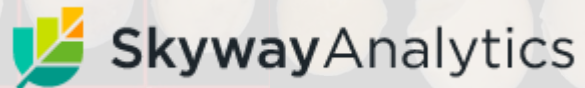


# Automating Visual Seed Inspections

with multispectral imaging

AOSA/SCST || June 12th, 2023





# Our Time

## Agenda

- Who We Are
- Challenges We Solve
- Technology
- Examples
- Q&A

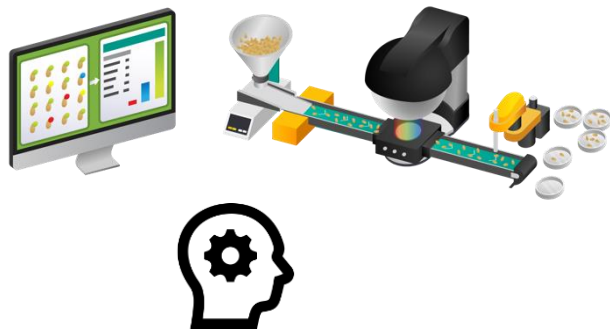
## Objectives

- ❑ Support AOSA/SCST mission
- ❑ Improve seed testing programs
- ❑ Feel inspired about the future
- ❑ Connect with collaborators



We help **agricultural** companies optimize **production and quality control** with **multispectral imaging technology**

