

Progress WP1: Above ground plant stress detection and identification using sensor fusion.

PPP Transition To A Data-Driven Agriculture (TTADDA)

12 January 2023 Annual meeting

Gerrit Polder, Bart van Marrewijk (WUR), Njane Stephen Njehia (NARO), *et al.*



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Outline


- Work done in 2022
 - Adapted deep learning on 2017/2018 data
 - MSc Thesis Jolien Hendriks
 - Bas Boom/Aravind Krishnaswamy Rangarajan/Hennie de Villiers
 - Solynta trial Achterberg
 - NARO trial (Stephen)
 - MSc thesis Herjan Riemens (Modelling)
- Plans 2023
 - Solynta trial 2023
 - Connection NTT

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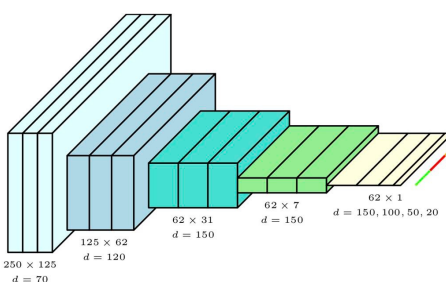


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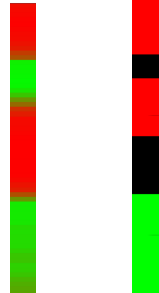
Virus Y detection in seed potatoes




Input
 500×250
 $d = 35$





Output
 62×1
 $d = 1$



Prediction Target

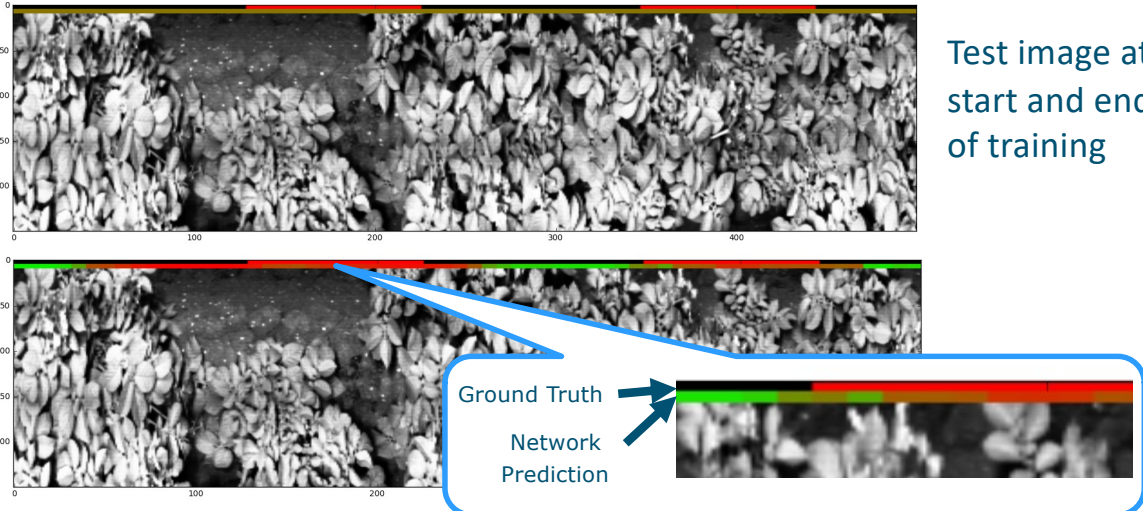


- Deep learning on spectral line images
- Network adapted to $x \times \lambda$ (2D) images

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Disease detection in seed potatoes



