Image Analysis & Machine Learning
for Plants in EcoFABs

BERKELEY LAB

What is image analysis?

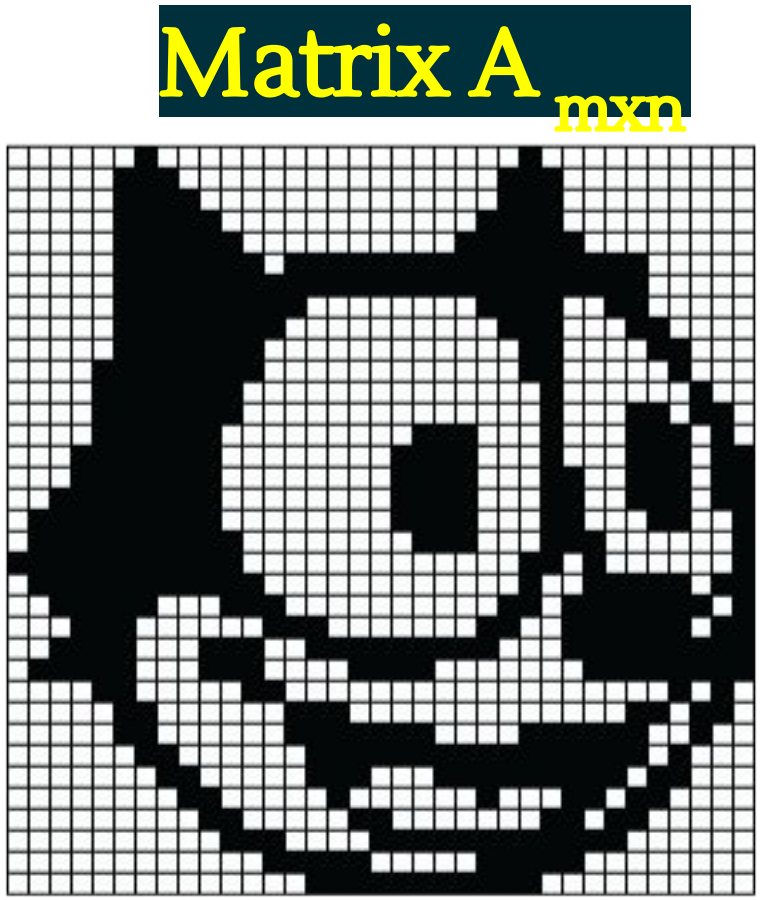
- **Digital image analysis** involves the application of matrix operations and linear algebra techniques to manipulate, process, and analyze visual data represented as matrices. Computer vision transform matrices into insights.
- **Goal**: extract information from images, such as identifying patterns, measuring objects, or detecting changes, which can be used in various applications like medical imaging, remote sensing, and robotic vision.