## Technology



## Partnership



## 200+ papers





# Quick Poll

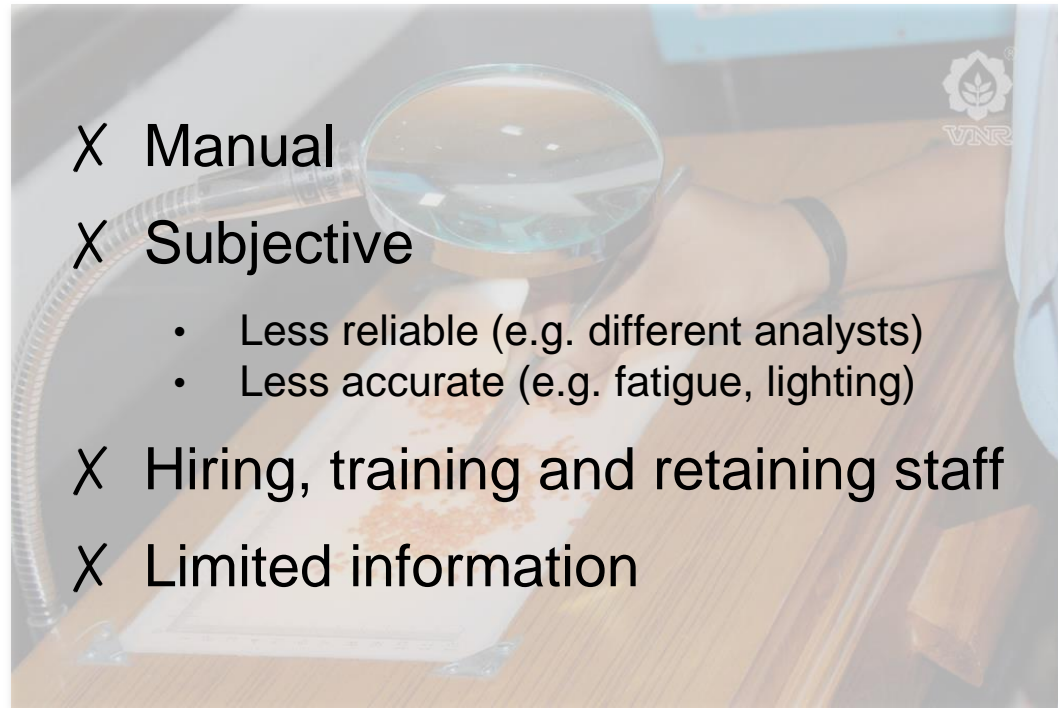


# Multispectral Imaging: **Seed Quality Assessment**

## Challenges



## Solutions













# What's possible?



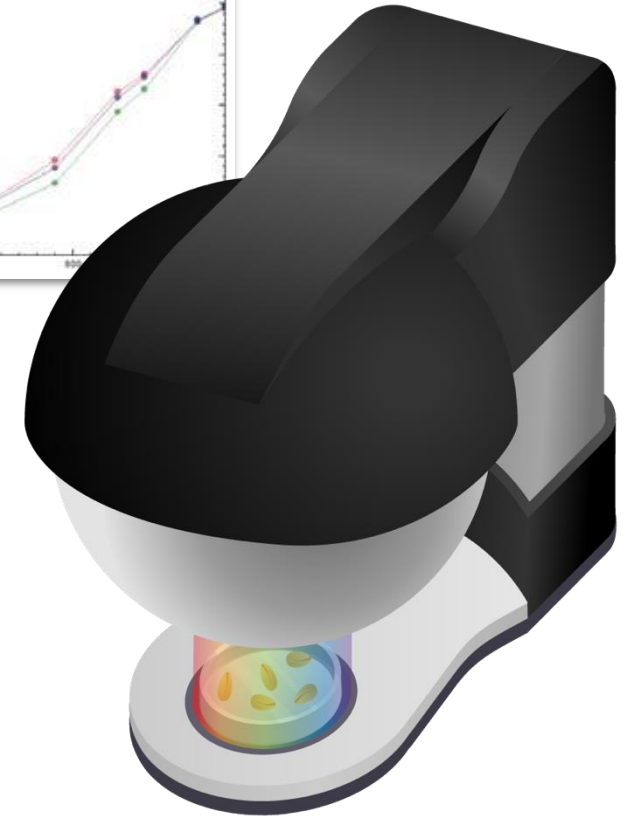
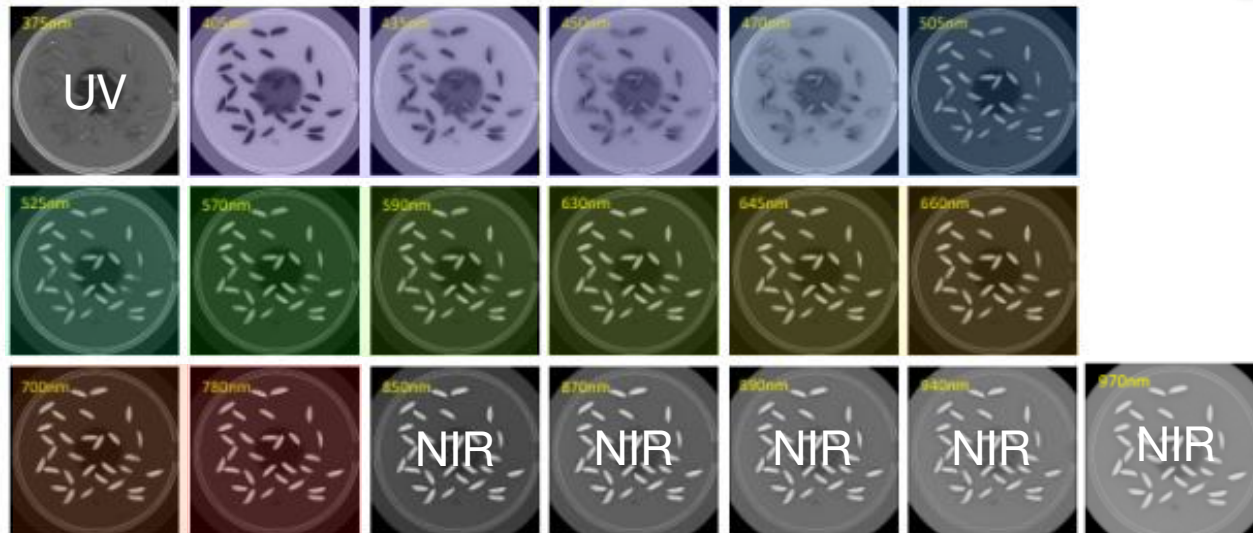
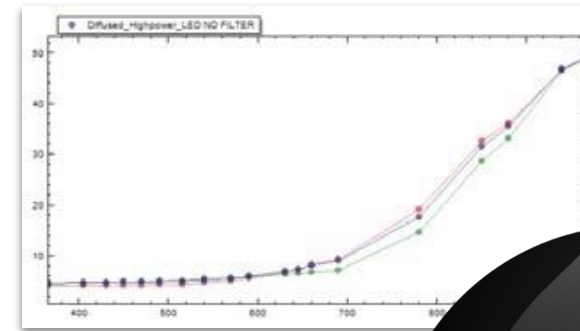
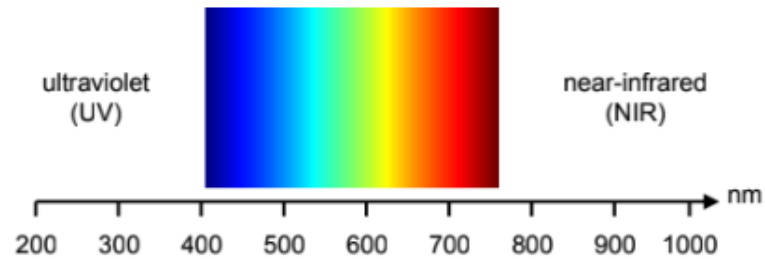
*Automated Corn Quality Inspection*

-  Genetics
  - ✓ **phenotyping, ploidy**, off-types
-  Technology
  - ✓ **coating**, pelleting, priming
-  Sowing
  - ✓ root and shoot, germ. & vigor prediction
-  Growing
  - ✓ phenotyping, stressors, resistance
-  Harvesting
  - ✓ maturity, preharvest sprout
-  Cleaning
  - ✓ **physical & genetic purity, damage, disease**
-  Refining
- 
  - ✓ milling, mixing, malting
- Custom





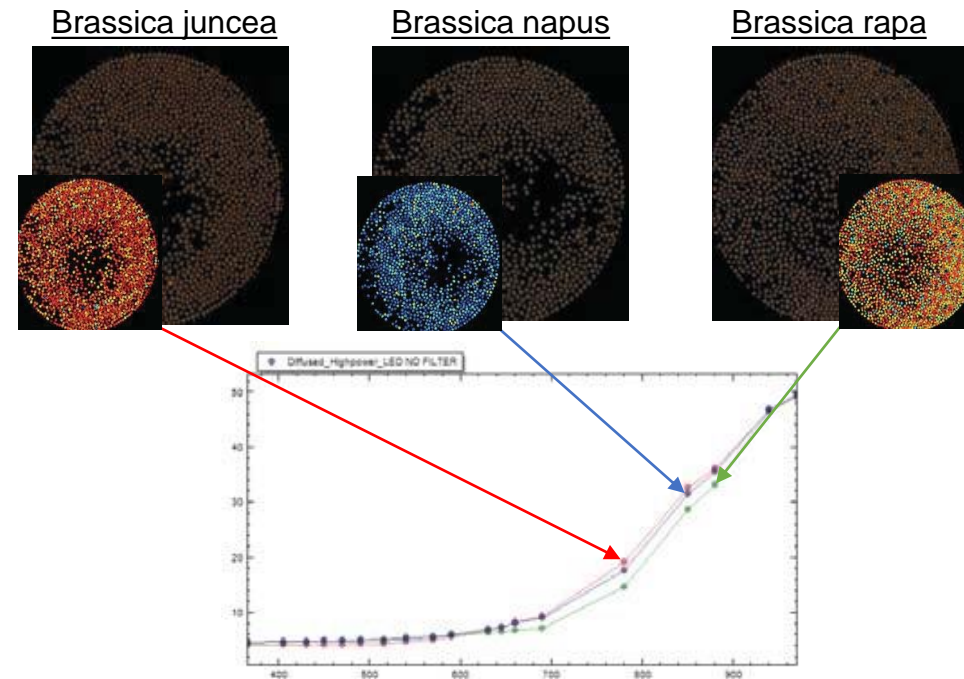
# How it Works: Captures Multispectral “Fingerprint”