Test image at start and end of training

Ground Truth


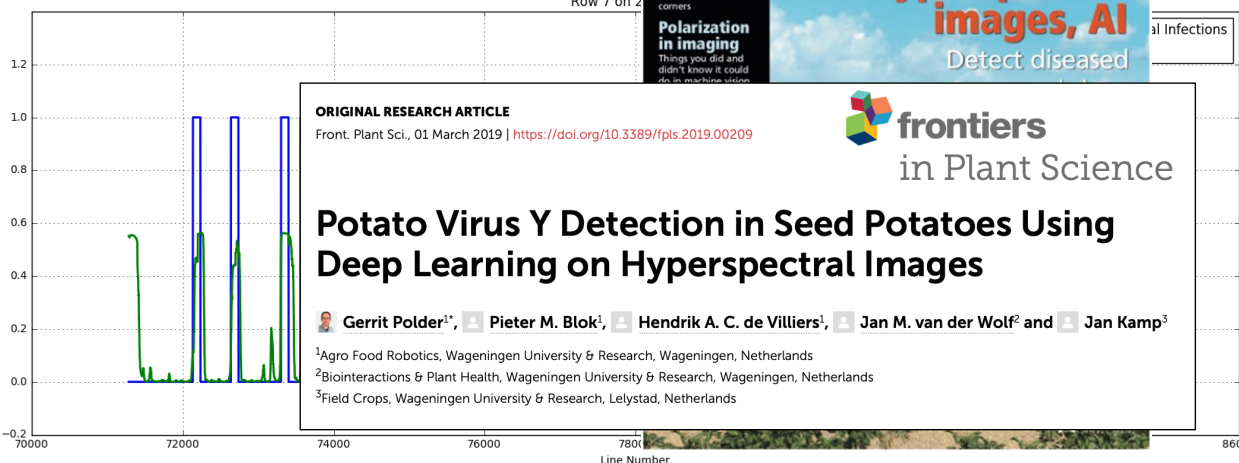
Network Prediction




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Disease detection in seed potatoes

■ Results: Row 7 (Vermont) 3/7/2019



ORIGINAL RESEARCH ARTICLE
Front. Plant Sci., 01 March 2019 | <https://doi.org/10.3389/fpls.2019.00209>



Potato Virus Y Detection in Seed Potatoes Using Deep Learning on Hyperspectral Images

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²Biointeractions & Plant Health, Wageningen University & Research, Wageningen, Netherlands
³Field Crops, Wageningen University & Research, Lelystad, Netherlands

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MSc Thesis Jolien Hendriks

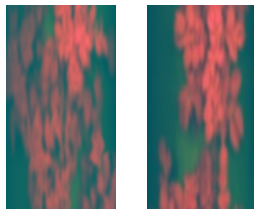
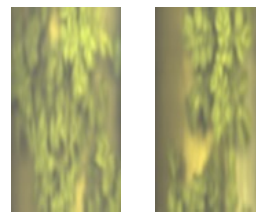
Good results on 2017 dataset could not be reproduced on 2018 dataset, Jolien tried a different approach.

- Method to reduce dimensionality
- Potential for machine learning methods on hyperspectral data

Materials & Methods (RGB & PCA)

Three methods to extract features:

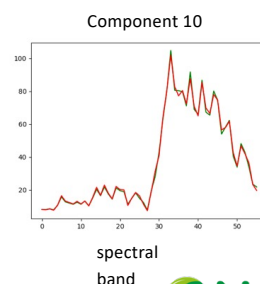
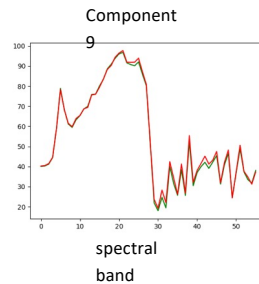
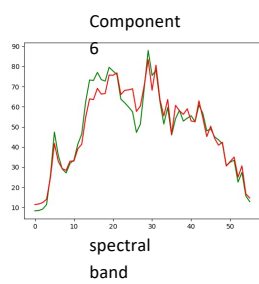
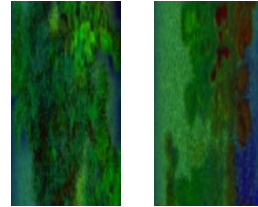
- RGB images
- Selection of three bands



- Principal component analysis
- Three components most variance

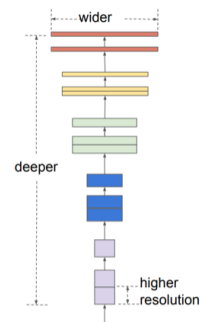
Materials & Methods (NMF)

- Nonnegative matrix factorization
- Effective for hyperspectral unmixing
- Understanding of distinction



Materials & Methods (classification)

- RGB, PCA & NMF input
- EfficientNet
- Pretrained on imagenet
- Parameters dropout & learning rate
- Class weights of {0: 0.56, 1: 4,40}
- Fine tuning



Results are also not good on 2018 dataset

	Predicted	Actual		
		Positive	Negative	
RGB	Positive	201	61	0.77
	Negative	22	6	0.21
PCA	Positive	239	23	0.91
	Negative	26	2	0.071
NMF	Positive	175	87	0.67
	Negative	19	9	0.32

OnePlanet (Bas/Aravind)

Also had disappointing results on the 2018 dataset. Currently they are validating their method on the 2017 dataset together with Hennie (WUR)

Solynta field trial

- 2022-05-19; first drone measurement
- 2022-06-19; testing segmentation software with new dataset
 - Solving bugs and issue -> **new software update**
 - Start linking TraitSeeker with drone data -> **Each individual plot can be exported as orthomosaic (.tiff)**
- Updated and improved version of software ->
- 2022-07-18 - 2022-07-22 visit Japan
- 2022-09-xx; last drone measurement
- 2022-10-xx; processing results dataset

