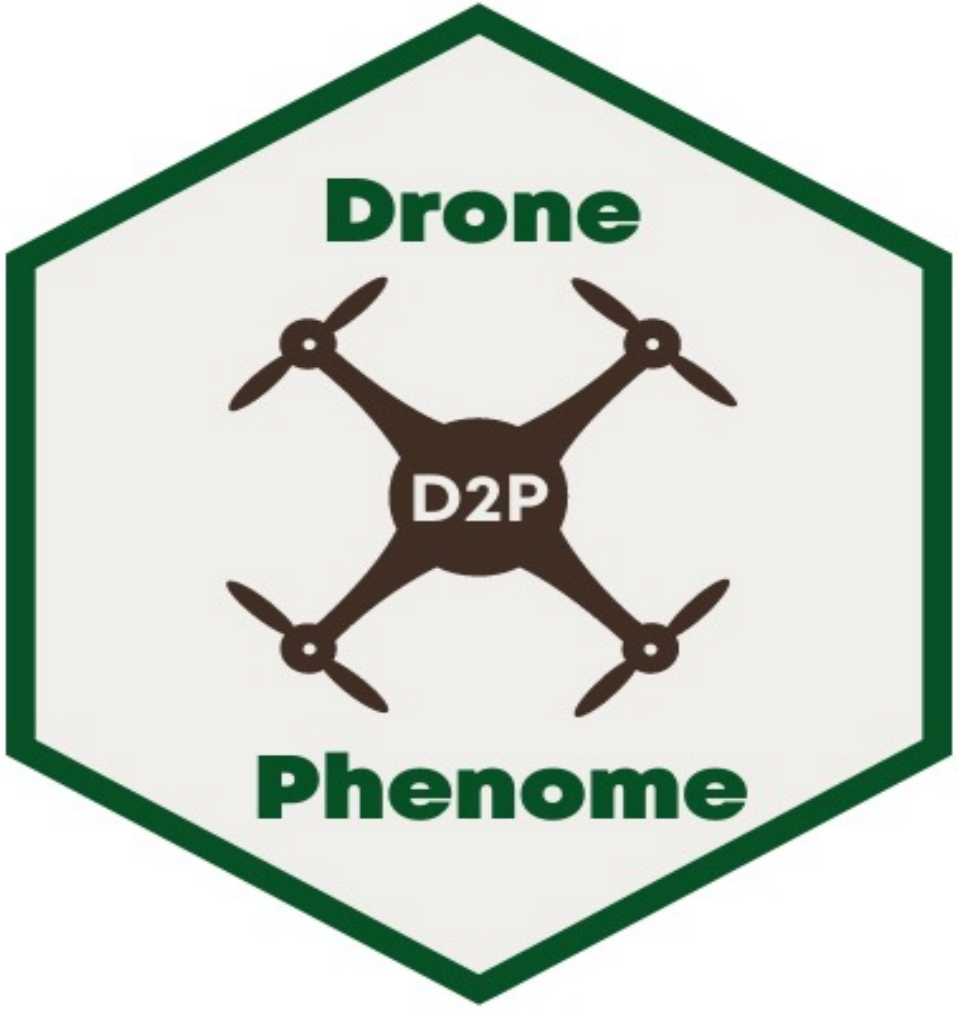
Empowering high-throughput phenotyping using UAVs



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Project Objectives

1) Complete an international community survey of UAV barriers to entry

Goal is to get 1000 on-line respondents for quantitative data

Perform follow up interviews with 100 respondents for more qualitative understanding

2) Develop accessible baseline pipelines and protocols to support standardization of UAV data collection, sharing, and analysis

Utilize knowledge from on-line survey to assess where resources should be invested to make adoption easier

Collect example datasets from several different commodities, experiment types, and/or locations

Develop tools to help streamline data processing and metadata curation

Generate hands-on tutorials to collect and process UAV data from field experiments

Project Objectives

1) Complete an international community survey of UAV barriers to entry

Who is using UAV? What are common research applications?

What is the difference between these scientists/research applications?

UAV in use

UAV NOT used

WHY ?

Demographic background

- Commodity
- Type of organization (public, private, etc.)
- Role in organization
- Size & budget of research team
- Focus of research/application
- Perceived value of UAV for research application

Interest level of deploying UAV in research/agronomy program

Three respondent tracks

1) Currently using UAV in research program

2) Interested, but not currently using UAV

3) UAV cannot help address research question

Project Objectives

1) Complete an international community survey of UAV barriers to entry

What can we learn about the specifics of deployment? How to make it easier?

