

Konkrete Anwendungsfälle in der Land- und Ernährungswirtschaft

Abschätzen des Blütenangebots auf
Biodiversitätsausgleichsflächen mit Hilfe von
Drohnen und Deep Learning

Helge Aasen

ETH Zürich

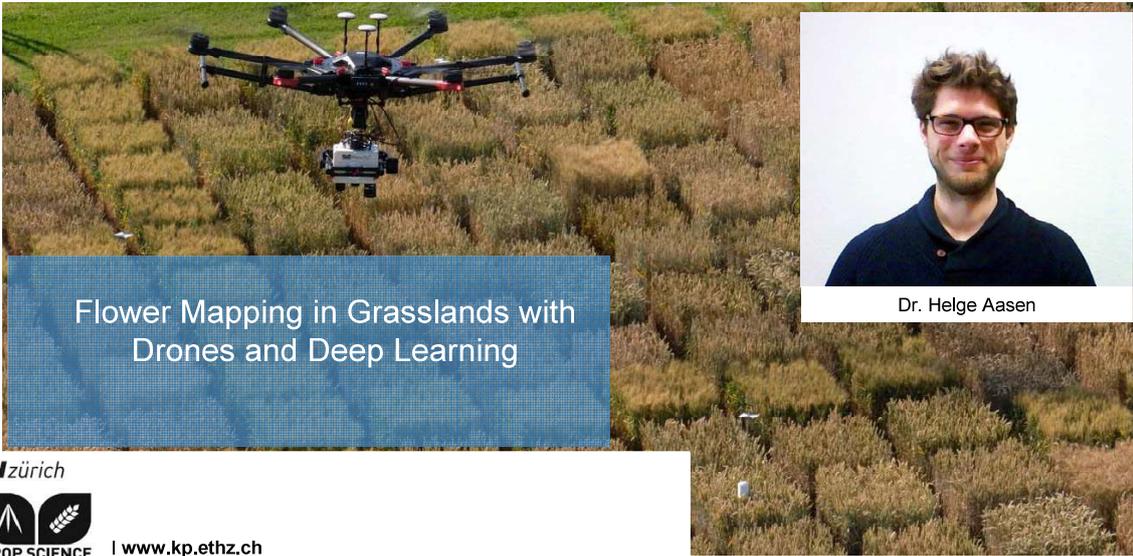
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20.031

