Status on WP4 “Automating counting of plants and plant organs”

Erik Alexandersson, Swedish University of Agricultural Sciences

WP4: counting plants!

- Year 1: business survey
- Year 2: outdoor testbed trial, incorporation in plotcut
- Year 3: workshop to disseminate results

Work Package 4:

- T4.1: In year 1, business intelligence by surveying available methods and publications on plant counting including identification of suitable available image material will be done. At this stage, we will try to identify current state-of-the-art in this rapidly developing area. Apart from identifying deep learning methods, a survey among project partners on what vehicles to use will be done as it is not obvious whether drone or ground-based vehicles will be most suitable. Both these tasks will be done in connection with WP3. Possibly, smaller trials can be conducted in controlled

environments such as the PhenoCave in the Biotron at SLU Alnarp where plant emergence and development can be closely monitored.

- T4.2: These efforts will help design outdoor testbed trials for validation of business surveying as well as technological development in WP3 for plant counting and flower development to be executed in Year 2. In these trials we are envisioning to try out different image collection methods and workflow analyses on different cases, including noise such as weed and different growth systems in both cereals and potato. During year 2, preparation to include plant counting into an appropriate platform such as PlotCut3 will be done (WP1). In addition, any reliable data as well as images will be forwarded to WP5 to aid the modelling activity.
- T4.3: In year 3, results will be collated and best practices will be established leading up to a workshop, communicating results and spreading knowledge gained by the WP. Methods will be packaged into PlotCut3 together with WP1. Limitations and future possibilities will be presented.

Representative artificial intelligence algorithms used in wheat heads/ears/spikes counting

Algorithm	Plant organ	Accuracy	Dataset used	Field/controlled environment (CE)	Data type	Platform	Publication
YOLOv3	Wheat heads	94.5%	GWHD dataset	Field	RGB	Mixed	Gong et al., 2021
EfficientDet-D0 object detection model, convolutional block attention module (CBAM)	Wheat ears	94%	GWHD dataset	Field	RGB	Mixed	Wang et al., 2021
Simple linear iterative clustering (SLIC) and CNN	Wheat spikes	98%	Original + WGIN dataset	Field	RGB	Field Scanalyzer, handheld	Sadeghi-Tehran et al., 2019
Web_SpikeSegNet (CNN)	Wheat spikes	99.65%	Original + annotated crop images dataset (ACID)	CE	RGB	LemnaTec imaging facility	Misra et al., 2021
TasselNet (CNN-based local regression model)	Wheat spikes	91.01%	Original (wheat spikes counting (WSC) dataset)	Field	RGB	Fixed digital camera	Xiong et al. 2019
Faster-RCNN	Wheat ears	-	Original	Field	RGB	Fixed digital camera	Madec et al., 2019
	Wheat spikes	95.18%	Original	Field	RGB	Land-based vehicle	Hasan et al., 2018

Erasmus student Orlando Giuseppe Sardella, UNITUS

Year 1: business survey, or rather small scientific overview

Type of data input similar but algorithms varying and rapid development

Annotation precision of ground truth and accuracy?

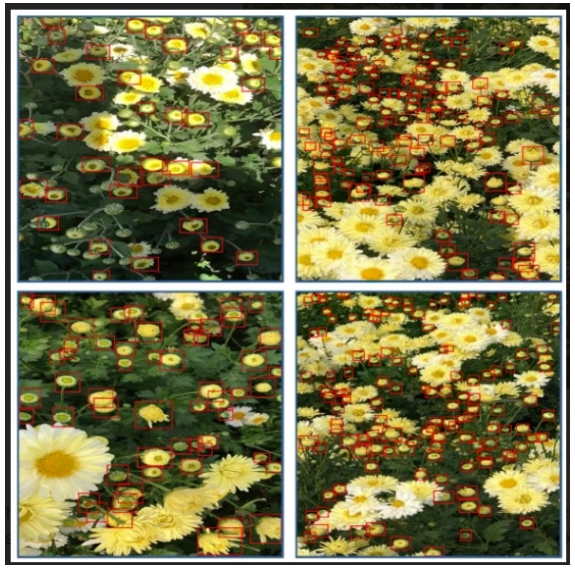
Counting of plants

- Biggest hurdle – finding the right competence!

