Advanced Machine Learning (AML)

Deep Learning Project 2:
Object detection

Introduction

The main goal of this coursework is the development of a Deep Learning approach to perform object detection and classification in images and videos. We are going to use YOLO (You Only Look Once), a well-known family of object detection algorithms for its speed and accuracy. In particular, we are going to base our work on the YOLOv8 version that can be found here: https://github.com/ultralytics/ultralytics.

Available YOLO models are commonly trained with the Microsoft COCO dataset (https://cocodataset.org), which consists of more than 200K annotated images containing more than 1.5M objects belonging to 80 different object classes. In this coursework, we are going to use these pretrained models in two different ways:

1) **Inference on test images and videos.**
    Start getting familiarized with the YOLOv8 framework. Use the command line or a python environment to run inference on images and videos.

    <u>**Task to do:**</u> use one of the models pretrained with the COCO dataset and analyze qualitatively the results obtained within a video that you choose or that you create by yourself.

2) **Transfer learning on a custom dataset to detect a novel object class.**
    First of all select one or different custom datasets to train a YOLOv8 model. You can select available ones or create your own videos and training images from scratch using tools like Roboflow (https://roboflow.com).

    You can train as many different models as you want, from simple ones with just one class to more complex ones with multiple classes, but make sure that **at least one** of them detects and classifies at least one **object not present in the COCO dataset**. Figure 1 shows an example of the detection of a novel object class.
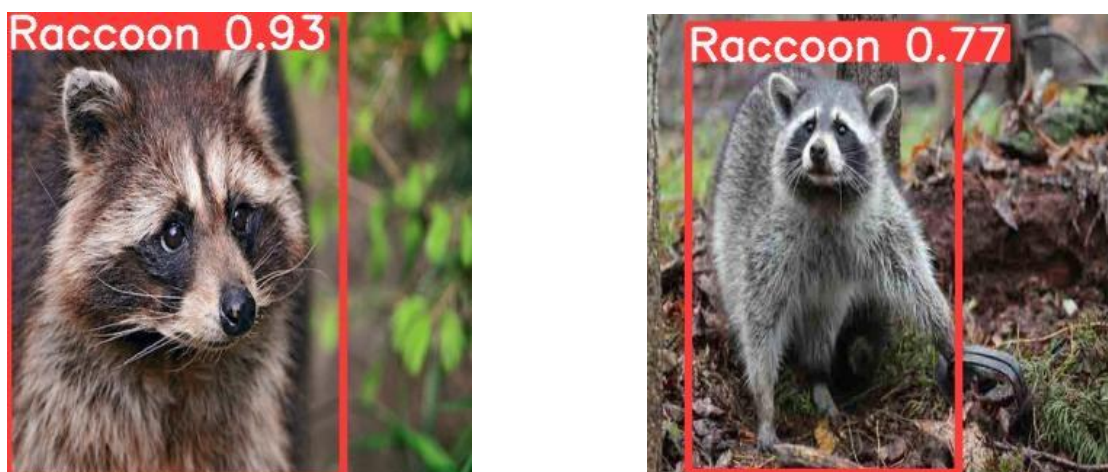

Figure 1. A couple of examples of test images with raccoons detected. Since the default YOLOv8 train with the COCO dataset does not include the raccoon class transfer learning has been performed with a dataset of this specific class.

<u>**Task to do:**</u> perform transfer learning on pretrained YOLOv8 models. Check its usage and tweak the different parameters in order to achieve the best possible performance. Finally, test the new models you trained on testing images and videos. **Analyze quantitatively and qualitatively the results obtained** on testing.

Objectives

A. **Information search.** It is important to understand how YOLO works and how to use its framework. Teamwork.
B. **To run inference on test images and videos**. Select interesting test datasets to try the default YOLOv8 model and analyze qualitatively the results.
C. **To train and test a custom model**. Select interesting train and validation datasets (at least one class not present in the COCO dataset). Start with a single model, trained with a single class, and tweak the parameters to achieve the best performance. Then, use more complex datasets and analyze the results qualitatively and quantitatively. For analyzing and reporting the results of your approaches, you should use the validation set and show the confusion matrices.
D. **Documentation**. Report all the trials and experiments, and analyze and explain the results achieved.

Coursework

A. PDF file or Colab notebook with the following sections:
   1. Dataset presentation.
   2. Experimental section and results analysis (speed, mAP, precision, recall, …).
   3. Conclusions.

Coursework evaluation

A. Report (90%)
B. During the lab sessions (10%).

DEADLINE: It will be the one indicated in the moodle submission link. Late submission will be penalized.