agri digital

Utilisations concrètes dans l'agriculture et l'industrie agroalimentaire

Estimation de la quantité de fleurs sur les surfaces de compensation écologique à l'aide de drones et de Deep Learning

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20.031

Journée annuelle de la communauté de la charte de digitalisation

Online zoom

22 octobre 2020

agridea

ENTWICKLUNG DER LANDWIRTSCHAFT UND DES LÄNDLICHEN RAUMS
DÉVELOPPEMENT DE L'AGRICULTURE ET DE L'ESPACE RURAL
SVILUPPO DELL'AGRICOLTURA E DELLE AREE RURALI
DEVELOPING AGRICULTURE AND RURAL AREAS

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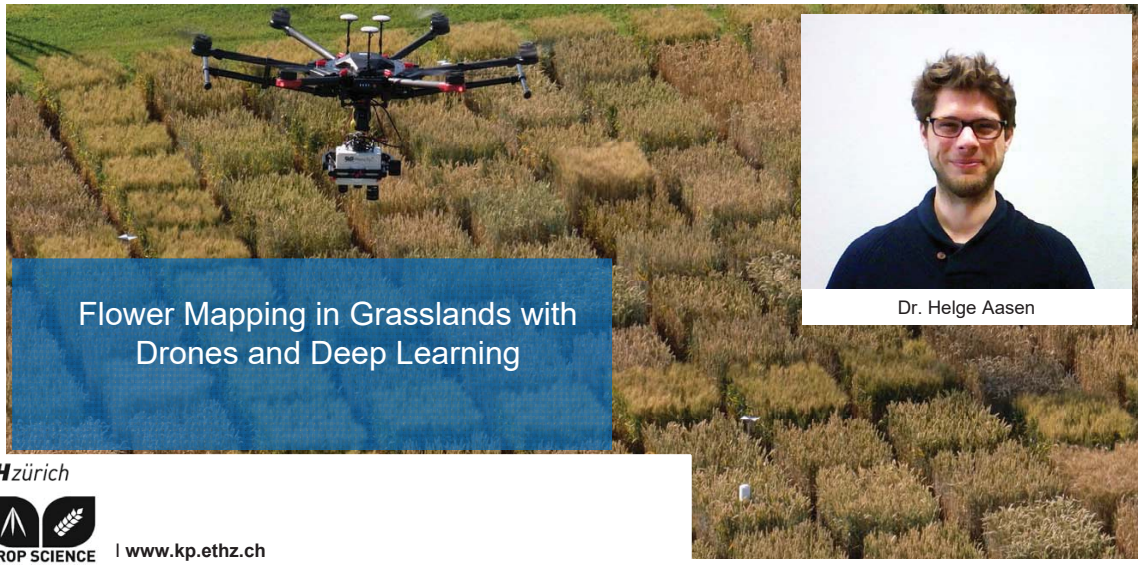

Flower Mapping in Grasslands with Drones and Deep Learning

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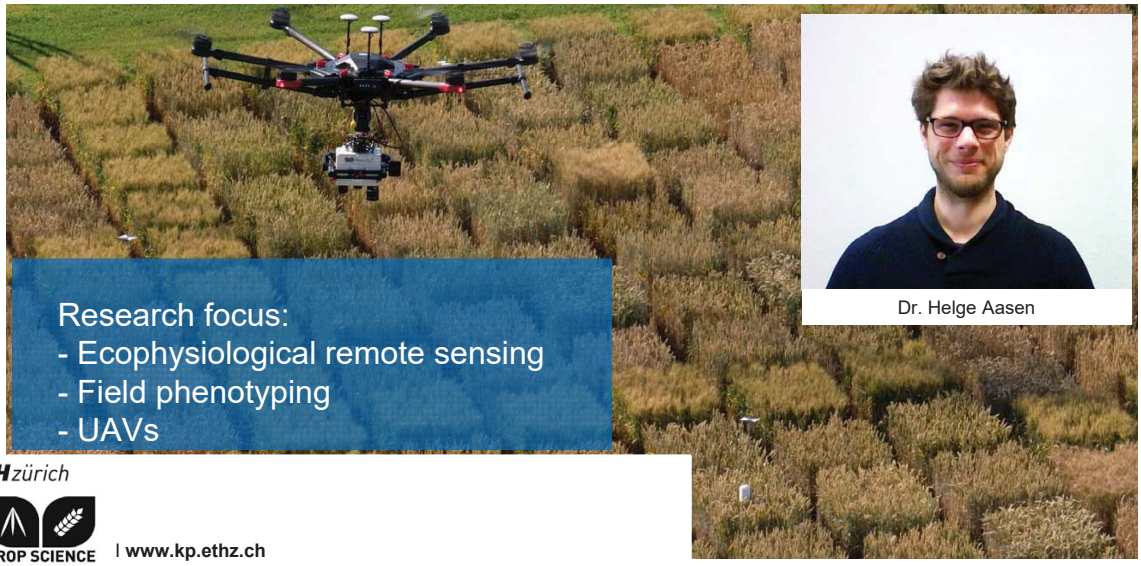

