The Dawn of AI-Assisted Deep Strawberry Learning

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Self-Introduction

- Assistant Professor of ABE at GCREC

- Education and training

  - BS, MS in Computer Science

  - PhD in Bio Ag Engineering

  - Postdoc in wheat breeding

- Joined UF in October 2021

- Research – AI for plant breeding

- Extension – AI applications for crop sensing and production practices

The Power of AI

- AI is changing our life.

  - Robot, content recommendation, ChatGPT...

- AI in Ag.

  - "Muscle" – Automation and robotics
  - "Eye" – Smart sensors and machine vision
  - "Brain" – Models for prediction and decision support

"Just as electricity transformed almost everything 100 years ago, today I actually have a hard time thinking of an industry that I don't think AI will transform in the next several years."
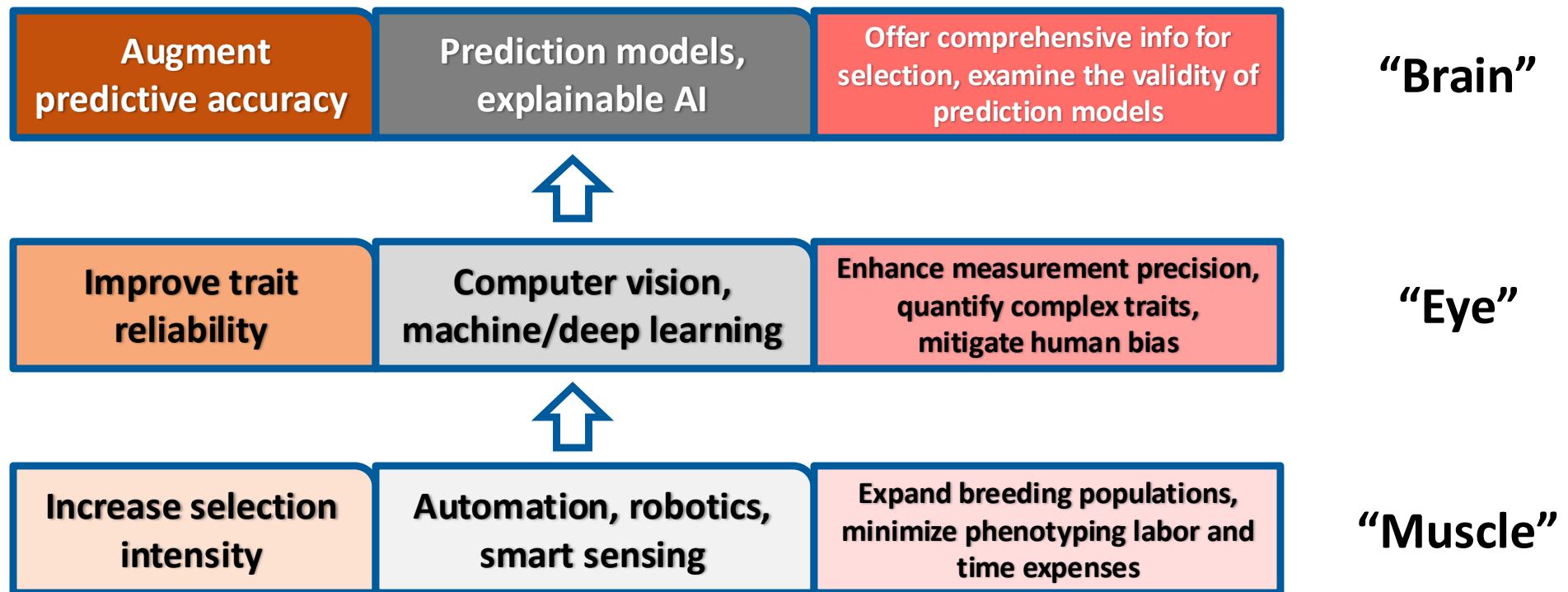
– Andrew Ng

How Can AI Advance Plant Breeding?

AI-Powered Phenomics for Plant Breeding

Primary objective: providing plant breeders with decision support tools to expedite the development of superior varieties.

