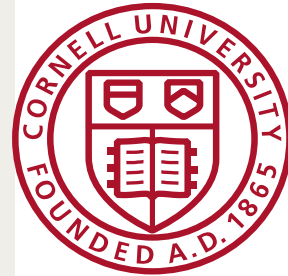


Disease scouting in apple orchards: Exploring the potential of computer vision and digital agriculture



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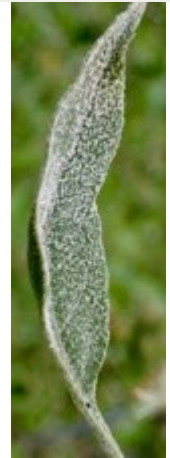
February 27, 2023

Economic and management challenges for diseases in apple orchards

- Large number of Diseases and pests
- Particularly threat for
 - High-density monocultures of susceptible cultivars
 - Favorable environment in Northern US
- Frequent chemical sprays pathogen resistance
- High input costs of orchard management
- Human health, and environmental concerns



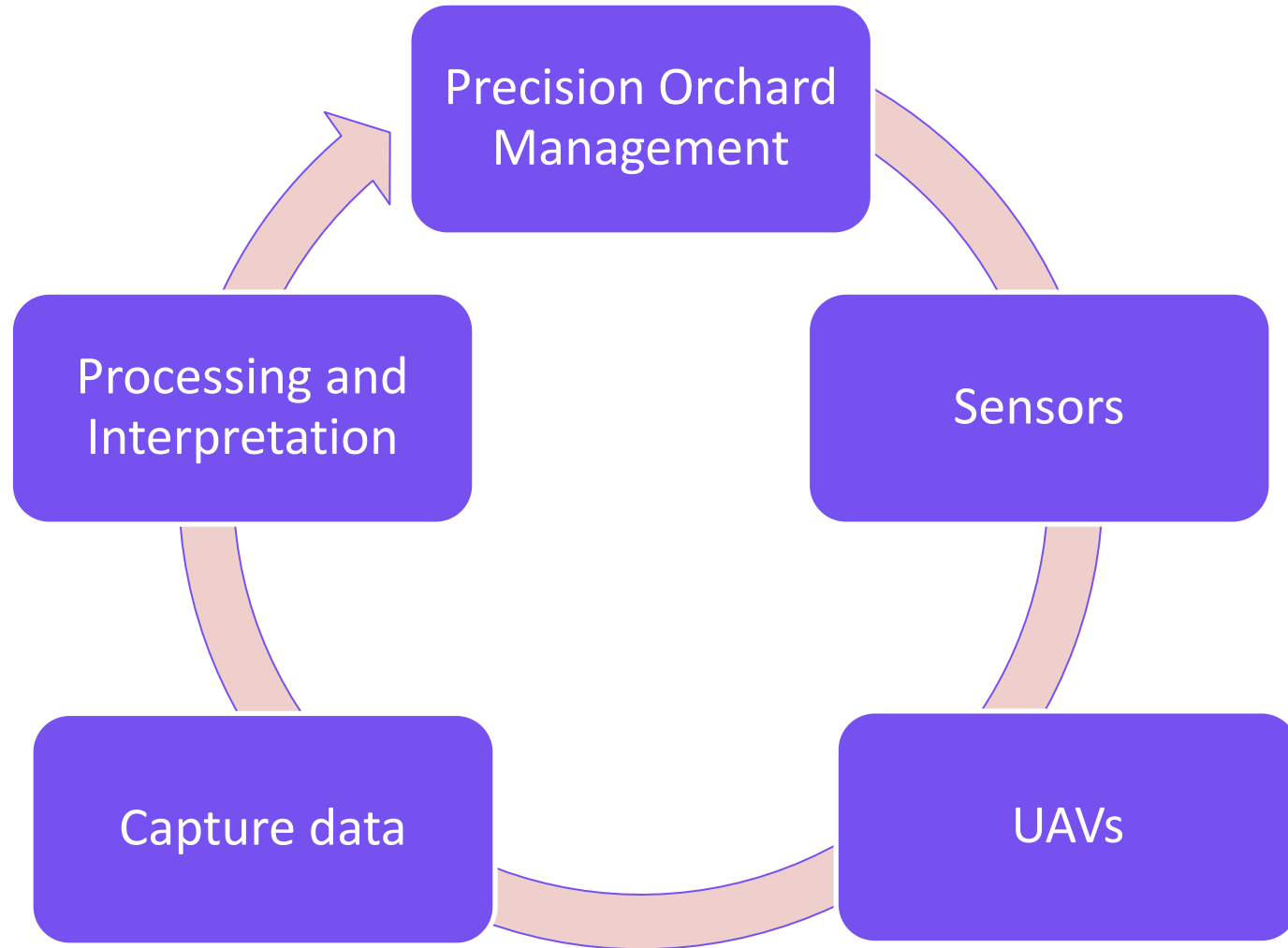
Why is accurate, rapid, and early detection of diseases and pathogens important?



