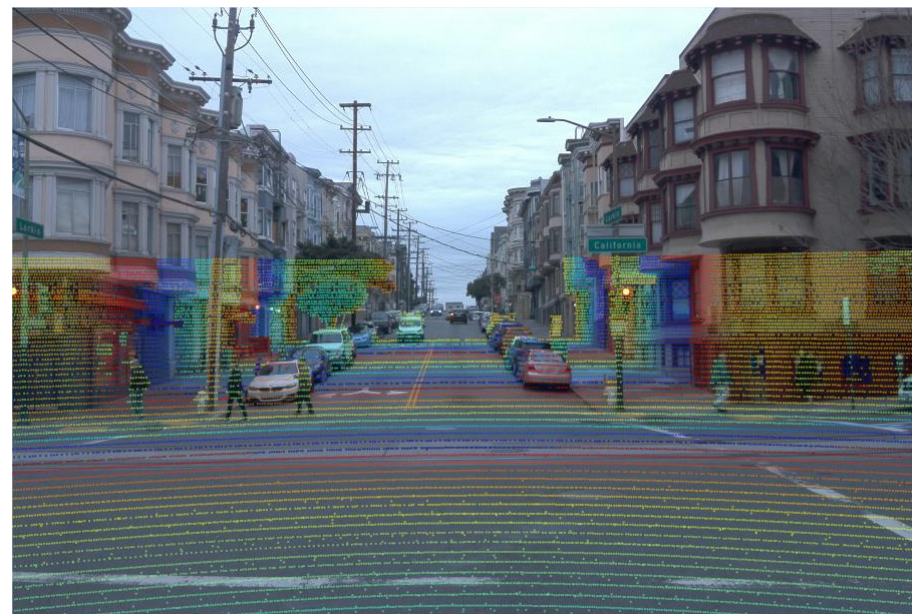


(d) Side-Left

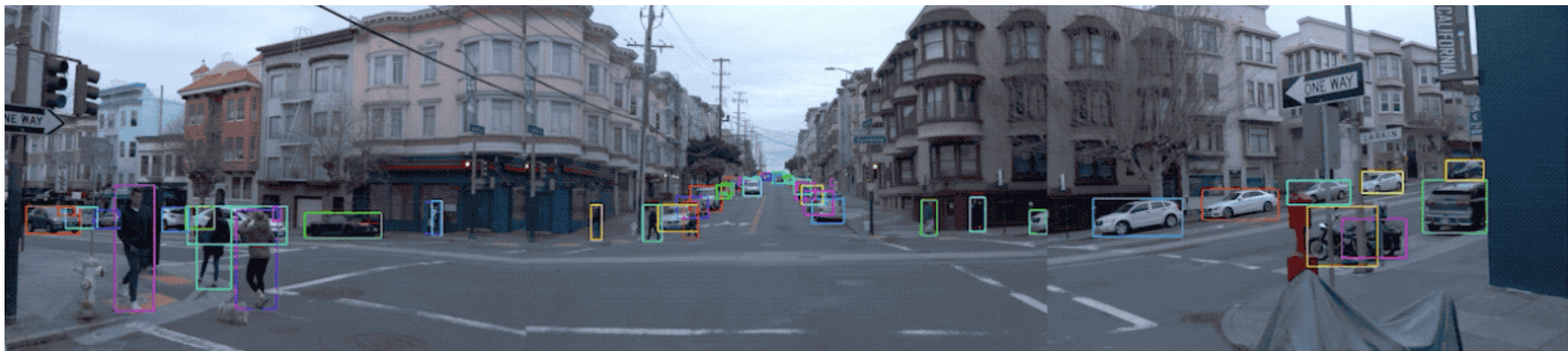


(e) Side-Right

One example of images captured by cameras of five different views from segment-11004685739714500220 of tar training_0000 in the Waymo Open Dataset.



fusion of image and LiDAR point cloud



Download Waymo Open Dataset (2021)

- The Dataset is almost 2TB after compression. Segments have been packaged into multiple files of 25GB or less.
- For programmatic downloading, please use the Google Cloud Storage bucket links at the bottom of this page.

