autovia

Analytics for Autonomous Driving: Large-scale sensor data processing

ROS-Industrial Conference 2019

Jan Wiegelmann

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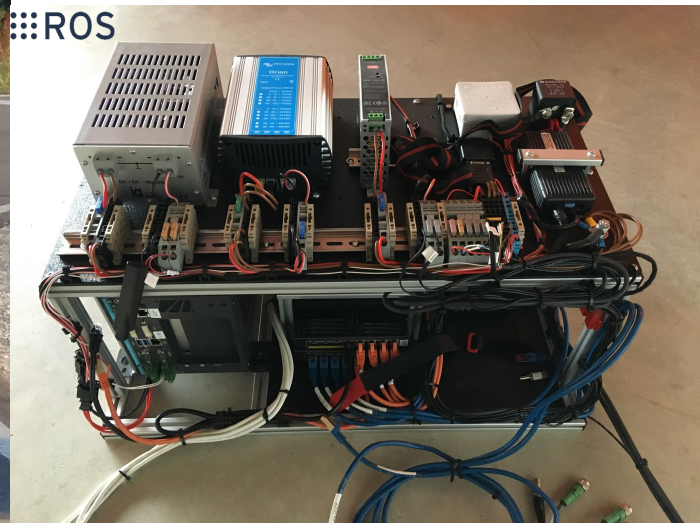
Autonomous vehicle generates up to

20 TB per day



MHP
A PORSCHE COMPANY

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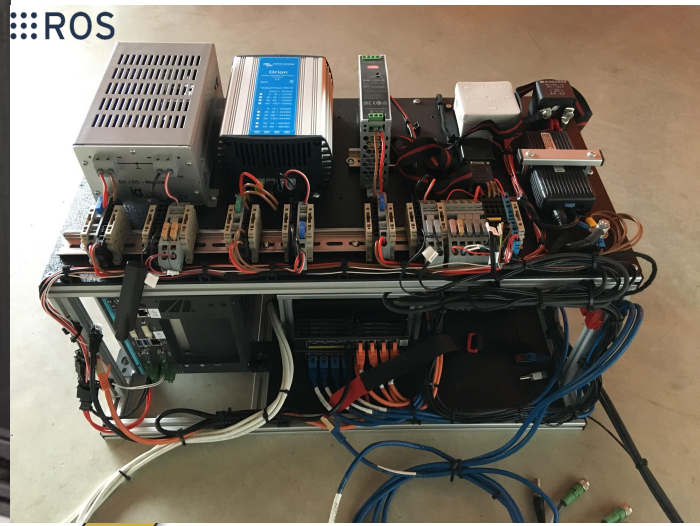
Autonomous vehicle generates up to **20 TB per day**



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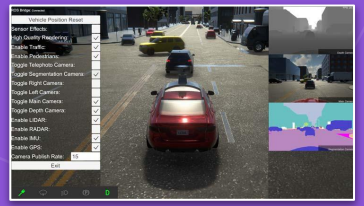
autovia

Autonomous driving development is a data challenge!

Real world driving and simulation of autonomous vehicles generates **petabytes of data per day**

Simulation



Real world driving

Petabytes of sensor data and simulation results

- **Hard to collect quality data**
- **Long running algorithms**
- **Small throughput**
- **No version control**
- **Infrastructure complexity**