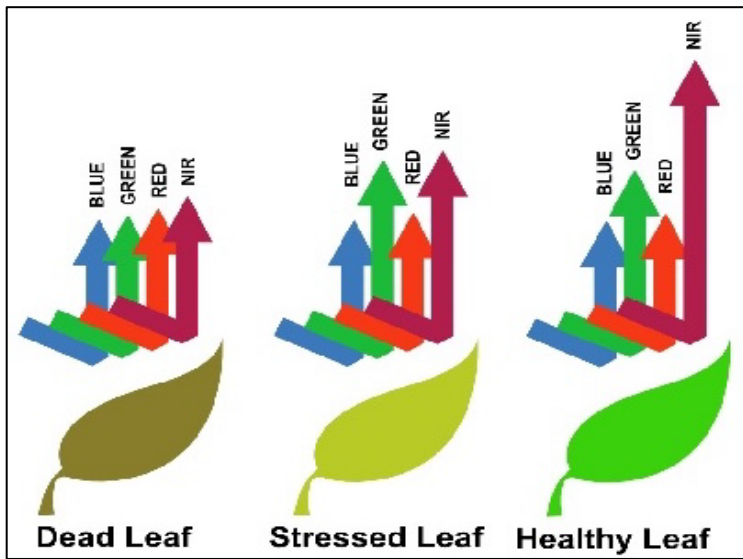
Why is accurate, rapid, and early detection of diseases and pathogens important?

- We surveyed 158 apple growers in 2019
 - 125 at Lake Ontario Fruit Tour
 - 33 at Young Fruit Growers Tour, Highland, NY
- Current practices in fire blight identification
 - Mostly visual identification
 - Few samples sent to test in Cornell Lab