Research focus:
- Ecophysiological remote sensing
- Field phenotyping
- UAVs

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Digitalisation

Comment est-ce que je considère les avantages de la numérisation ?

- Les **processus standard** peuvent être automatisés et rendus plus compréhensibles grâce à l'enregistrement numérique des données.
  - Réduction des possibilités d'erreur
  - A plus long terme, réduction de la charge de travail
- En collectant les données et en les combinant avec un grand nombre de données de type «Big Data», des méthodes d'analyse modernes peuvent être utlisées pour améliorer notre compréhension des données/processus.
- Feedback : 1) Les processus de travail sont améliorés et 2) Diverses procédures sont normalisées.

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ETH Plant research station, Eschikon, Lindau

FIP field 360°

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Low-altitude / high-resolution remote sensing at the Crop Science Group

Low-altitude remote sensing

Close range

Proximal

FIP[1]

LS, hyper-spec, thermal, RGB

Multi-rotor UAVs

Hyper-spec, thermal, RGB

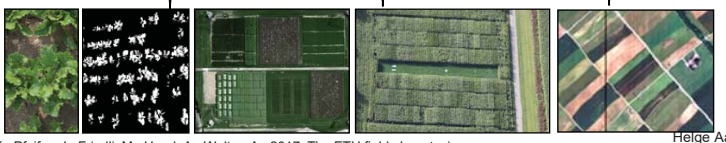
Fixed-wing UAVs

Multi-spec, RGB

Leaf, plant, plot

Plot to field (<2 ha)

Field to region (< 100 ha)



[1]Kirchgessner, N., Liebisch, F., Yu, K., Pfeifer, J., Friedli, M., Hund, A., Walter, A., 2017. The ETH field phenotyping platform FIP: a cable-suspended multi-sensor system. Functional Plant Biology

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Flower Mapping in Grasslands with Drones and Deep Learning

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Gallmann, J., Schüpbach, B., Jacot, K., Albrecht, M., Winizki, J., Aasen, H., “in review.” Flower Mapping in Grasslands with Drones and Deep Learning. Methods in Ecology and Evolution.

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What is the motivation?

Information is needed for:

- Studies about Biodiversity
- Studies about Bees
- Feed quality

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How is this information obtained traditionally?

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Method

1. Develop method to efficently collect and annotate training data
2. Collect training data
3. Train and tune a machine learning model (CNN)
4. Evaluate the model's performance
5. Make predictions using trained model

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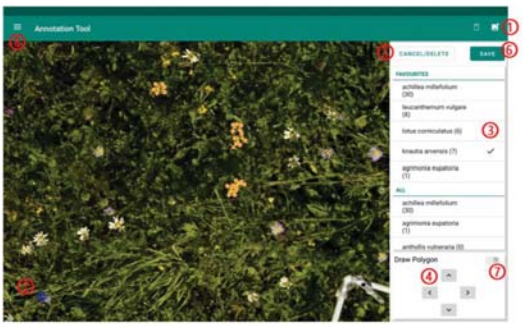
Method: Collect Training Data

1.

