RE Report

Introduction

I have explored a dataset called nuscenes dataset which is used in autonomous vehicles.In this project, I have understood the structure of the dataset and I have loaded the data into csv files and I have implemented 20 queries on this dataset using pyspark.

Dataset

Nuscenes dataset is a public large-scale dataset for autonomous vehicles.It enables researchers to study challenging urban driving situations using the full sensor suite of a real self-driving car.Motional is making driverless vehicles a safe, reliable, and accessible reality. By releasing a subset of our data to the public, Motional aims to support public research into computer vision and autonomous driving.For this purpose it has been collected 1000 driving scenes in Boston and Singapore, two cities that are known for their dense traffic and highly challenging driving situations. The scenes of 20 second length are manually selected to show a diverse and interesting set of driving maneuvers, traffic situations and unexpected behaviours. The rich complexity of nuScenes will encourage development of methods that enable safe driving in urban areas with dozens of objects per scene. Gathering data on different continents further allows us to study the generalization of computer vision algorithms across different locations, weather conditions, vehicle types, vegetation, road markings and left versus right hand traffic.For the nuScenes dataset approximately 15h of driving data in Boston and Singapore is collected.. Driving routes are carefully chosen to capture challenging scenarios

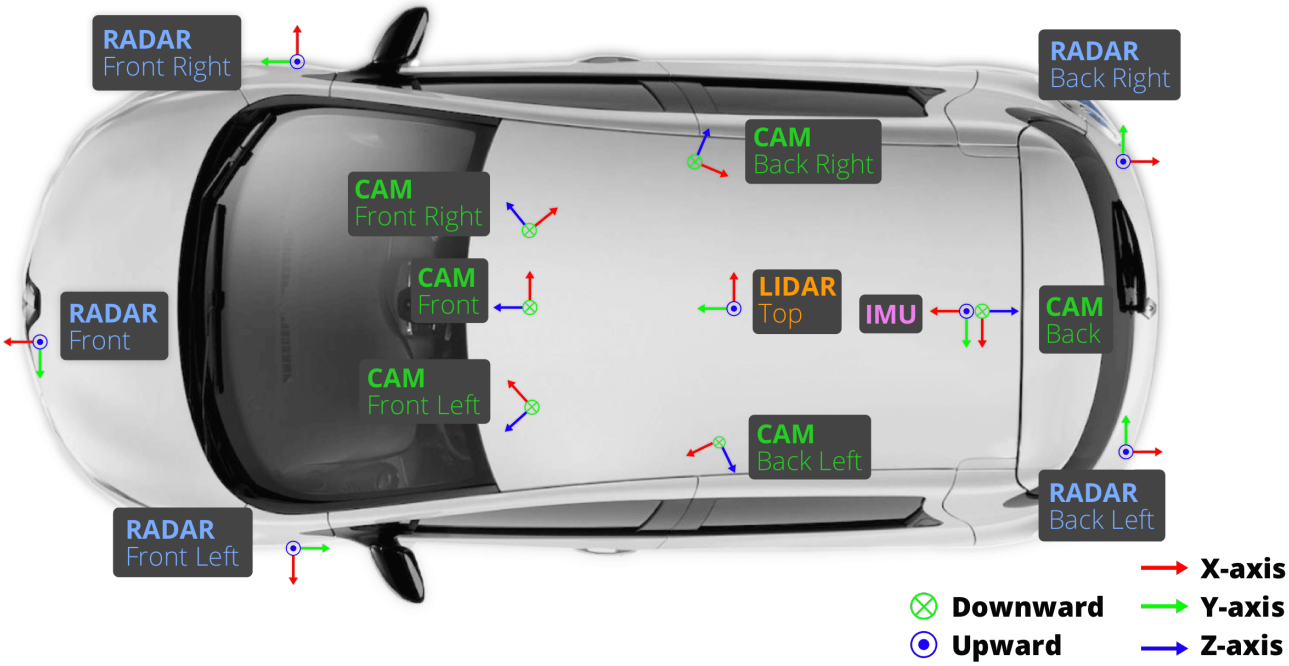
The nuScenes dataset is a large-scale autonomous driving dataset with **3d object annotations.** It features:

- Full sensor suite (1x LIDAR, 5x RADAR, 6x camera, IMU, GPS)
- 1000 scenes of 20s each
- 1,400,000 camera images
- 390,000 lidar sweeps
- Two diverse cities: Boston and Singapore

- Left versus right hand traffic
- Detailed map information
- 1.4M 3D bounding boxes manually annotated for 23 object classes
- Attributes such as visibility, activity and pose

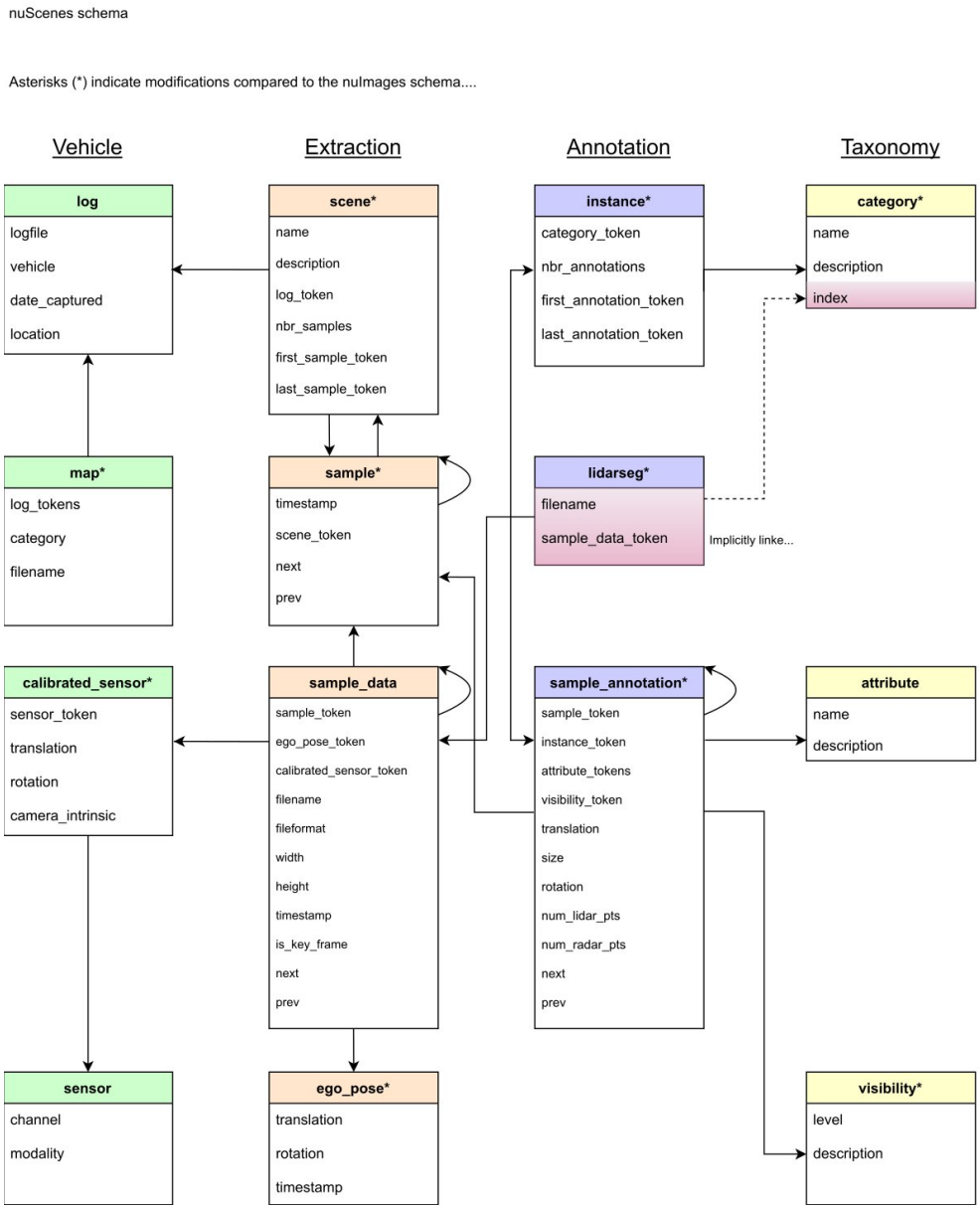
Car Setup

Two Renault Zoe cars with an identical sensor layout to drive in Boston and Singapore. The data was gathered from a research platform and is not indicative of the setup used in Motional products. Data released from the following sensors:



Structure of the Dataset

Nuscenes Schema :



- log : - Log information from which the data was extracted.
- scene : - 20 second snippet of a car's journey.
- sample : - An annotated snapshot of a scene at a particular timestamp.

- sample_data : - Data collected from a particular sensor.
- ego_pose : - Ego vehicle poses at a particular timestamp.
- sensor : - A specific sensor type.
- calibrated_sensor : - Definition of a particular sensor as calibrated on a particular vehicle.
- Instance : - Enumeration of all object instance we observed.
- category : - Taxonomy of object categories (e.g. vehicle, human).
- Attribute : - Property of an instance that can change while the category remains the same.
