Artificial Intelligence in Agriculture

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April 30, 2021

Agriculture in the 21st century

NEWS

New viral disease threatens region's cassava farming

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Commercial cassava growers. Uganda scientists are currently doing research to understand the virus, and how to develop resistant varieties. Photo/FILE

Environment and Disasters **Feature** 29 March 2017

After drought, Zimbabwe contends with fall armyworm invasion

Network of Climate Journalists of the Greater Horn of Africa (NECJOGHA)

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10 Kenya counties attacked by locusts, Uganda under threat

By **admin** - January 22, 2020 2334 0

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Locusts in Tana River County.

Crop Disease Diagnosis




Agricultural experts

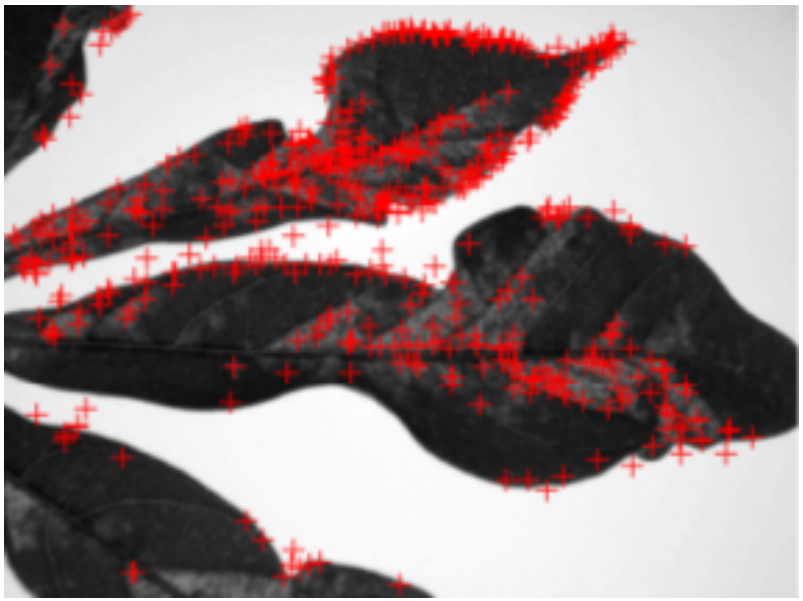
- Scarcity of experts
- Labor intense, time e.t.c