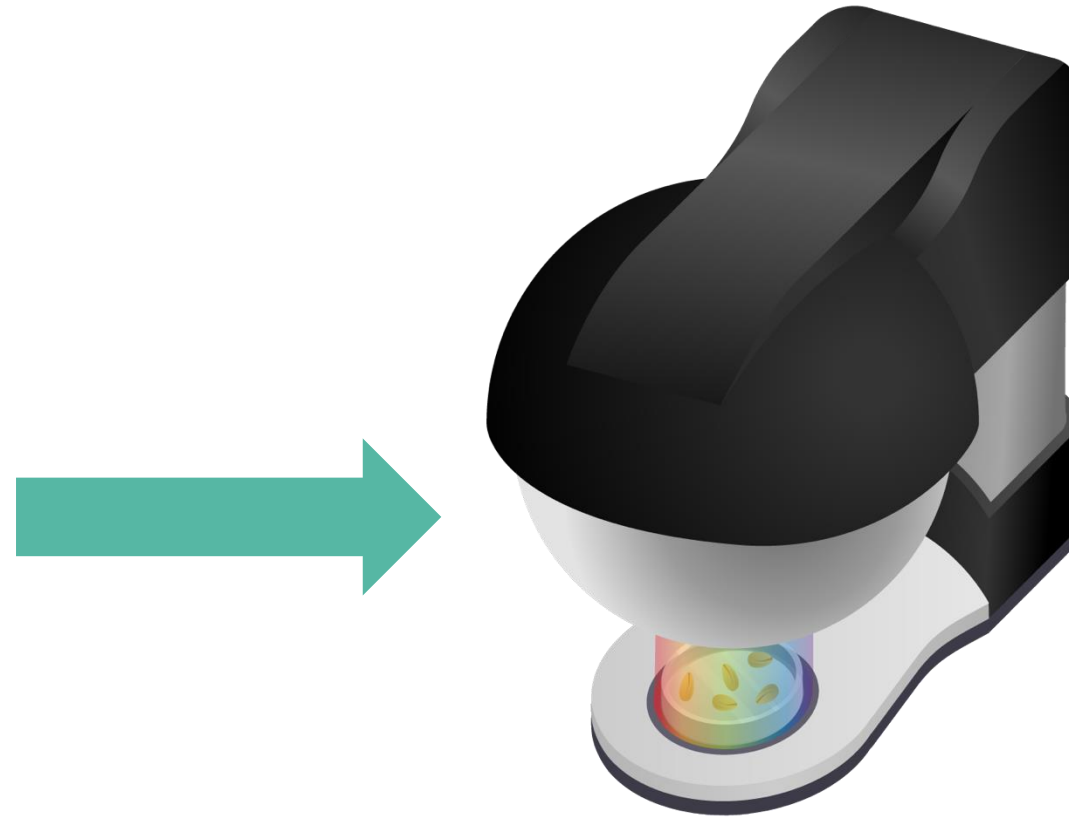
# How it Works: **Analyzes Wavelengths**

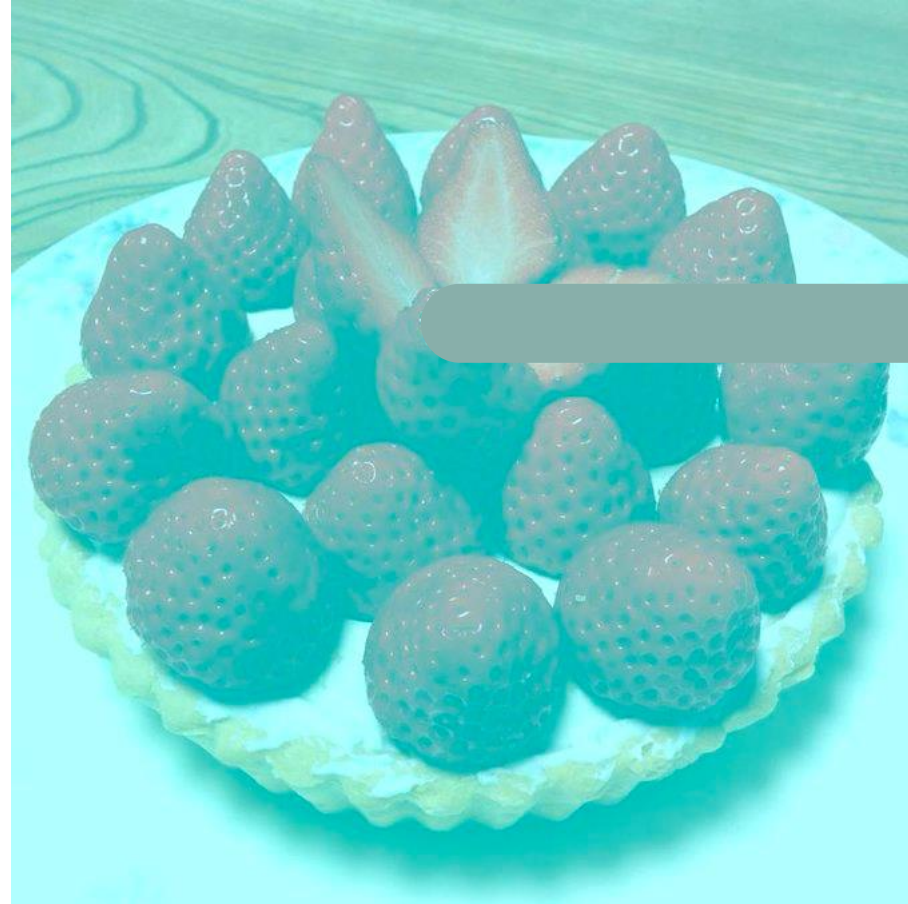
Isolates specific wavelengths that provide helpful quality information



