# Computer Vision for Automated Surveying of Flowering Plants

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European Commission - Joint Research Center

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# Introduction

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- Flower diversity monitoring and conservation requires data on scale difficult to cover with traditional surveying methods
- Learning from citizen science: Using computer vision could help large scale biodiversity monitoring
- Aim: Explore the type and accuracy of information on flower diversity and abundance that can be collected through Computer Vision based methodology


Pl@ntNet

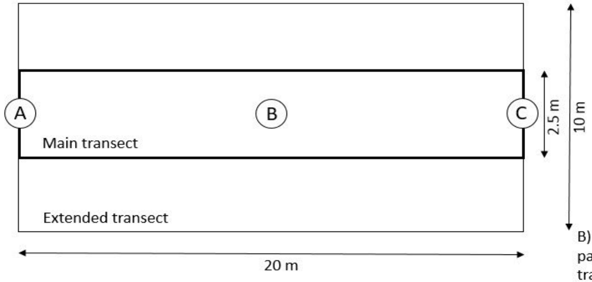
1. Are flower present?
2. How many flower?
3. What colors are the flowers?
4. Can we determine the species?

# Grassland module

Collected between April and July 2018 as part of the LUCAS Survey

**2173** points surveyed **730** points with additional control by experienced botanists

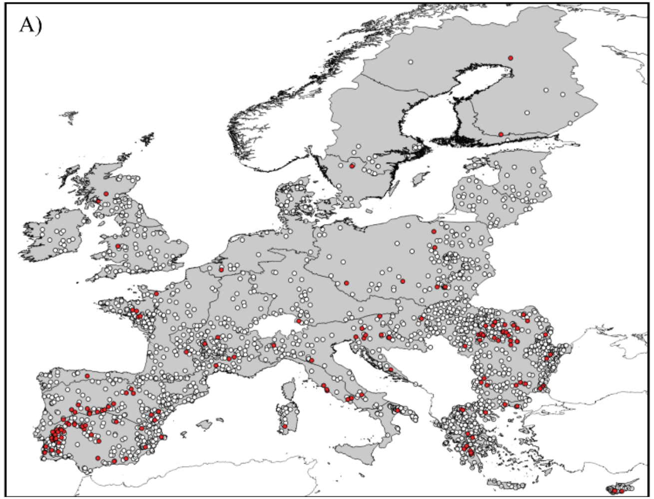
New survey being done in 2022 with ~20K grassland module points




B) Image of a representative patch of vegetation in the transect, taken 1.5m from above the ground

A) Image from start to end of the transect

C) Image from end to start of the transect




Variables collected in the grassland module:

Habitat type (e.g. EUNIS type, presence of structural species)
Environmental conditions (e.g. slope in degrees, orientation, heterogeneity of soil surface)
Age of grassland (estimated based on visible evidence)
Use type (e.g. type of grazing animal, evidence of abandonment, presence of agroforestry)
Use intensity (e.g. evidence of reseeding or fertiliser application)
Structure of vegetation (e.g. heights and coverages of different elements of vegetation layers)
Biodiversity value (e.g. presence of indicator species, balance of elements of herb layer)
Pollinator value (e.g. number of flowering species, flower density)

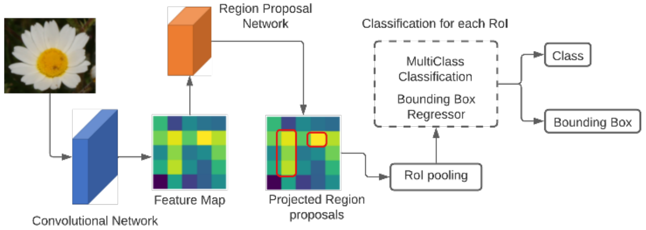
1) Presence of flowers in the image
2) Number of flowers in the image