You can access this release as well as prior releases via the below links to our Google Cloud Storage Bucket. It may take up to 2 business days to be granted access after accepting the license agreement.

v1.2, March 2020: Added Test Set with 150 segments, plus 800 segments for domain adaptation across Training, Validation, and Test - [tar files](#), [individual files](#)

v1.1, February 2020: Added camera labels for 900 segments - [tar files](#), [individual files](#)

v1.0, August 2019: Initial release - [tar files](#), [individual files](#)

Training

training_0000.tar



training_0001.tar



training_0002.tar



training_0003.tar



Validation

validation_0000.tar



validation_0001.tar



Domain Adaptation Validation (Unlabeled)

validation_0000.tar



validation_0001.tar



Domain Adaptation Test (Unlabeled)

testing_0000.tar



testing_0001.tar



Test (Unlabeled)

testing_0000.tar



testing_0001.tar



testing_0002.tar



testing_0003.tar



Domain Adaptation Training (Labeled)

training_0000.tar



Domain Adaptation Training (Unlabeled)

training_0000.tar



training_0001.tar



training_0002.tar



training_0003.tar



Domain Adaptation Validation (Labeled)

validation_0000.tar



<https://waymo.com/open/download/>

Past Challenges 2020(2D Detection)

- Waymo Open Dataset (WOD) is a public large-scale dataset for autonomous driving research.
- The dataset provides 1000 scenes for training and validation and 150 scenes for testing.
- Each scene contains about 200 frames for each camera and there are 5 high-resolution cameras with resolutions of 1280×1920 and 886×1920.
- Overall, the dataset contains about 1.15M images and 9.9M 2D bounding boxes for vehicles, pedestrians, and cyclists.

Challenge <https://waymo.com/open/challenges/>

Challenges - 2022

Challenge 1 Motion Prediction → Given agents' tracks for the past 1 second on a corresponding map, predict the positions of up to 8 agents for 8 seconds into the future.	Challenge 2 Occupancy and Flow Prediction → Given agents' tracks for the past 1 second on a corresponding map, predict the bird's-eye view (BEV) occupancy and motion flow of all currently-observed and currently-occluded vehicles for 8 seconds into the future.
Challenge 3 3D Camera-Only Detection → Given one or more images from multiple cameras, produce a set of 3D upright boxes for the visible objects in the scene.	Challenge 4 3D Semantic Segmentation → Given one or more lidar range images and the associated camera images, produce a semantic class label for each lidar point.

