# Advanced Computer Vision for AI (ARI3129)

Group Project Specifications

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| Title: | Automatic Detection & Attribute Classification of Maltese Traffic Signs |
| Deadline: | 21st January 2026 |
| Team size: | Maximum of 4 persons. Equal contribution will be assumed. |
| Maximum Marks: | 100 marks contributing to 50% of the final mark of the study unit |

# Preliminaries

The focus of this applied task is the use of computer vision techniques to analyse traffic signs and assess a chosen sign attribute.

**This component is organised into three tasks:**
The **first task** involves capturing images of traffic signs on Maltese streets. The **second task** focuses on building a dataset to train object detectors for this project. The **third task** requires training an object detector to **locate and classify a traffic sign** from an input image and to **train another** to classify one chosen sign attribute: **Viewing Angle** *(Front, Back, or Side)*, **Mounting Type** *(Wall-mounted or Pole-mounted)*, **Sign Condition** *(Good, Weathered or Heavily Damaged)* or **Sign Type** *(Circle, Square, Triangle, Octagonal or Damaged)*.

You are expected to document your work throughout all the tasks.

## Deliverables per group

Each group must submit the following deliverables:

1. 20 Pages (Maximum) Document
2. 10 Page (Maximum) Generative AI Usage Journal
3. All practical work must be clearly documented in Jupyter Notebooks and stored in a well-structured GitHub repository, accompanied by a **README.md** file that describes each component.
    a. Dataset folder containing all captured images, along with a subfolder for exported COCO and JSON annotation files.
    b. 1_data_visualisation.ipynb
    c. 2a_[object_detector_architecture_name]_[student].ipynb *(one per student)*
    d. 2b_[sign_attribute]_[student].ipynb *(one per student)*
    e. 2c_results_comparison.ipynb

## General Marking Scheme for the Applied CV Task:

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| - Task 1 (Dataset): | 40% |
| - Task 2 (Object Detection): | 35% |
| - Documentation: | 15% |
| - Generative AI Journal: | 10% |

# Specifications

## Task 1: Building a Dataset (40%)

Modality: Dataset in a structured GitHub repository, and a Jupyter Notebook visualising the Annotated Images.

Marking Scheme:

- Planning of the dataset and the choices about its format, configuration and content. Image capture and quality of collected images, including location data and date/timestamp: 20%
- Annotation process and preparation of the dataset for training and testing object detectors: 10%
- Jupyter Notebook for visualisation of the dataset and its statistics: 10%

Brief:

1. The team is required to capture good-quality images of traffic signs in Maltese streets from multiple viewing angles. Each physical sign should be photographed from different perspectives (front, back, and side views - left and right sides being equivalent) to support a comprehensive analysis.
    a. **Specific sign type:** Stop, No Entry (One Way), Pedestrian Crossing (Zebra Crossing), Roundabout Ahead, No Through Road (T-Sign) and Blind-Spot Mirrors (Convex Mirrors).
    b. **Note: When capturing images at night, ensure that the flash does not distort the sign, as the reflective material on traffic signs may affect the photo quality.**
2. **The following sign attribute should also be noted:**
    a. **Viewing Angle:** Front, Side, or Back view
    b. **Mounting Type:** Wall-mounted or Pole-mounted
    c. **Sign Condition:** Good, Weathered (e.g., faded, scratched, discoloured, or with minor dirt accumulation), or Heavily Damaged
    d. **Sign Shape Type:** Circular, Square, Triangular, Octagonal or Damaged
3. The Maltese Traffic Signs Dataset (MTSD) should contain a **minimum of 50 distinct** traffic signs per team member, with each sign captured from multiple viewing angles.
    a. Additionally, the dataset may be supplemented with external images of traffic signs that closely match Maltese signage (beyond the required 50). Any such images must be clearly tagged as externally sourced, and all public dataset sources must be referenced.
4. Any personal or identifiable information, such as faces or vehicle number plates, must be avoided, blurred, masked, or removed adequately through generative inpainting. The dataset must comply with GDPR.
5. Students should analyse and report on the balance or imbalance across all labelling categories (sign types as well as the four sign attributes) in the documentation. No strict balance is required, but the distribution must be documented and discussed.