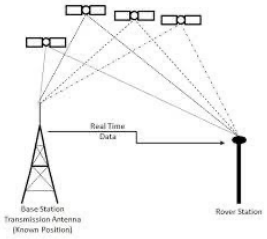
Poll following respondents:

- 1) Currently using UAV in research program
- 2) Interested, but not currently using UAV

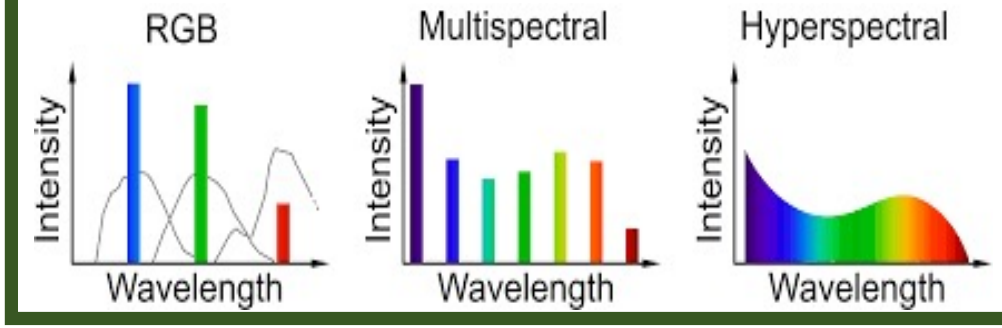
Type of sUAS

Flight planning

Ground truth coordinate data

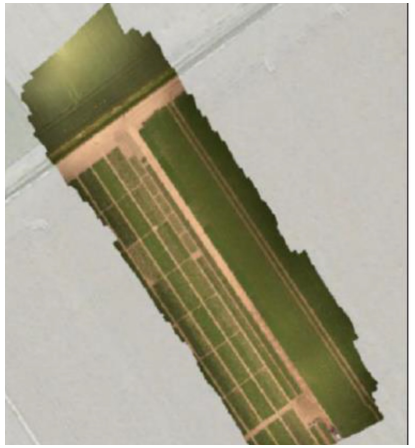


Type of sensor



Sensor calibration

Generating orthomosaics



Numerical data from plots

Project Objectives

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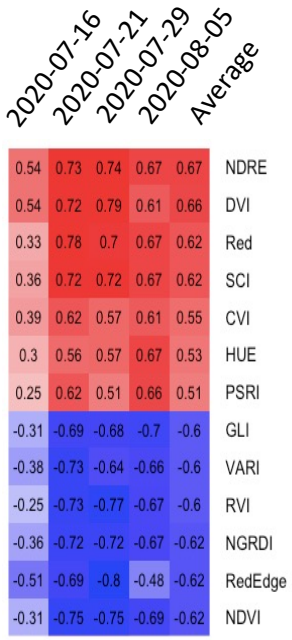
Manual measurement of trait

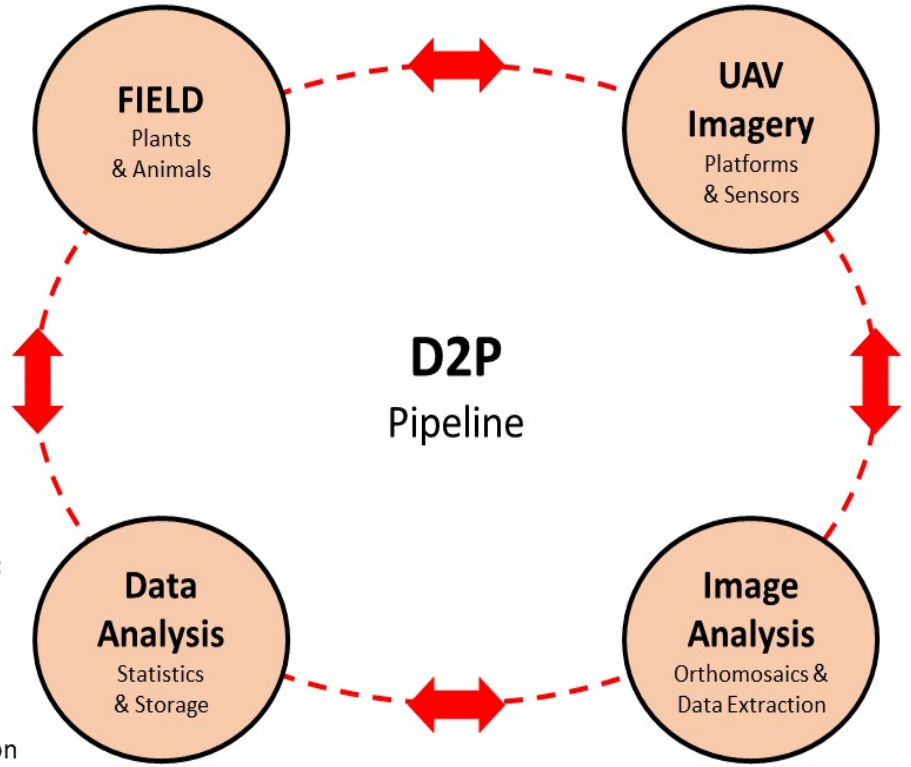
Correlation between traits and indices



Example application workflows

Traditional Phenotyping:
- ✓ Yield
- ✓ Plant height
- ✓ Vine maturity
- ✓ Diseases symptoms
- ✓ Milk production
- ✓ Beef production
- ✓ Etc.