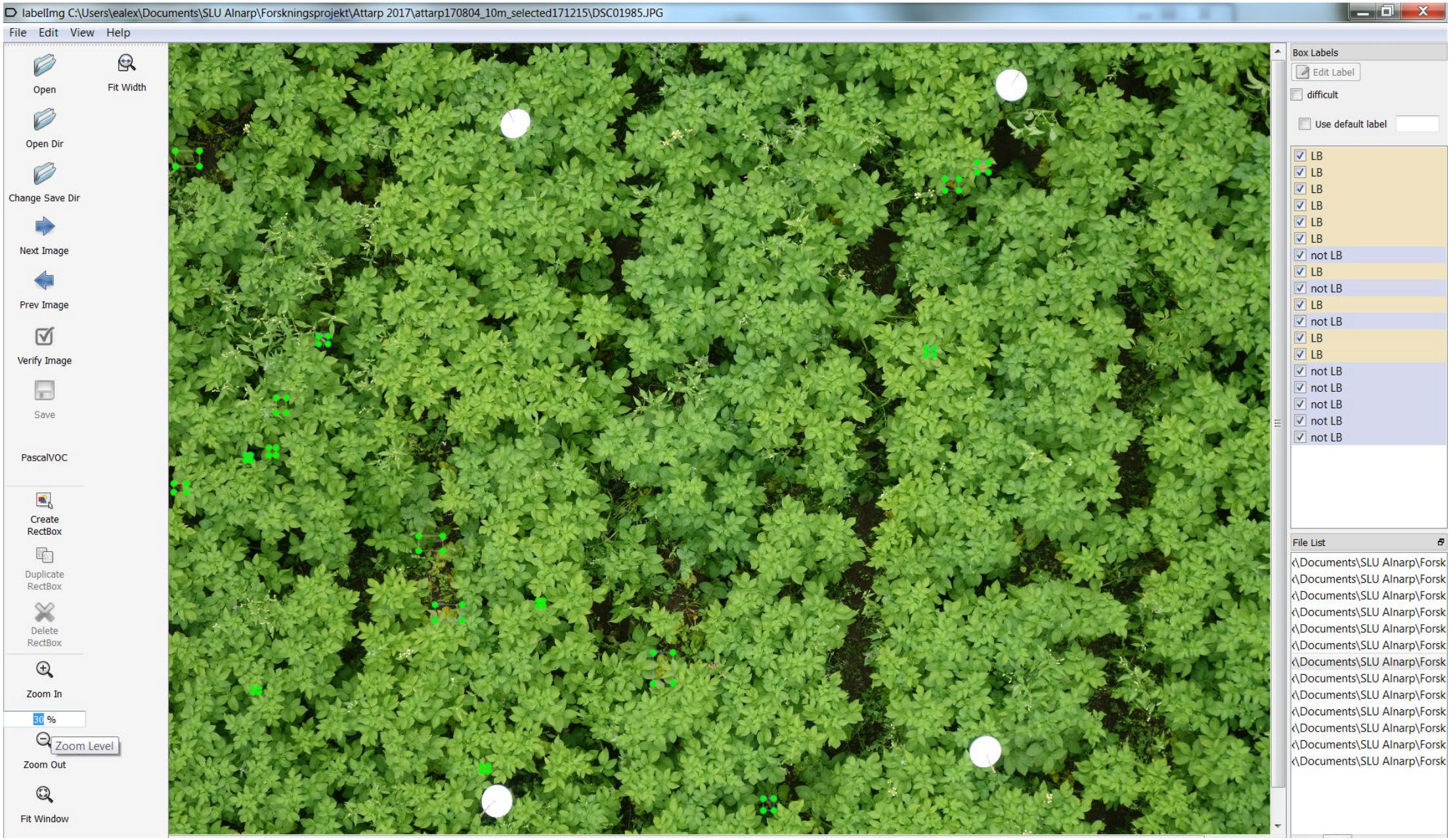
From Kamil Lelonek's blog post "Not everyone can be a programmer"

Way ahead 2023

- First short overview done of publications and methods
- Teamed up with Junfeng Gao and Post doc Chao Qi at Lincoln University for analysis of flower numbers and counting of plants
- Survey of suitable available image data among breeders -> discussion on ground truth/annotation with computational biologists important
- Data for Daisy?