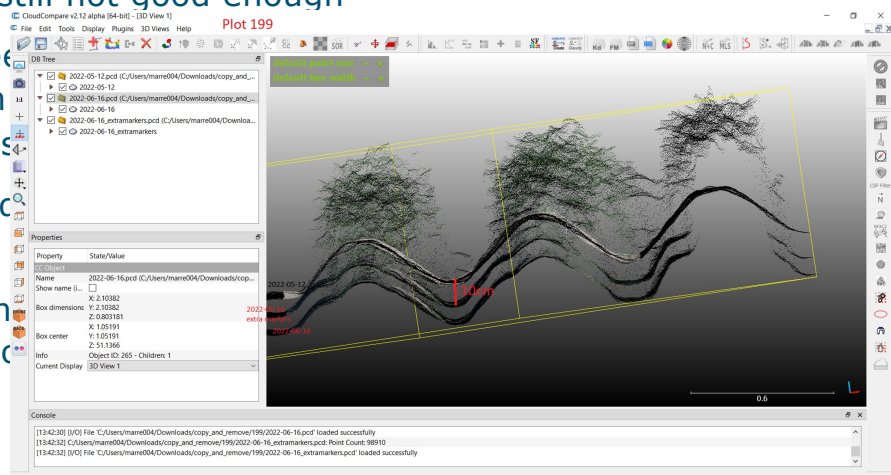
Data 2022

- 14 drone flights from 2022-05-12 till 2022-08-10
- 3 Traitseeker runs
- From Solynta
 - Weather data
 - Ground coverage
 - # flowers
 - Plots with disease
 - Size and weight potatoes

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Height maps are inaccurate

- Many hours spend to improve drone data quality
 - First all data processed again by uniform -> slightly better results but still not good enough
 - Internal meeting wageningen again processed
 - Still height correction markers
 - Finding many inaccurate endpoints



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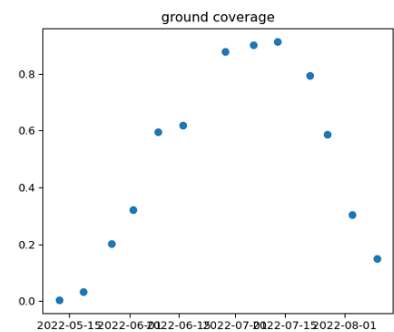
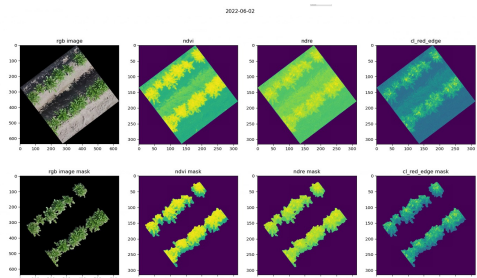
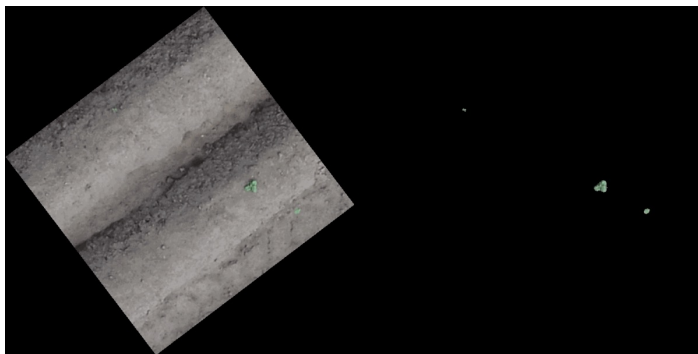
Height maps are inaccurate

- Originally planned to have two extra markers in the middle of the field
- but all plots in the field were fully planted
- Unfortunately, that this means that there is no height information available for this year ...