UAV Phenotyping:
- ✓ RGB
- ✓ Multispectral
- ✓ Hyperspectral
- ✓ Thermal
- ✓ Fixed-wing UAV
- ✓ Multi-Rotor UAV
- ✓ Etc.



UAV Data Applications:
- ✓ Data bank
- ✓ Data sharing
- ✓ Statistical models
- ✓ Quality validation
- ✓ Prediction/Estimation
- ✓ Etc.

Potential UAV Data:
- ✓ Indices
- ✓ Canopy
- ✓ Biomass
- ✓ Estimated height
- ✓ Objects counting
- ✓ Etc.

Multispectral imaging

Orthomosaic of field

Example application: Quantify Colorado potato beetle damage

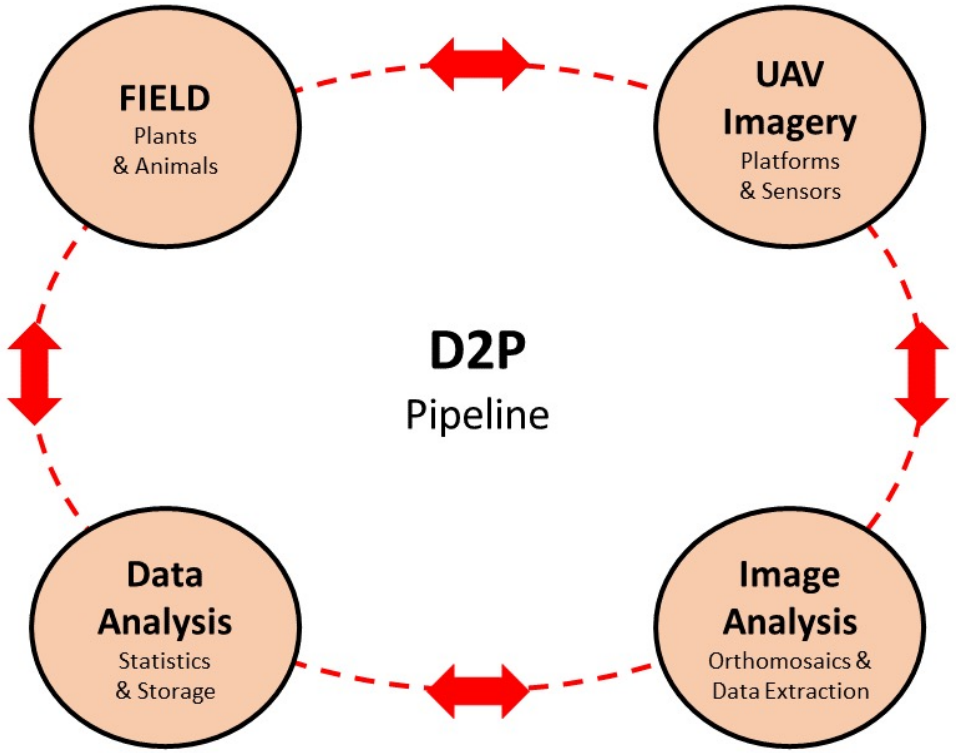
Project Objectives

2) Develop accessible baseline pipelines and protocols to support standardization of UAV data collection, sharing, and analysis

CYVERSE

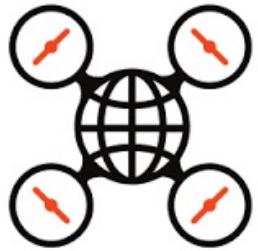
Software development and tutorials

Potential software:
- ✓ FieldBook
- ✓ OpenDataKit
- ✓ Etc.



Potential software:
- ✓ Pix4D
- ✓ DroneDeploy
- ✓ FieldAgent
- ✓ Etc.

PIX4D



OpenDroneMap

Potential software:
- ✓ ASREML
- ✓ lme4
- ✓ Jump
- ✓ Cyverse
- ✓ Cloud options
- ✓ Etc.

Potential software :
- ✓ OpenDroneMap
- ✓ OpenCV
- ✓ Metashape
- ✓ Pix4D
- ✓ FIELDimageR
- ✓ QGIS
- ✓ Etc.

Deliverables

1) Project website, hosted on GitHub (or similar)

2) International survey about UAV imagery applications and challenges

3) Videos to explain platforms and data collection (shared via project website, YouTube, protocols.io)

4) Crops and animal agriculture examples for benchmarking (linked from project website)

5) Data analysis pipelines (linked from project website)

6) Data standards and quality assurance validation tool for UAV data

7) White paper summarizing results of the survey work and initial plans for UAV standards adoption (linked on project website)

8) Publication on best practices

9) Presentation at the North American Plant Phenotyping Network 2022 by PI Matias

10) Evaluation system in place from community and partners for deliverables 3-5 (linked on project web-site)