Augment predictive accuracy	Prediction models, explainable AI	Offer comprehensive info for selection, examine the validity of prediction models	**"Brain"**
Improve trait reliability	Computer vision, machine/deep learning	Enhance measurement precision, quantify complex traits, mitigate human bias	**"Eye"**
Increase selection intensity	Automation, robotics, smart sensing	Expand breeding populations, minimize phenotyping labor and time expenses	**"Muscle"**

AI-Assisted Applications for Strawberry Breeding

- **Strawberry runners, flowers, and fruits detection**

- Strawberry growth condition monitoring and analysis

- Strawberry biomass prediction

Strawberry Plant Parts Detection

- Objective
  - Accurate quantification of strawberry plant parts (runners, fruit, and flowers) through AI-assisted machine vision
  - Selection support for breeding
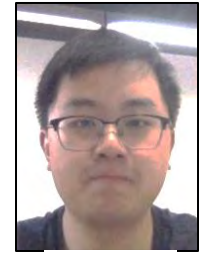 - Yield estimation and prediction

- Flowers
- Mature fruit
- Immature fruit
- Runner

Strawberry Plant Parts Detection

Will Haxton   **Kai Shen**

- Ground imaging systems, 2023-2024
    - Amiga, all electric micro-tractor, Farm-ng, CA
    - 2 cameras, 4K video recording at 30fps
    - Covered by a shade sail

Strawberry Plant Parts Detection

- Multi-object identification and segmentation through YOLOv8-based deep convolution neural network
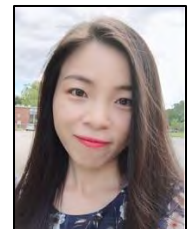
Dr. Xue Zhou

Prediction demo using the 2024 model

Confusion Matrix Normalized
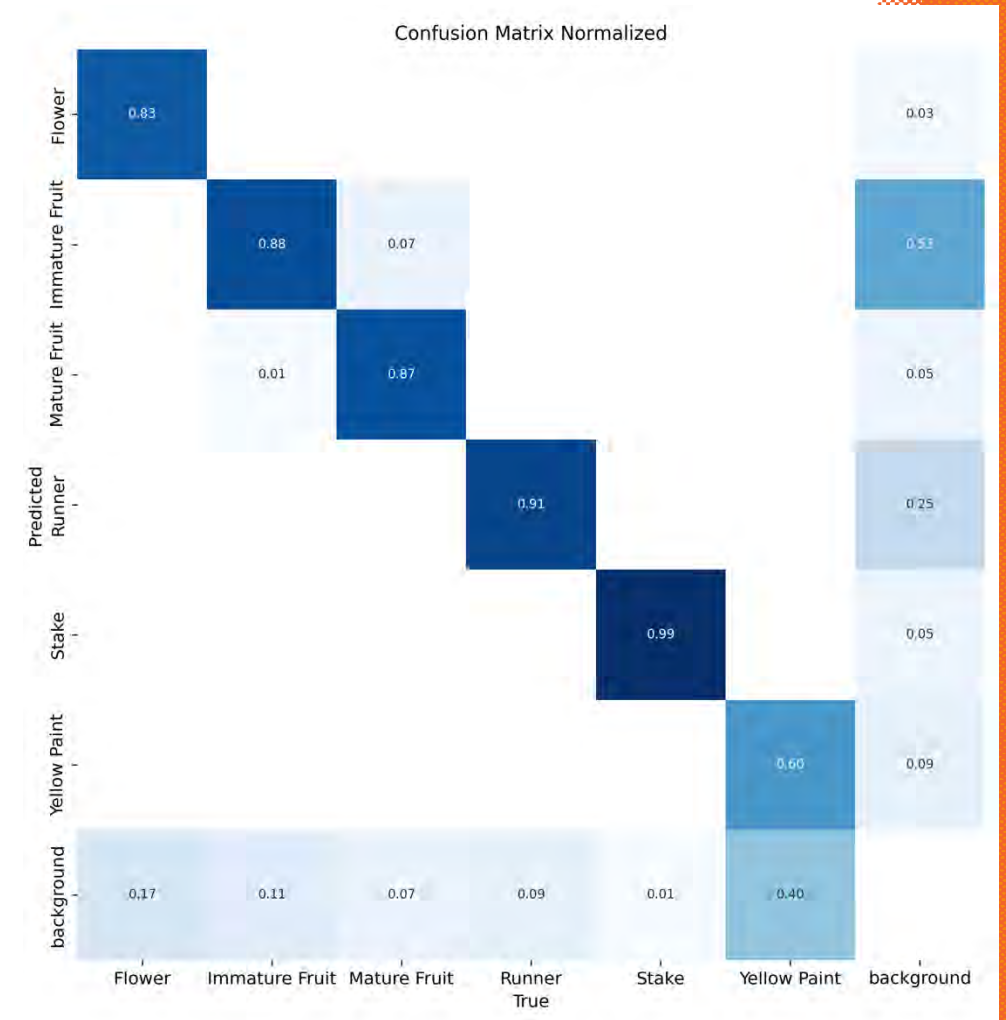
Strawberry Plant Parts Detection
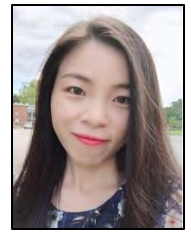
- Runners quantification error analysis

