

# Affordable high-throughput processing of multi-scale images to phenotypic data

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**Can we phenotype hundreds of pots/plants/plots automatically with an affordable solution?**

## Problem

3D reconstruction workflow is time-consuming because it is not automated  
Point clouds require processing to extract phenotypic traits data  
Built-in tools to process multiple image sets do not exist

## Question

Can 3D reconstruction workflow process be automated?  
Can phenotypic traits be extracted from point cloud automatically?  
Can multiple image sets be processed automatically?

## Applications

Time series data of plot (e.g. daily UAV photos)  
Individual or grouped plants photographed separately in same environment  
e.g. single-plant turntable rig, 6 plants with scalebars (pictured)

## Materials and methods

Plants—Open field, greenhouse, container  
Scale bars (depending on use case)  
Ground control points (Coded targets)  
RGB camera (UAV mounted or handheld)  
Photos from RGB camera  
PC with Agisoft Metashape Professional  
Python script and functions  
Camera calibration sheet or calibration cube

## Phenotyping traits calculation

1. Length & Width
2. Canopy Cover Area
3. Height
4. Convex Volume

## Conclusion

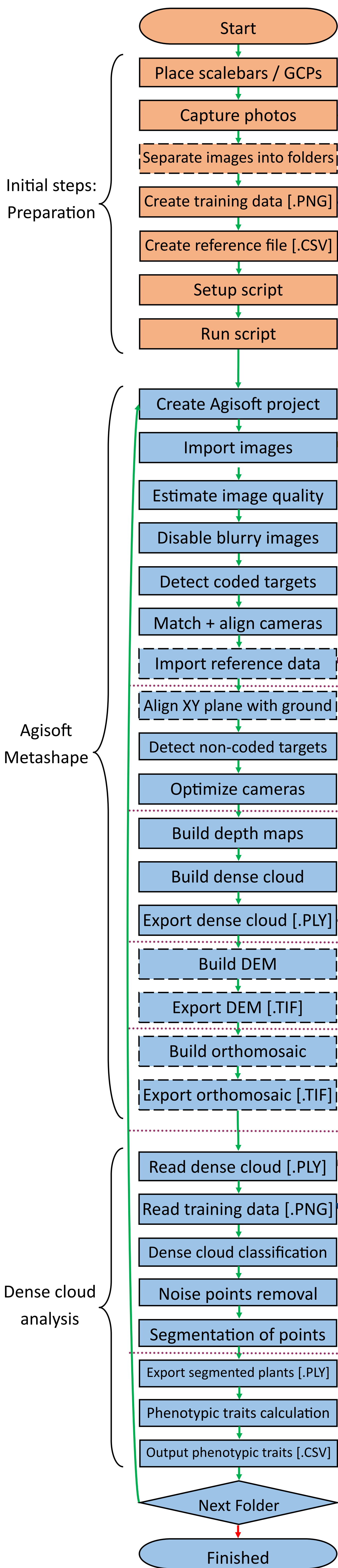
With raw images of adequate resolution, sharpness and overlap >80 %, a high-quality 3D point cloud can be produced automatically.  
Phenotypic traits can be extracted from point cloud automatically using Python.  
High throughput: Process multiple image sets with similar conditions

## Challenges

Manually clicking markers  
Markers may be occluded by plants  
Must use coded target scale bars  
Result depends on training data