Qi, C., Nyalala, I., & Chen, K. (2021). Detecting the Early Flowering Stage of Tea Chrysanthemum Using the F-YOLO Model. *Agronomy*, *11*(5), 834.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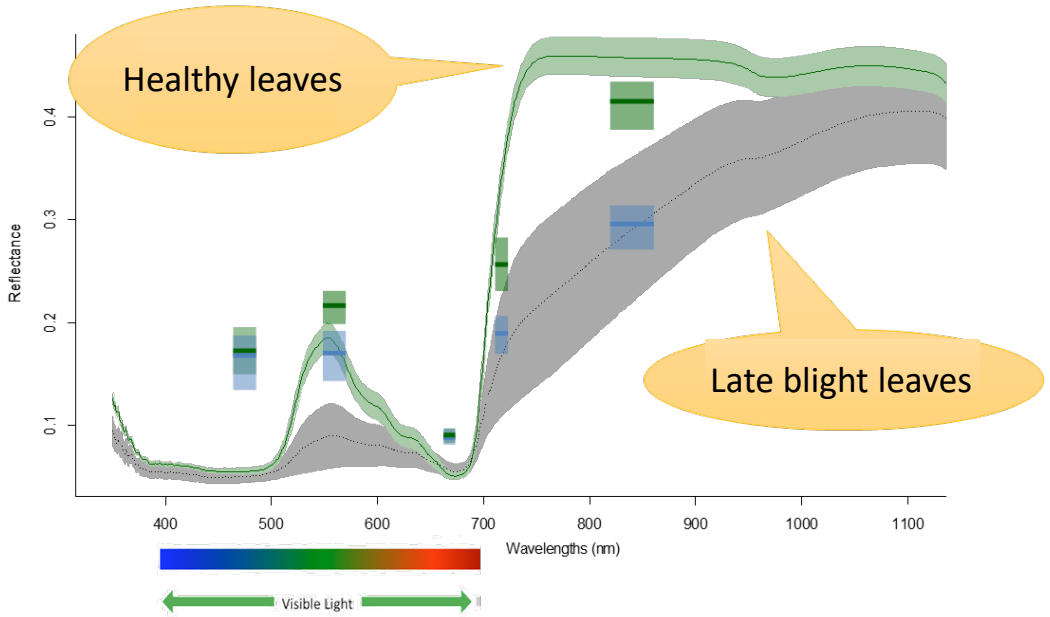
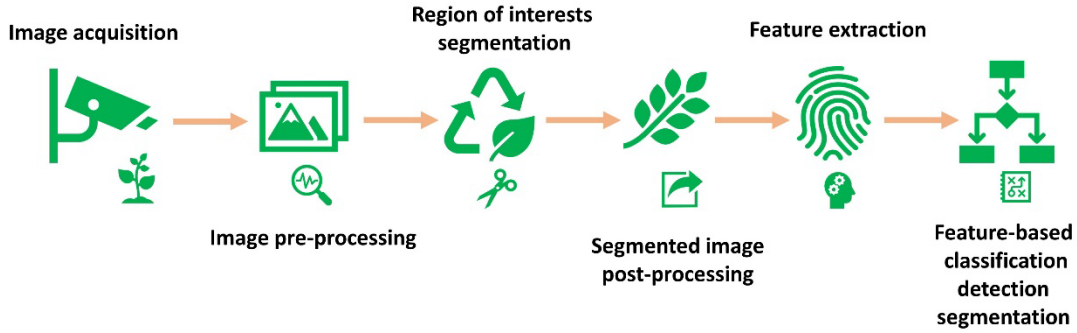
EnBlightMe! team/6P2/NordPlant

Reflectance vs computer vision for late blight detection in potato



Deep learning

Field RGB images
Encoder-Decoder SegNet-based CNN
Segmentation important
Majority voting of scales
visual scoring vs lesion detection (R2=0.655)



