

An integrated weed management system based on deep learning identification models and biodiversity indices: Initial system design and models

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Objective

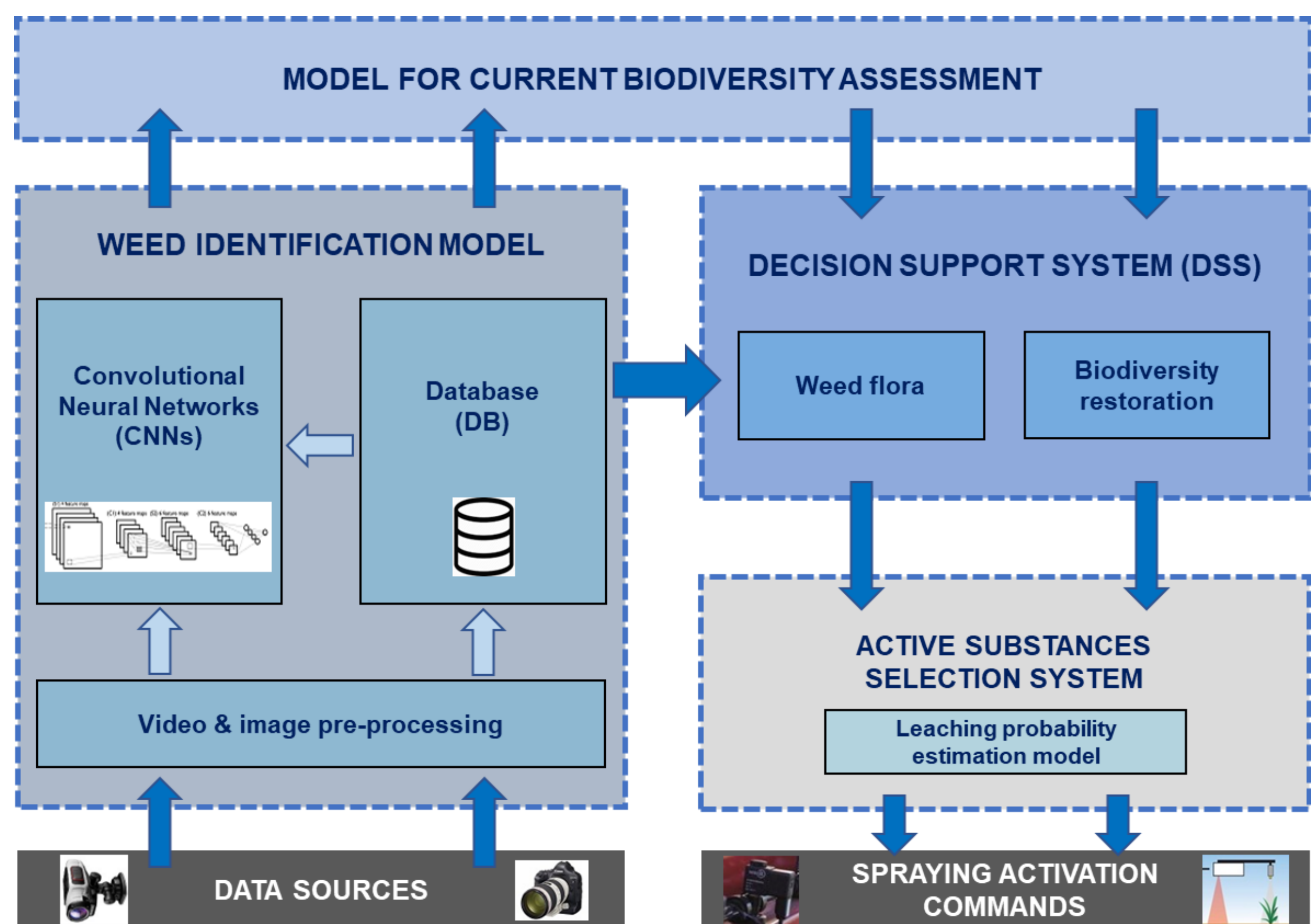
The aim of this work is to create an intelligent system that will decide with high spatial accuracy the application of targeted spraying applications, and which, if adapted to sprayers, will lead to the practical application of precision spraying.