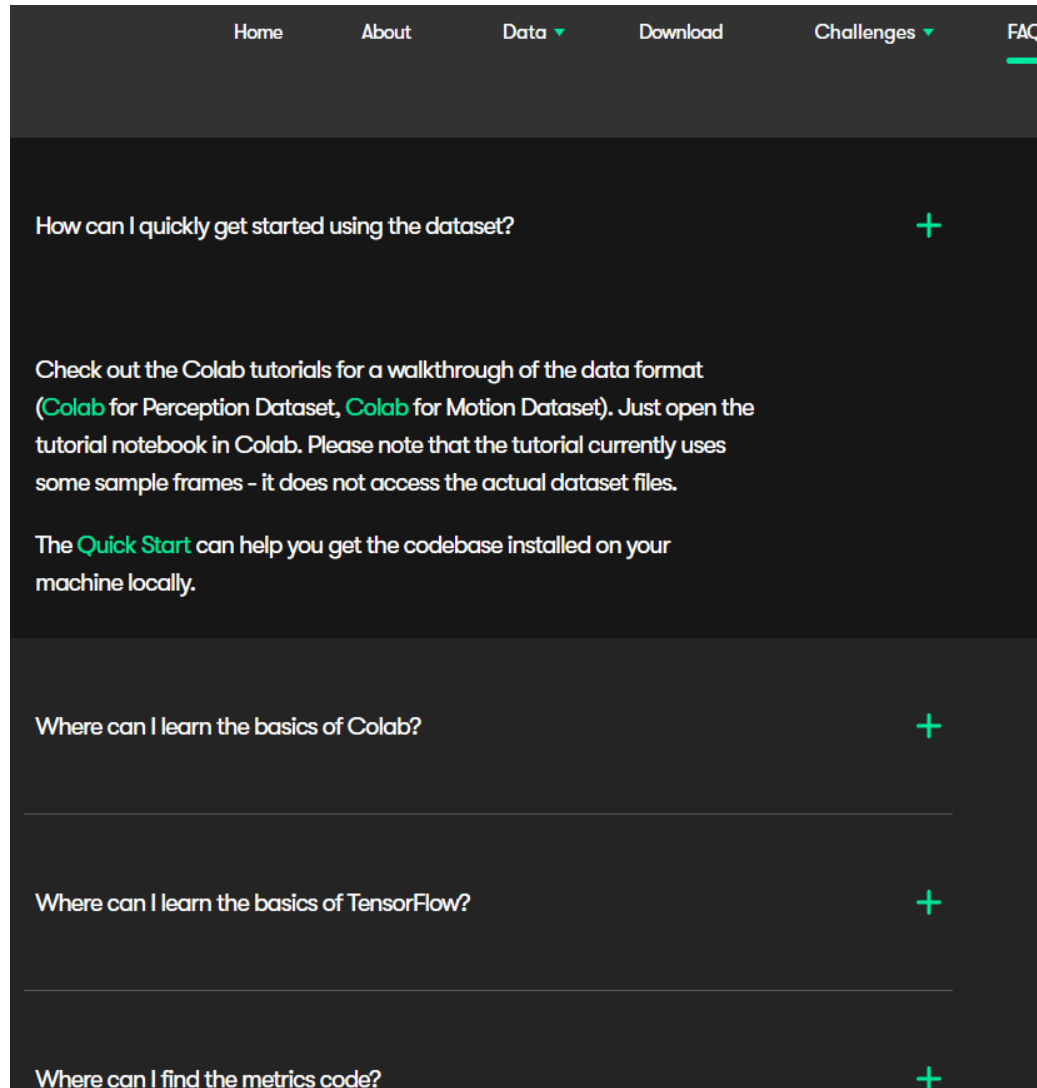
Past Challenges - 2021

Challenge 1 Motion Prediction → Given agents' tracks for the past 1 second on a corresponding map, predict the positions of up to 8 agents for 8 seconds into the future.	Challenge 2 Interaction Prediction → Given agents' tracks for the past 1 second on a corresponding map, predict the joint future positions of 2 interacting agents for 8 seconds into the future.	Challenge 3 Real-time 3D Detection → Given three lidar range images and the associated camera images, produce a set of 3D upright boxes for the objects in the scene.	Challenge 4 Real-time 2D Detection → Given a set of camera images, produce a set of 2D boxes for the objects in the scene, with a latency requirement.
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Past Challenges - 2020