ELSEVIER

Knowledge-Based Systems

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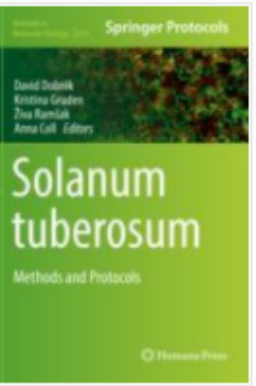
Automatic late blight lesion recognition and severity quantification based on field imagery of diverse potato genotypes by deep learning

Junfeng Gao [a], Jesper Cairo Westergaard [b], Ea Høegh Riis Sundmark [c], Merethe Bagge [c], Erland Liljeroth [d], Erik Alexandersson [d]

[a] Lincoln Agri-Robotics, Lincoln Institute for Agri-Food Technology, University of Lincoln, Lincoln, UK
[b] Department of Plant and Environmental Sciences, University of Copenhagen, Taastrup, Denmark
[c] Danespo Breeding Company, Give, Denmark
[d] Department of Plant Protection Biology, Swedish University of Agricultural Sciences, Alnarp, Sweden



Solanum tuberosum pp 273-299 | Cite as

Computer Vision and Less Complex Image Analyses to Monitor Potato Traits in Fields

Authors | Authors and affiliations

Junfeng Gao 1

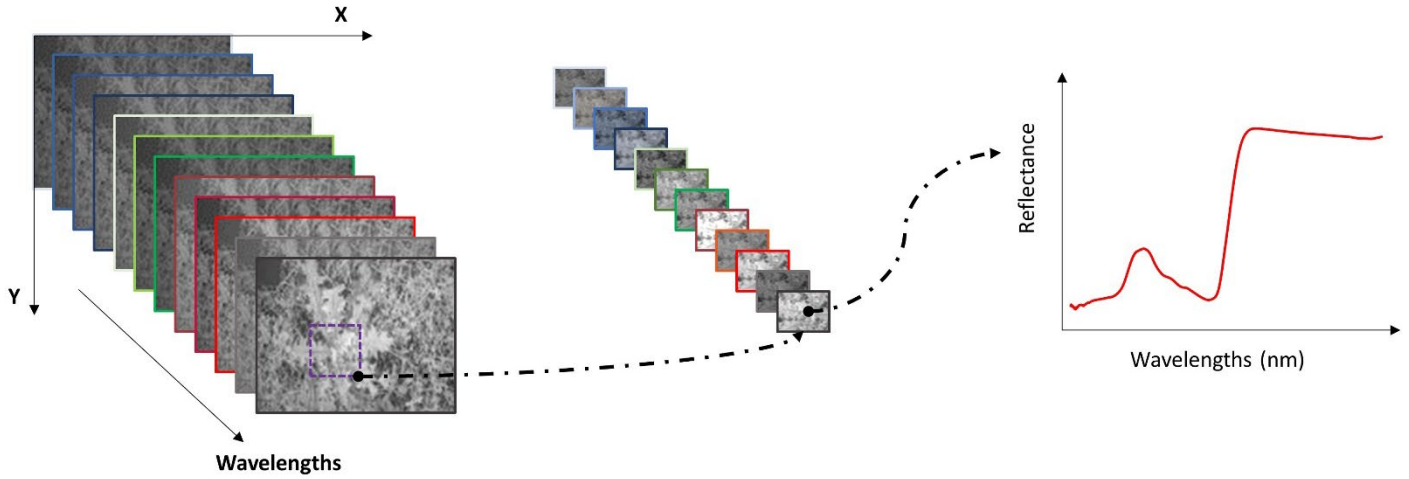
Jesper Cairo Westergaard 2

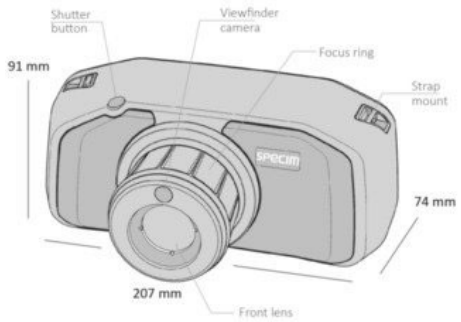
Erik Alexandersson 3

Email author

1. Lincoln Agri-Robotics, Lincoln Institute for Agri-Food Technology, University of Lincoln, Lincoln, UK
2. Department of Plant and Environmental Sciences, University of Copenhagen, Taastrup, Denmark
3. Department of Plant Protection Biology, Swedish University of Agricultural Sciences, Alnarp, Sweden