Autonomous vehicle generates up to 20 TB per day

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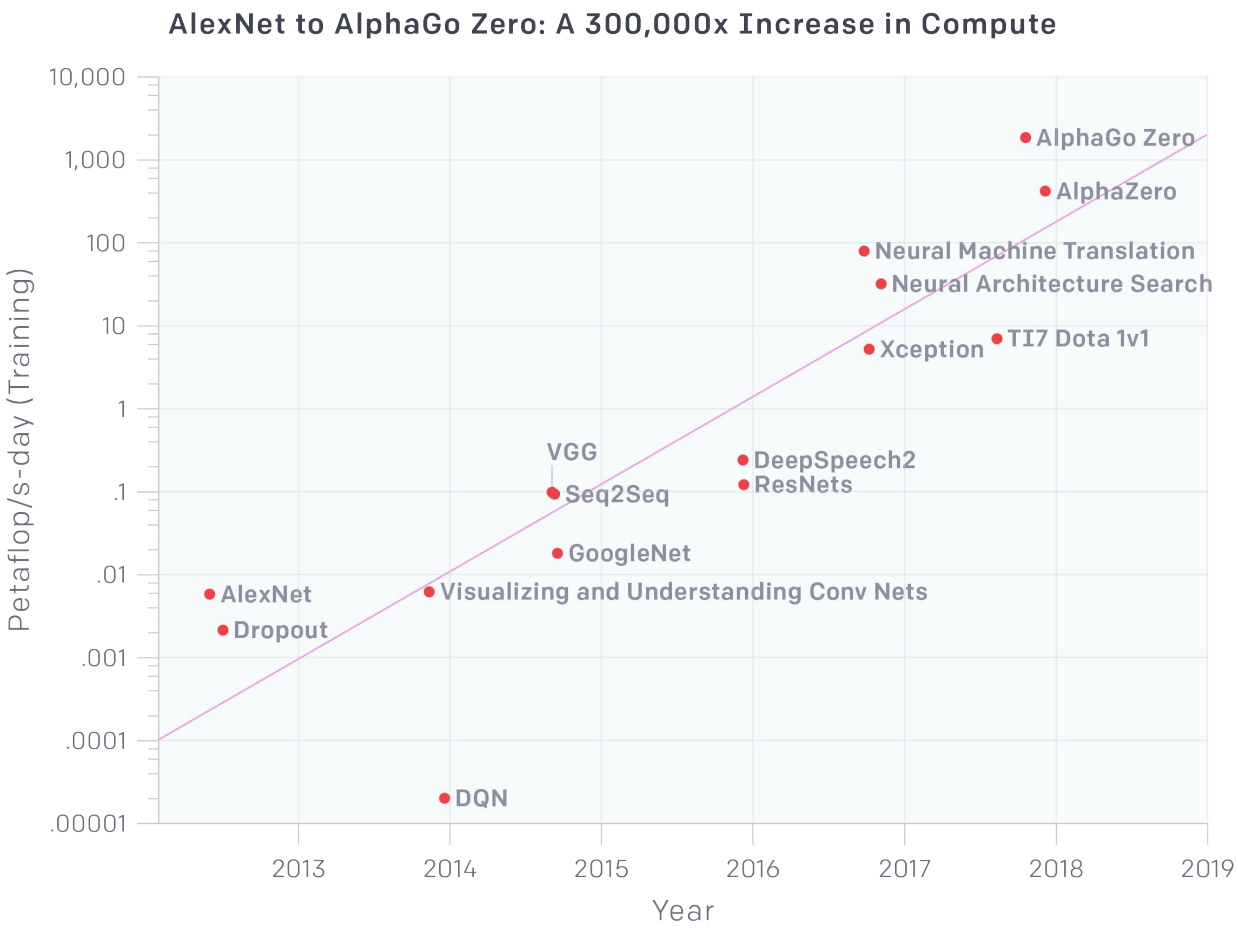

https://openai.com/blog/ai-and-compute/

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cruise

Testing at Scale

- **200,000+** hours/day
- 30,000+ VM instances
- 300,000+ CPU cores
- 5,000+ GPUs
- 3 regions, 10 zones
- 300TB/day of results

https://www.youtube.com/watch?v=NGXZ-mYqyUo

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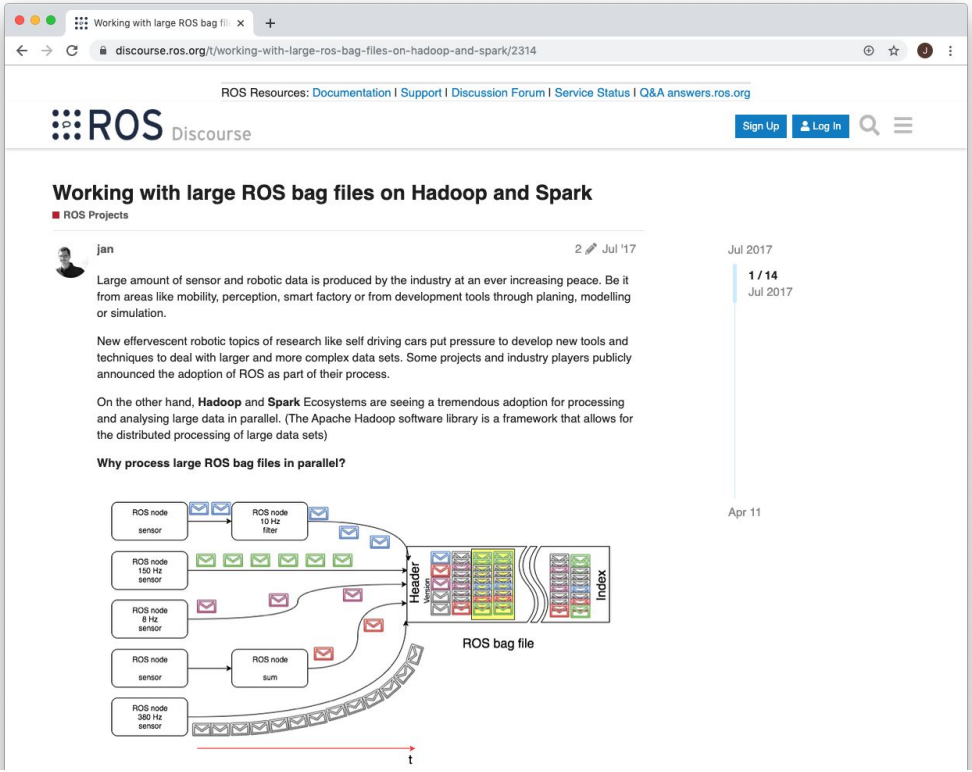
ros_hadoop