Dr. Xue Zhou

7. Background (light/tire print/dead stem), 2.34%

8. Stake blocked runner, 1.17%

9. Runner out of the frame, 0.58%

6. Double count, 3.51%

5. Calyx was identified as runner, 7.02%

4. Overlap runners, 7.60%

Causes of errors in runner quantification

1. Missed runners, 37.43%

2. Leaf stem was identified as runner, 28.07%

3. Runner from neighbor plant, 12.28%
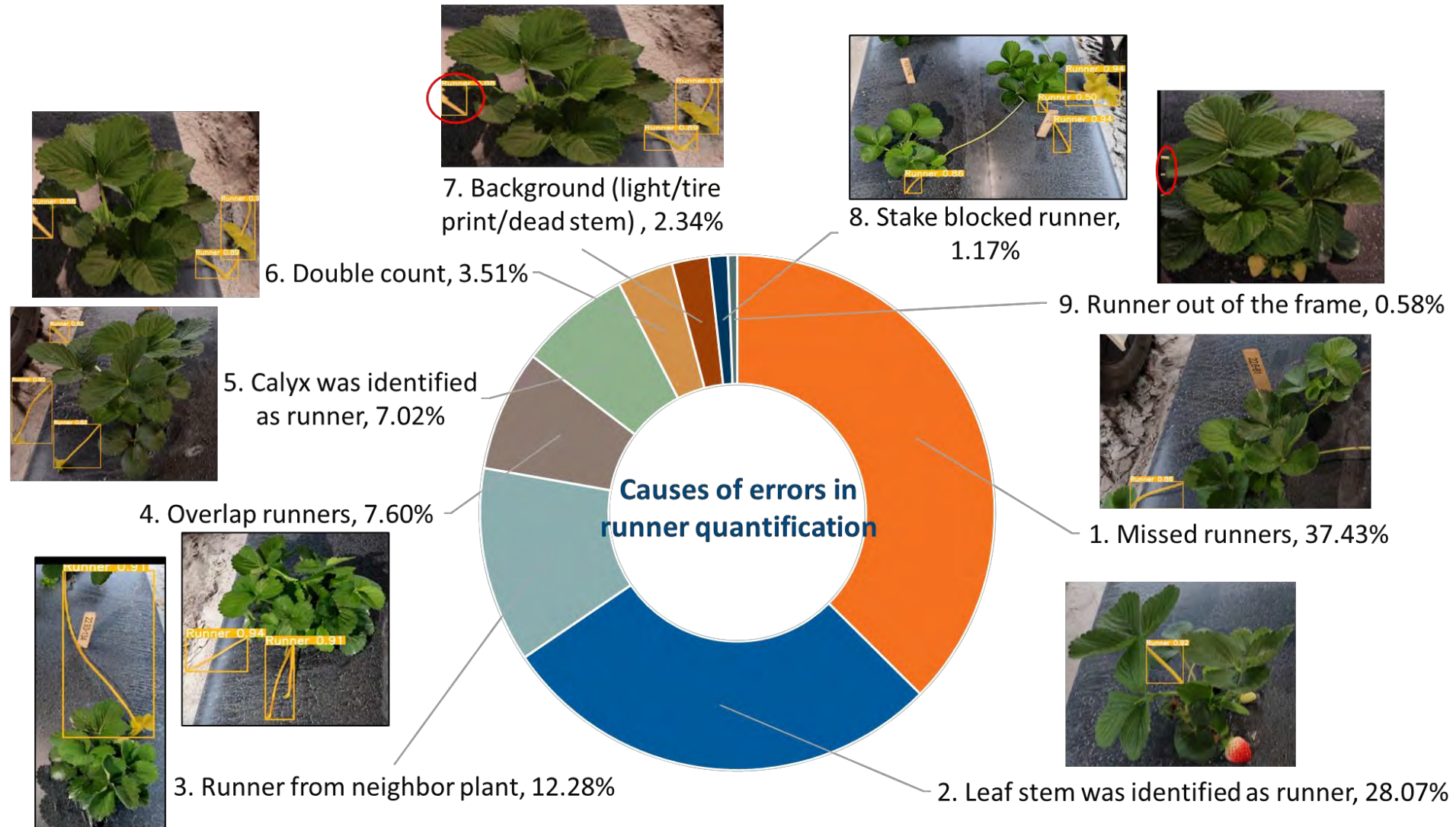
Strawberry Plant Parts Detection

- Future work
  - Improve model prediction accuracy
  - Increase camera viewing angles
  - Detect more traits, such as disease and nutrient deficiency