6. Using these images, prepare a dataset to train a custom object detector. Each image must be labelled with all the attributes listed above. Include data augmentation as applicable.
7. Label Studio[1] is to be used in this process.
8. **Each team member must fully annotate all their images**, ensuring that every object is labelled with all required attributes (viewing angle, mounting type, condition, and sign shape type). After completing annotation, they should **follow the steps outlined in the README.md** to consolidate all members' JSON and ZIP files into a single dataset and convert it into the required COCO format for the assignment.
9. After completing annotation, each student must export their own annotations from Label Studio in **two parts**: the **JSON export and the COCO with Images export**. **Only the images folder** from the latter export should be used. It must be manually zipped before being used as that member's ZIP upload during the consolidation step.

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## Task 2: Object Detection/Localisation (35%)

Modality: One Jupyter Notebook for each object detector technique

Marking Scheme:

- Training object detection techniques **(TWO per team member)**: 20%
- Evaluation and Analytics of the models: 15%

Brief:

Each team member must:

1. Train any object detector of your choice to detect traffic signs in an image using Ultralytics, Tensorflow, or PyTorch.

    a. **It is recommended to use YOLOv8, v11, or v12, as well as other detectors such as RF-DETR, RetinaNet, Faster R-CNN, or EfficientDet.**
    b. **Note: Only groups consisting of three or more members may use different YOLO versions within the same project.**
    c. **Note: Models trained using Roboflow or the Ultralytics Hub online platforms will not be accepted.**
2. Repeat the training process for one selected attribute (viewing angle, mounting type, sign condition or sign shape type).
    a. **Note: Each team member should work on a different sign attribute.**
3. Evaluate and compare the performance of the models using tools like Tensorboard or Ultralytics, alongside code-based metrics such as mAP.
4. Following the detection, you are expected to provide analytics of the input image, specifying the number of traffic signs detected and their chosen attribute. This information supports the maintenance and monitoring of traffic signs.

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[1] https://labelstud.io/

# Documentation (15%)

A single, adequately formatted and structured PDF file needs to be submitted to document the project's progress. The documentation needs a section for each task above, clearly showing how it was implemented and evaluated/tested. Where appropriate, students are expected to properly cite third-party work. The documentation should include figures and tables to provide as much information as possible about the process and support its discussion.

The document should be **no more than 20 pages**.

This component carries 15 marks that are allocated accordingly:

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| ● General structure, use of proper English and clarity: | 2 marks |
| ● Proper acknowledgement of third-party work and references: | 5 marks |
| ● Methodology and evaluation of each task: | 8 marks |

# Documentation Outline

1. Introduction
2. Background on the techniques used
3. Data Preparation
4. Implementation of the object detectors
5. Evaluation of the object detectors
6. References and List of Resources Used

# Generative AI Journal Guidelines (10%)

The objective of this document is to critically examine and reflect on how generative AI models, like Gemini, Claude or ChatGPT, were used in this project. This documentation will focus on ethical considerations, the methodology employed, and the specific contributions of generative AI to improving your work. It is important to cite any references or resources you consulted about generative AI.

The document, which is separate from the technical paper, has a page **limit of 10 pages**, including references and should contain the following sections:

1. **Introduction**
    a. Briefly describe the generative AI models you chose to use and the rationale behind that choice. (Maximum of 1 page)

2. **Ethical Considerations**
    a. Discuss the ethical aspects of using generative AI in your project. This should include issues such as data bias and privacy concerns. (Maximum of 1 page)

3. **Methodology**
    a. Outline the methods and steps to integrate the generative AI model into your work. Which tools did you use, and in which sequence? Did you create your own pipeline, or did you use a single tool? There is no wrong answer, and this journal aims for transparency and accountability.

4. **Prompts and Responses**
    a. List down the specific prompts that were used with the generative AI model and that you found noteworthy. For each prompt, also include the generated response and explain how it contributed to improving your project. It is advisable to use screenshots for this part.

5. **Improvements, Errors and Contributions**
    a. Discuss the areas where generative AI contributed to enhancing your work or instances where the output contained errors. This can include but is not limited to, data analysis, formulation of ethical considerations, literature review enhancement, or idea generation. Highlight specific cases where this happened.

6. **Individual Reflection**
    a. Reflect on your personal experience using generative AI in your project. Discuss what you learned, what surprised you, and how your perspective on using AI in academic projects has changed, if at all. Did Gen AI help you be more efficient? Do you feel you wasted more time when you used it? For which part was it most helpful? Literature review, debugging?

7. **References and List of Resources Used**

End of Project Specifications