RosbagInputFormat is an open source splittable Hadoop InputFormat for the rosbag file format

Requirements

- ROS installation on each node
- Manual index extraction
- HDFS and Spark installation

Release July 2017 with Apache 2.0



created Jul '17 | last reply Apr 11 | 13 replies | 4.7k views | 8 users | 3 likes | 7 links

https://discourse.ros.org/t/working-with-large-ros-bag-files-on-hadoop-and-spark/2314

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ros_hadoop

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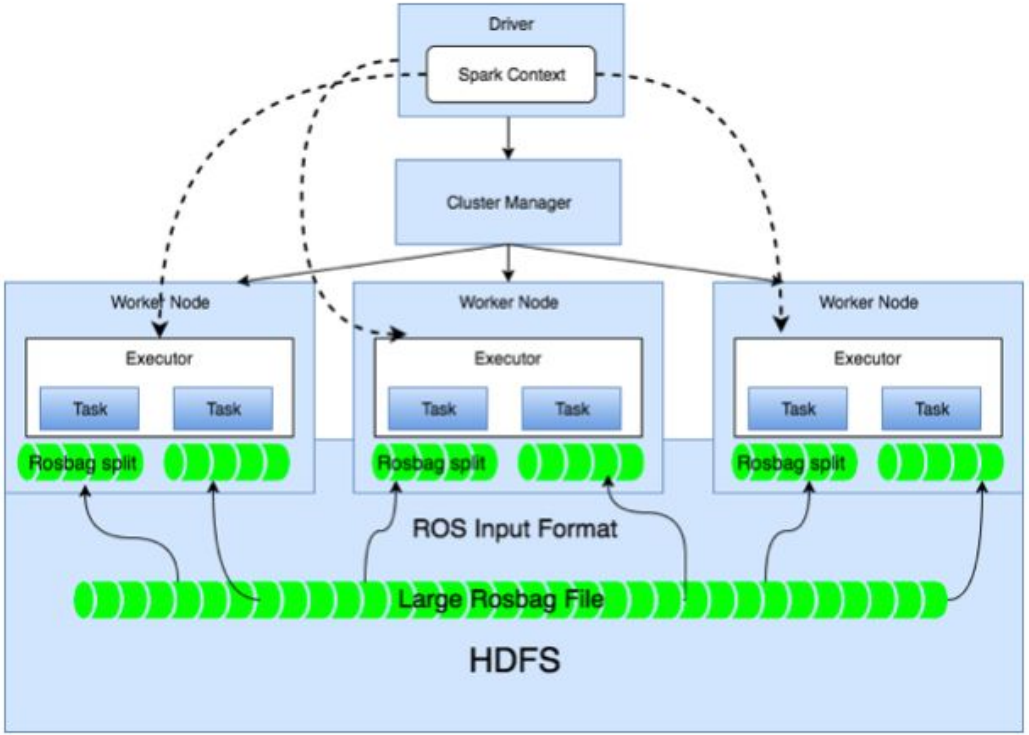

https://discourse.ros.org/t/working-with-large-ros-bag-files-on-hadoop-and-spark/2314