(e.g. brassica species are visually similar but have separation in NIR)



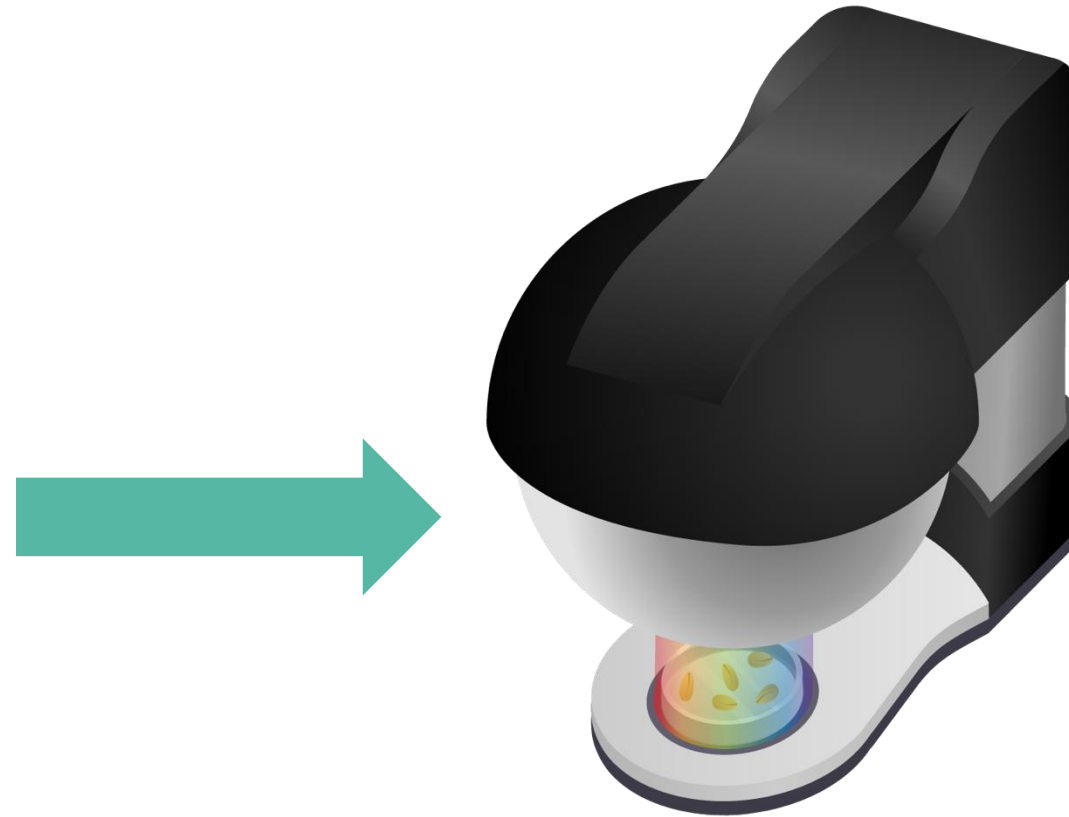














Raw  
Image  
Data

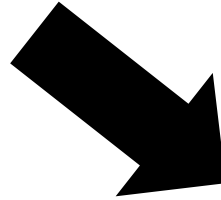
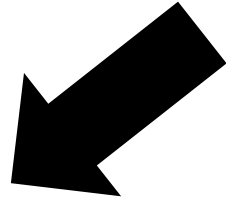
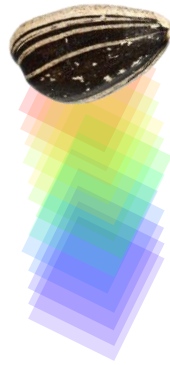