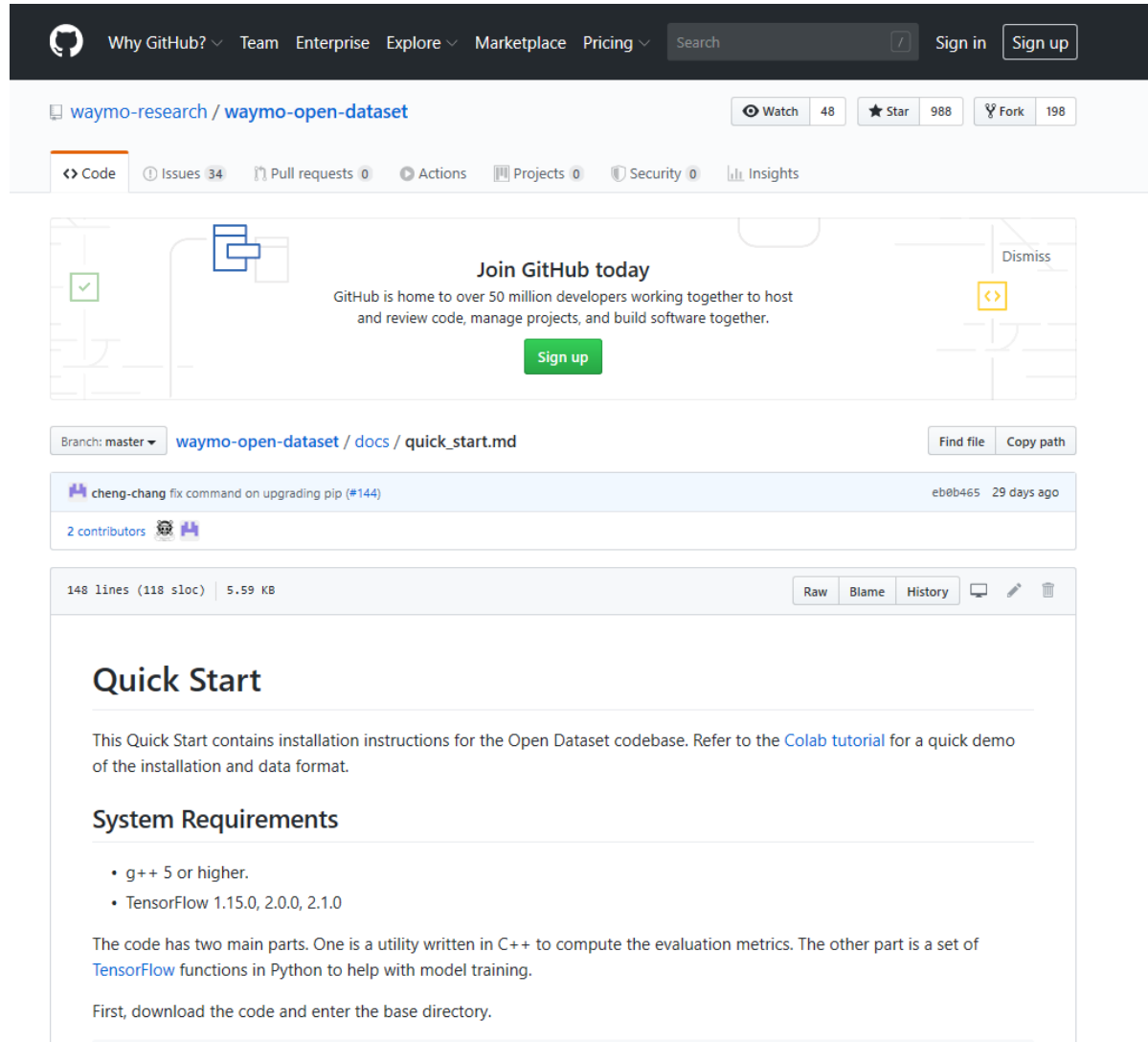
Challenge 1 3D Detection → Given one or more lidar range images and the associated camera images, produce a set of 3D upright boxes for the objects in the scene.	Challenge 2 2D Detection → Given a set of camera images, produce a set of 2D boxes for the objects in the scene.	Challenge 3 3D Tracking → Given a temporal sequence of lidar and camera data, produce a set of 3D upright boxes and the correspondence between boxes across frames.	Challenge 4 2D Tracking → Given a temporal sequence of camera images, produce a set of 2D boxes and the correspondence between boxes across frames.	Challenge 5 Domain Adaptation → Similar to the 3D Detection Challenge, but we provide additional segments from a new location and only a subset have labels.
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WAYMO dataset FAQ



<https://waymo.com/open/faq/>

WAYMO dataset Quick Start



The screenshot shows the GitHub interface for the repository `waymo-research/waymo-open-dataset`. The repository has 48 watches, 988 stars, and 198 forks. The `Code` tab is selected, showing the file `docs/quick_start.md` on the `master` branch. A commit by `cheng-chang` is visible, titled "fix command on upgrading pip (#144)". The file content includes a "Quick Start" section with installation instructions, a "System Requirements" section listing `g++ 5` or higher and `TensorFlow 1.15.0, 2.0.0, 2.1.0`, and a note about the code structure.

waymo-research / waymo-open-dataset

Watch 48 Star 988 Fork 198

Code Issues 34 Pull requests 0 Actions Projects 0 Security 0 Insights

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Sign up

Branch: master waymo-open-dataset / docs / quick_start.md Find file Copy path

cheng-chang fix command on upgrading pip (#144) eb0b465 29 days ago

2 contributors

148 lines (118 sloc) 5.59 KB Raw Blame History

Quick Start

This Quick Start contains installation instructions for the Open Dataset codebase. Refer to the [Colab tutorial](#) for a quick demo of the installation and data format.