2.



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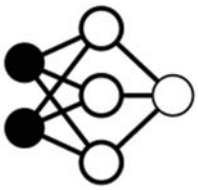
Method: Model training and predictions



(Faster R-CNN)

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Results: Full Meadow Prediction (730 m^2)

Knautia arvensis	8308	8059	- 3 %
Lotus Corniculatus	51139	50365	- 2 %
Leucanthemum vulgare	10778	7044	- 35 %
Onobrychis viciifolia	3761	595	- 84 %

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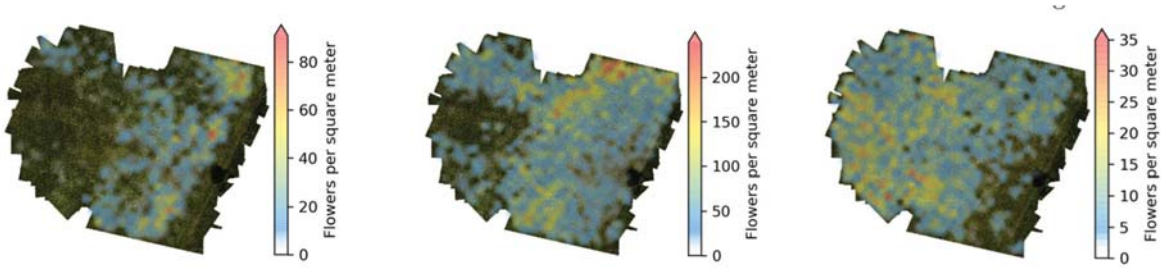
Results: Heatmaps



Leucanthemum vulgare | Lotus corniculatus | Knautia arvensis

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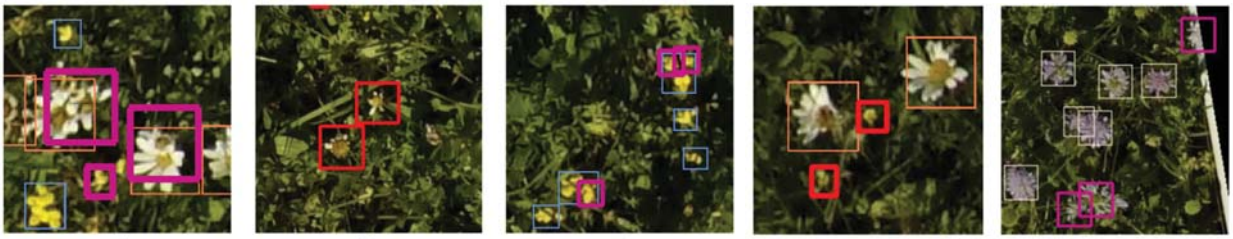
Results: Common Errors

- Lack of training data
- Flowers hardly distinguishable on aerial images
- Flower specific errors:



a) b) c) d) e)

All thin bounding boxes are correct predictions.
The bold red bounding boxes denote false positive and the bold violet bounding boxes denote false negative predictions

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En résumé :

- La quantité et le choix des données d'étude sont determinants.
- De bons résultats dans de nombreux cas.
- Réduction significative de la charge de travail.
- Certaines choses ne sont pas (encore) possibles.

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Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Bundesamt für Landwirtschaft BLW

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Confederaziun svizra
Innosuisse - Schweizerische Agentur für Innovationsförderung

FNSNF
Swiss National Science Foundation

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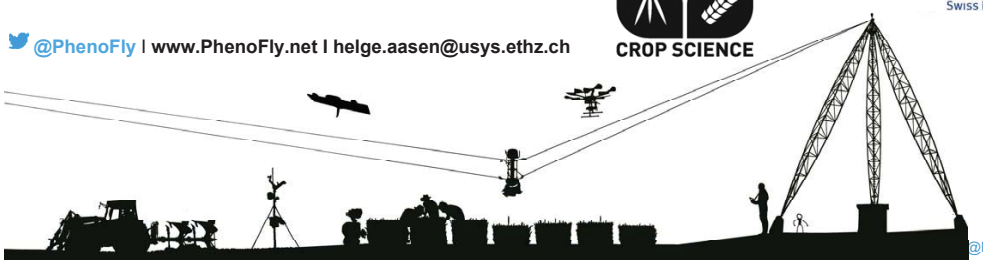