Raw  
Image  
Data





Standard Features

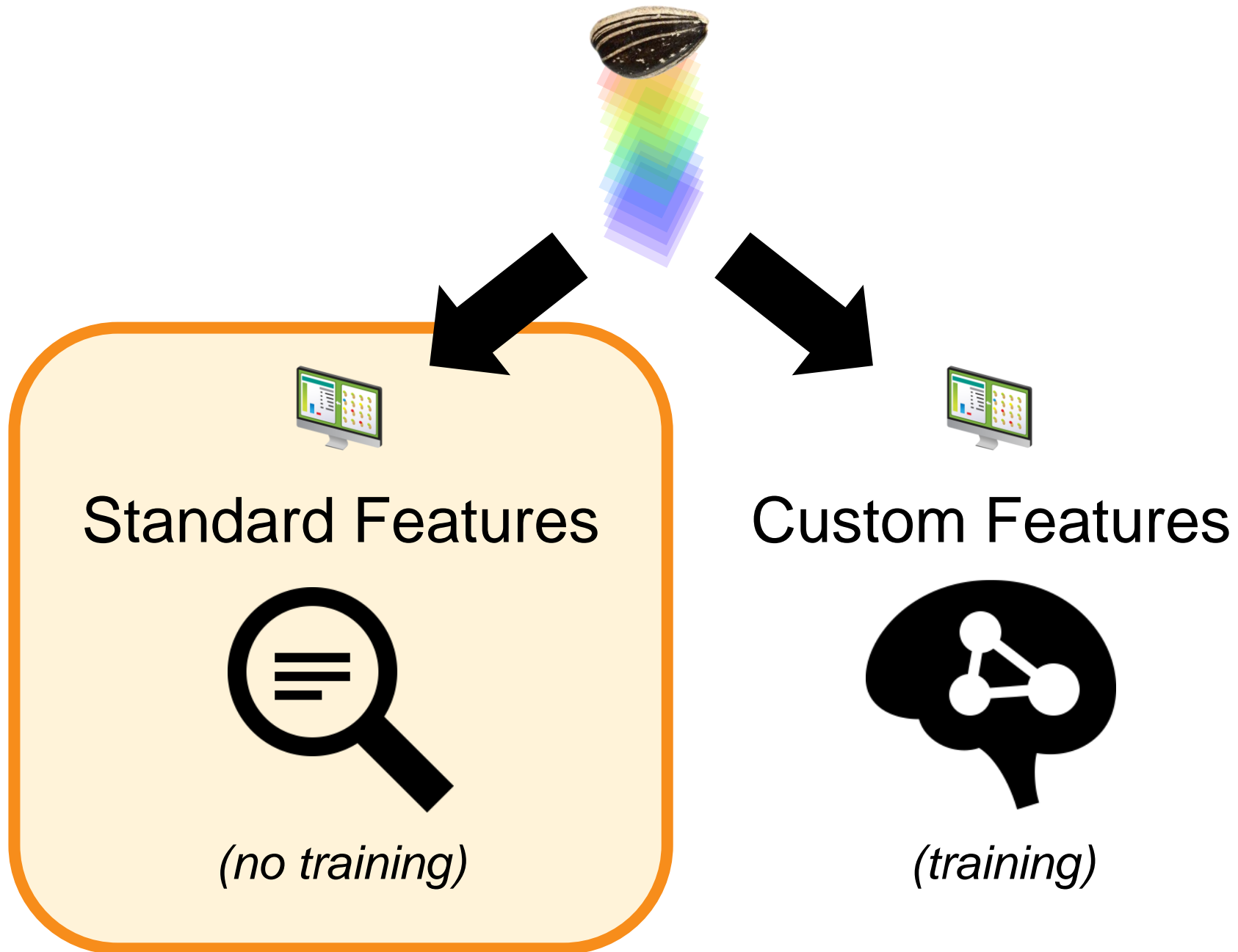
Custom Features



*(no training)*



*(training)*

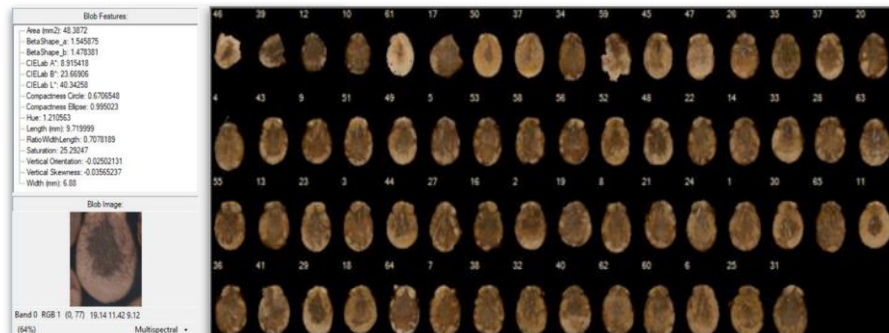
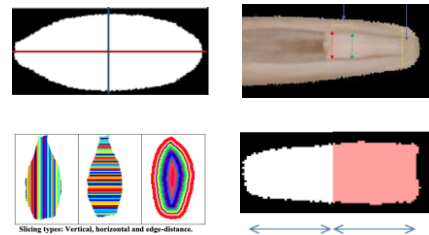