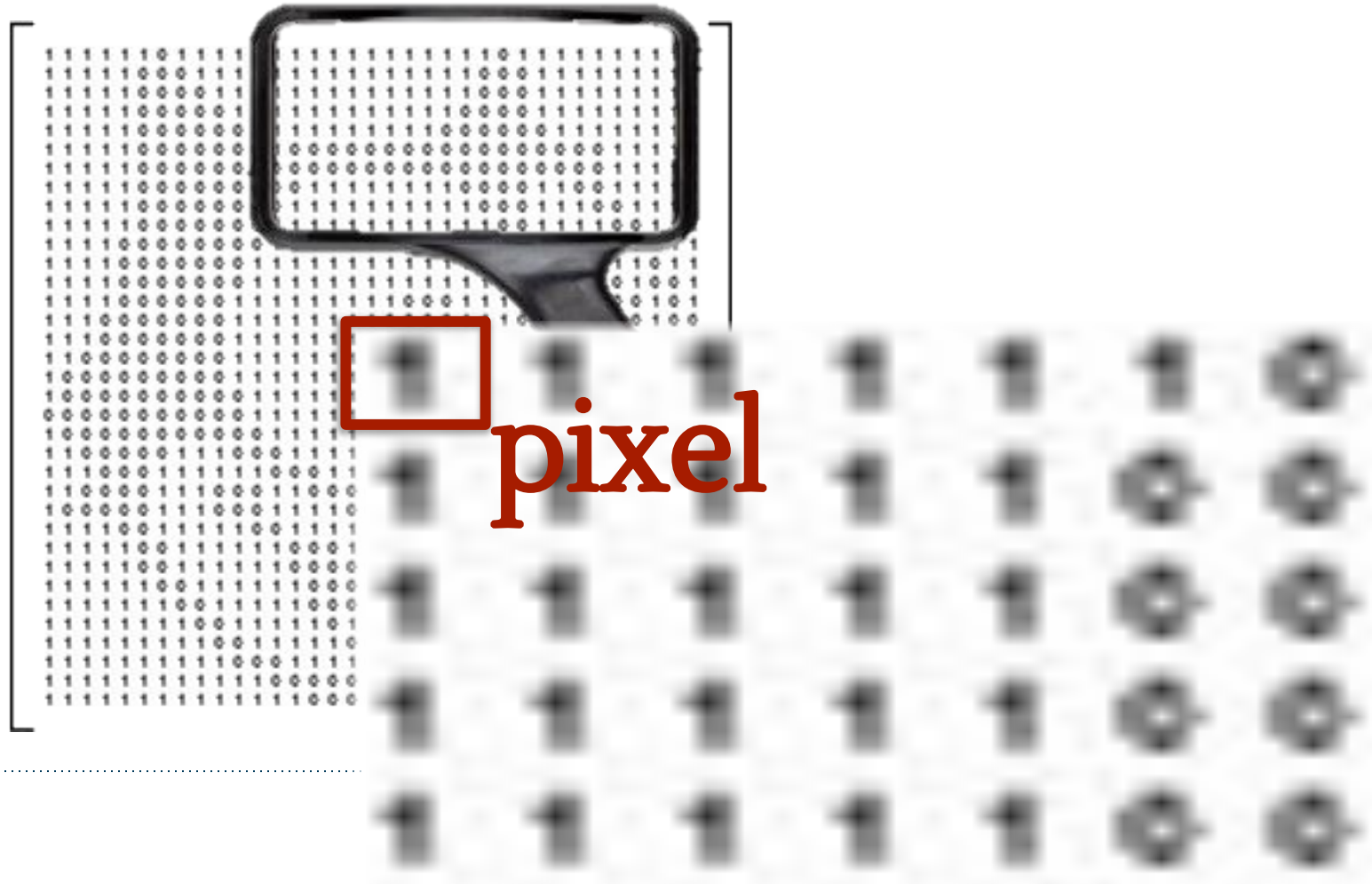
ML

- Classification of a picture: Is it an animal or a vehicle?
- Segmentation of a picture: What is the area of this object?

What is an image?