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End

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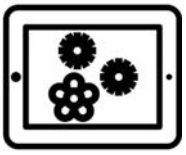
Results: Error Prone Manual Counting



	Trad. Count	Tablet Count	
Leucanthemum vulgare	724	960	+33 %
Knautia arvensis	371	471	+27 %
Ranunculus	431	474	+10 %
Onobrychis viciifolia	483	105	-78 %

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Results

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Results: Precision and Recall

	Precision	Recall
Leucanthemum vulgare	97 %	89 %
Knautia arvensis	90 %	94 %
Lotus corniculatus	87 %	86 %
Onobrychis viciifolia	77.6 %	47 %
Overall	87 %	84 %

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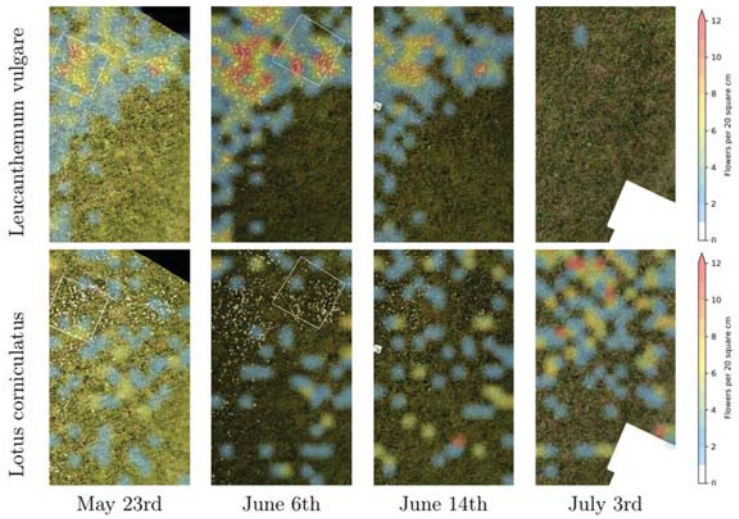
Results: Time Series



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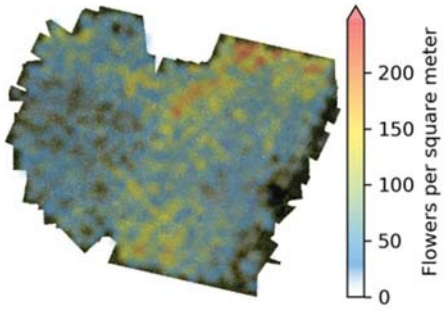
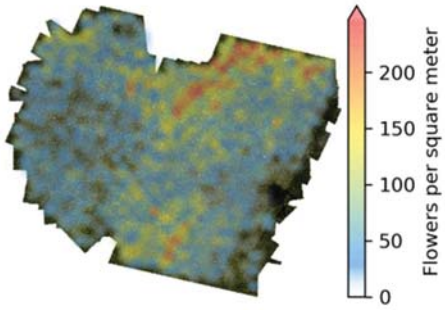
Results: Overlapping Images



(a) Generated from ortho image.