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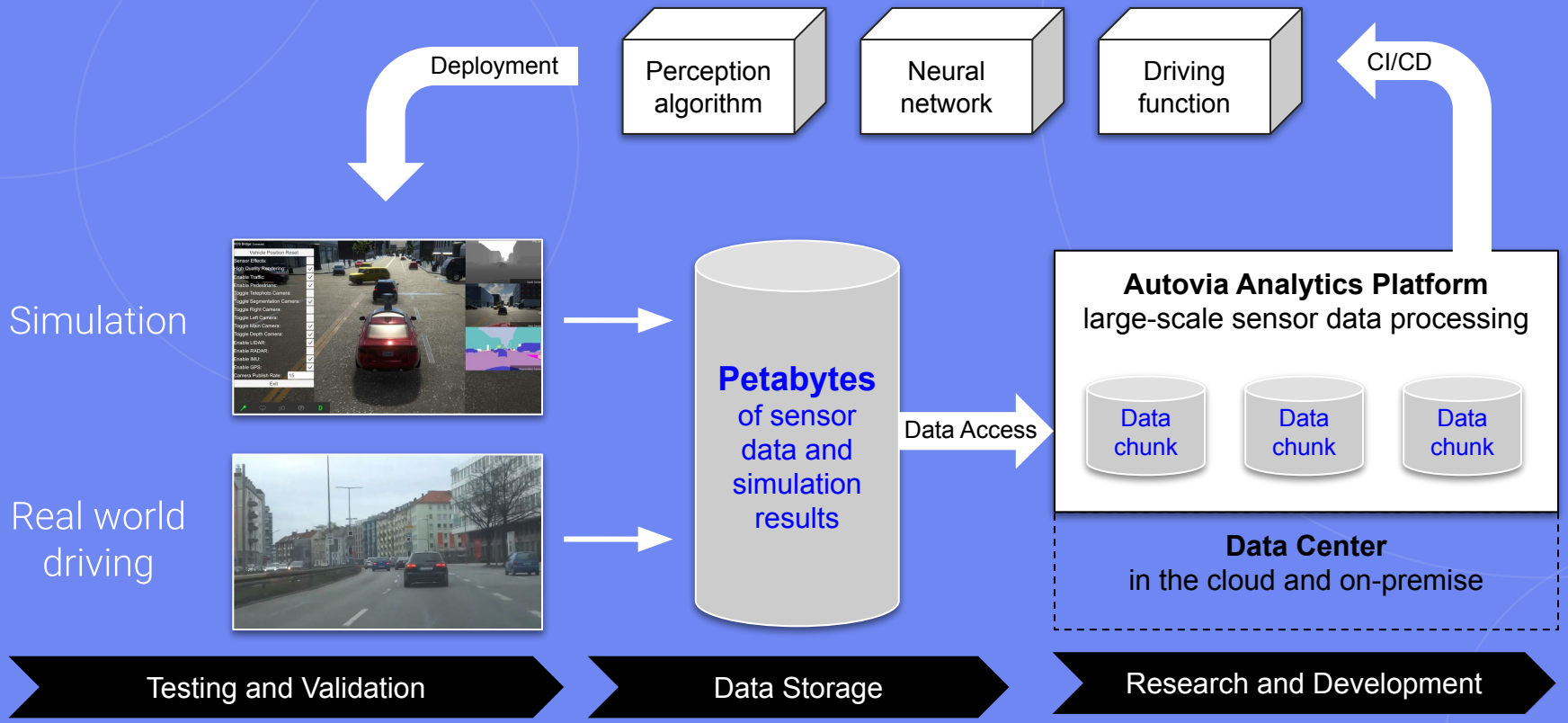
Autovia Solution

Complete development & testing lifecycle



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Autovia IO

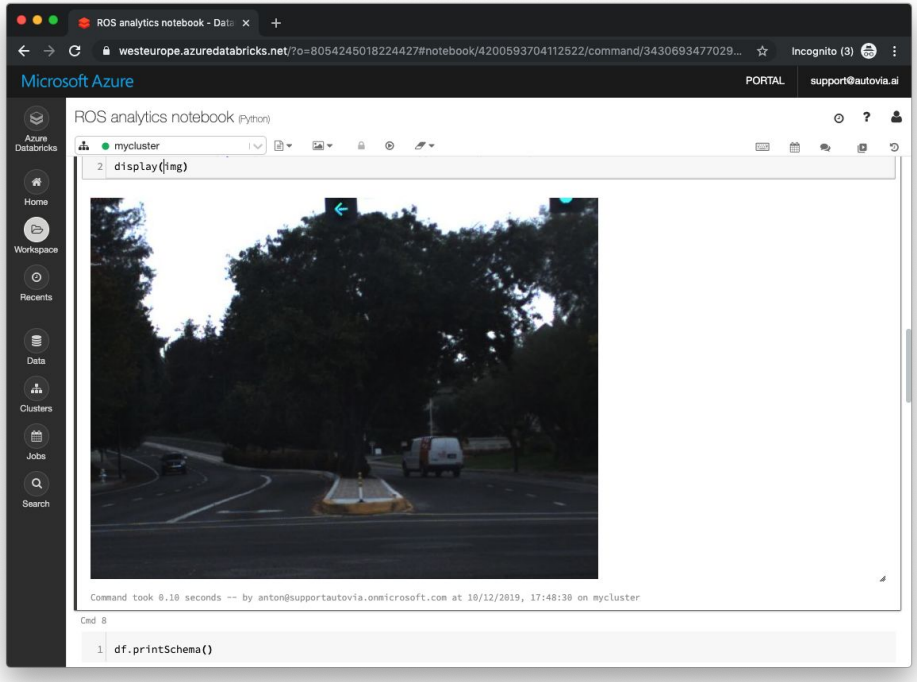
is a data access layer that enables analytics apps to read ROS bags from local and cloud storage

Not needed

- ROS installation
- Data converting & copying

Supported platforms

- AWS EMR
- Azure HDInsight
- GCP Dataproc
- Databricks
- Hadoop
  - Cloudera
  - Hortonworks
  - MapR