- visibility : - Fraction of pixels visible in all the images collected from 6 different cameras.
- sample_annotation : - An annotated instance of an object within our interest.
- map : - Map data that is stored as binary semantic masks from a top-down view.

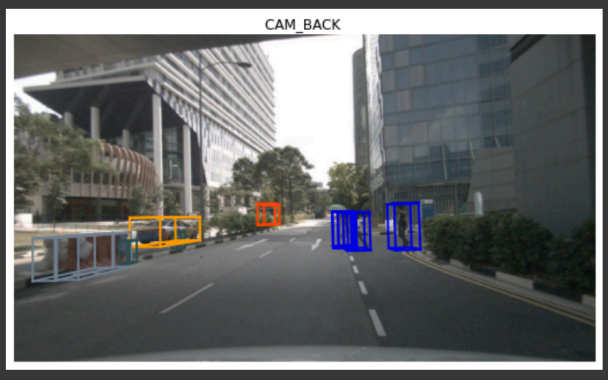
Queries

1. Query1 : -

Image you got from sensor ‘CAM_BACK’ in a particular sample.

Code : -

```
[ ] sample1=nusc.sample[0]
    query2=spark.read.csv('samples/sample1.csv', sep=',',
                          inferSchema=True, header=True)
    query3=query2.select('token','data').where(query2.token==sample1["token"])
    answer=[data1[0] for data1 in query3.select('data').collect()]
    cam="CAM_BACK"
    answer=(eval(answer[0]))
    nusc.render_sample_data(answer[cam])
```



2. Query2 : -

Print the token,first_sample_token into a csv file.Code : -

```
scene=spark.readStream.format("csv").schema(schema1).option("header",True
).option("maxFilesPerTrigger",1).load("scenes")

query2=scene.select('token','first_sample_token')q=query2.writeStream.forma
t("csv").option("path","/query1").option ("checkpointLocation", "/
checkpoint_path").outputMode("append").start()
```

3. Query3 -

Given sample annotation tokens, return what kind of category they belong to.