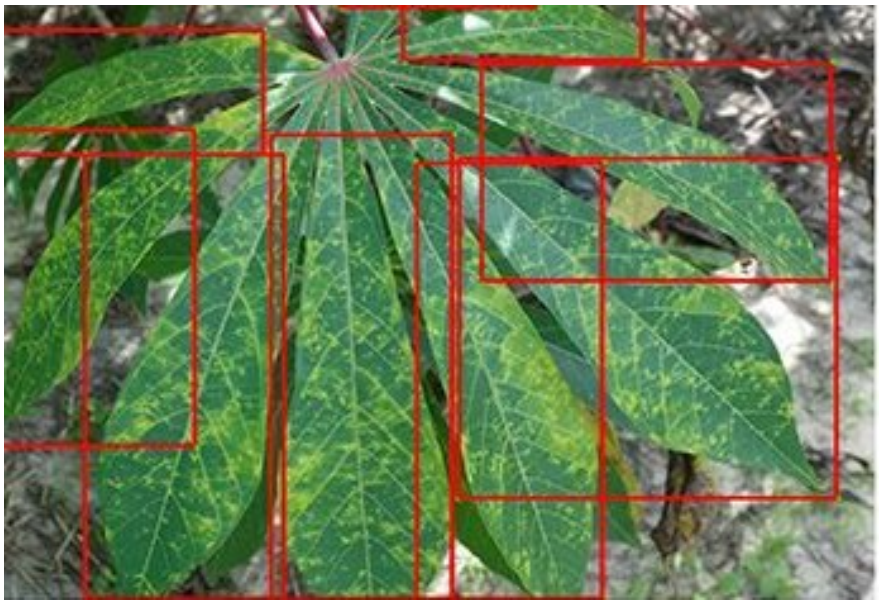
Crop disease monitoring

- Transition from use agricultural experts to machine learning techniques

Machine learning techniques

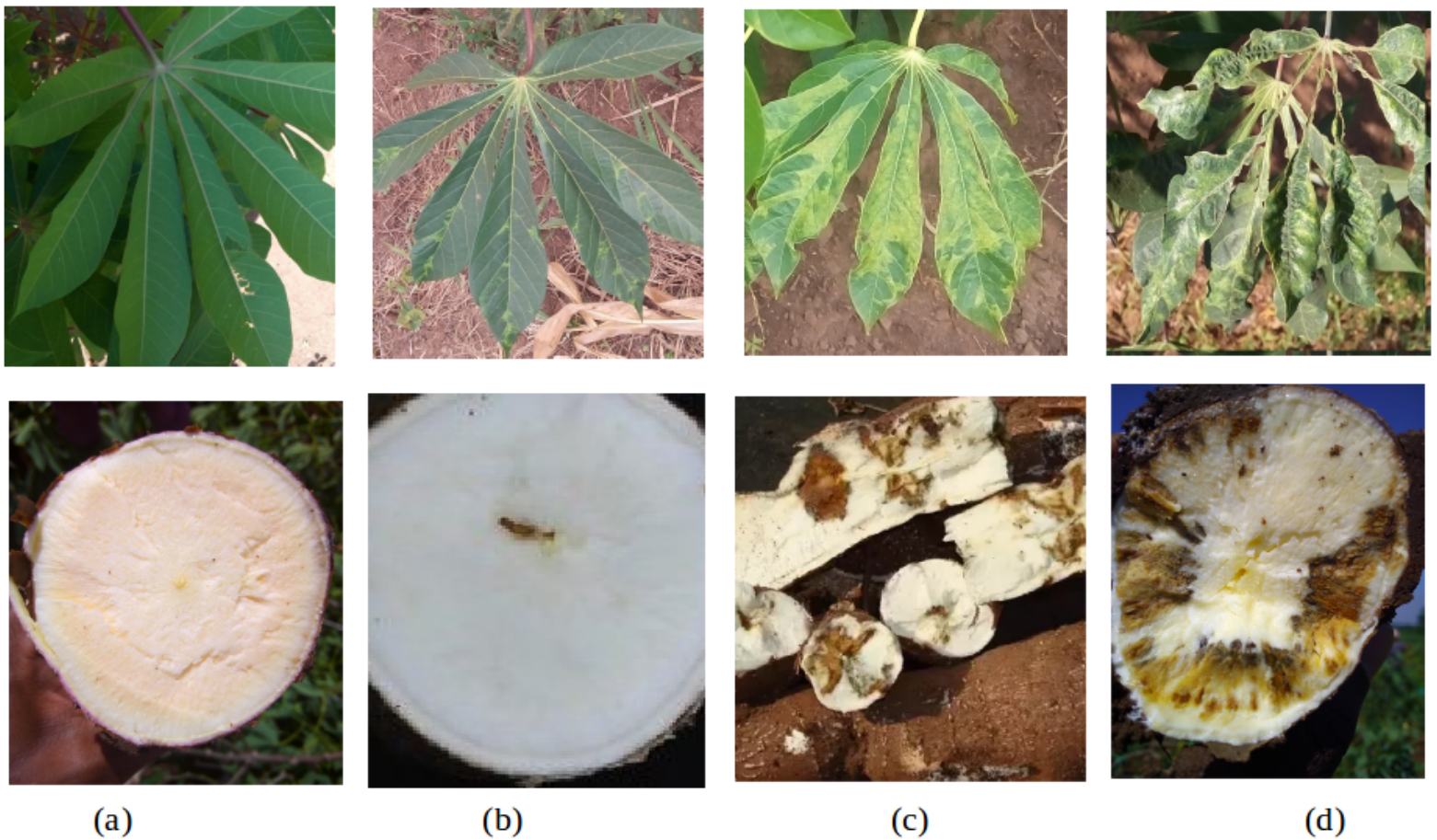
Machine learning models





Challenge?