Jahrestagung der Chartagegemeinschaft Digitalisierung

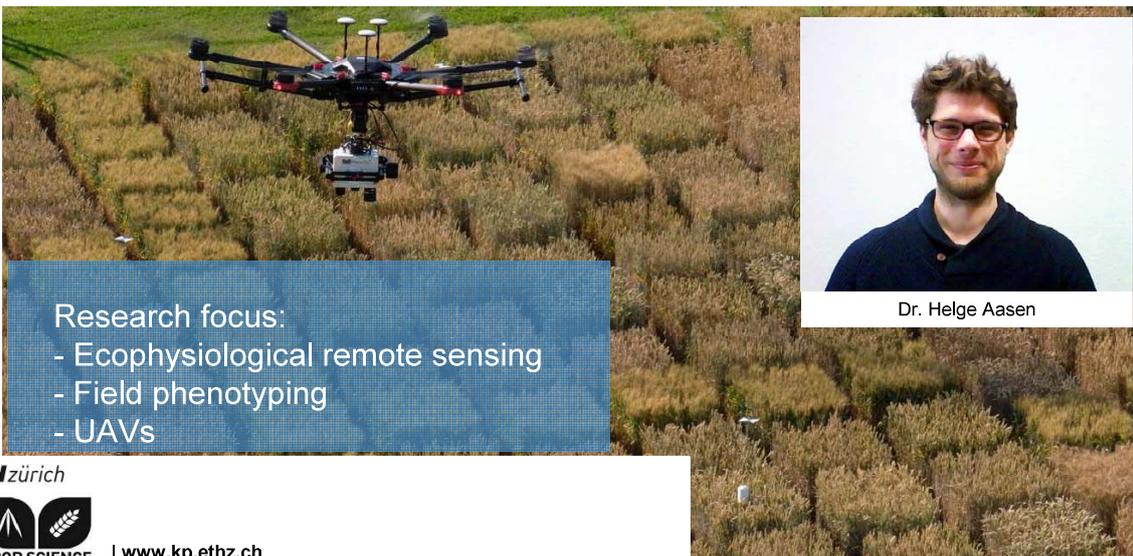
Online Angebot via zoom

22. Oktober 2020



Flower Mapping in Grasslands with Drones and Deep Learning

Dr. Helge Aasen



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

Dr. Helge Aasen

Digitalisierung

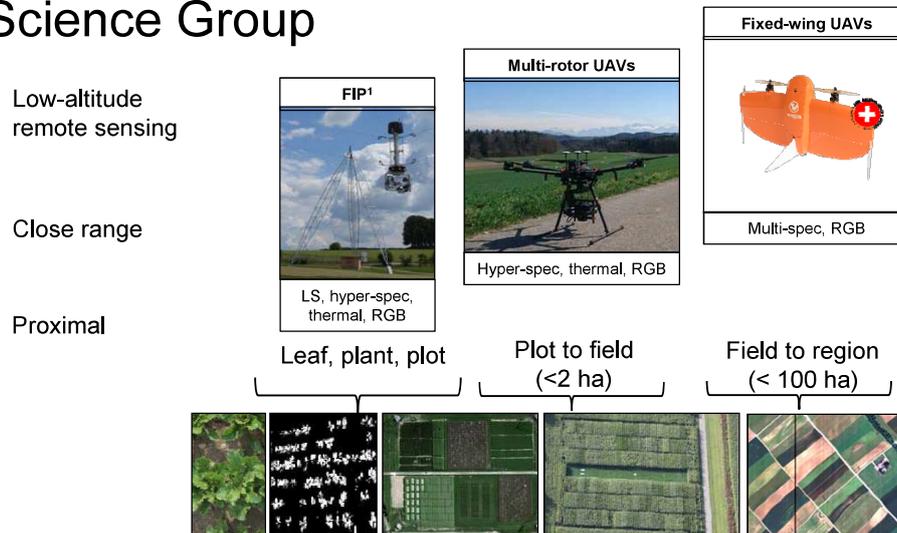
Wo sehe ich die Vorteile von Digitalisierung:

- Durch ein digitales Erfassen von Daten können **Standardabläufe** nachvollziehbar gemacht und automatisiert werden
 - Reduzierung der Fehleranfälligkeit
 - Langfristig eine Reduzierung des Arbeitsaufwands
- Durch die Erfassung der Daten und Kombination von vielen Daten «big data» können moderne Analysemethoden zur Verbesserung unseres Verständnisses von Daten / Abläufen eingesetzt werden.
- Feedback: 1) Arbeitsabläufe verbessert und 2) weitere Verfahren standardisiert werden

ETH Plant research station, Eschikon, Lindau



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



¹Kirchgessner, 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

Flower Mapping in Grasslands with Drones and Deep Learning

What is the motivation?



Information is needed for:

- Studies about Biodiversity
- Studies about Bees
- Feed quality

How is this information obtained traditionally?



Method

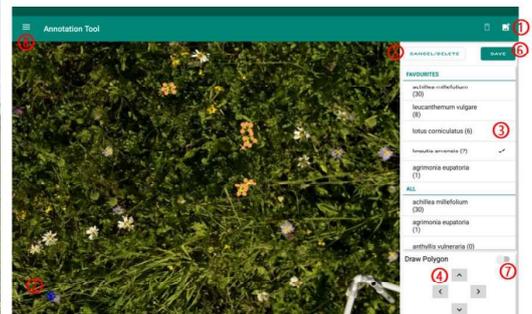
1. Develop method to efficiently collect and annotate training data
2. Collect training data
3. Train and tune a machine learning model (CNN)
4. Evaluate the model's performance
5. Make predictions using trained model

Method: Collect Training Data

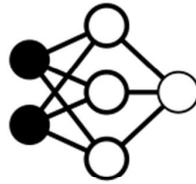
1.