(b) Generated from overlapping images

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Results: Ground Resolution

1 mm/pixel | 1.4 mm/pixel | 2 mm/pixel | 3.3 mm/pixel | 5 mm/pixel | 10 mm/pixel | 20 mm/pixel

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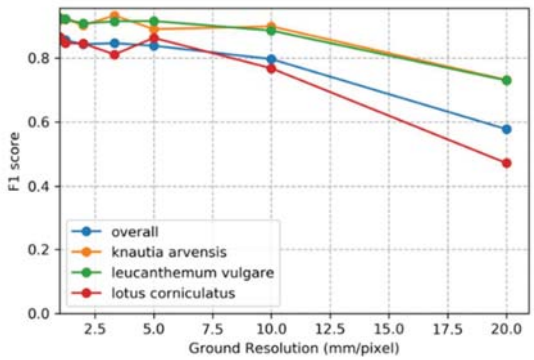
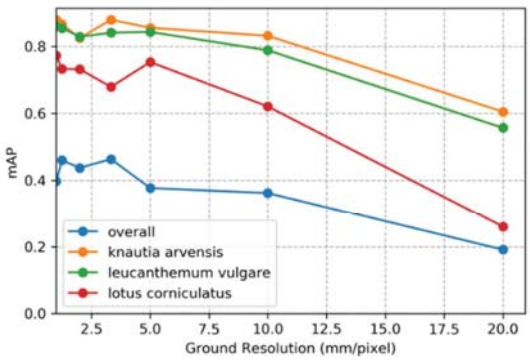
Results: Ground Resolution



(a) Evolution of F1 score.



(b) Evolution of mAP.

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Impression of detail visible in the UAV images (1 mm GSD)

Flower	Tablet Annotations
Leucanthemum vulgare	960
Onobrychis viciifolia	105
Lotus corniculatus	748
Salvia pratensis	127
Ranunculus	474
Knautia arvensis	471
Trifolium pratense	72
Medicago lupulina	5
Centaurea jacea	28

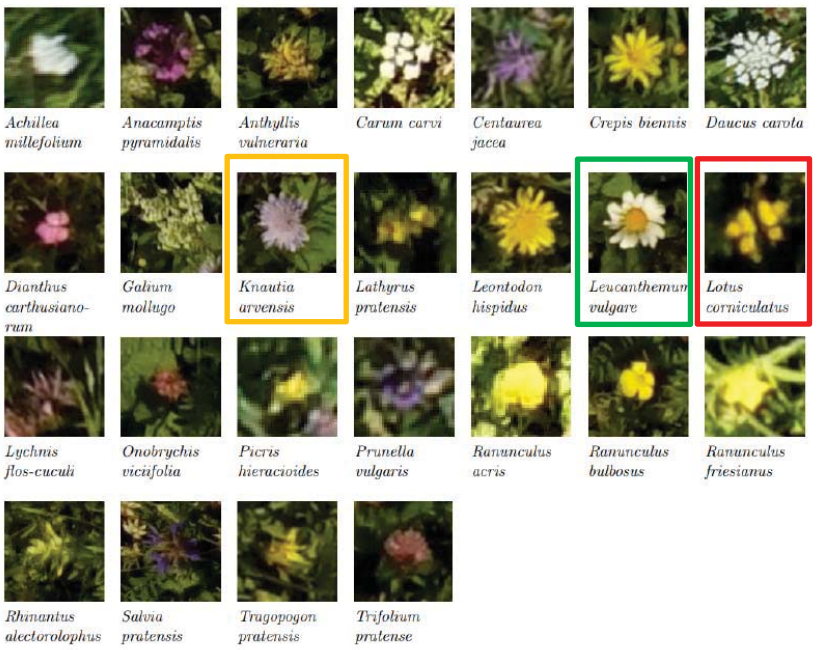

Figure 2: Excerpts from aerial images of the most common flowers.

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Impression of detail visible in the UAV images (1 mm GSD)