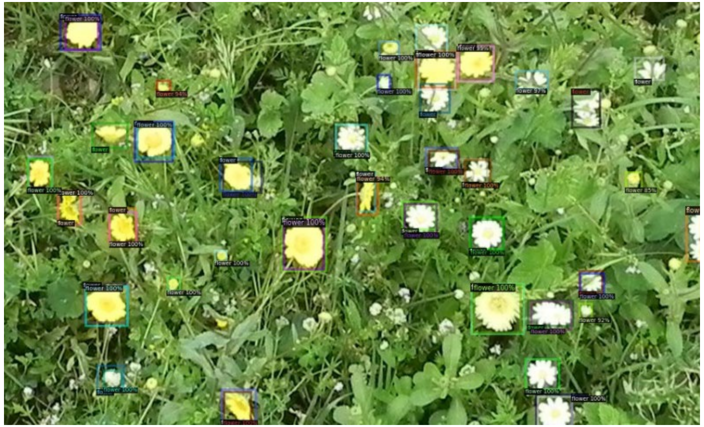
3) Color of the flower
4) Identifying species

# Object Detection

Extract individual flowers with Faster R-CNN

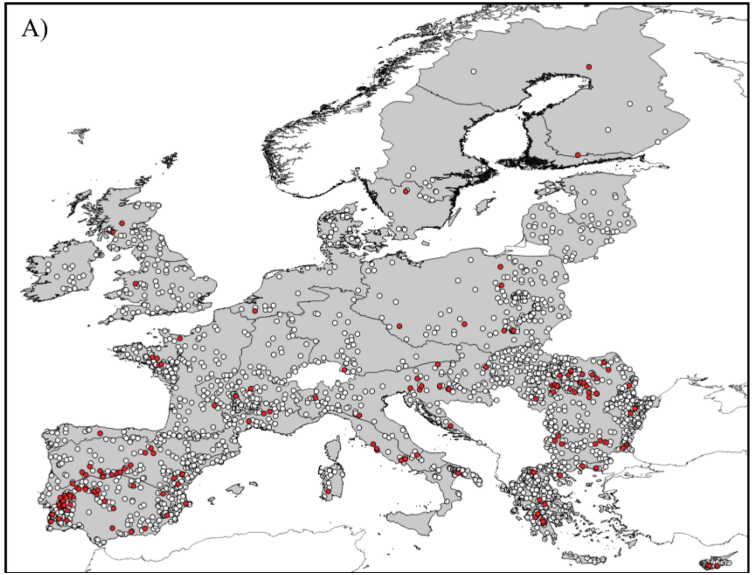
1. Creating training data
2. Choosing model configurations
3. Extracting performance metrics

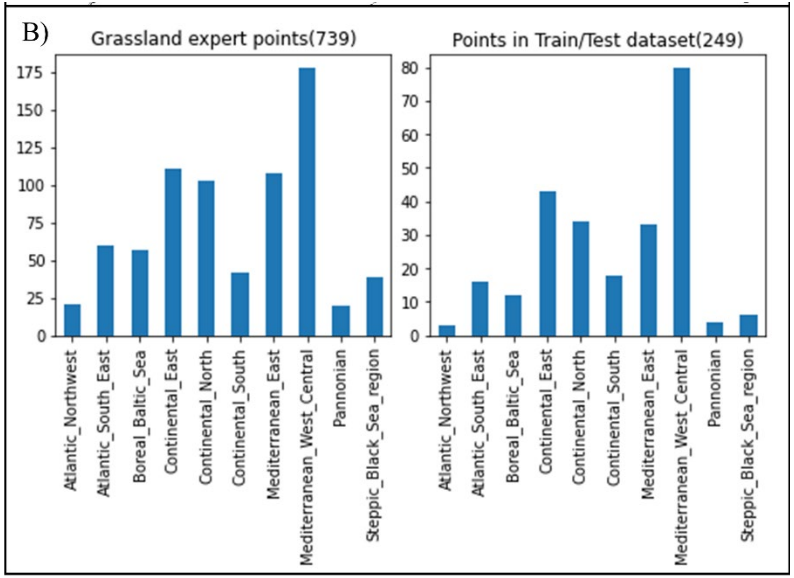


# Creating Dataset

Sample points from LUCAS Grassland data



# Creating Dataset

Manually delineate all flowers on 250 images using the CVAT tool

Due to overpopulated images we slice each image into 4. Include two slices from each image in dataset