Autovia IO

Blob Storage

aws Azure Google Cloud

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Autovia IO: Load Rosbag

Cmd 2

```
1  file_path = "/dbfs/mnt/ros/dataspeed/mkz_20151207_extra.new.bag"
2
3  msgs_path =
   "/dbfs/mnt/ros/msgs/common_msgs:/dbfs/mnt/ros/msgs/tf2_msgs:/dbfs/mnt/ros/msgs/can_msgs:/dbfs/mnt/ros/msgs/velodyne_msgs:/d
   bfs/mnt/ros/msgs/std_msgs:/dbfs/mnt/ros/msgs/dynamic_reconfigure:/dbfs/mnt/ros/dataspeed"
4
5  dfmeta = spark.read.format("ai.autovia.ros")\
6      .option("ai.autovia.fstype", "fs")\
7      .option("ai.autovia.schematype","metadata")\
8  .load(file_path)
9
10 df = spark.read.format("ai.autovia.ros")\
11                .option("ai.autovia.fstype", "fs")\
12                .option("ai.autovia.ros.msgdir", msgs_path)\
13                .load(file_path)
```

```
dfmeta: pyspark.sql.dataframe.DataFrame
  version: string
  connections: map
      key: integer
      value: struct
          conn: integer
          topic: string
          type: string
          md5Sum: string
          message_definition: string
  index: array
      element: long
```

Command took 0.28 seconds -- by adrian@supportautovia.onmicrosoft.com at 10/12/2019, 20:11:48 on mycluster

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Autovia IO: List connections

Cmd 3

```
meta = dfmeta.collect()[0].asDict()
```

▸ (1) Spark Jobs

Command took 0.06 seconds -- by adrian@supportautovia.onmicrosoft.com at 10/12/2019, 20:12:37 on mycluster

Cmd 4

```
[(v.conn, v.topic) for v in meta["connections"].values()]
```

```
Out[13]: [(0, '/can_bus_dbw/can_rx'),
 (1, '/oxford_gps/gps/fix'),
 (2, '/oxford_gps/gps/vel'),
 (3, '/oxford_gps/imu/data'),
 (4, '/tf'),
 (5, '/velodyne/points')]
```

Command took 0.03 seconds -- by adrian@supportautovia.onmicrosoft.com at 10/12/2019, 20:21:17 on mycluster

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Autovia IO: Filter “/oxford_gps/gps/vel” and plot data

Cmd 5

```
arr = df.filter(df.conn == 2).select(\
            "data.conn2.twist.twist.linear.x",
            "data.conn2.twist.twist.linear.y",
            "data.conn2.twist.twist.linear.z",
            )
```

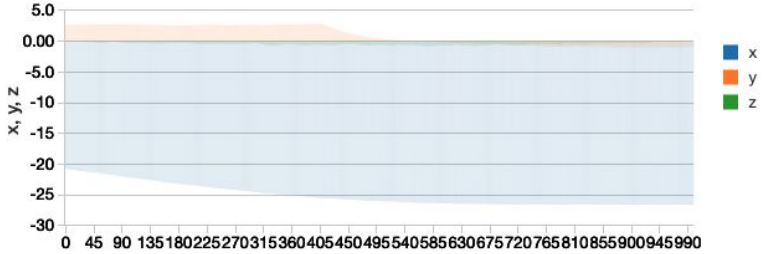
arr: pyspark.sql.dataframe.DataFrame = [x: double, y: double ... 1 more fields]

Command took 0.05 seconds -- by adrian@supportautovia.onmicrosoft.com at 10/12/2019, 21:00:08 on mycluster

Cmd 6

```
display(arr)
```

(3) Spark Jobs



Showing sample based on the first 1000 rows.

Plot Options...

Command took 35.03 seconds -- by adrian@supportautovia.onmicrosoft.com at 10/12/2019, 21:02:19 on mycluster

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Autovia FS

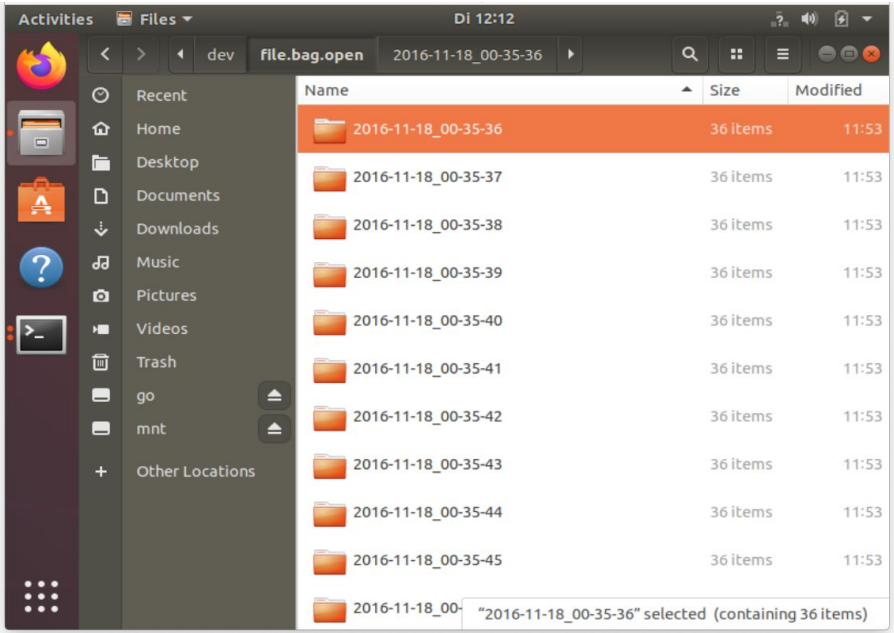
is a virtual filesystem that enables all applications to read ROS bags from local and cloud storage