2.



Method: Model training and predictions



(Faster R-CNN)



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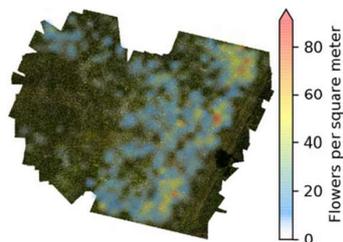
Results: Full Meadow Prediction (730 m²)



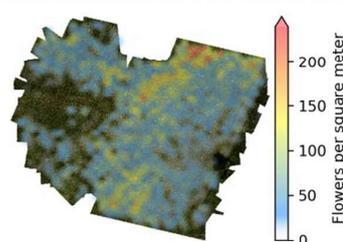
Knautia arvensis	8308	8059	- 3 %
Lotus Corniculatus	51139	50365	- 2 %
Leucanthemum vulgare	10778	7044	- 35 %
Onobrychis viciifolia	3761	595	- 84 %

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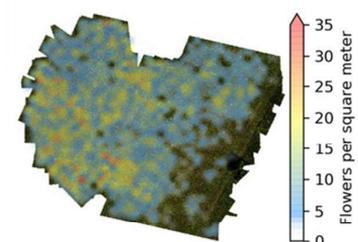
Results: Heatmaps



Leucanthemum vulgare



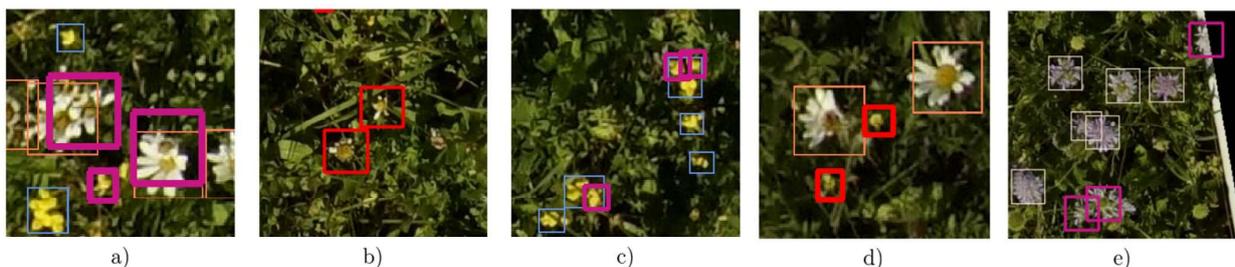
Lotus corniculatus



Knautia arvensis

Results: Common Errors

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



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

Zusammenfassung

- Menge und Auswahl der Trainingsdaten entscheidend
- Gute Ergebnisse in vielen Fällen
- Signifikante Reduktion des Arbeitsaufwands
- Manches geht (noch) nicht

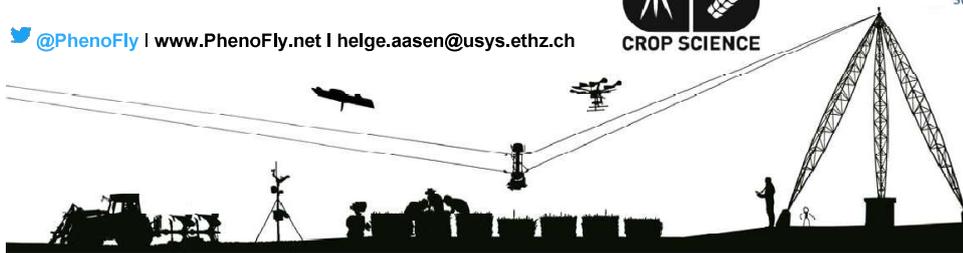
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Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Bundesamt für Landwirtschaft BLW