Split dataset into Training and test data:

400 slices for training

100 slices for testing

# Model Training

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## Dataset creation and preprocess

- Gather Grassland data
- Choosing points
- CVAT delineation

## Train model

- Testing different models
- Hyper-parameter tuning
- Train models

## Inference and improve dataset

- Enhance dataset with predictions
- Divide images into 4 slices
- Improve delineation

## Retrain and inference with improved dataset

- Train additional 5k iterations
- Extract accuracy metrics

## Performance metrics for top three models:

Calculated with IoU threshold of 0.5

| Model ID | Precision | Recall | F1 |
|---|---|---|---|
| 22 | 0.69 | 0.48 | 0.57 |
| 14 | 0.74 | 0.50 | 0.60 |
| **23** | **0.74** | **0.50** | **0.60** |

| Model ID | Precision | Recall | F1 |
|---|---|---|---|
| 22 | 0.76 | 0.74 | 0.75 |
| 14 | 0.75 | 0.76 | 0.76 |
| **23** | **0.78** | **0.74** | **0.76** |

## Change metrics:

| | Precision | Recall | F1 |
|---|---|---|---|
| Min | - 0.09 | + 0.22 | + 0.12 |
| Max | + 0.07 | + 0.31 | + 0.18 |
| Mean | - 0.02 | + 0.28 | + 0.15 |