Not needed

ROS installation
Data converting & copying

Start filesystem

```
$ av fs /home/<username>/mnt
```



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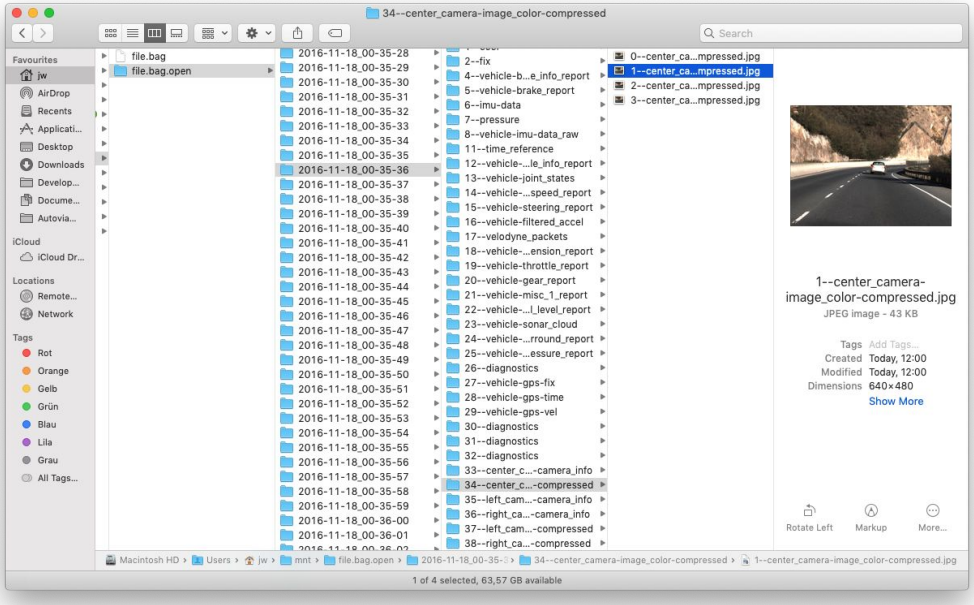

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Autovia FS

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Not needed

ROS installation
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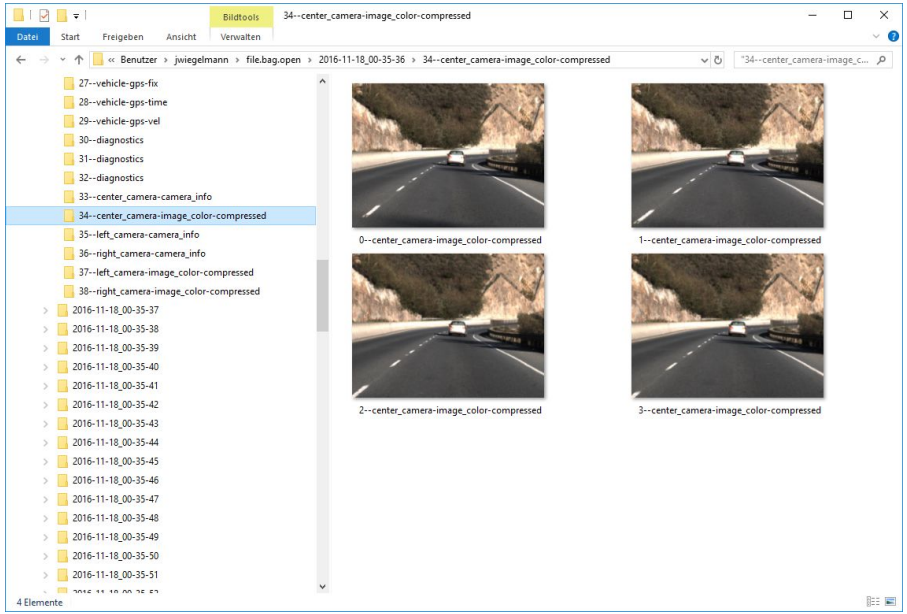
Start filesystem

```
av.exe fs C:\Users\<username>\mnt
```