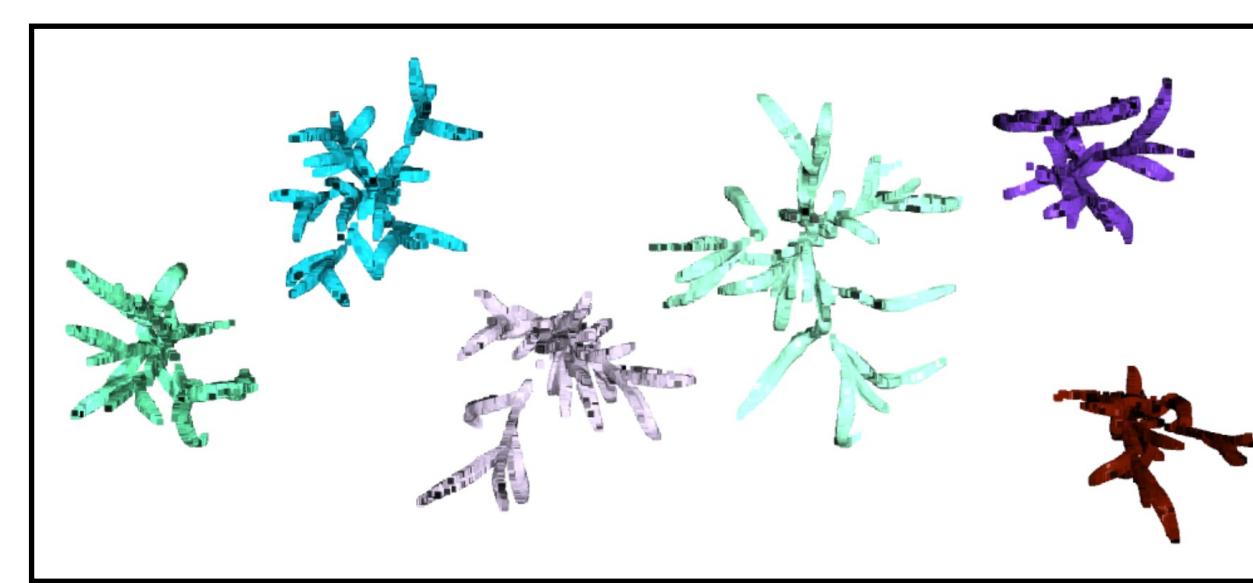
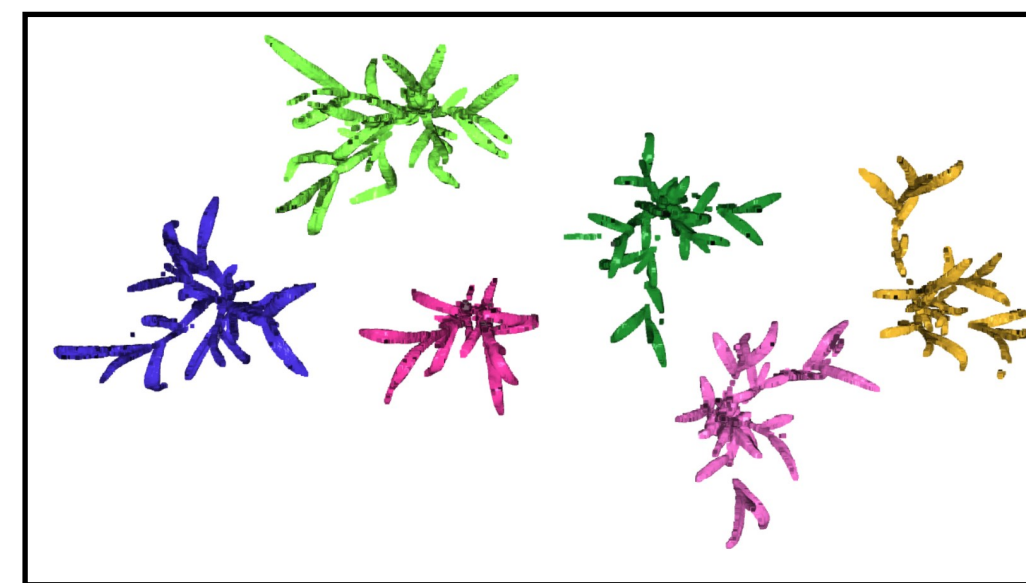