System Requirements

- g++ 5 or higher.
- TensorFlow 1.15.0, 2.0.0, 2.1.0

The code has two main parts. One is a utility written in C++ to compute the evaluation metrics. The other part is a set of [TensorFlow](#) functions in Python to help with model training.

First, download the code and enter the base directory.

Quick Start

https://github.com/waymo-research/waymo-open-dataset/blob/master/docs/quick_start.md

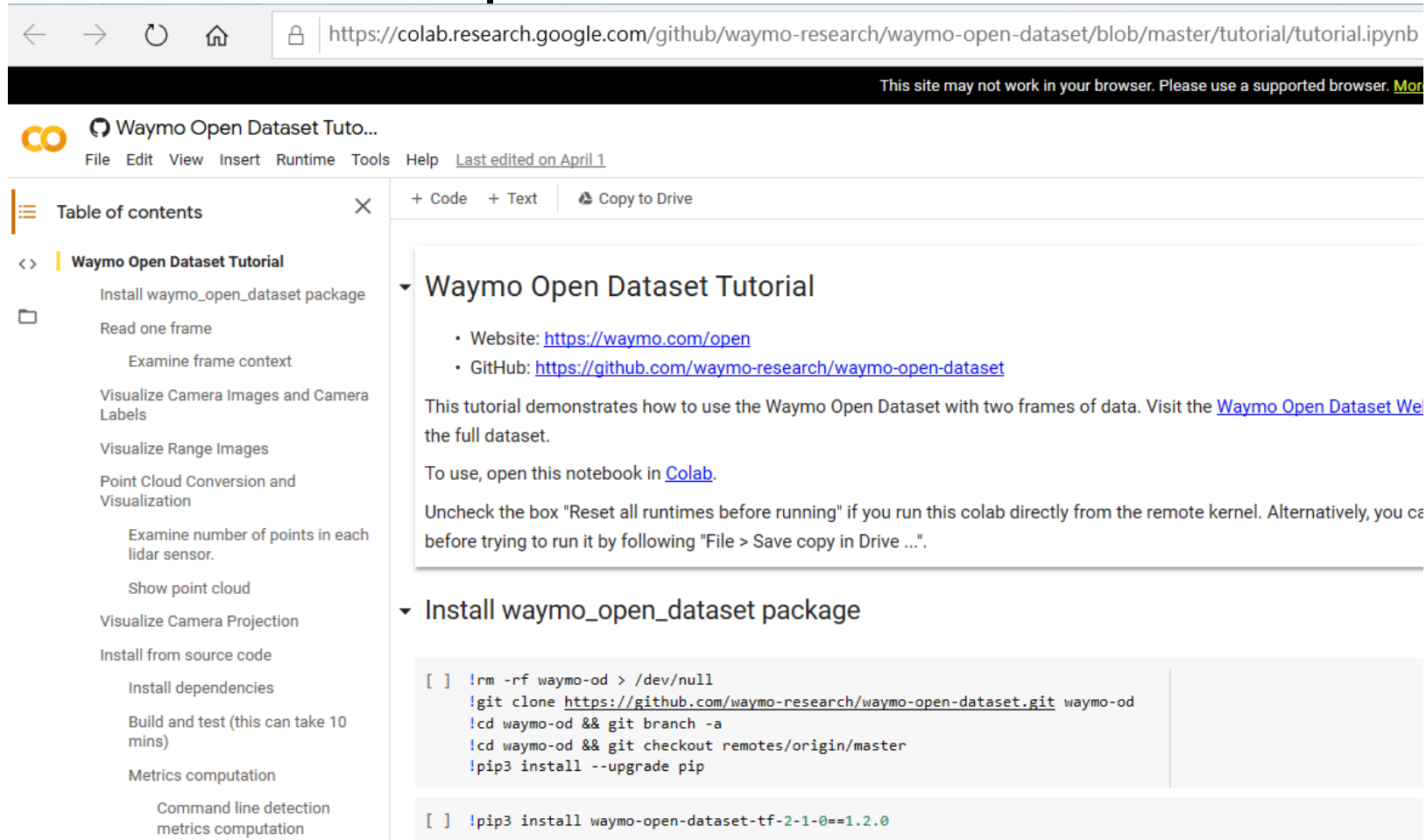
TensorFlow 1.14.0

https://github.com/waymo-research/waymo-open-dataset/blob/v1.0.1/docs/quick_start.md