- Time of diagnosis
- Disease severity (1-5)

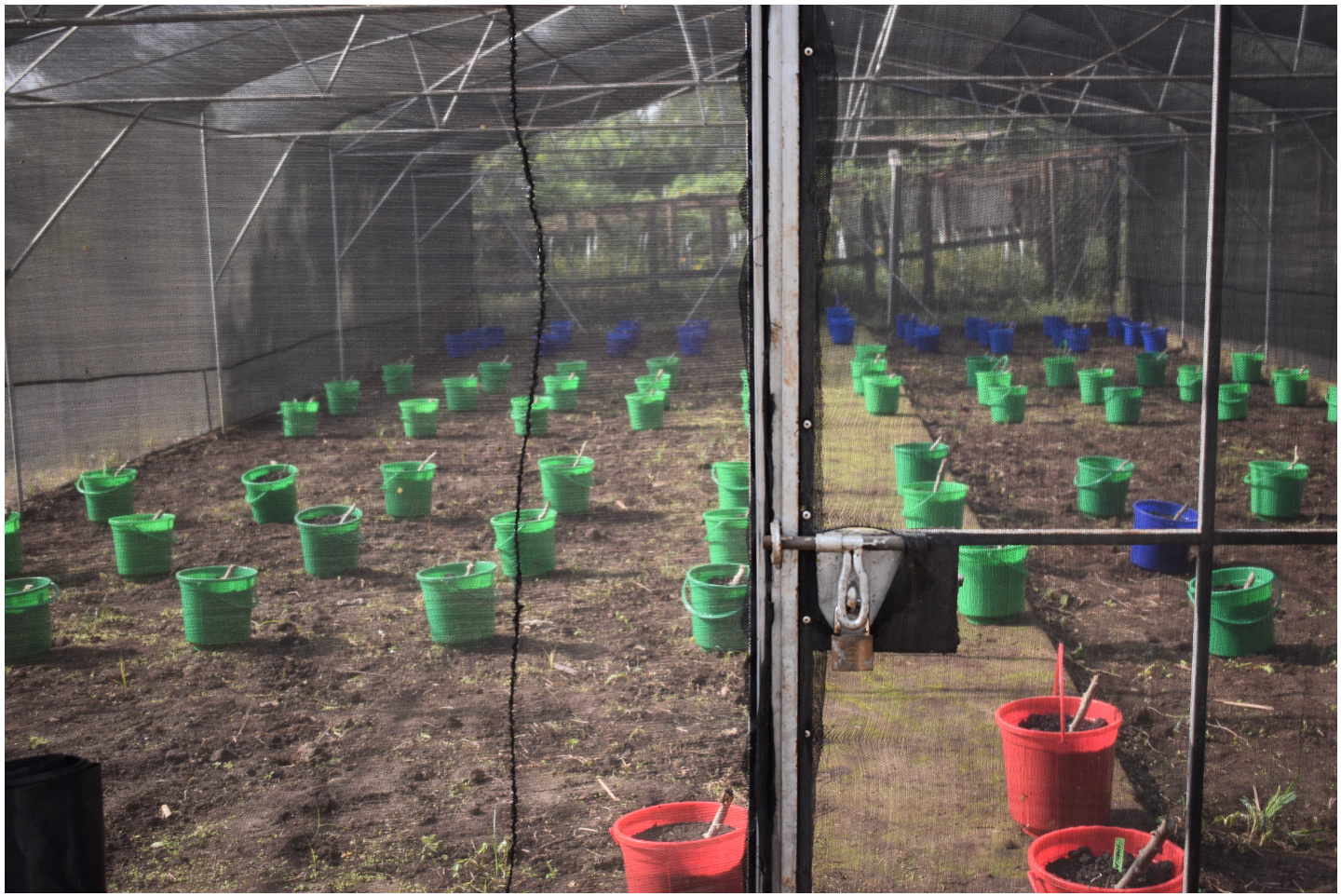


(a) (b) (c) (d)

Spectrometry for early disease detection

- Hypothesis: diseased crops without visible symptoms can be detected using spectral information, allowing for early action measures

Screen house Experiments



Screen house Experiments

Early disease detection

- How early to detect the disease before symptoms are seen by a human eye?
- Hypothesis: Disease causes several metabolic changes in the biology of the leaf that can be teased out through spectroscopy.