Code :

```
sample_ann1=nusc.sample_annotation[0]
sample_ann2=nusc.sample_annotation[60]
query3=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                      inferSchema=True, header=True)
answer1=query3.select('category_name').where(query3.token == sample_ann1['token'])
answer2=query3.select('category_name').where(query3.token == sample_ann2['token'])
result1=[data[0] for data in answer1.select('category_name').collect()]
result2=[data[0] for data in answer2.select('category_name').collect()]
print(result1)
print(result2)
```

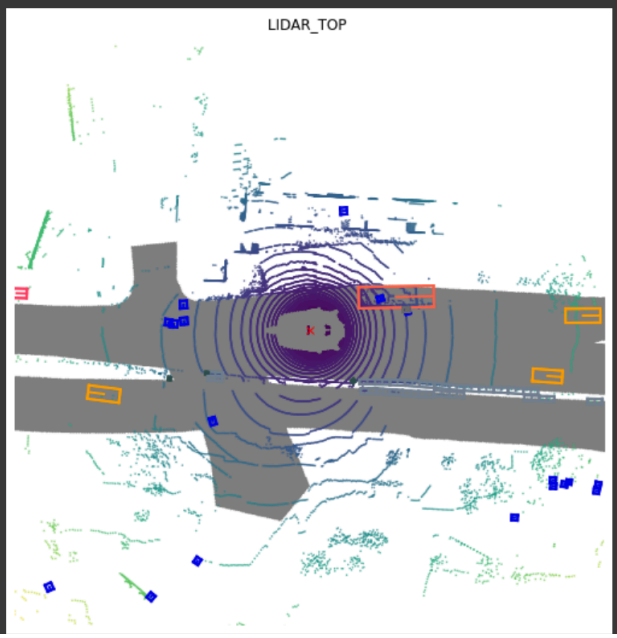
```
['human.pedestrian.adult']
['human.pedestrian.adult']
```

4.Query4-

Given a sample token return data from sensor LIDAR_TOP.

Code :-

```
sample1=nusc.sample[1]
query4=spark.read.csv('samples/sample1.csv', sep=',',
                      inferSchema=True, header=True)
query4_2=query2.select('token','data').where(query4.token==sample1["token"])
answer=[data1[0] for data1 in query4_2.select('data').collect()]
cam="LIDAR_TOP"
answer=(eval(answer[0]))
nusc.render_sample_data(answer[cam])
```



5.Query5 -

Return number of sample_annotations whose category is vehicle.

Code : -

```
query5=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                      inferSchema=True, header=True)
result1=[data[0] for data in query5.select('category_name').collect()]
answer=0
for i in result1:
  result2=i.split('.')
  if (result2[0]=="vehicle"):
     answer=answer+1
answer
```

```
9648
```

6.Query6 -

Return number of sample_annotations whose category is pedestrian.

Code : -

```
query6=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                      inferSchema=True, header=True)
result1=[data[0] for data in query6.select('category_name').collect()]
answer=0
for i in result1:
  result2=i.split('.')
  if (result2[1]=="pedestrian"):
     answer=answer+1
answer
```

```
5040
```

7.Query7 : -

Given an sample_annotation,calculate number of instances of that annotation.

Code : -

```
[ ] query7=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                          inferSchema=True, header=True)
    sample_ann=nusc.sample_annotation[20]
    query7=query7.select('instance_token').where(query7.token ==  sample_ann['token'])
    result1=[data[0] for data in query7.select('instance_token').collect()]
    query7=spark.read.csv('instance/instance1.csv', sep=',',
                          inferSchema=True, header=True)
    query7=query7.select('nbr_annotations').where(query7.token == result1[0]);
    result2=[data[0] for data in query7.select('nbr_annotations').collect()]
    result2[0]

    39
```

8.Query8 : -

Given a sample annotation,return the third instance of that annotation.

Code : -

```
query8=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                      inferSchema=True, header=True)
sample_ann=nusc.sample_annotation[20]
curr_ann=sample_ann['token']
next_ann=sample_ann['next']
i=2
while(i!=0):
  query8.select('next').where(query8.token == curr_ann)
  result1=[data[0] for data in query8.select('next').collect()]
  curr_ann=result1[0]
  i=i-1
nusc.render_annotation(curr_ann)
```

9.Query9 : -

Given a sample,number of annotations in that sample.