Hyperspectral camera in the field

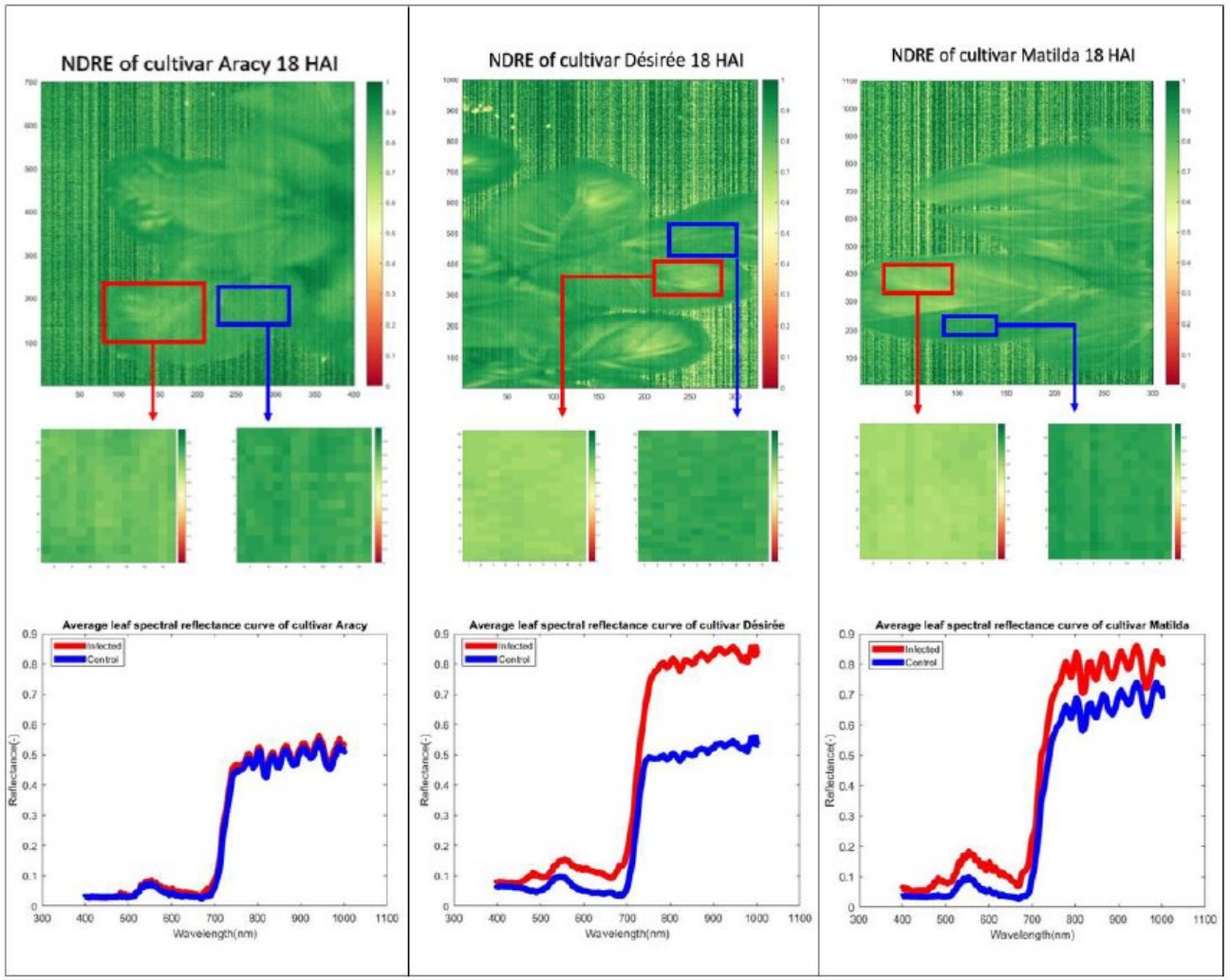




Qi, C., Sandroni, M., Westergaard, J. C., Sundmark, E. H. R., Bagge, M., Alexandersson, E., & Gao, J. (2021). In-field early disease recognition of potato late blight based on deep learning and proximal hyperspectral imaging. *arXiv preprint arXiv:2111.12155*.