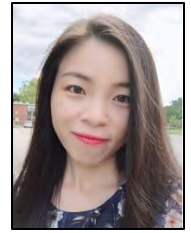
Dr. Xue Zhou
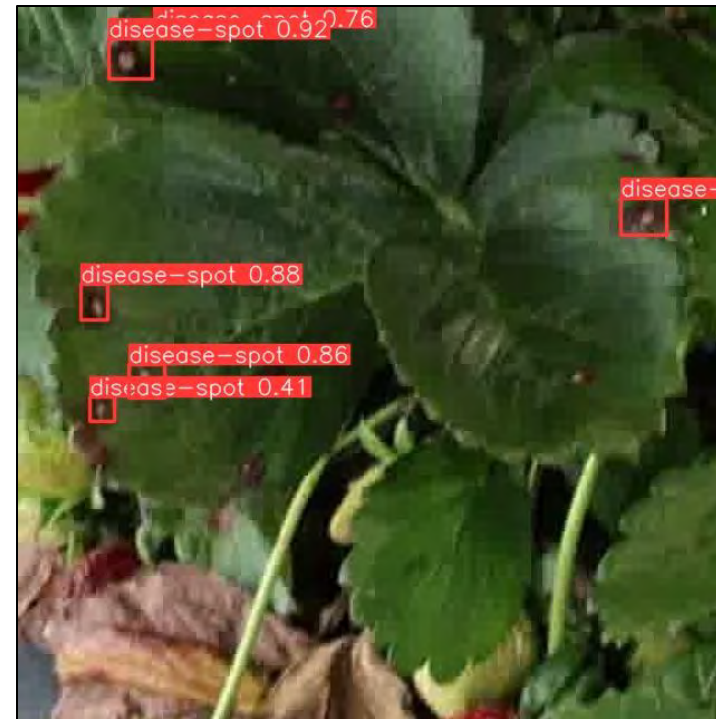
AI-Assisted Applications for Strawberry Breeding

- Strawberry runners, flowers, and fruits detection

- **Strawberry growth condition monitoring and analysis**

- Strawberry biomass prediction

Strawberry Growth Condition Monitoring and Analysis

- Objective
    - Large-scale field mapping by aerial (drone) imaging.
    - Phenome Insight – a web application developed for field map generation and visualization, and analysis of strawberry growth conditions.
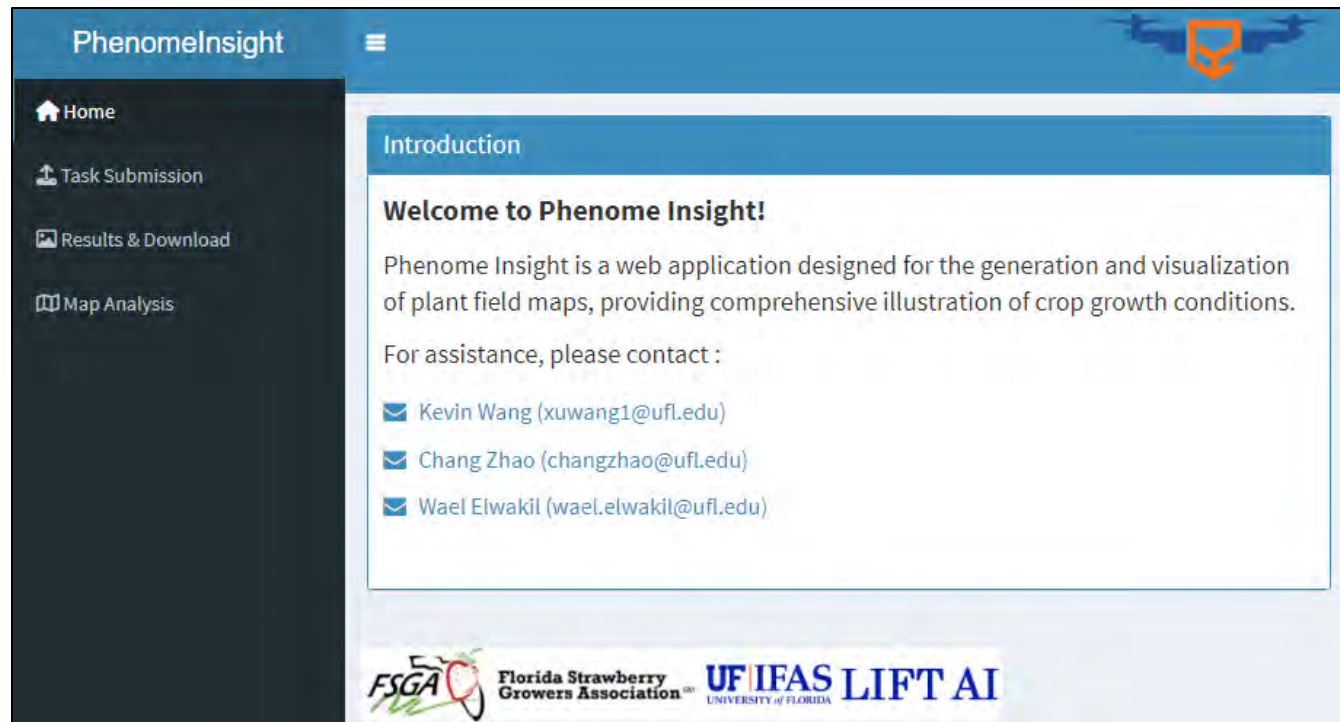
Dr. Chang Zhao
Asst. Prof.
Agronomy