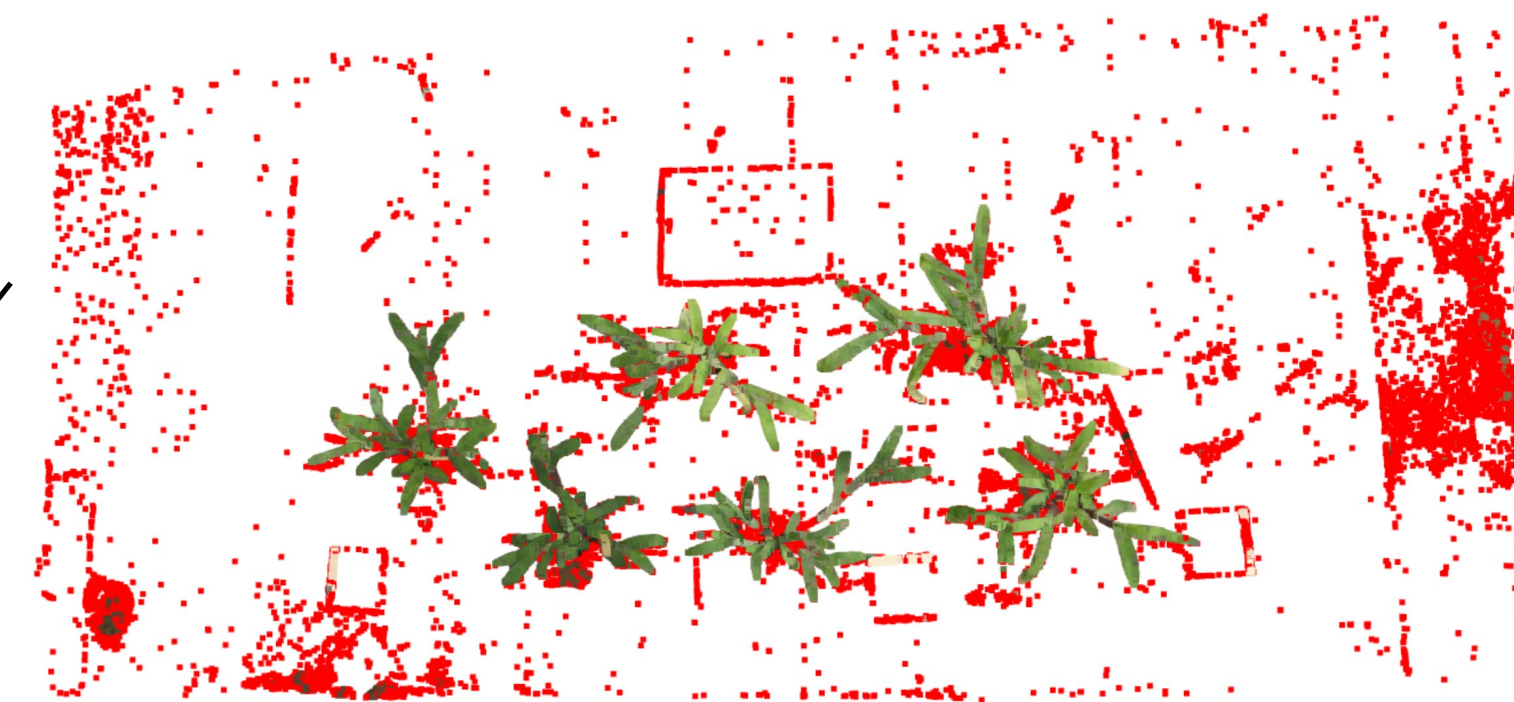
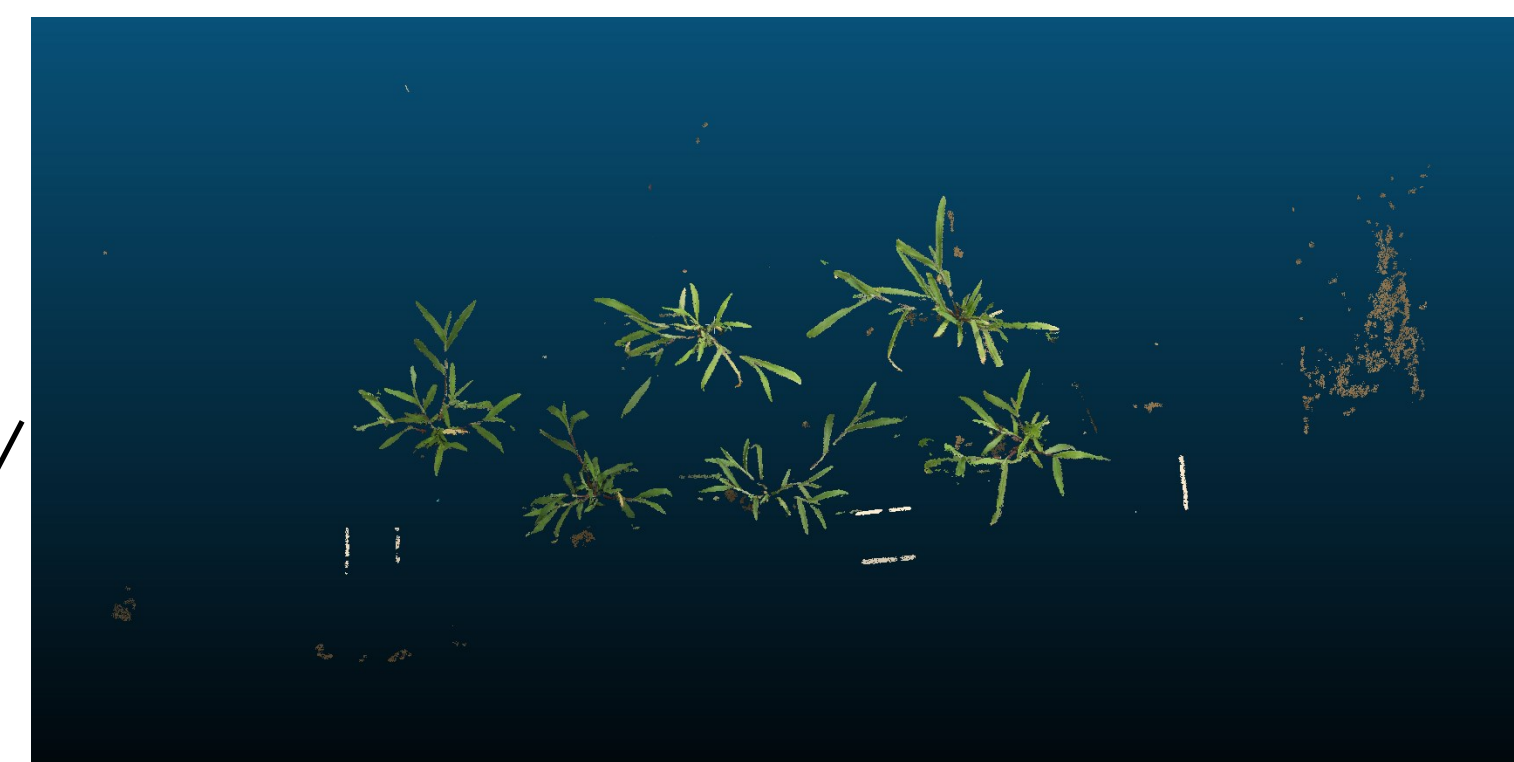
## Future work