The project proposes an integrated weed management system (**WeeDetect**) consisting of:

- an automated weed identification model based on deep learning object detection and identification algorithms, specialized for specific weeds of domestic crops
- an integrated decision making system for the necessity of targeted spraying or not, on the basis of the identified weeds, combined with:
 - specific indices of both the prevailing biodiversity, and
 - other parameters such as resistance, stability degradation, and the possibility of surface and groundwater pollution.

Registered herbicides will be prioritized on the basis of resistance management, reduced environmental risk and increased efficacy.

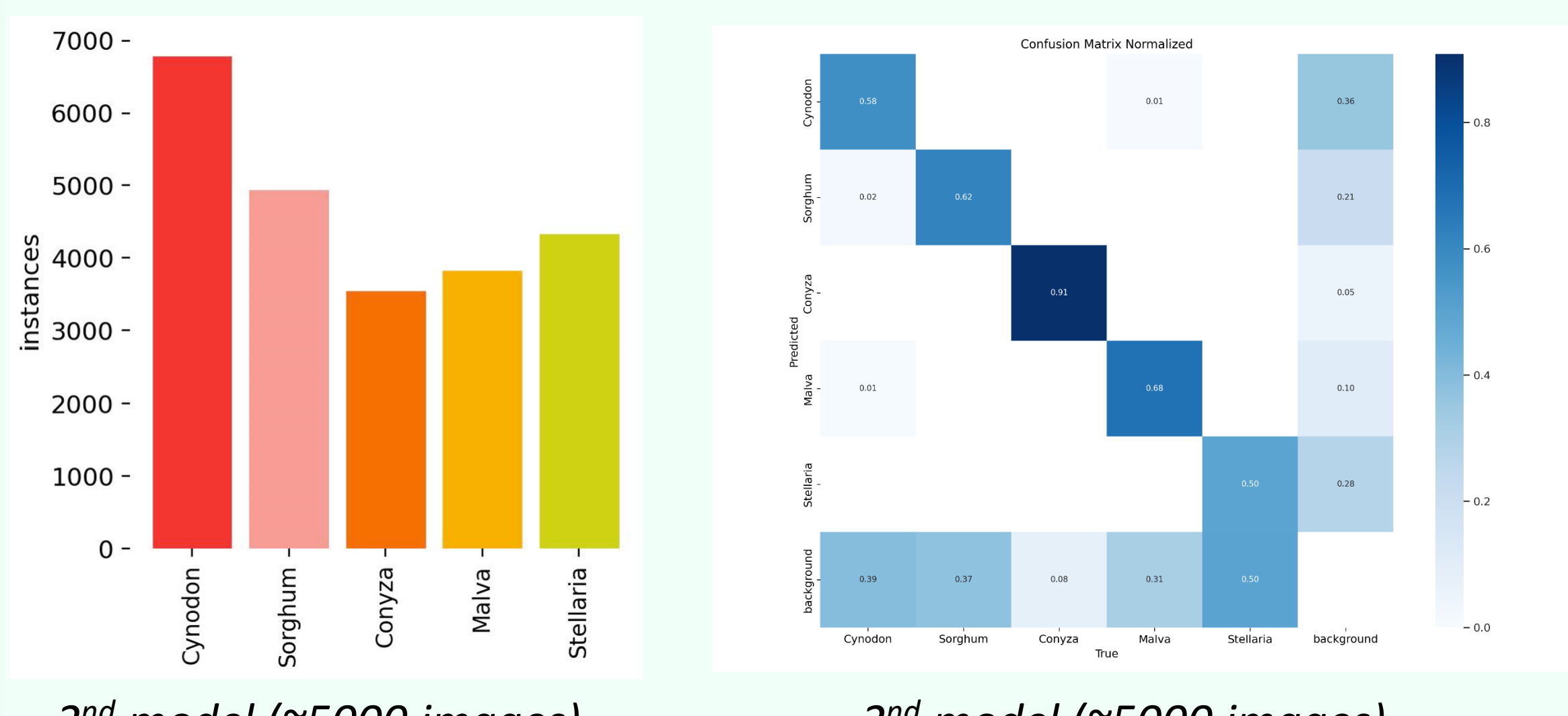
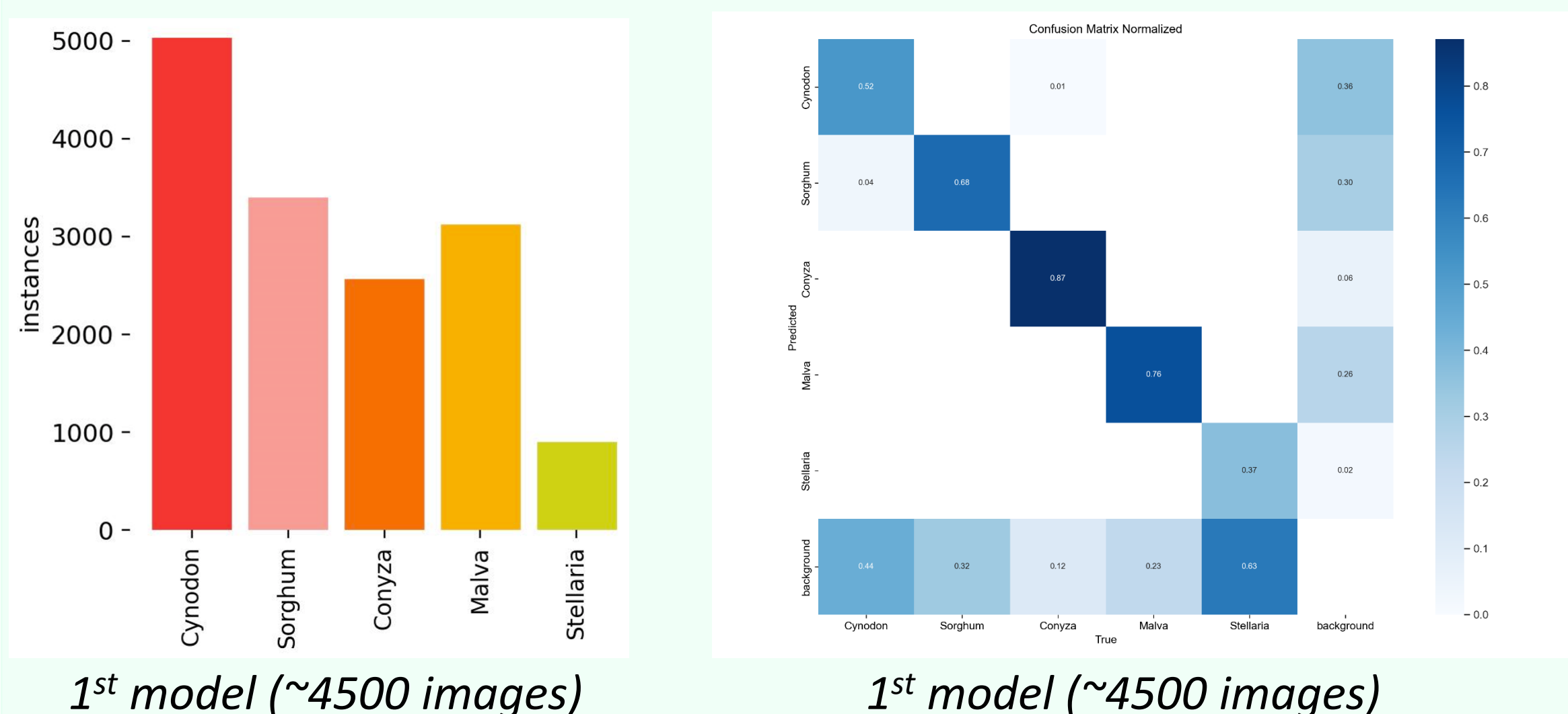
Initial system design