Dr. Wael Elwakil
Extension Faculty

Strawberry Growth Condition Monitoring and Analysis
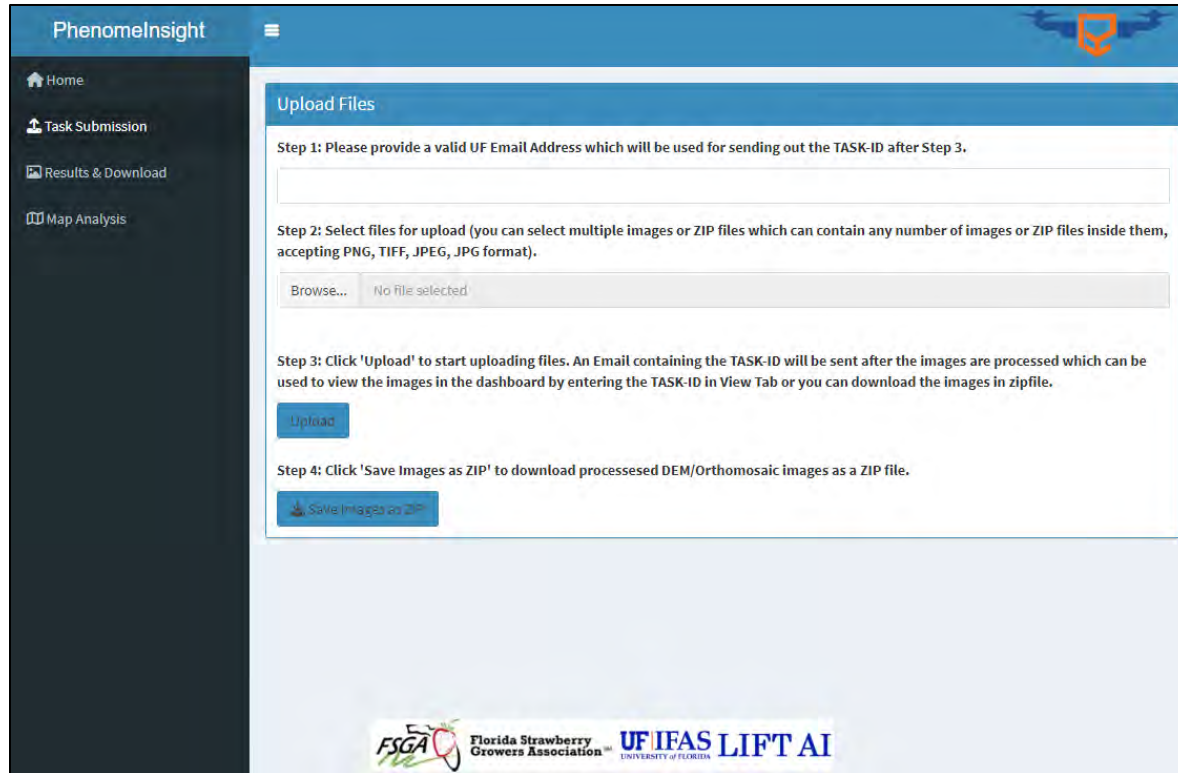