Results - Bio-chemist

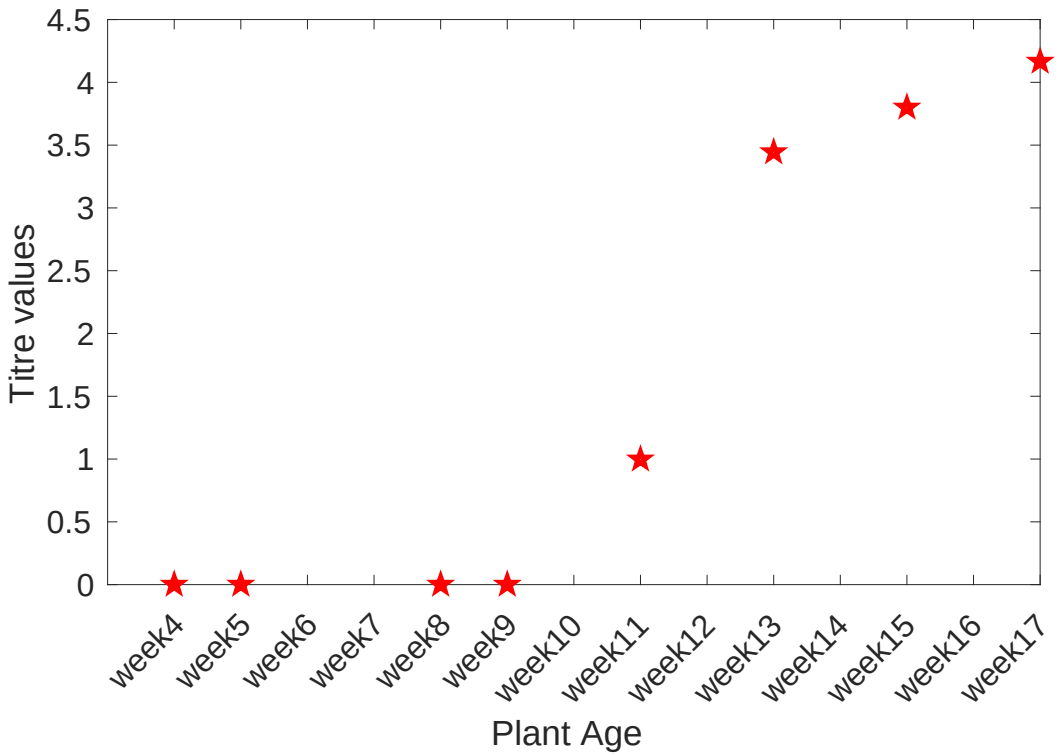


Figure: RT-PCR analysis

Results

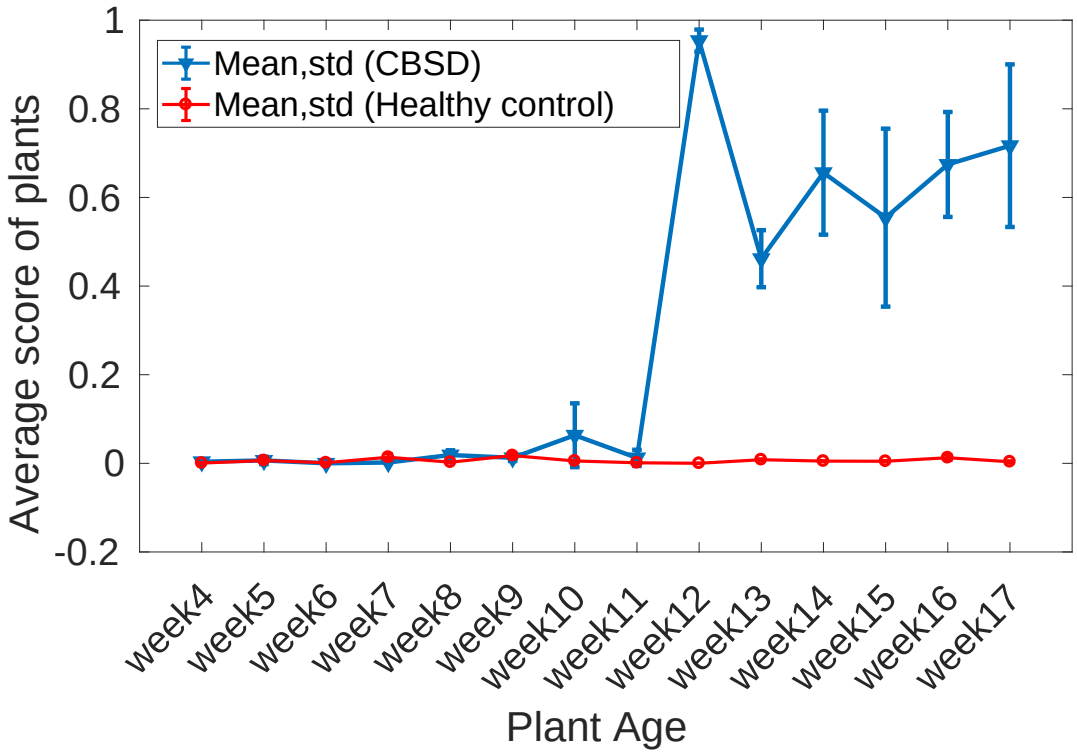


Figure: Machine learning

Findings

Cassava Brown Streak Disease can be detected from leaf spectra six weeks before the appearance of visual symptoms.

Machine learning models

- Standard classifiers (SVM, KNN, Random Forest) and GMLVQ
- Matrix relevance learning (finding the most relevant wavelength bands)
- CNN

Learning Vector Quantization (LVQ)

- Learns prototypes from labeled training dataset.

$$\{\mathrm{x}^{\mu}, y^{\mu}\}_{\mu=1}^{\mathrm{P}} \tag{1}$$

  where x^{μ} are feature vectors and y^{μ} specify the class.
- Distance measure: Usually the squared Euclidean distance.

  $d(\mathrm{x} - \mathrm{w}) = \sum_{i=1}^{N} (\mathrm{x}_i - \mathrm{w}_i)^2$
- Winner, $\mathrm{w}^{+} = \mathit{argmin}_j(d(\mathrm{x}^{\mu}, \mathrm{w}^{j}))$

  $\mathrm{w}^{+} = \mathrm{w}^{+} \pm \eta(\mathrm{x}^{\mu} - \mathrm{w}^{+})$

Classification

Employs a full matrix Λ of feature relevances in d.