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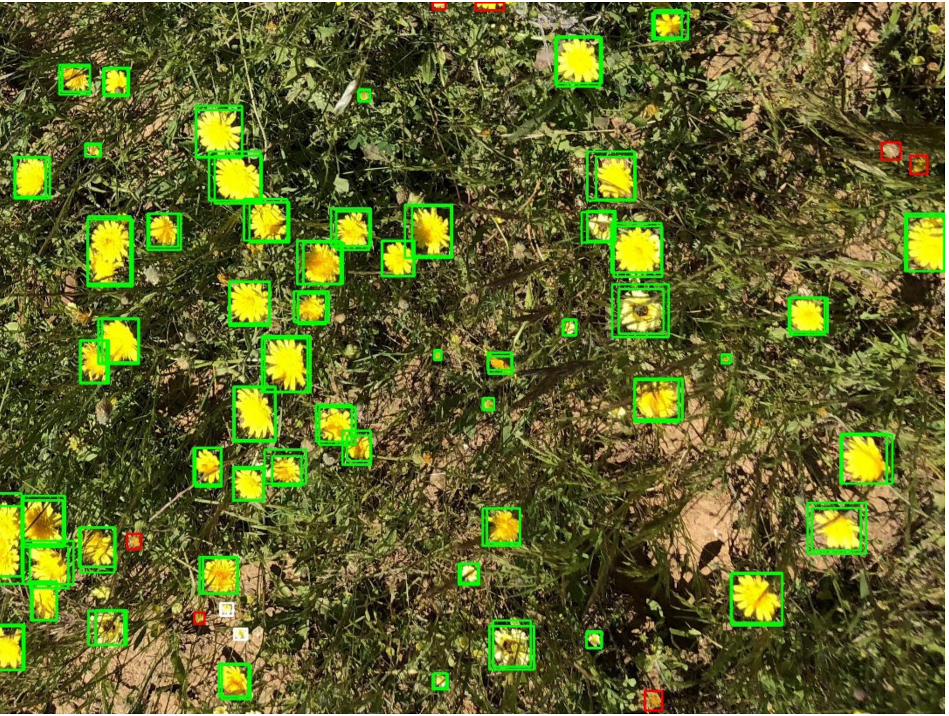
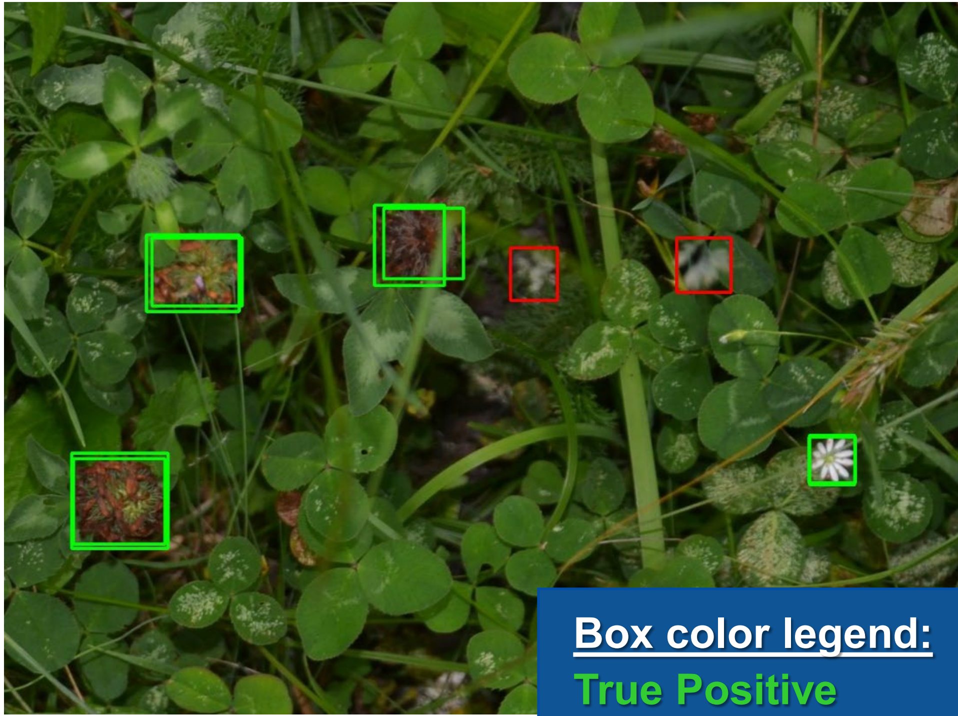
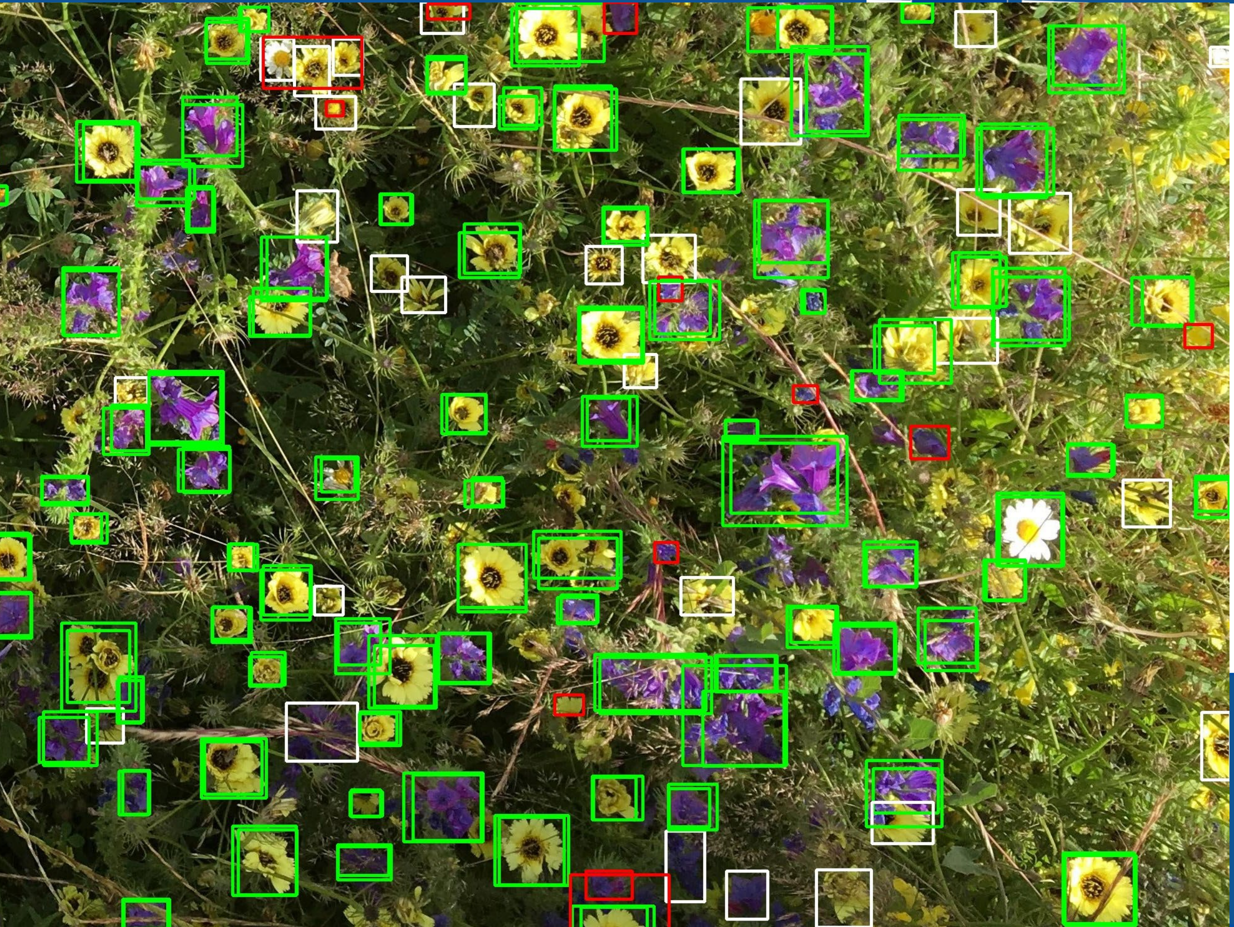
# Model Predictions