Code : -

```
query9=spark.read.csv('samples/sample1.csv', sep=',',
                      inferSchema=True, header=True)
sample=nusc.sample[15]
query9=query9.select('anns').where(query9.token == sample['token'])
result1=[data[0] for data in query9.select('anns').collect()]
answer=eval(result1[0])
len(answer)
```

```
143
```

10. Query10 : -

Given a sample_annotation,return last instance.

Code : -

```
query10=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                       inferSchema=True, header=True)
sample_ann=nusc.sample_annotation[20]
query10=query10.select('instance_token').where(query10.token == sample_ann['token'])
result1=[data[0] for data in query10.select('instance_token').collect()]
query10=spark.read.csv('instance/instance1.csv', sep=',',
                       inferSchema=True, header=True)
query10=query10.select("last_annotation_token").where(query10.token == result1[0])
result1=[data[0] for data in query10.select('last_annotation_token').collect()]
nusc.render_annotation(result1[0])
```

11.Query11 : -

Given a sample annotation,list all activities that annotation has done .

Code : -

```
query11=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                       inferSchema=True, header=True)
sample_ann=nusc.sample_annotation[9]
query11=query11.select('instance_token').where(query11.token == sample_ann['token'])
result1=[data[0] for data in query11.select('instance_token').collect()]
query11=spark.read.csv('instance/instance1.csv', sep=',',
                       inferSchema=True, header=True)
query11=query11.select('category_token').where(query11.token == result1[0])
result1=[data[0] for data in query11.select('category_token').collect()]
query11=spark.read.csv('category/category1.csv', sep=',',
                       inferSchema=True, header=True)
query11=query11.select('description').where(query11.token==result1[0])
result1=[data[0] for data in query11.select('description').collect()]
result1[0]
```

```
'Adult subcategory.'
```

12. Query12 : -

Check whether given annotation is vehicle or not.

Code : -

```
query12=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                       inferSchema=True, header=True)
sample_ann=nusc.sample_annotation[100]
query12=query12.select('category_name').where(query12.token == sample_ann['token'])
result1=[data[0] for data in query12.select('category_name').collect()]
result1=result1[0].split('.')
if (result1[0]=='vehicle'):
   print(True)
else:
  print(False)
```

```
True
```

13. Query13 : -

Check whether given annotation is pedestrain or not.

Code : -

```
query13=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                       inferSchema=True, header=True)
sample_ann=nusc.sample_annotation[40]
query13=query13.select('category_name').where(query13.token == sample_ann['token'])
result1=[data[0] for data in query13.select('category_name').collect()]
result1=result1[0].split('.')
if (result1[0]=='human'):
   print(True)
else:
  print(False)
#print(result1[0])
```

```
True
```

14. Query14 : -

How many vehicles are there in an sample?

Code : -

```
query14=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                       inferSchema=True, header=True)
query14_2=spark.read.csv('samples/sample1.csv', sep=',',
                       inferSchema=True, header=True)
sample=nusc.sample[10]
answer=0
query14_2=query14_2.select('anns').where(query14_2.token == sample['token'])
result1=[data[0] for data in query14_2.select('anns').collect()]
result1=eval(result1[0])
#print(result1)
for ann in result1:
 # print(ann)
  query15=query14.select('category_name').where(query14.token == ann)
  result2=[data[0] for data in query15.select('category_name').collect()]
  result2=result2[0].split('.')
  if (result2[0]=='human'):
    answer=answer+1
answer
```

```
39
```

15. Query15 : -

How many pedestrains are there in an annotation?

Code : -

```
query14=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                       inferSchema=True, header=True)
query14_2=spark.read.csv('samples/sample1.csv', sep=',',
                       inferSchema=True, header=True)
sample=nusc.sample[10]
answer=0
query14_2=query14_2.select('anns').where(query14_2.token == sample['token'])
result1=[data[0] for data in query14_2.select('anns').collect()]
result1=eval(result1[0])
#print(result1)
for ann in result1:
 # print(ann)
  query15=query14.select('category_name').where(query14.token == ann)
  result2=[data[0] for data in query15.select('category_name').collect()]
  result2=result2[0].split('.')
  if (result2[0]=='vehicle'):
    answer=answer+1
answer
```

```
22
```

16. Query16 : -

number of cycle sample annotations who has a rider ?