# How it Works: Standard Features

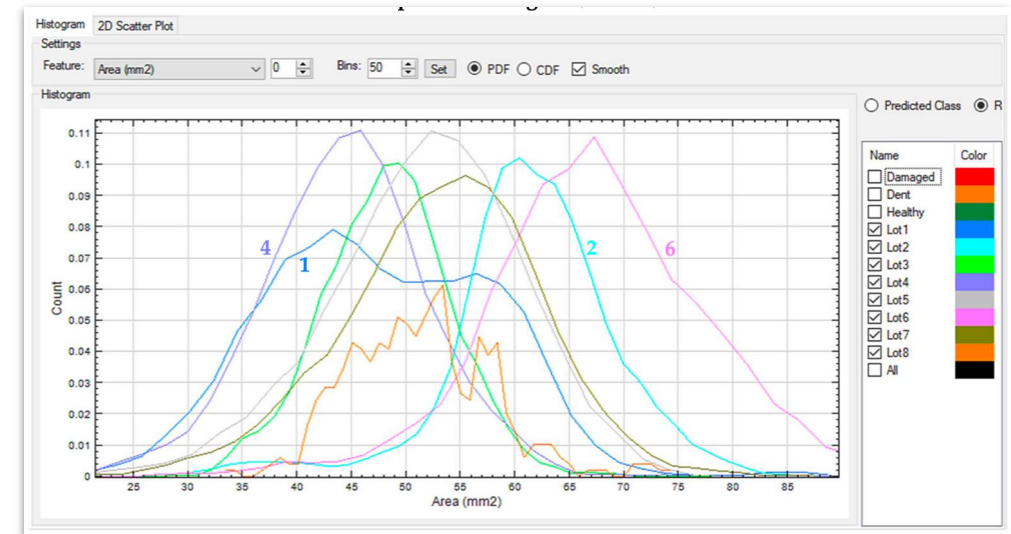
## 200+ measurements of each seed

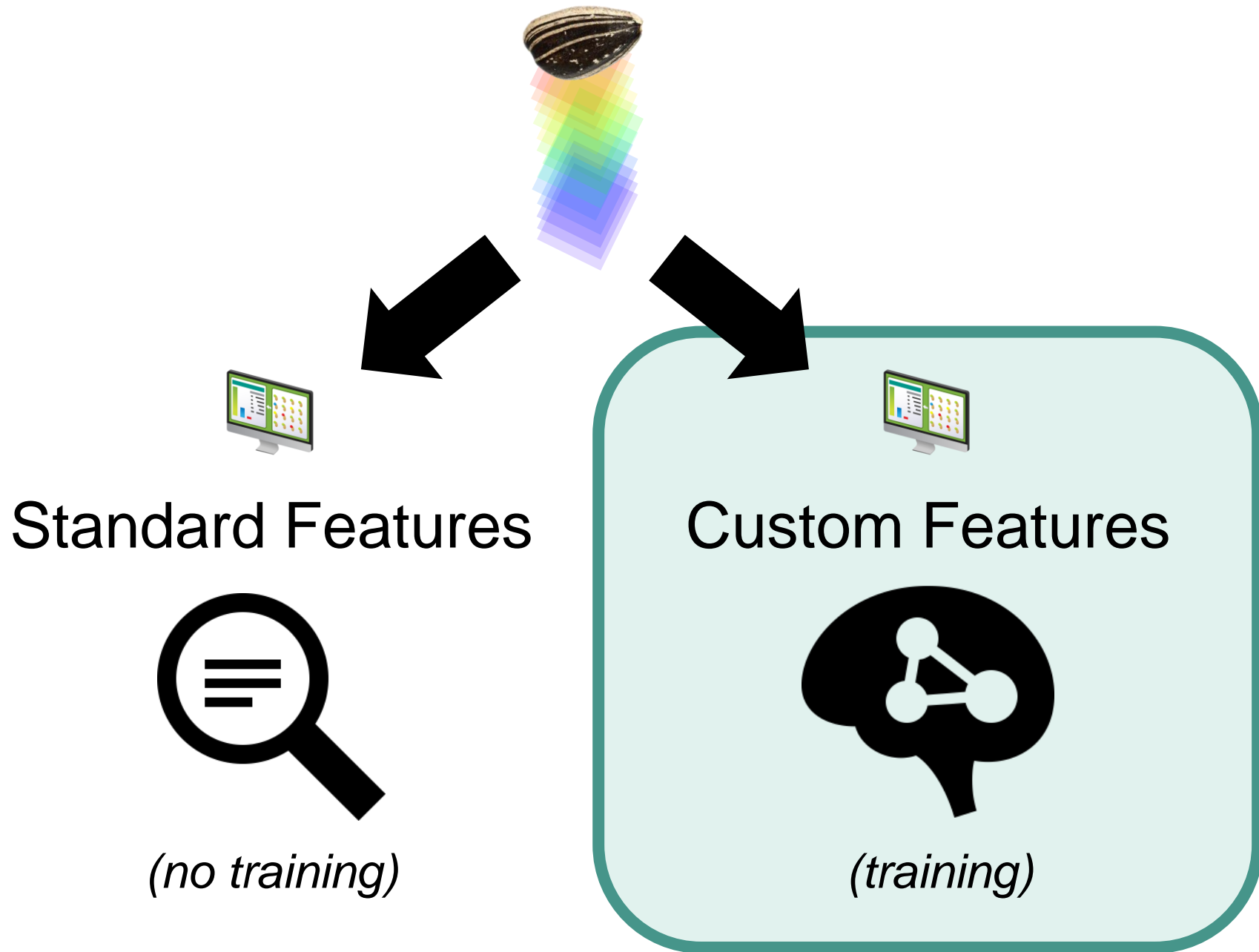
- Count
- Size
- Color
- Shape
- Texture



## Lot statistics

- Distributions





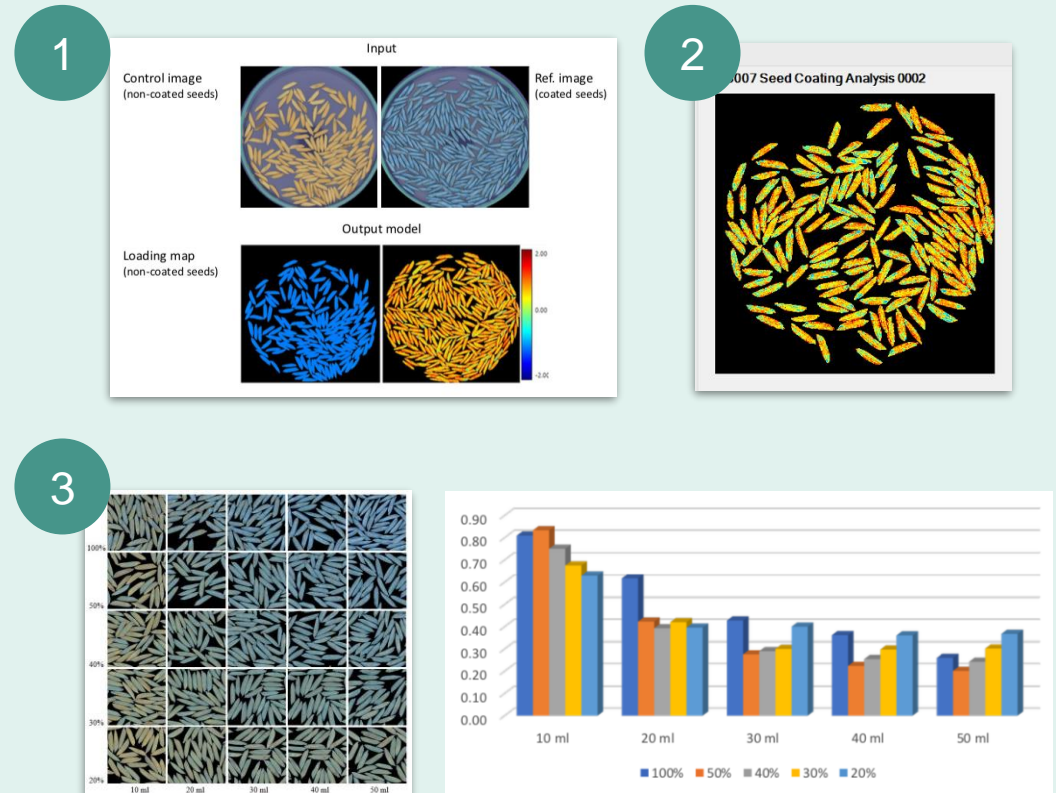


# How it Works: Custom Features

## Train software to quantify surface chemistry

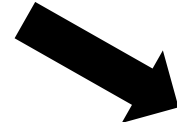
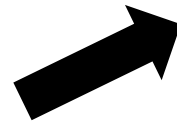
- **Physical purity** (crop, other, inert, weed)
- **Damage** (mechanical, insect, mold)
- **Health** (pathogens, mycotoxins)
- **Treatment** (coating, disinfection, pelleting)
- Germination & vigor prediction
- Early emergence, priming, preharvest sprouting