Precision orchard management for automated and rapid detection of stresses



Electromagnetic spectrum-based Sensors and UAVs



Processing and interpretations



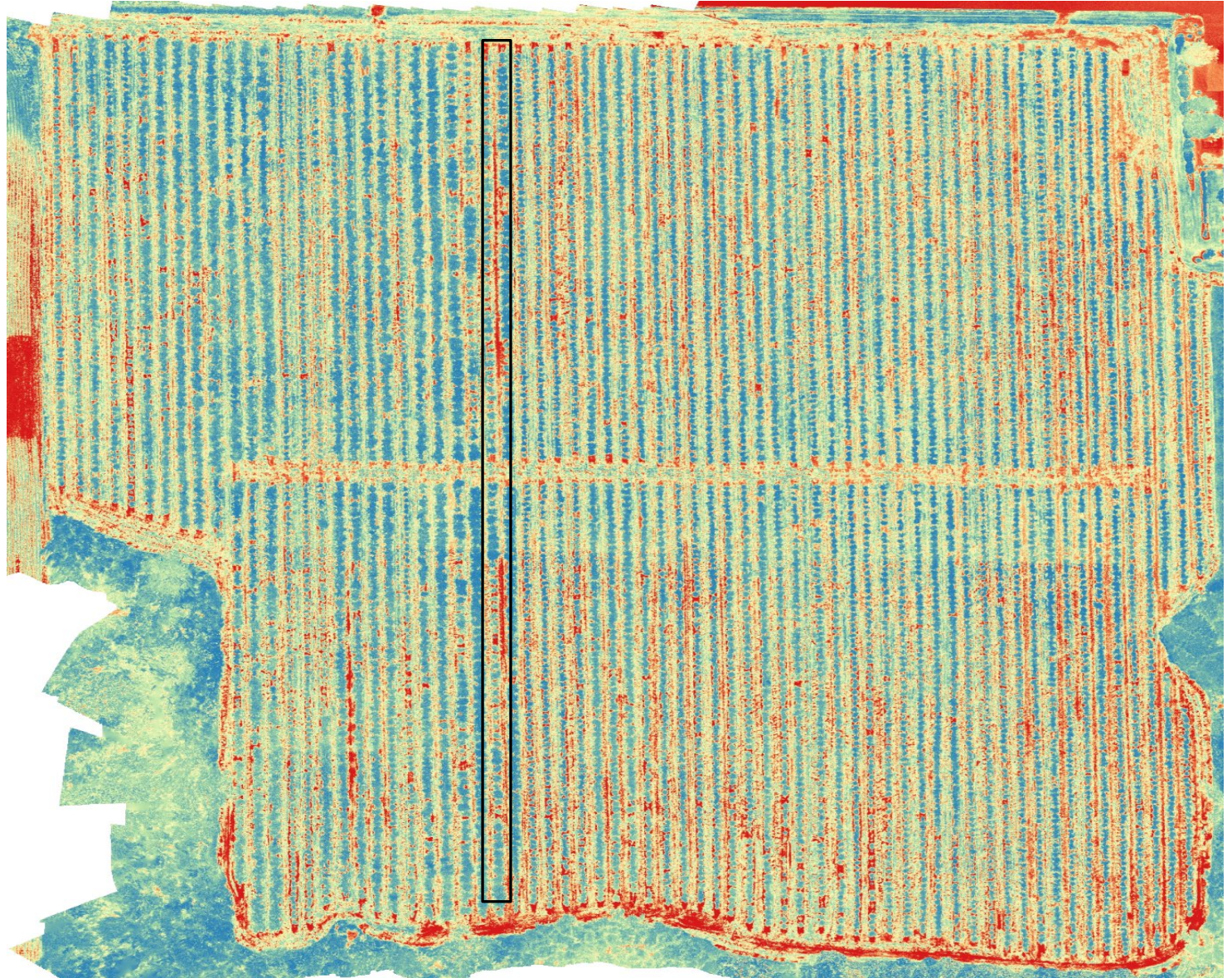
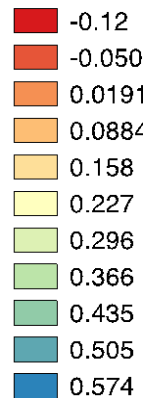
RGB map

Processing and interpretations

NDRE map

Legend

NDRE



Precision orchard management

Orchard Mapping

Orchard elevation and drainage management

Soil nutrient management

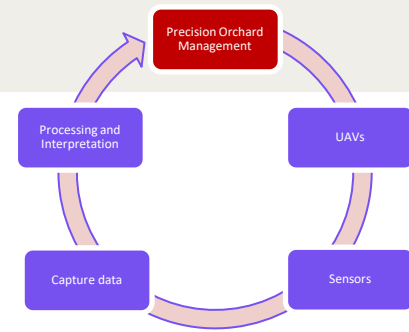
Optimization of plant growth, replanting, pruning and training

Damage estimates for crop insurance

Pest and disease Scouting

Early and proactive pest control???