- Image is just a matrix of pixels





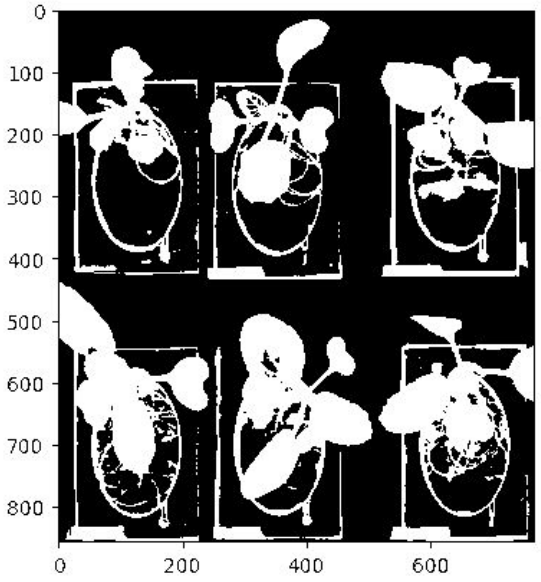
Flavors of image

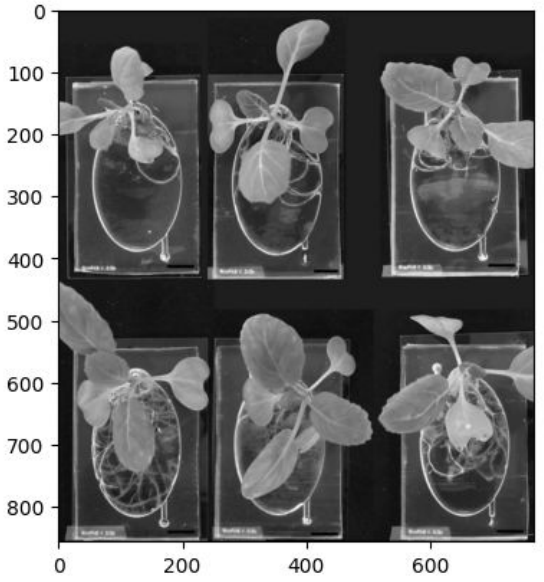
- Depends on the content of the cell matrix

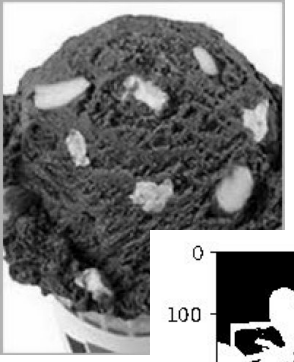
binary

grayscale

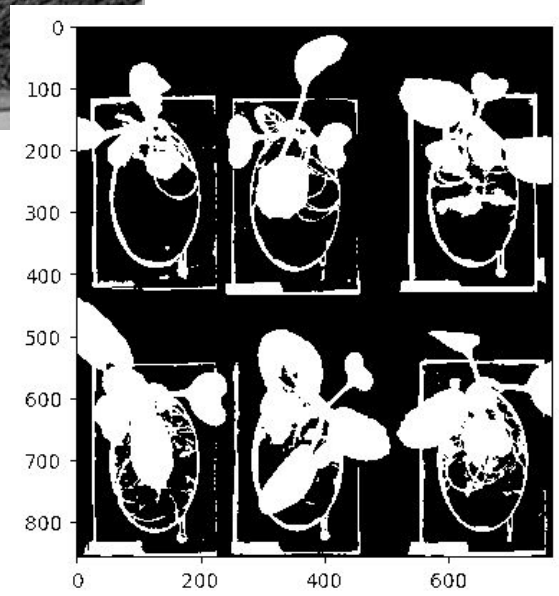
color







Binary



Only two possible values (*bi-*), zero and one;

Aka black-and-white, B&W, monochrome or monochromatic;

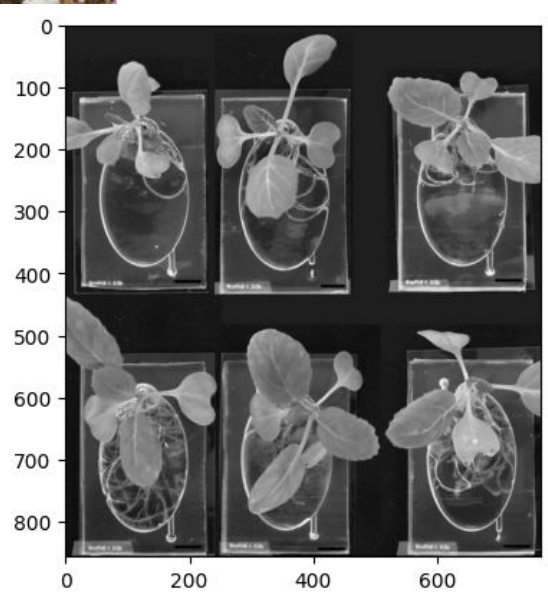
Each pixel needs 1 bit to hold this information;

- Pixel depth = 1;
- Question: How many unique possible intensities?

Applications:

- OCR;
- Forensics: fingerprints.