- Phenome Insight – field map generation and visualization
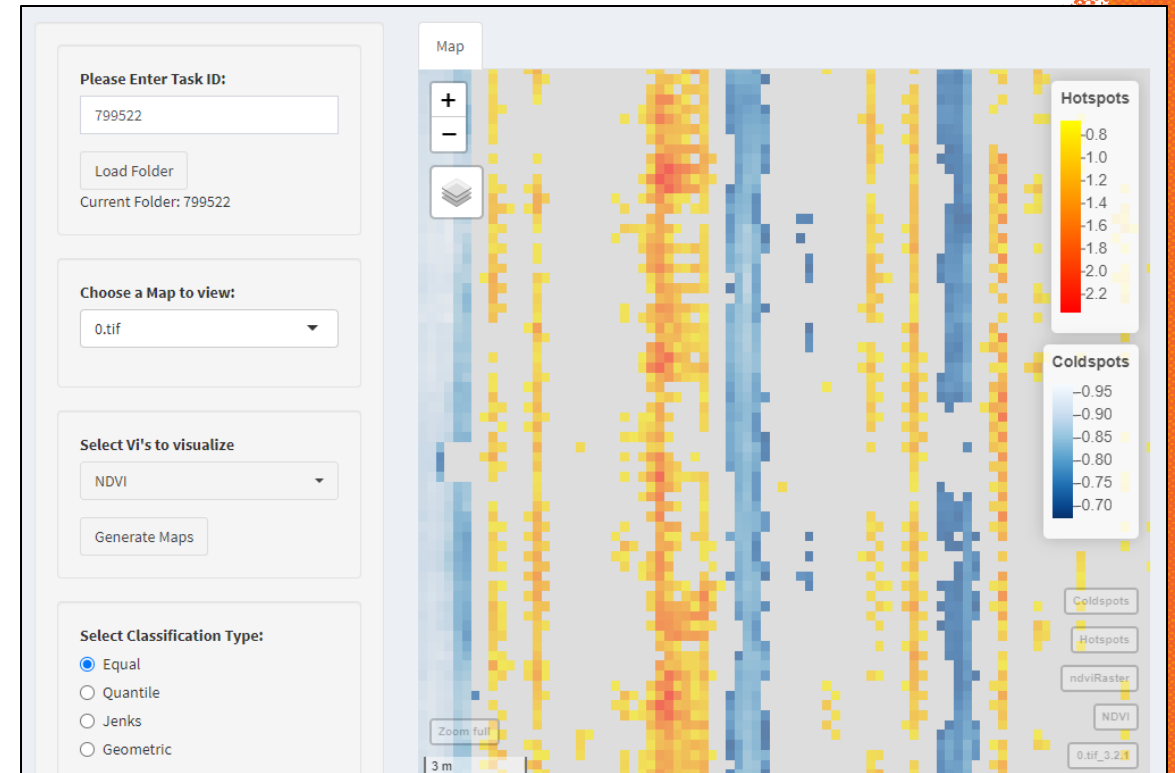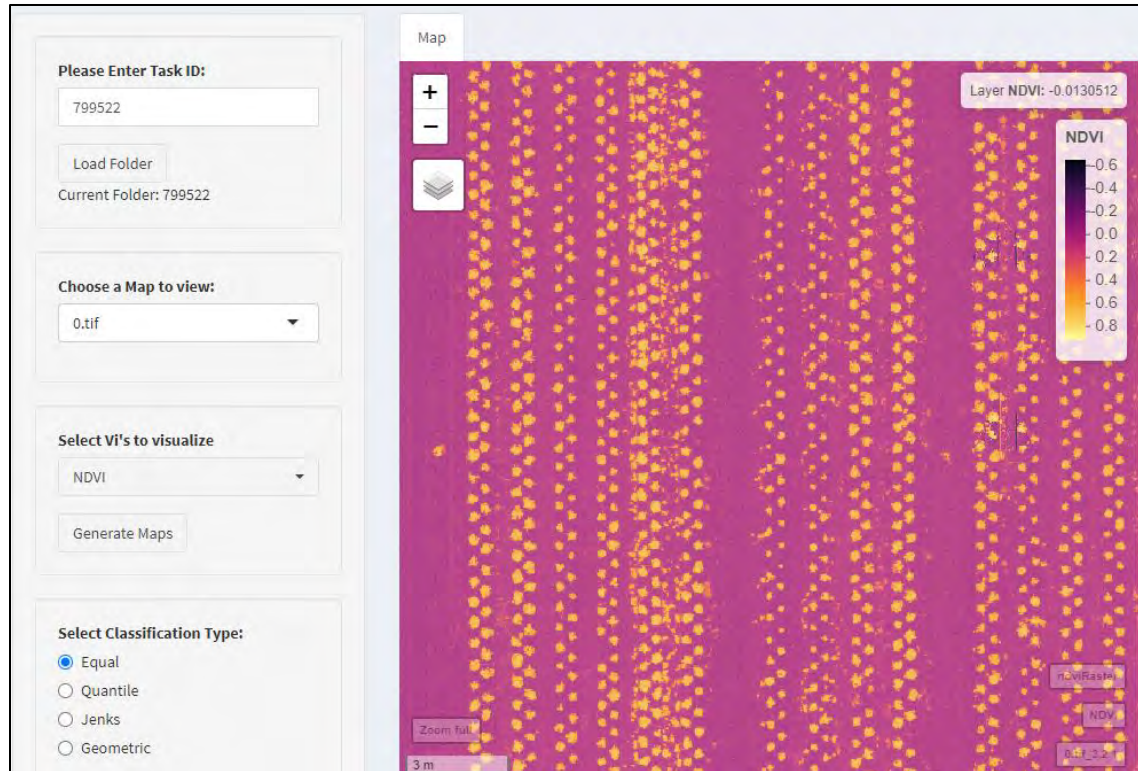