## Example: Treatment Uniformity





# Classify and Report



Standard Features



Custom Features



*Actionable  
information in CSV  
and PDF format*



# Once Trained, It Repeatedly Analyzes Granular Products the Same Way

Feeder Setting: Baseline

Class	Class Count	Class %	Area %
Total Count	505		
Healthy	57	11.3	10.9
Wrinkle	58	11.5	10.2
Crack	134	26.5	28.1
Green Seed	8	1.6	1.2
Mycrotoxin	248	49.1	49.5

Continue Stop

Flush Finish

Recipe: Corn 7 Classes-110919

Active Feeder Setting: Baseline

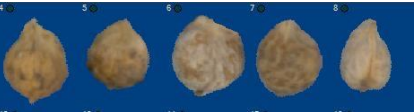
Class	Class Count	Class %	Area %
Total Count	266		
Healthy	136	51.1	51.1
Mycrotoxin	63	23.7	23.7
Multiple	0	0.0	0.0
Insect Damage	16	6.0	6.0
Broken	35	13.2	13.2
Inert matter	16	6.0	6.0
Coated	0	0.0	0.0

Continue Stop

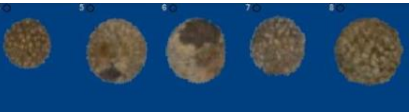
Flush Finish



# Physical Purity of Spinach Seed



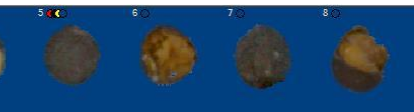
Spinach



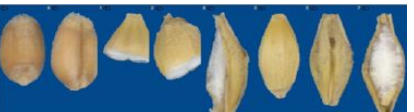
Cleavers



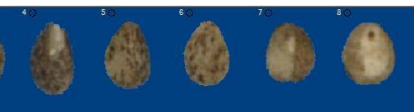
Radish



Rapeseed



Cereal



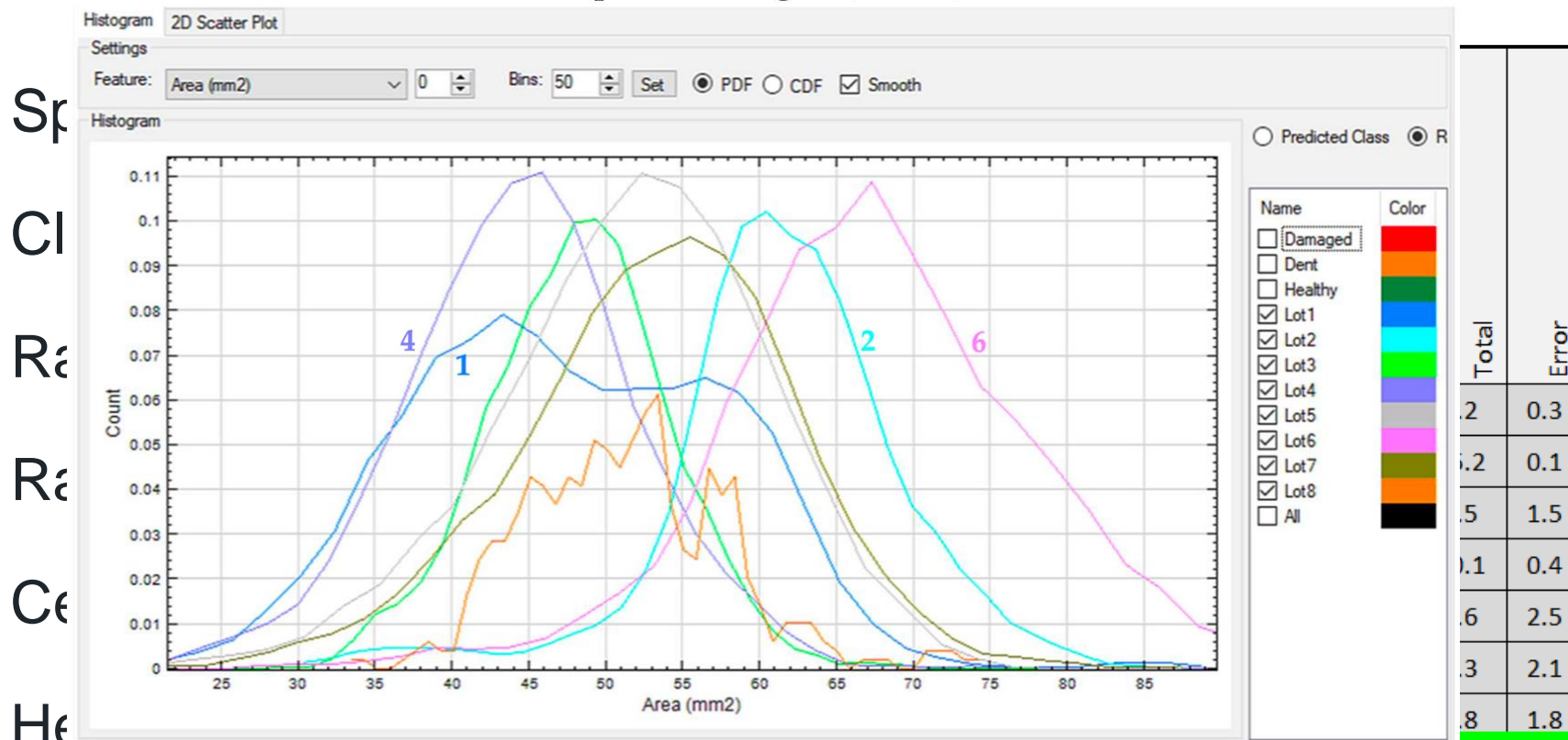
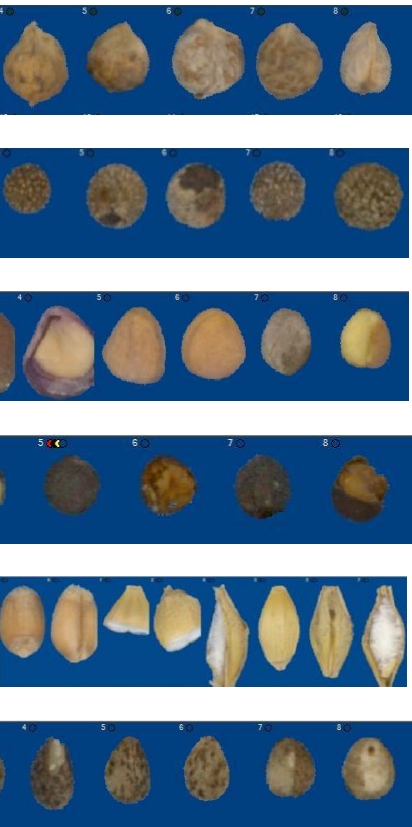
Hemp-nettle