Code : -

```
query16=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                       inferSchema=True, header=True)


result1=[data[0] for data in query16.select('attribute_tokens').collect()]
query16_2=spark.read.csv('attribute/attribute1.csv', sep=',',
                       inferSchema=True, header=True)

result2=[]
for i in result1:
 result2.append(eval(i))
result3=[]
for i in result2:
  if (len(i)==1):
   result3.append(i[0])
#print(result3)
answer=0

for cat in result3:
  query16_3=query16_2.select('name').where(query16_2.token==cat)
  result2=[data[0] for data in query16_3.select('name').collect()]
  #print(result2[0])
  if (result2[0]=='cycle.with_rider'):
     answer=answer+1
answer
```

17 .Query17

Number of instances who are adult and child?

Code : -

```
[ ]  query17=spark.read.csv('instance/instance1.csv', sep=',',
                            inferSchema=True, header=True)
     query17_2=spark.read.csv('category/category1.csv', sep=',',
                            inferSchema=True, header=True)
     result1=[data[0] for data in query17.select('category_token').collect()]
     adult=0
     child=0
     for cat in result1:
         result2=[data[0] for data in query17_2.select('name').collect()]
        # print(result2[0])
         if (result2[0]=='human.pedestrian.adult'):
           adult=adult+1
         if (result2[0]=='human.pedestrian.child'):
           child=child+1
     print('adult:'+str(adult))
     print('child:'+ str(child))
```

```
adult:911
child:0
```

18. Query18 : -

Given an instance,return description of that instance.

Code : -

```
[ ] query18=spark.read.csv('instance/instance1.csv', sep=',',
                           inferSchema=True, header=True)
    query18_2=spark.read.csv('category/category1.csv', sep=',',
                           inferSchema=True, header=True)
    inst=nusc.instance[2]
    query18=query18.select('category_token').where(query18.token == inst['token'])
    result1=[data[0] for data in query18.select('category_token').collect()]
    query18=query18_2.select('description').where(query18_2.token==result1[0])
    result2=[data[0] for data in query18.select('description').collect()]
    result2[0]

    'Vehicle designed primarily for personal use, e.g. sedans, hatch-backs, wagons, vans, mini-vans, SUVs and jeeps. If the vehicle is designed to carry more
    than 10 people use vehicle.bus. If it is primarily designed to haul cargo use vehicle.truck. '
```

19. Query19 : -

Given sample annotation,return visibility.

Code : -

```
query19=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                       inferSchema=True, header=True)
sample_ann=nusc.sample_annotation[5]
query19=query19.select('visibility_token').where(query19.token == sample_ann['token'])
result1=[data[0] for data in query19.select('visibility_token').collect()]
result1[0]

1
```

20.Query20 : -

Return number of sample_annotations whose visibility is less than 60%.

Code : -

```
query19=spark.read.csv('sample_annotation/sample_annotation1.csv', sep=',',
                       inferSchema=True, header=True)
result1=[data[0] for data in query19.select('visibility_token').collect()]
answer=0
for i in result1:
  if ((int(i))<=2):
     answer=answer+1
answer
```

```
7116
```

Code

I have created separate folders for sample, sample_data, sample_annotation Instance, Visibility, scenes, instance, category, attribute, sensor, calibrated_sensor ,ego pose, map and log to store respective data in that folders in the form of csv files.Then I have implemented queries on those files. I have implemented 20 queries for this project.

Tools used :

- Pyspark
- Python

Conclusion : -

Nuscenes dataset is a very vast and complex dataset .It contains data of 1000 scenes .But only small portion of the data is released.They released data of 10 scenes.So in this project I explored only 10 scenes of nuscenes dataset and implemented queries on that.