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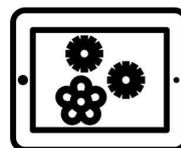
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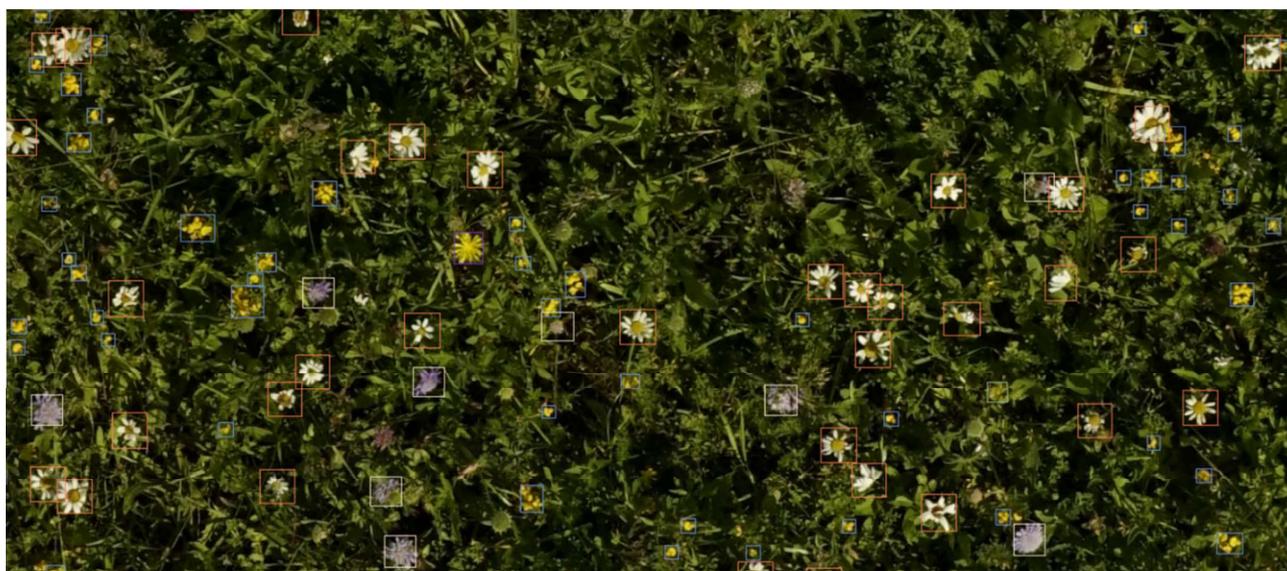
Results: Error Prone Manual Counting



	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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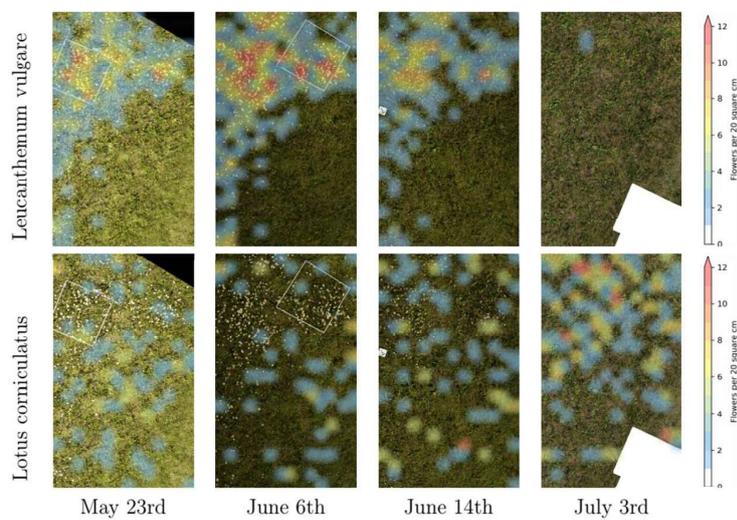
Results