Home

<https://github.com/waymo-research/waymo-open-dataset>

Colab: WAYMO Open Dataset Tutorial



The screenshot shows a Google Colab notebook interface. At the top, the browser address bar displays the URL: <https://colab.research.google.com/github/waymo-research/waymo-open-dataset/blob/master/tutorial/tutorial.ipynb>. A black banner below the address bar contains the text: "This site may not work in your browser. Please use a supported browser. [More](#)".

The notebook title is "Waymo Open Dataset Tuto...". The menu bar includes "File", "Edit", "View", "Insert", "Runtime", "Tools", and "Help", along with a timestamp "Last edited on April 1".

On the left, a "Table of contents" sidebar lists the following sections:

- Waymo Open Dataset Tutorial
 - Install waymo_open_dataset package
 - Read one frame
 - Examine frame context
 - Visualize Camera Images and Camera Labels
 - Visualize Range Images
 - Point Cloud Conversion and Visualization
 - Examine number of points in each lidar sensor.
 - Show point cloud
 - Visualize Camera Projection
 - Install from source code
 - Install dependencies
 - Build and test (this can take 10 mins)
 - Metrics computation
 - Command line detection metrics computation

The main content area shows the first section, "Waymo Open Dataset Tutorial", which includes links to the Waymo website and GitHub repository. Below this is the "Install waymo_open_dataset package" section, which contains a code cell with the following commands:

```
[ ] !rm -rf waymo-od > /dev/null
!git clone https://github.com/waymo-research/waymo-open-dataset.git waymo-od
!cd waymo-od && git branch -a
!cd waymo-od && git checkout remotes/origin/master
!pip3 install --upgrade pip
```

A second code cell is partially visible at the bottom, showing the command: `[] !pip3 install waymo-open-dataset-tf-2-1-0==1.2.0`.

<https://colab.research.google.com/github/waymo-research/waymo-open-dataset/blob/master/tutorial/tutorial.ipynb>

Scalability in Perception for Autonomous Driving: Waymo Open Dataset

Scalability in Perception for Autonomous Driving: Waymo Open Dataset

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¹Waymo LLC ²Google LLC

Abstract

The research community has increasing interest in autonomous driving research, despite the resource intensity of obtaining representative real world data. Existing self-driving datasets are limited in the scale and variation of the environments they capture, even though generalization within and between operating regions is crucial to the overall viability of the technology. In an effort to help align the research community's contributions with real-world self-driving problems, we introduce a new large-scale, high quality, diverse dataset. Our new dataset consists of 1150 scenes that each span 20 seconds, consisting of well synchronized and calibrated high quality LiDAR and camera data captured across a range of urban and suburban geographies. It is 15x more diverse than the largest camera+LiDAR dataset available based on our proposed geographical coverage metric. We exhaustively annotated this data with 2D (camera image) and 3D (LiDAR) bounding boxes, with consistent identifiers across frames. Finally, we provide strong baselines for 2D as well as 3D detection

instance segmentation [7, 17, 23, 10].

To further accelerate the development of autonomous driving technology, we present the largest and most diverse multimodal autonomous driving dataset to date, comprising of images recorded by multiple high-resolution cameras and sensor readings from multiple high-quality LiDAR scanners mounted on a fleet of self-driving vehicles. The geographical area captured by our dataset is substantially larger than the area covered by any other comparable autonomous driving dataset, both in terms of absolute area coverage, and in distribution of that coverage across geographies. Data was recorded across a range of conditions in multiple cities, namely San Francisco, Phoenix, and Mountain View, with large geographic coverage within each city. We demonstrate that the differences in these geographies lead to a pronounced domain gap, enabling exciting research opportunities in the field of domain adaptation.