Predicted \ Reference	Cereal	Spinach	Cleavers	Black bindweed	Radish	Rapeseed	Hemp-nettle	Total	Error
Cereal	99.7	0.3	0	0	0	0	0	1.2	0.3
Spinach	0	99.9	0.1	0	0	0	0	75.2	0.1
Cleavers	0	0.4	99.5	0.1	0	0.1	0	7.5	1.5
Black bindweed	0	0.3	0	99.7	0	0	0	10.1	0.4
Radish	0	1.8	0.5	0	97.6	0	0.1	2.6	2.5
Rapeseed	0	0.5	0.9	0	0.4	97.9	0.4	2.3	2.1
Hemp-nettle	0	0.5	0.2	0	0.2	0.9	98.2	0.8	1.8
Total	1.2	75.3	7.5	10.1	2.5	2.2	0.8	57115	
Error	0	0.2	1.6	0.3	0.7	1.2	3.2		0.4

**99.6% model accuracy**



# Physical Purity of Spinach Seed



Total	1.2	75.3	7.5	10.1	2.5	2.2	0.8	57115	
Error	0	0.2	1.6	0.3	0.7	1.2	3.2		0.4

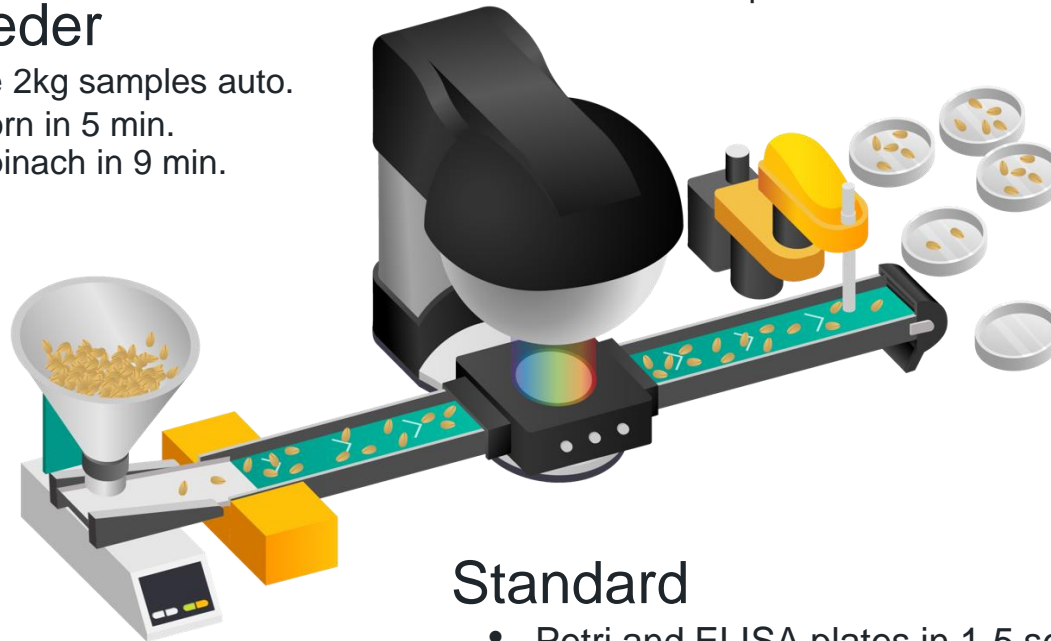
**99.6% model accuracy**



# Workflow

## AutoFeeder

- Analyze 2kg samples auto.
- 300g corn in 5 min.
- 100g spinach in 9 min.

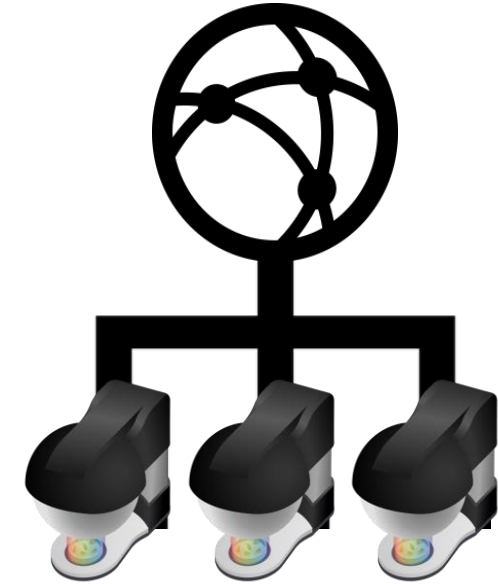


## SeedLab Robot

- Picking (purity and other custom features)
- Prepare weighing or destructive tests
- 120 picks in 1 min.

## Standard

- Petri and ELISA plates in 1-5 seconds



## Cloud Services

- Standardize across locations
- Share data and information
- CSV, PDF, and API data output









# Thank you

taylor@getskywayanalytics.com

(720) 616-1044



# How We Solve Challenges