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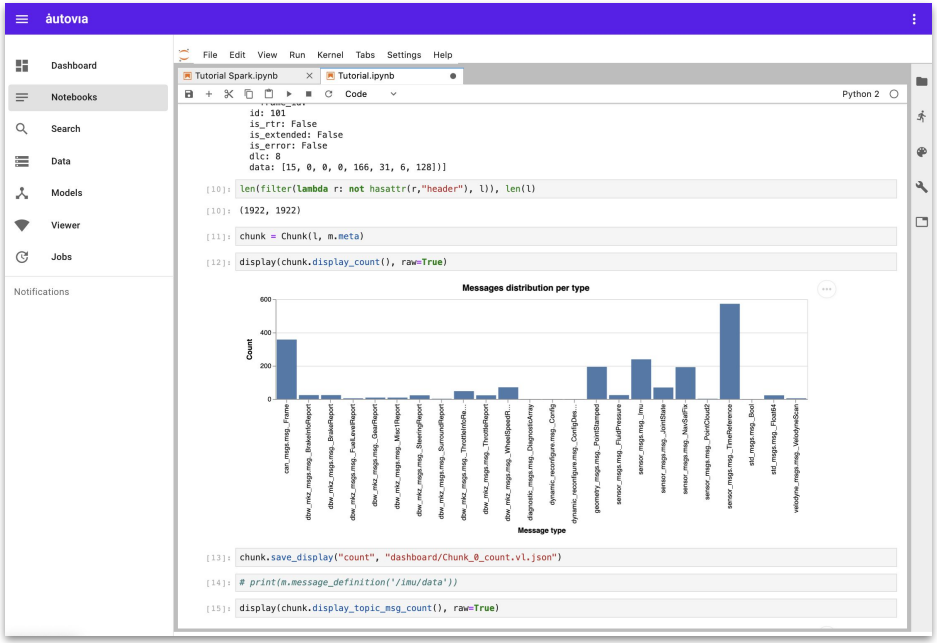
Autovia IDE

For R&D engineers in automotive and aviation industry we built an analytics toolbox running as a managed service. Autovia works on existing big data infrastructure, on bare metal or on top of existing Hadoop or Spark clusters. It can ingest R&D data directly from HDFS, S3, Azure Data Lake or any other data source.



