Incremental Learning for Object Detection on Embedded Systems using Machine Generated Buonding Boxes

Vittorio Mazzia

PhD Supervisors:

Marcello Chiaberge Mario Roberto Casu

Motivation and background

Training object class detectors typically requires large amount of data in which images are **manually annotated** with bounding boxes (bbox) for every instance of each class. This is particularly true for lightweight object class detectors that progressively improve their mean average precision (mAP) increasing the number of examples available. The presented research suggests a methodology to exploit **generated data** from the field and a **collaboration** with multiple independent deep neural networks to obtain an increasingly more performing **embedded model** for the designated tasks.

Materials and methods

- **Dataset:** (OIDv4_ToolKit)

OIDV4		Apple	Grape	Lemon	Orange	Pear
	Train	624	755	367	583	204
	Validation	24	44	41	25	4
	Test	57	124	79	95	27
	Videos	5’ 4’’	12’ 25’’	34’ 3’’	7’ 9’’	9’ 43’’

- **Hardware**:
  - Tesla K80 (4992 Cuda Cores)
- **Networks**:
  - Faster R-CNN (with ROI-align)
  - SSD (with Focal-Loss (1.1))

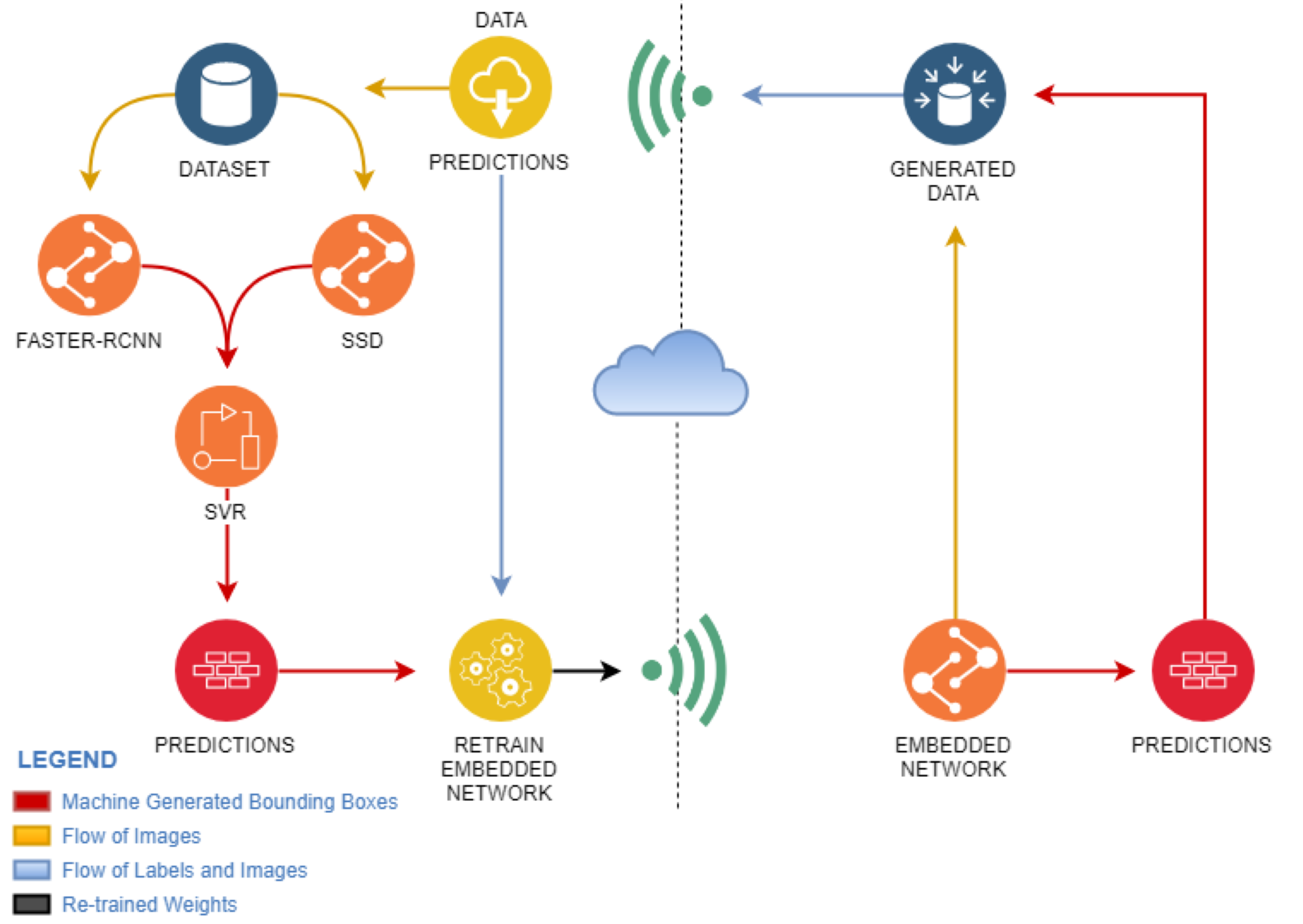
$$\mathrm{CE}(p_t) = -\log(p_t) \tag{1}$$