**Box color legend:**
True Positive
False Negative
False Positive

# Model Predictions



Challenges with predictions:

- Natural and complex scenes
- Overpopulated images
- Quality and brightness

**Box color legend:**
**True Positive**
**False Negative**
**False Positive**

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# Model Predictions

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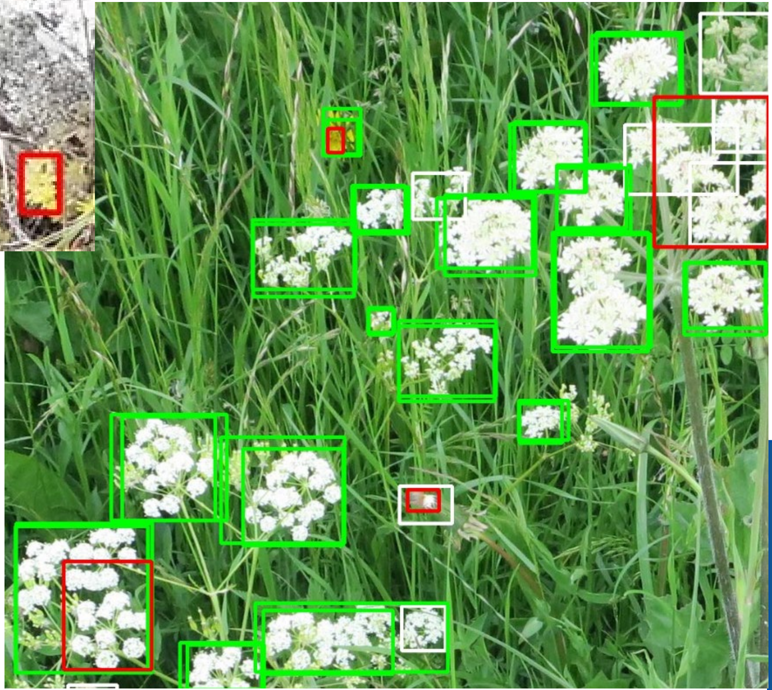

Challenges with predictions:

- Diverse class
- Variation in shape, infloresence etc.

