* **ADAS - Advanced Driver Assistance Systems. These systems are based on**

1. Camera
2. Lidar
3. Radar
4. Ultrasound

To obtain information from the environment.

* **Available Datasets**

1. nuScenes
2. Astyx
3. Waymo Open Dataset
4. KITTI

* **the use of cameras and lidar for the detection and classification of objects:**

1. Mask RCNN
2. Faster RCNN
3. YOLO

* **Why would the use of radar be beneficial compared to cameras and lidars?**

1. The radar provides complementary information to the lidar and the camera.
2. A radar can detect objects regardless of weather and light conditions (night, fog, snow, etc.),
3. Automobile radars display very good performance in accurately measuring the
   * Distance
   * Speed
   * Angle of arrival of surrounding objects.
4. Radars achieve better performance for speed estimation but at a much lower computational (and monetary) cost.

* Radar gives only information on position, speed, probability of being a target or not, and power returned by the target
* Is it possible to use radar data further upstream of the processing chain instead of the camera for target detection and classification?
* Database containing both:

1. Unannotated images.
2. Radar data (Doppler range or azimuth range) annotated.

The objective is to **obtain the highest detection score** (mean average precision) on the range-Doppler data initially.

NOTE: Given the impossibility of using mean average precision as a metric directly in Kaggle, you will calculate this metric beforehand and the evaluation metric will be the MAE between reference results and yours.

* **Range-Doppler spectrum**

range-Doppler spectrum is obtained after **two successive Fourier transforms** on the data received by the radar.

represents the vehicle's environment based on the

* Distance
* Speed

of each target.

In the figure below, 2 pedestrians are present in the radar field at

22m and 26m respectively and at a speed of 1 m/s and -1 m/s respectively.

A positive speed means the target is getting closer and a negative speed otherwise.

* **Range-azimuth spectrum**

The range-azimuth spectrum is obtained after **three successive Fourier transforms** on the data received by the radar.

It allows a representation of the vehicle's environment based on the

* Distance
* Angle of arrival

of each target.

In the figure below (same sequence as previously), 2 pedestrians are present in the radar field at 22m and 26m respectively and at angles of 17° and -5° relative to the radar respectively.

* **Estimation of distance, speed, and angle from spectra**

Based on the distance, speed, and angle resolution of the radar

It is possible to estimate these parameters for a given target directly on the spectrum.

By a bounding box these parameters could be estimated:

* Extract the position (x, y) of the maximum value in a bounding box
  + **x = range**
  + **y = speed or angle**

Let Rres, Dres, and Ares respectively be the resolution in distance, speed, and angle.

1px = Rres, Dres or Ares.

SO:

**Distance = Rres\*x**

**Velocity = (64/2-y) \* Dre** (on the range-Doppler spectrum of size 256x64)

**Angle = (256/2-y) \* Ares**  (on the range-Azimuth spectrum of size 256x256)

* **Database distribution**

The database is made up of **30 sequences** lasting **between 30:90 seconds**.

* 1. Each sequence corresponds to a different scenario.
  2. These sequences are divided into three different data sets: training, validation, and test.
  3. The sequence breakdown can be found in the data\_seq\_ref.json file.
  4. The distribution was made beforehand when creating the annotation files (see annotations section).

**Dataset structure**

Each sequence is named according to its collection date and contains the following folders:

1. camera\_images: contains camera images.
2. range\_angle\_numpy: contains the range-azimuth spectra.
3. range\_doppler\_numpy: contains range-Doppler spectra.

A file containing the radar data timestamps (not used here)

**Annotations**

The annotations provided are JSON files in COCO format.

1. carradaTrain\_rd.json corresponds to the training base.
2. carradaVal\_rd.json corresponds to the validation base.
3. carradaTest\_rd.json corresponds to the test database.

**Only 3 classes are present in the database:**

0: Pedestrians

1: Cyclists

2: Cars

Bounding boxes in the format (x, y, h, w) are provided.

**Range-Doppler spectra format** is NumPy matrices of size 64x256 containing the amplitude values of the signal at a given distance and speed.

**Range-Doppler spectra format** is NumPy matrices of size 256x256 containing the amplitude values of the signal at a given distance and angle.

**Camera images** are RGB 1232x1028 with No annotation.

It is not prohibited to use them to train the model. However, the objective of this challenge is to detect targets ONLY on the range-Doppler spectrum (or range-azimuth)