Our proposed dataset contains a large number of high-quality, manually annotated 3D ground truth bounding boxes for the LiDAR data, and 2D tightly fitting bounding boxes for the camera images. All ground truth boxes contain track

<https://arxiv.org/pdf/1912.04838.pdf>

1912.04838v7 [cs.CV] 12 May 2020

1st Place Solutions of Waymo Open Dataset Challenge 2020 2D Object Detection Track

1st Place Solutions of Waymo Open Dataset Challenge 2020 2D Object Detection Track

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Abstract

In this technical report, we present our solutions of Waymo Open Dataset (WOD) Challenge 2020 - 2D Object Detection Track. We adopt FPN as our basic framework. Cascade RCNN, stacked PAFPN Neck and Double-Head are used for performance improvements. In order to handle the small object detection problem in WOD, we use very large image scales for both training and testing. Using our methods, our team RW-TSDet achieved the 1st place in the 2D Object Detection Track.

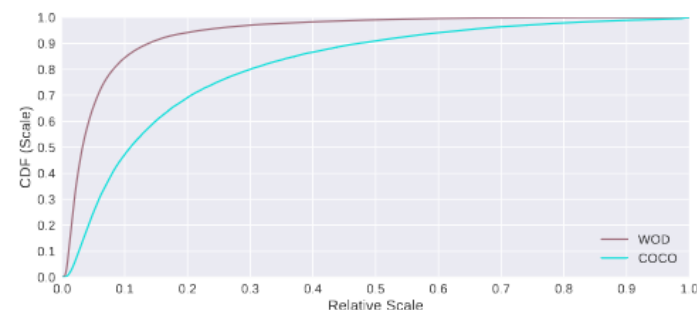


Figure 1. Fraction of bounding boxes in the dataset vs scale of bounding boxes relative to the image.

Paper: <https://arxiv.org/pdf/2008.01365.pdf>

Term Project

- Term project report with presentation
- Final project report should contain introduction, related work, problem definition, methods, result and conclusion (12 pages either in Chinese or English)
- Presentation : 12 minutes
- Q&A : 3 minutes

paperswithcode.com

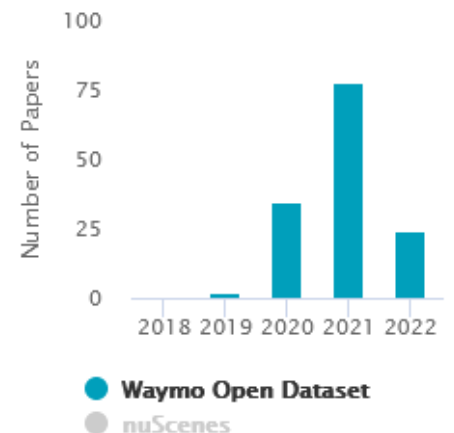
Waymo Open Dataset

Introduced by Sun et al. in [Scalability in Perception for Autonomous Driving: Waymo Open Dataset](#)

The Waymo Open Dataset is comprised of high resolution sensor data collected by autonomous vehicles operated by the Waymo Driver in a wide variety of conditions.

The Waymo Open Dataset currently contains 1,950 segments. The authors plan to grow this dataset in the future. Currently the datasets includes:

- 1,950 segments of 20s each, collected at 10Hz (390,000 frames) in diverse geographies and conditions
- Sensor data
 - 1 mid-range lidar
 - 4 short-range lidars
 - 5 cameras (front and sides)
 - Synchronized lidar and camera data
 - Lidar to camera projections
 - Sensor calibrations and vehicle poses
- Labeled data
 - Labels for 4 object classes - Vehicles, Pedestrians, Cyclists, Signs
 - High-quality labels for lidar data in 1,200 segments
 - 12.6M 3D bounding box labels with tracking IDs on lidar data
 - High-quality labels for camera data in 1,000 segments
 - 11.8M 2D bounding box labels with tracking IDs on camera data



Reference

- [Waymo Web Site](#)
- [CVPR'20 \(google.com\)](#)
- [\[CVPR'20 Workshop on Scalability in Autonomous Driving\] Waymo Open Dataset Challenge - YouTube](#)