Autovia Workspace

Your Data | Your Algorithm | Your Model

Autovia Runtime

ROS | Apache Spark | TensorFlow

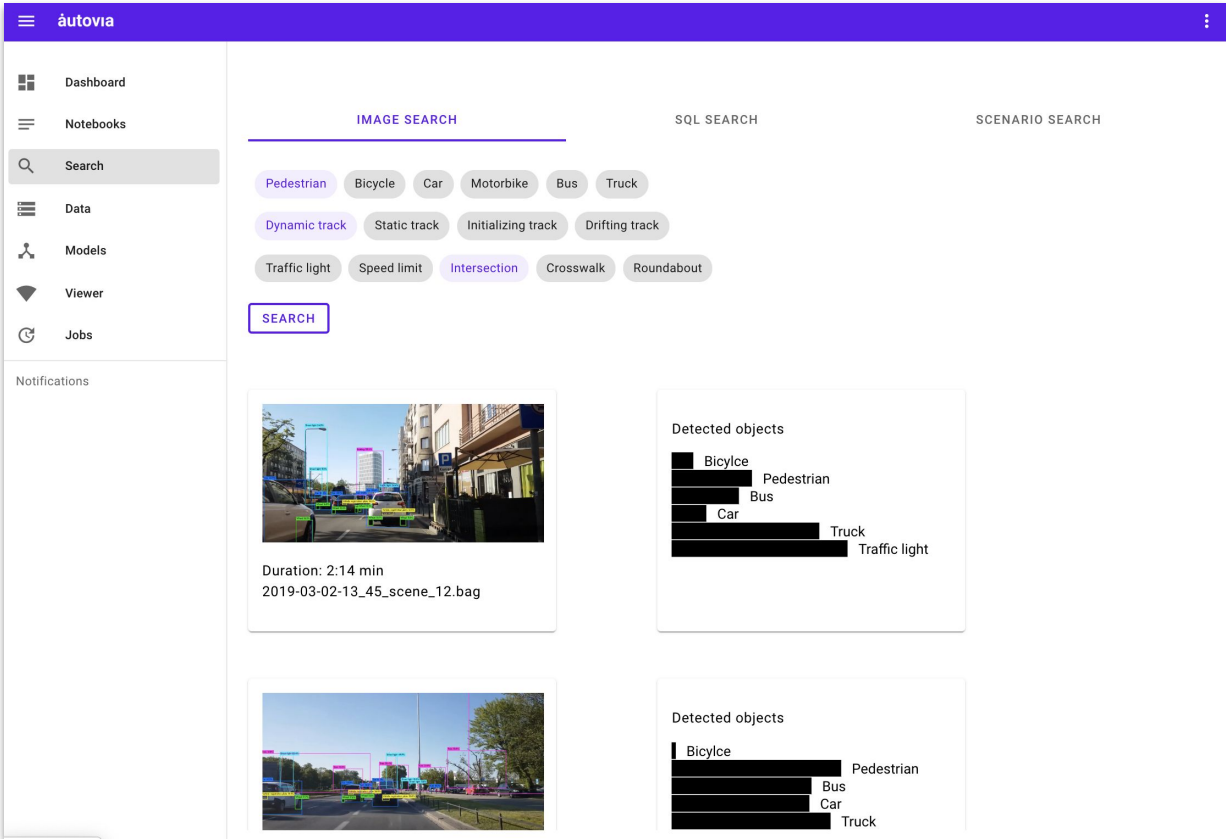
Autovia Cloud Service

aws | Azure | Google Cloud

Fast search at sensor level

Find the right scenarios for development, testing and validation

- 👍 Query results within seconds
- 👍 Search in raw sensor data
- 👍 OpenSCENARIO compatible
- 👍 Various data source support
- 👍 Find train & test data for AI



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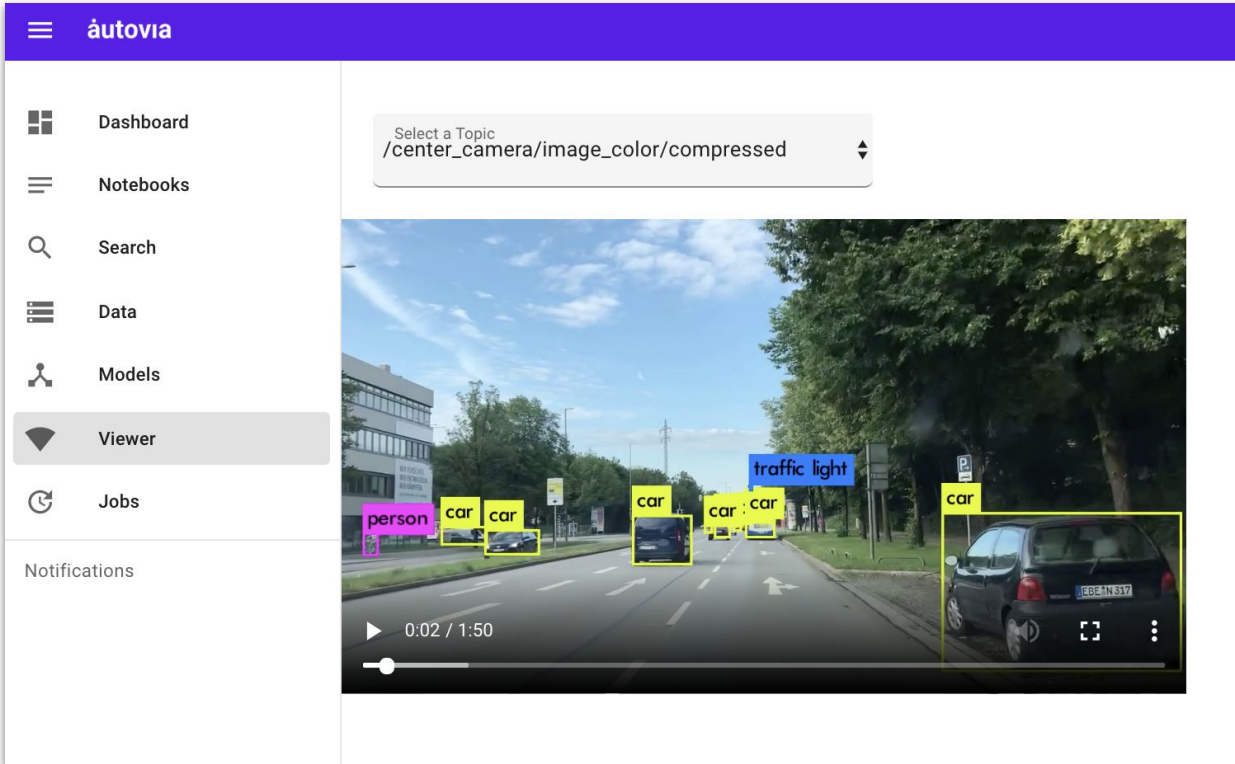
Explore and validate data at sensor level

Test and see recorded driving scenes

- 👍 Built-in 3D point cloud viewer
- 👍 Vision output after perception
- 👍 See sensor fusion results
- 👍 Metadata management
- 👍 Validate algorithms



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Thank you!

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