Hyperspectral camera in controlled environment of *Alternaria solani* (MSc thesis by I. Abdelmeguid)

In collaboration with Florent Abdelghafour, INRAE



Detecting late blight in the field

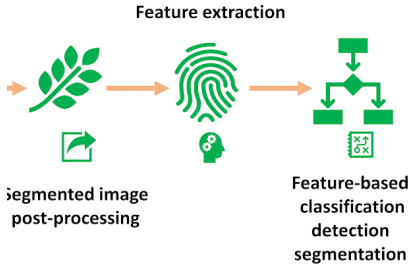
START

Spectral analysis

(5%)

Computer vision

(lesions: ~70%, pixels:~40%)



Spectral analysis

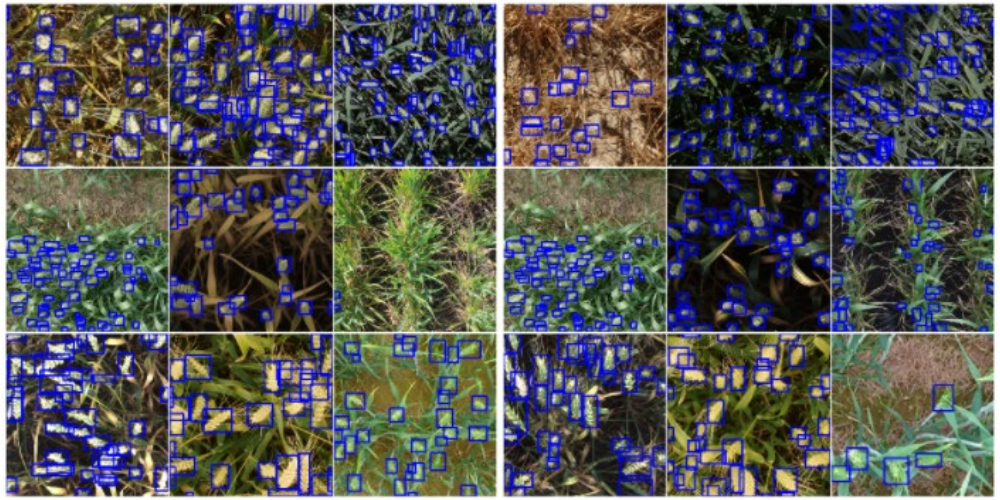
Joint?

?

Controlled climates
Gene expression
Pathogen quantification

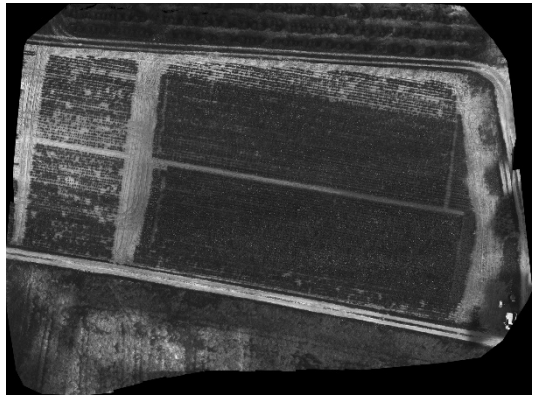
Reach out: We are looking for annotated datasets to analyse!

- So far we have one dataset with flowers in potato fields (Danespo)



The **Global What Challenge 2021** has come to an end. 🎉

We want to thank you for making this challenge successful. Over the course of 2 months, the challenge gathered a whopping 🚀 **2,400+ submissions** with participants joining from over 🌎 **25 countries**.



Acknowledgements

EnBlightMe! team/6P2-3/NordPlant

NordPlant

VINNOVA

PROTECTA

MARIE CURIE ACTIONS

Murilo Sandroni, SLU
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Merethe Bagge, Danespo