Aishwarya T. K.   Dinesh Chowdary

Strawberry Growth Condition Monitoring and Analysis

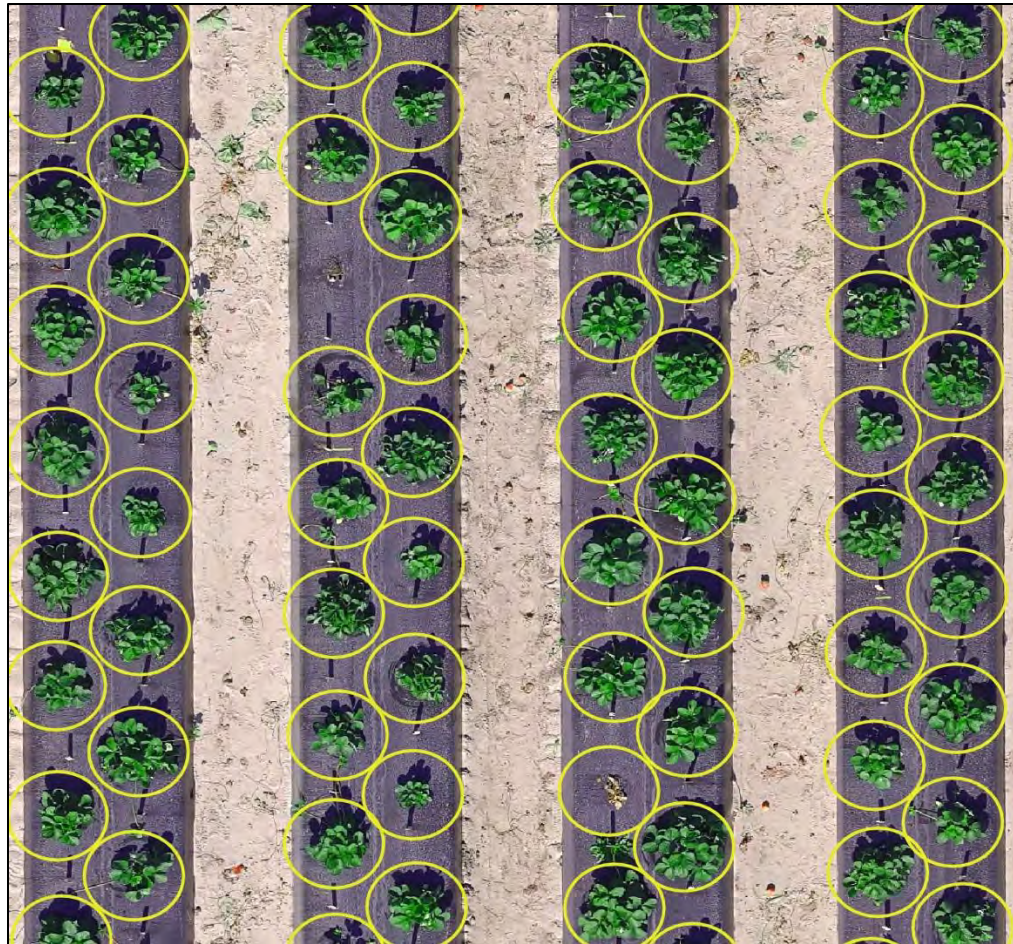- Phenome Insight – VI calculation and hotspot analysis