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Drone results

- Despite height maps still many data to be analyzed
- Example of plot 1

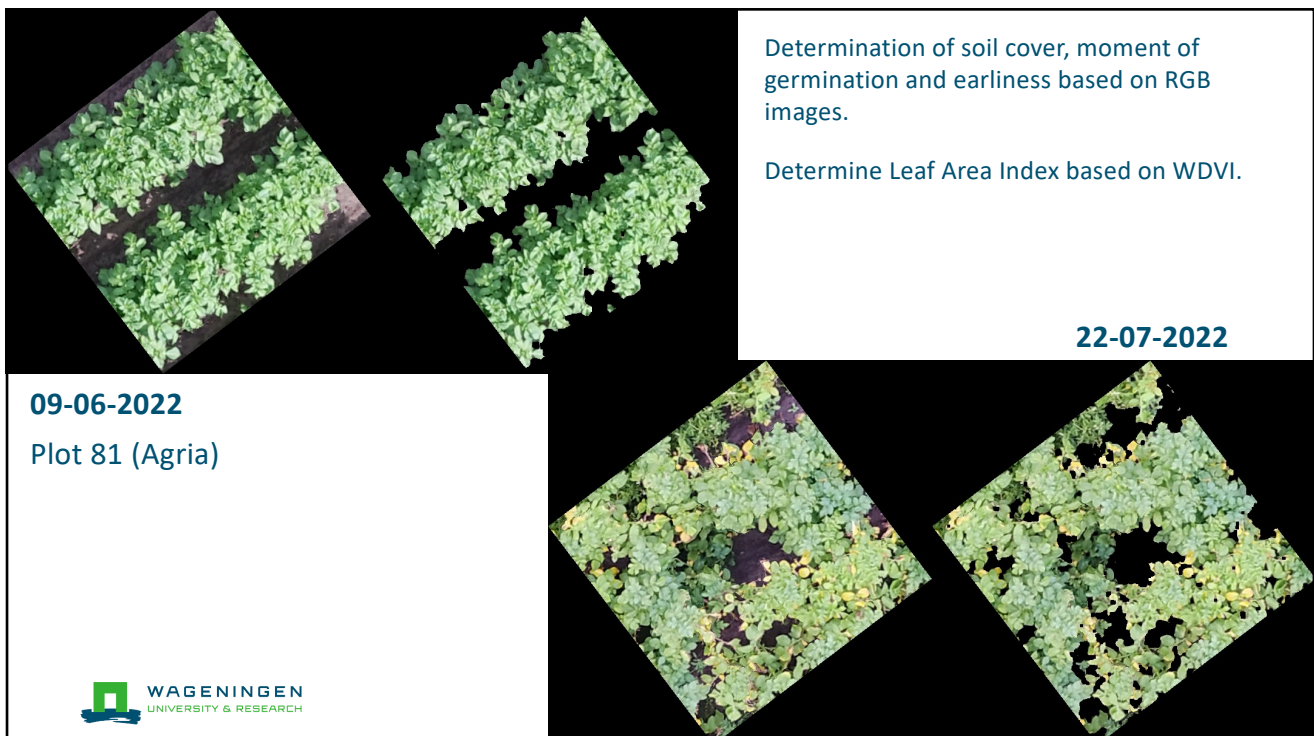


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MSc thesis Herjan Riemens

- Connect the WP1 drone and possibly TraitSeeker data to crop models.
- Tipstar yield prediction model (Bernardo WP4)
- Reflectance data WDVI, has a solid relationship to LAI. Model predicts on biomass, using weather (temp max/min, radiation and precipitation), soil, management and earliness.

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Determination of soil cover, moment of germination and earliness based on RGB images.

Determine Leaf Area Index based on WDVI.

09-06-2022
Plot 81 (Agria)

22-07-2022



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TIPSTAR model:

Better yield prediction by means of data assimilation LAI
 Model parameters (time of germination, earliness)

Amount of data assimilation
 Time of data assimilation (early vs. late in season)

Correction in model prediction
 Based on observed LAI:

In this case: predicted LAI > observed LAI

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Plans 2023

- Joseph Mango (Solynta) and Bart (WUR) will align activities
- Solynta new experiment 18 genotypes similar to 2022, earliness is important, genetic modelling (Marcel)
- Improve drone imaging using better/more ground control points.
- Finalise and submit paper (Stephen)
- Proceed on Traitseeker-Drone data integration

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Plans 2023



- NTT satellite data, mainly not available for right period/frequency.
- We met Takuya Murayama during CIGR in Kyoto.
- Also Dr Kusumi had a very interesting keynote showing an impressive involvement of NTT many areas connected to agriculture.



The XX CIGR World Congress 2022 (International Commission of Agricultural and Biosystems Engineering) **Kusumi**

NTT Confidential

NTT Group Initiatives in the Food and Agriculture Sector

Production → Distribution/Sales → Consumption / Food → Environment

Main Initiatives using NTT

- Horticulture using advanced facilities
- Livestock and fisheries
- Weather & Maps
- Real world
- Farm Produce distribution DX
- Organic vegetables and food delivery
- Residue composting
- Biotechnology & genetics
- Automation and labor saving
- Traceability
- Food cultural heritage
- Well-being in food and health
- Biomass power generation

Partners

- HOKKAIDO UNIVERSITY
- Kubota
- NARO vegetalia
- TOKA
- Oisix ra daichi
- RITSUMEIKAN
- Bird

Plant Based Lifestyle Lab

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Discussion

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