Flower	Tablet Annotations
Leucanthemum vulgare	960
Onobrychis viciifolia	105
Lotus corniculatus	748
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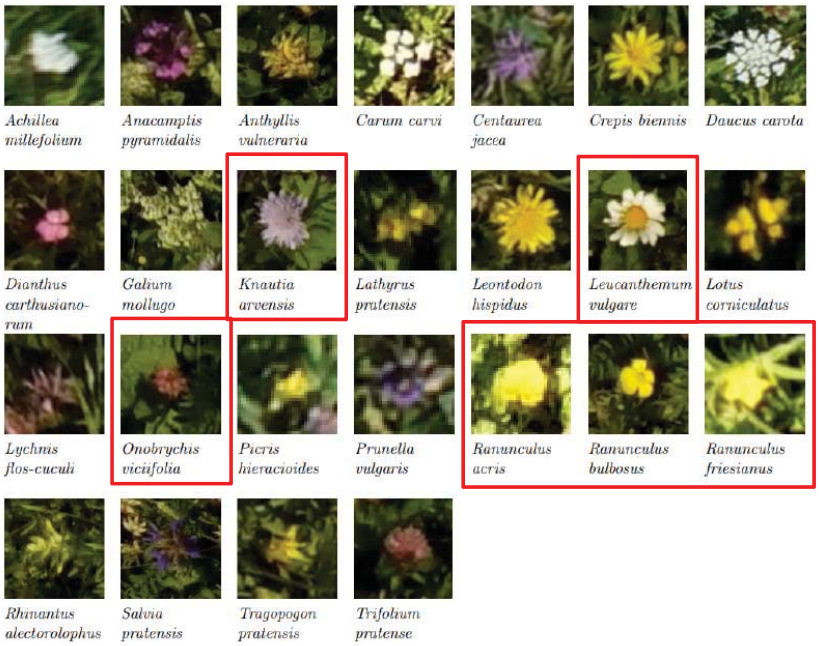

Figure 2: Excerpts from aerial images of the most common flowers.

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Method: Train a Machine Learning Model (Faster R-CNN)

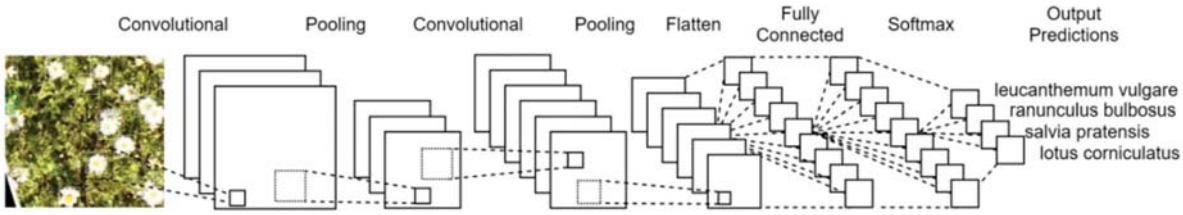

Diagram created with draw.io

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Discussion

- Effect of Ground Resolution
- Point annotations vs Bounding Box annotations
- Other imaginable use cases
  - E.g. Weed control (Precision Agriculture), Neophyte detection
- Neural Net Optimizations:
  - a) 2x Scaling b) Data augmentation c) Leveraging Overlapping Images
- Scalability
- Highly Reusable Suite of Tools

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Flowers that where combined into a super classes

Ranunculus (n = 474)	*Lotus corniculatus* (3271)	*Galium mollugo* (659)	*Crepis biennis* (159)	*Centaurea jacea* (805)
-*Ranunculus bulbosus* (442) -*Ranunculus friesianus* (8) -*Ranunculus acris* (24)	-*Lotus corniculatus* (2926) -*Lathyrus pratensis* (345)	-*Galium mollugo* (202) -*Achillea millefolium* (338) -*Daucus carota* (65) -*Carum carvi* (54)	-*Crepis biennis* (89) -*Leontodon hispidus* (10) -*Tragopogon pratensis* (8) -*Picris hieracioides* (52)	-*Centaurea jacea* (786) -*Lychnis flos cuculi* (19)

Table 1: Flowers that are combined into one super class.

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Comparison of selected manually counted vs tablet annotations

Flower	Manually Counted	Tablet Annotations
Leucanthemum vulgare	724	960
Onobrychis viciifolia	483	105
Lotus corniculatus	1943	748
Salvia pratensis	142	127
Ranunculus	431	474
Knautia arvensis	371	471
Trifolium pratense	129	72
Medicago lupulina	117	5
Centaurea jacea	25	28

Table 2: Comparison of selected manually counted results to tablet annotations.

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