GMLVQ distance measure is quadratic

$$d^{\Lambda}(\mathrm{x}, \mathrm{w}) = (\mathrm{x} - \mathrm{w})^{\top} \Lambda (\mathrm{x} - \mathrm{w}), \tag{2}$$

where the parameterization $\Lambda = \Omega^{\top} \Omega$ guarantees that $d^{\Lambda}(\mathrm{x}, \mathrm{w}) \geq 0$ for arbitrary matrices $\Omega \in \mathbb{R}^{M \times N}$.

Low-cost spectrometer device

A low-cost 3-D printed smartphone add-on spectrometer for diagnosis of crop diseases in the field.

Figure: First prototype

G. Owomugisha, P. K. B. Mugagga, F. Melchert, E. Mwebaze, J. A Quinn, M. Biehl. "A low-cost 3-D printed smartphone add-on spectrometer for diagnosis of crop diseases in field", 3rd ACM SIGCAS Conference on Computing and Sustainable Societies, 331–332, 2, 2020

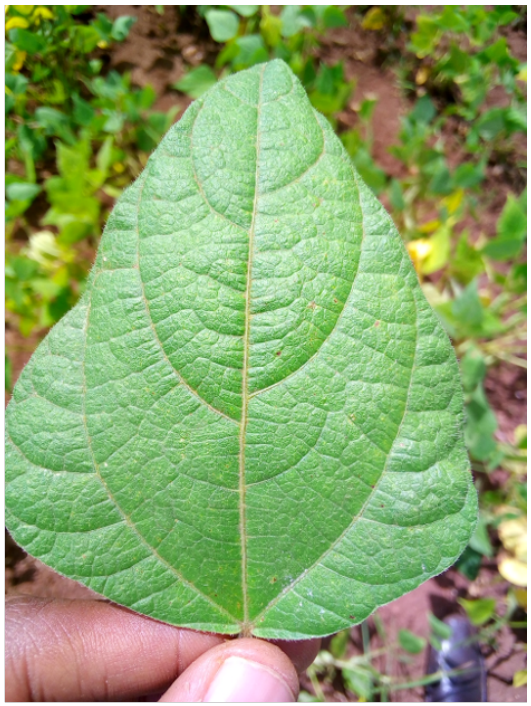
Extension of our early work

- Study: more diseases, more crops, plant stress effects.

Diseases in Beans

Bean Rust Disease

Angular Leaf Spot



Healthy

Diseases in Maize

Maize Streak Disease

Fall Army Worm Damage

Healthy

End

Thank you!