Compare accuracy to ground truth  
Analyze more traits!  
• Leaf number  
• Total leaf area

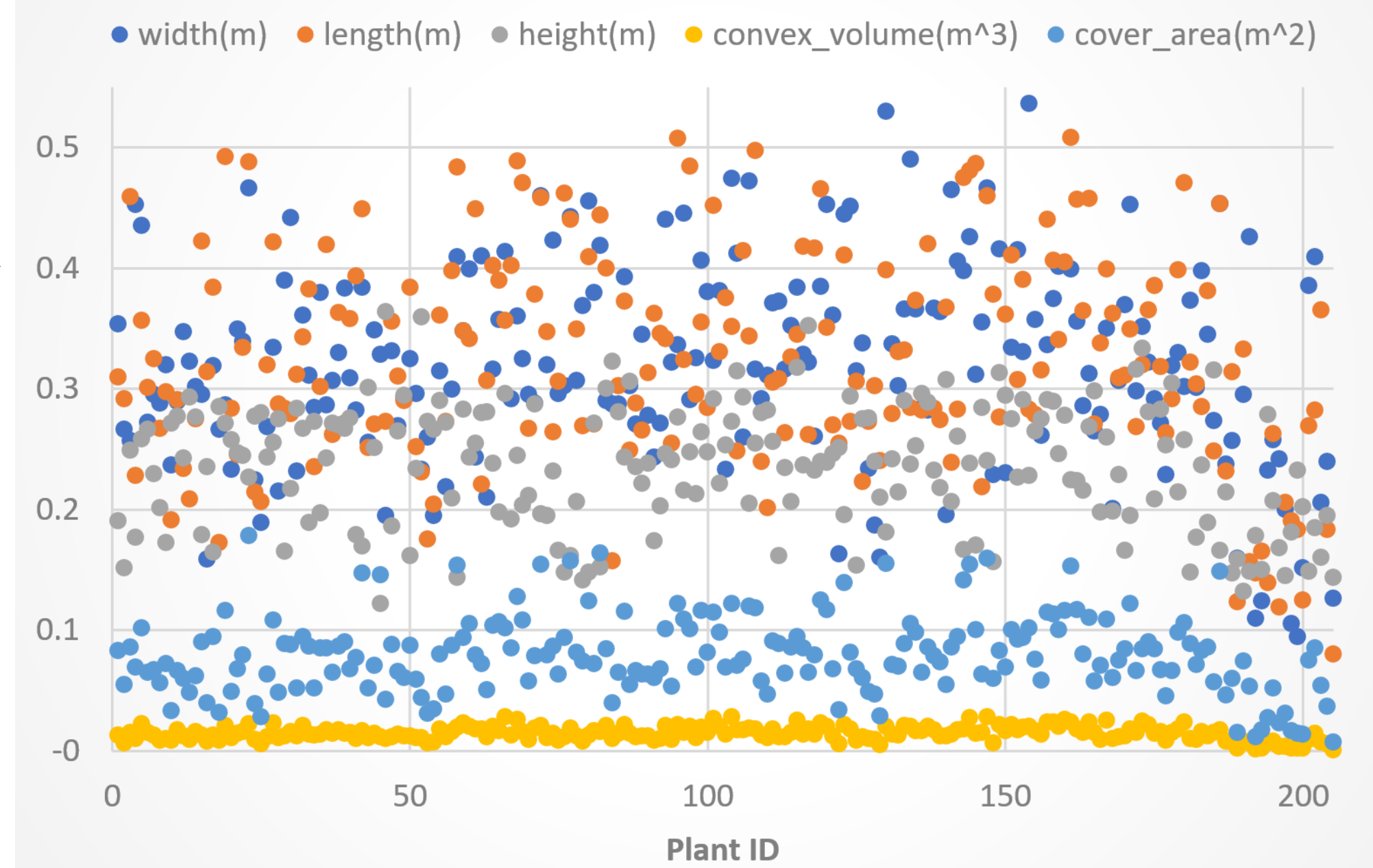


205 container plants, ~6 plants per photo set (36 photo sets)

~20 photos per image set



205 plants dimensional measurements



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