**Box color legend:**

True Positive

False Negative

False Positive



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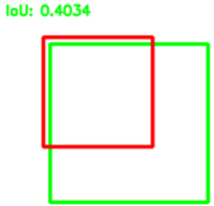
# Model Predictions

| | Precision | | Recall | | F1 | |
|---|---|---|---|---|---|---|
| Min | 0.63 | **+ 0.05** | 0.72 | **+ 0.05** | 0.67 | **+ 0.06** |
| Max | 0.78 | **+ 0.09** | 0.80 | **+ 0.07** | 0.76 | **+ 0.08** |
| Mean | 0.70 | **+ 0.07** | 0.77 | **+ 0.06** | 0.73 | **+ 0.07** |

Hidden True Positives:

- Capturing flowers not in original delineation
- Overlap and flower parts




**Box color legend:**
**True Positive**
**False Negative**
**False Positive**

# Model Predictions

35 flowers detected

- 18 yellow
- 7 purple
- 5 white
- 5 blue

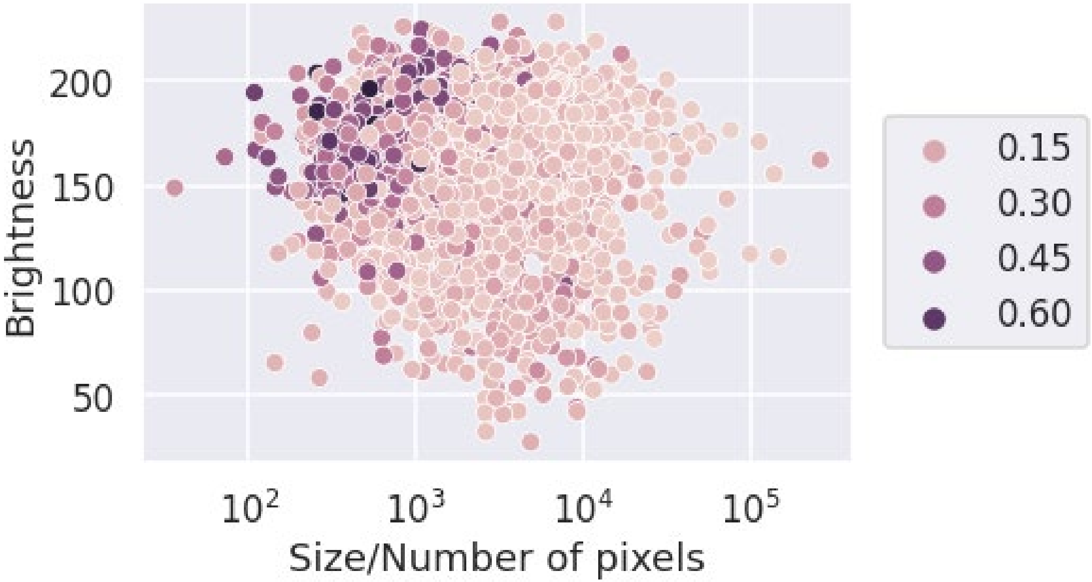
# Pl@ntnet Identification

100 images predicted 2395 flowers

Increasing Plantnet scores requires better images

Next step: compare Plantnet results with survey

Mean Pixel brightness and number of pixels for each predicted flower. Categorized by Plantnet 1st score.



# Recap and Conclusion

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- Output: object detection **model and test/training dataset for flower detection**
- With this model we can **quantify presence and abundance** of flowers, as well as color and size distribution of the detected flowers
- Using **Plantnet**: Species level identification of the flowers depends on image quality.
- Next steps: comparing the extracted measures with the survey data

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# Thank you!


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