The main sub-systems of the **WeeDetect** system are the following:

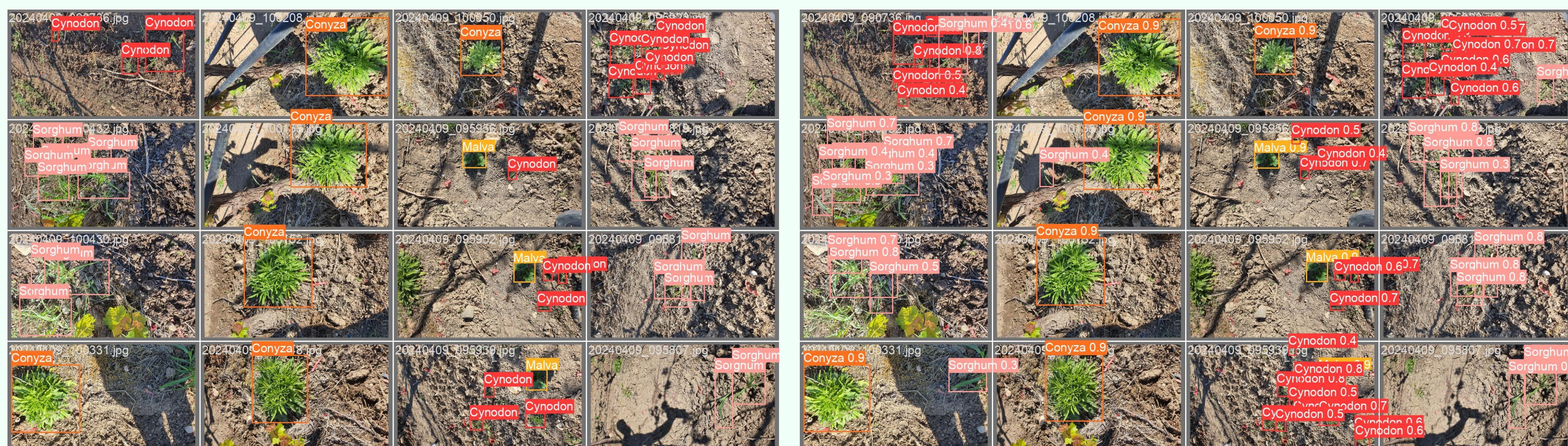
- **Weed identification system**
 - Database for training and testing of models
 - Convolutional neural network models
 - **Output:** the number of identified weeds per species and the percentage of coverage of each identified species in the image
- **Model for estimating current biodiversity**
 - i) will receive information of the existing quantity of each weed species
 - ii) will calculate the land cover of weeds in square centimeters
 - iii) will calculate the ratio of the ground cover of target weeds in relation to the total percentage of ground cover of weeds in the fixed square meter
 - **Output:** Results based on the Shannon and Simpson diversity indices
- **Decision Support System (DSS) to perform spatially targeted spraying**
 - i) will take into account the period of high vegetative growth of weeds (winter, spring)
 - ii) will take into account their current growth stage
 - **Output:** Spatially targeted spraying necessity assessment (provide information on whether or not to use chemical herbicides)
- **System for the selection of active substances for weed control**

Initial weed detection and identification models



Annotations per weed species for the 2 initial models

Confusion matrices for the 2 initial models



Ground truth

2nd model detection results in test sample images

Predictions



1st model



2nd model

Improvement in *Stellaria media* detection (test video screenshots)

Conclusions – Future work

- The **WeeDetect** system will be based on 4 independent but interconnected sub-systems towards the provision of specialized advice on high spatial accuracy application of targeted spraying applications
- Initial development of automated weed detection and identification models led to the optimization of the weed annotation process in the collected weed images database, achieving better prediction results for specific initially problematic cases (e.g., *Stellaria media*)
- Future steps include the design and training of more sophisticated models and the development of the other sub-systems of the **WeeDetect** integrated system (Biodiversity assessment model, DSS for spatially targeted spraying necessity assessment, and active substances selection system)