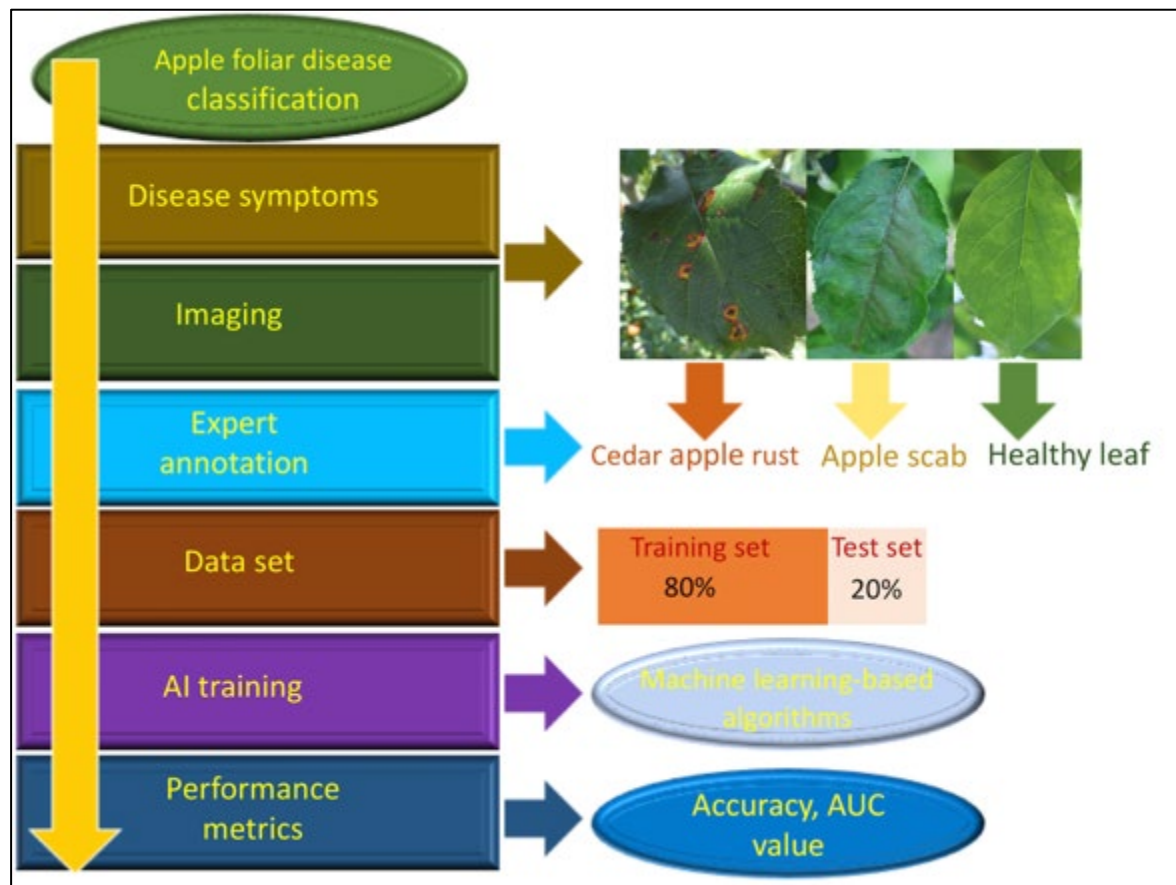
Early and proactive disease management???



A demonstration of drones for apple growers and crop consultants at VanDeWalle Sharps Farm in Alton, NY

Computer vision for automated disease detection in apple orchards

- ✓ Precise and early identification of diseases and pests for timely management
- ✓ Computer vision for automated, time and cost-effective disease scouting
- ✓ Challenges
 - Similar symptoms
 - Wide variation in symptoms
 - Multiple diseases/leaf



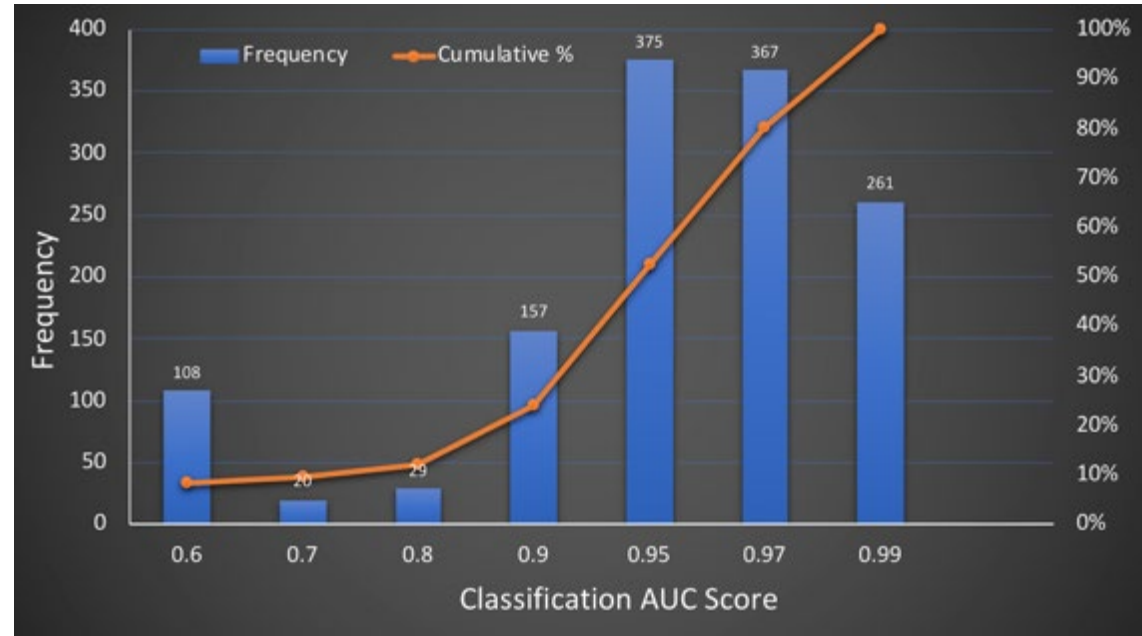
Expert annotated apple foliar disease symptoms images of real-life scenarios in apple orchards