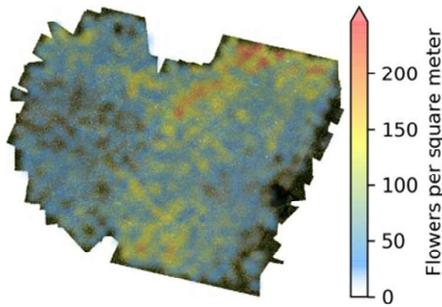
Results: Precision and Recall

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

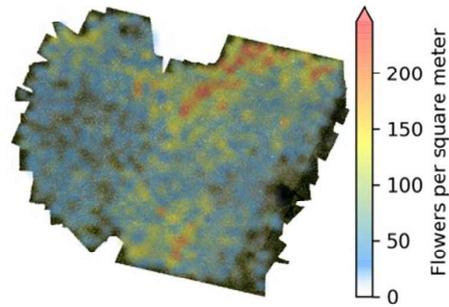
Results: Time Series



Results: Overlapping Images

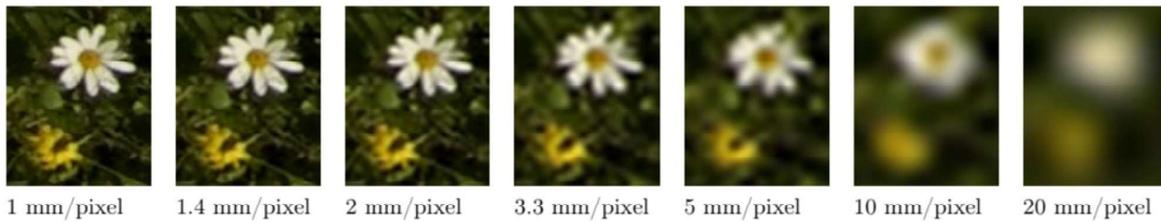


(a) Generated from ortho image.