Dinesh Chowdary

Strawberry Growth Condition Monitoring and Analysis

- Future work
  - Enrich more AI functions in Phenome Insight, such as strawberry canopy area segmentation and parts detection
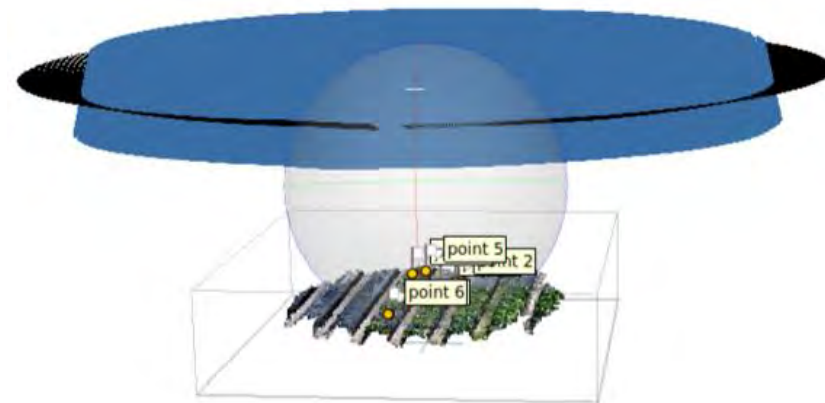
Liyike Ji

AI-Assisted Applications for Strawberry Breeding

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- Strawberry growth condition monitoring and analysis

- **Strawberry biomass prediction**

Strawberry Biomass Prediction

- Objective
  - Non-destructively estimate strawberry plant volume as a major quantitative factor for biomass prediction

Strawberry Biomass Prediction

- 3D virtual environment of strawberry field in late Feb. 2024
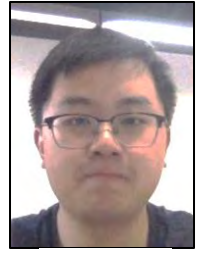
Kai Shen   Liyike Ji

Strawberry Biomass Prediction

- Biomass prediction preliminary result
  - DPC-A-SfM and DS-A-GS, 2023-2024, 18 genotypes × 2 reps
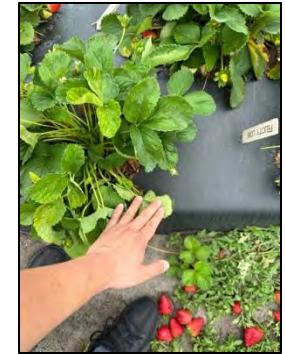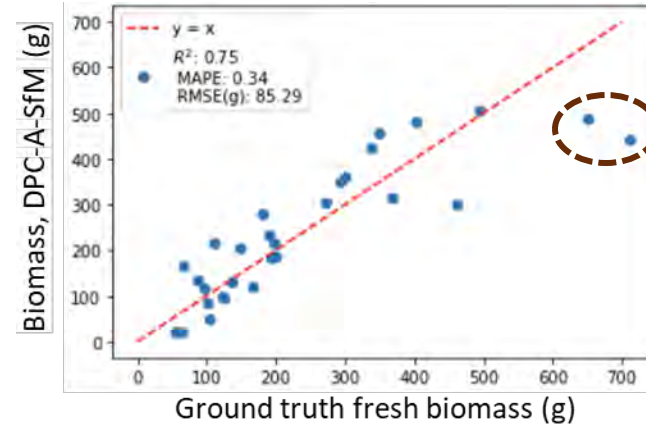
Kai Shen

Top view

Side view

3D dense point cloud, aerial video, SfM (DPC-A-SfM)
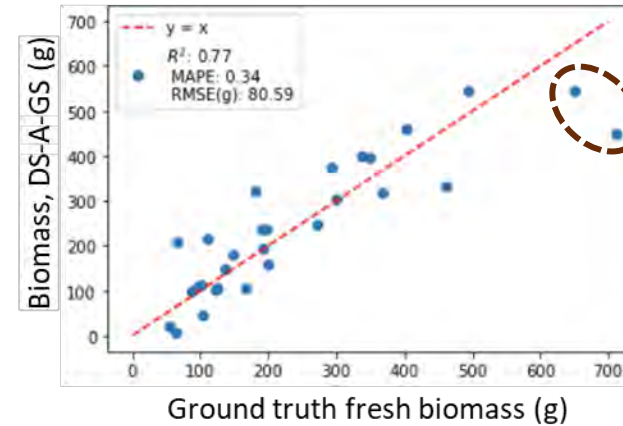
Felicity

Top view

Side view

3D splats, aerial video, 3DGS (DS-A-GS)

Camarosa

Take Home

- AI has demonstrated significant potential in revolutionizing agriculture.

- A successful AI application = Talents + Computility + Data

- There are still bottlenecks in leveraging AI techniques.

  - Data integration – from fragmented information to decision support

  - Data ownership

  - Data integrity and reliability – trust in AI applications

Acknowledgement

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- Strawberry working groups at GCREC
- Collaborators
  - Dr. Chang Zhao (Agronomy) and Dinesh Chowdary Gogineni