- ~25K images of 5 apple foliar disease symptoms in growing seasons 2020, & 2021
- Manual annotation of diseases/leaf symptoms
 - Distinct disease categories
 - Multiple disease symptoms/leaf
 - Disease severity (% infection)/leaf
- The pilot image dataset of symptoms were randomly split into training (80%) and test (20%) datasets



Machine learning models for automated image-based disease classification and quantification

- Launched “*Plant Pathology Challenge*”, a global competition at Kaggle to develop ML models in 2020, 2021
- 1,317 teams submitted ~22,551 ML models
- The 3 winners with top models had mean prediction accuracy >0.985



Distribution of the accuracy scores

Blue bars: the total number of teams

Red line: the cumulative percentage of the total teams

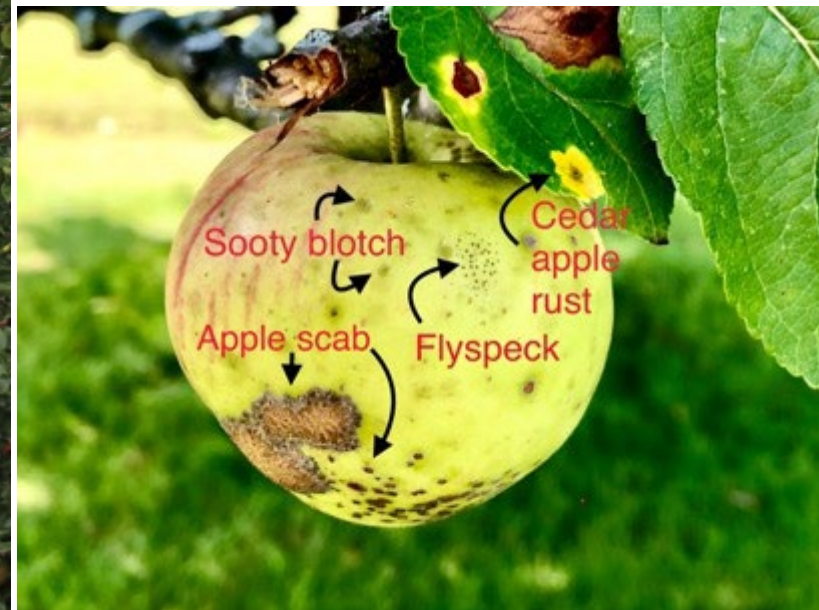
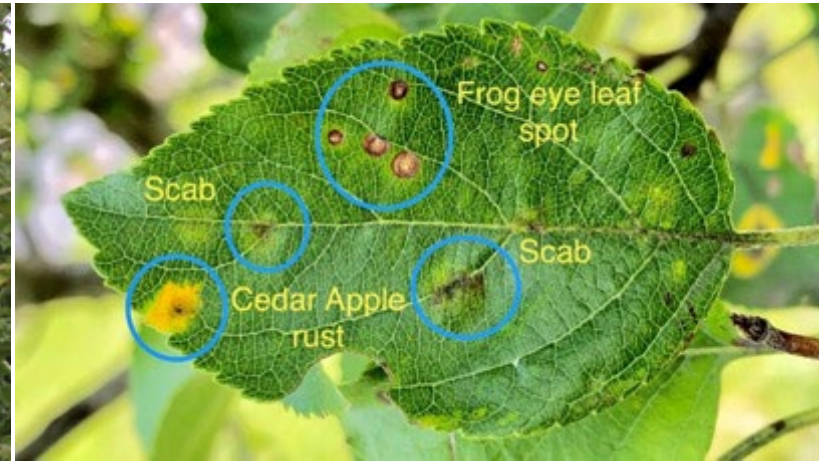
Challenges for ML and automated disease detection in the orchards

Canopy depth --- above ground imaging cannot capture symptoms in lower canopy or under leaves etc.

Difficult to distinguish, annotate, symptomatically similar looking biotic, abiotic stresses, insect damage

Symptoms can look different depending on cultivars, age of cultivar, age of symptom, co-infecting pathogen, light condition, and sensor type

A very largeannotated dataset is required



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Thank you for attention!