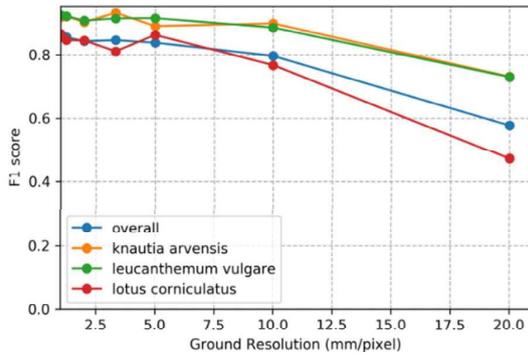


(b) Generated from overlapping images

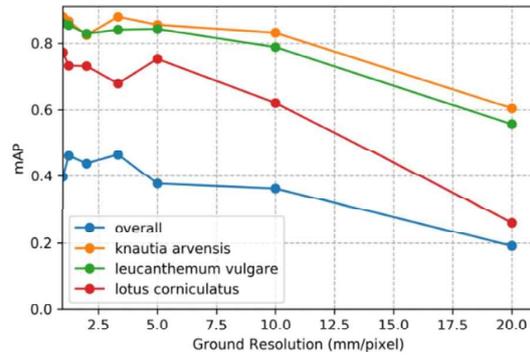
Results: Ground Resolution



Results: Ground Resolution

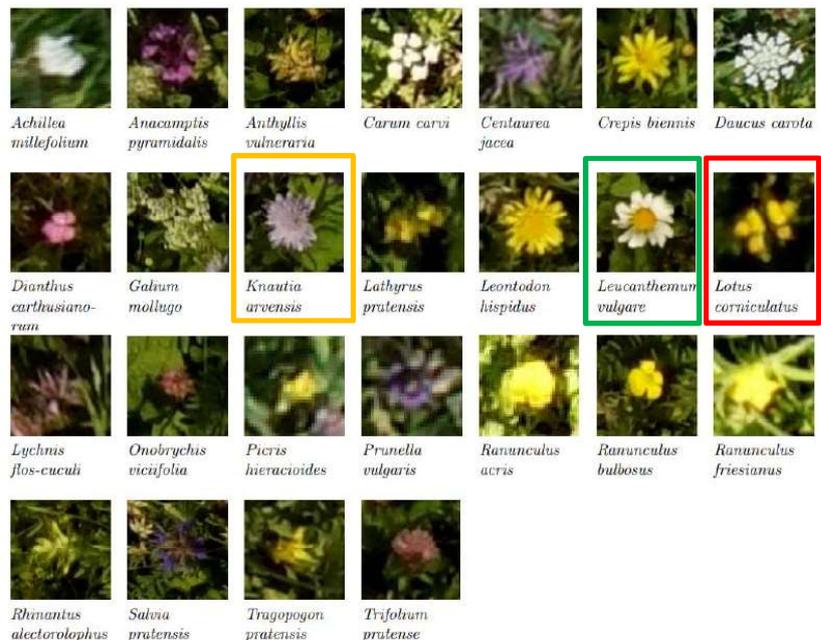


(a) Evolution of F1 score.



(b) Evolution of mAP.

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



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

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

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

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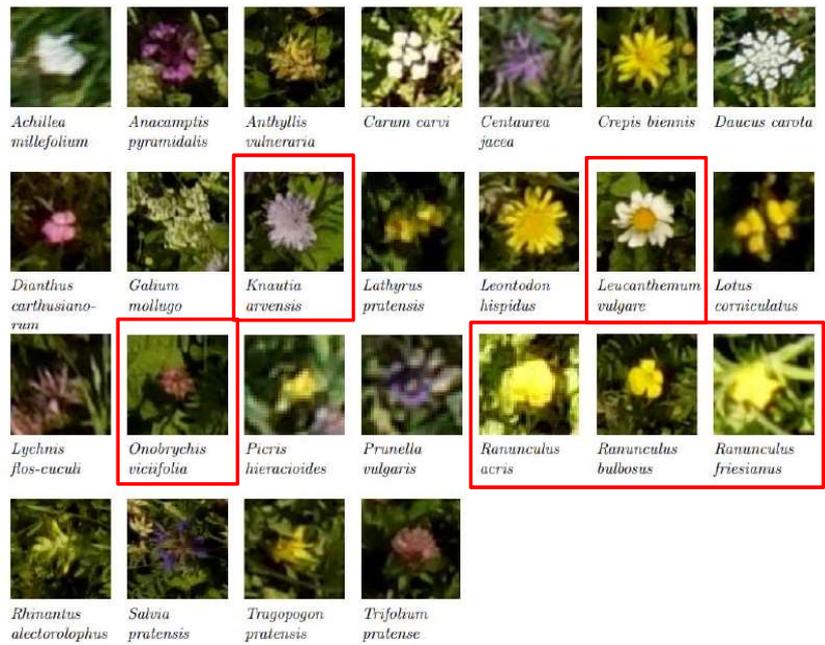


Figure 2: Excerpts from aerial images of the most common flowers.

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

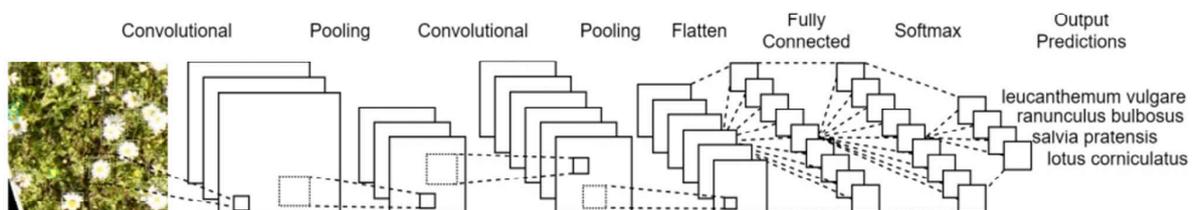


Diagram created with draw.io

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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

Flowers that were combined into a super classes

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

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

Comparison of selected manually counted vs tablet annotations

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

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