$$\mathrm{FL}(p_t) = -(1-p_t)^{\gamma}\log(p_t) \tag{1.1}$$

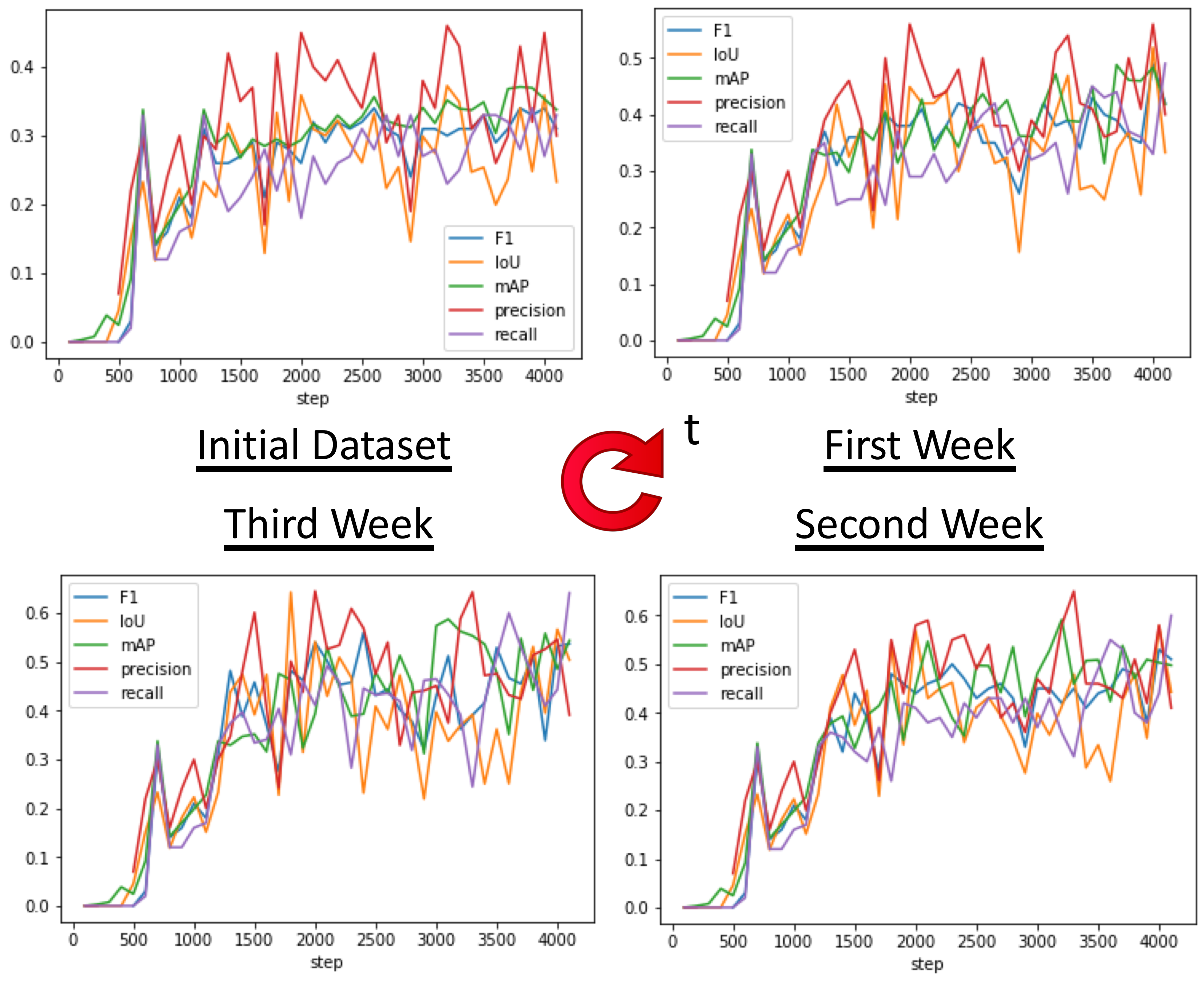
Proposed Algorithm

A first architecture of the algorightm is shown in the graph at the bottom and it follows the following steps:

- An initial dataset is used to train a two-stage Faster-RCNN, a Single Shot Multibox Detector (SSD) and a **lightweight version** of it.
- Data generated by the embedded network (frames & predictions) is sent to the cloud.
- Received images are elaborated by the **ensemble network** that generates new bbox.
- New data are merged with the old one and, through a re-training, novel weights of the embedded SSD are generated



Simulation Results



Initial Dataset

First Week

Third Week

Second Week

Conclusions and future work

The methodology presented is the first of its kind and preliminary results have proven a remarkable effectiveness of the overall system. However, the proposed research requirese further studies to improve the algorithm and asesess its limitations and drawbacks.

- Substitute the SVR block with a FC layer that exploits backbone extracted features
- Look for saturation value of mAP