Grayscale



- Same as binary, it uses only one *m x n* matrix;

- Different from binary, each pixel needs 2+ bits to hold different shades of gray;

- Question: how many intensities if 5 bits?
- Common number of bits: 8, 16, 24, 32

- You can use grayscale images to obtain the binary image:

- Image histogram
- Knowledge-based models
- ML

Histogram

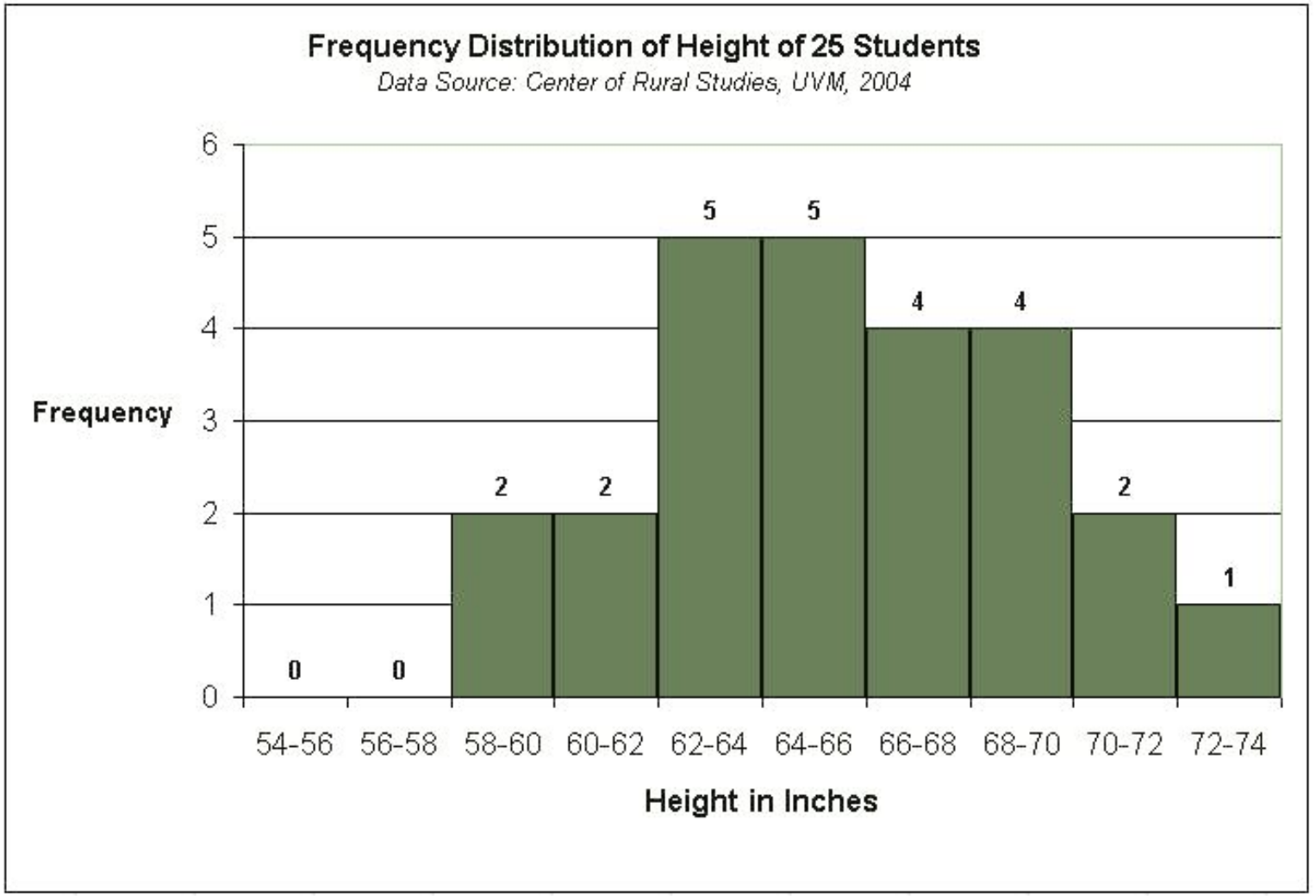
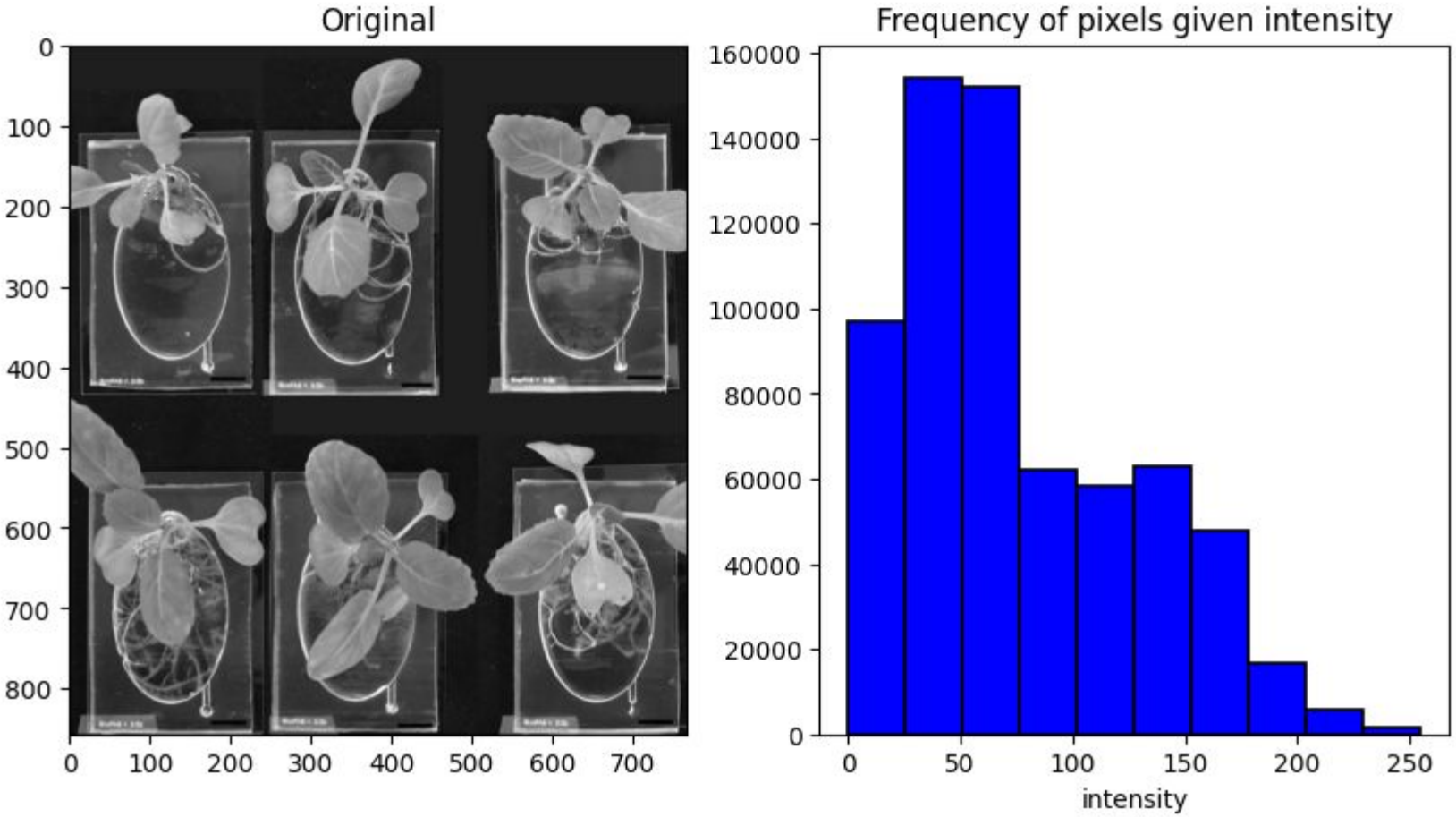
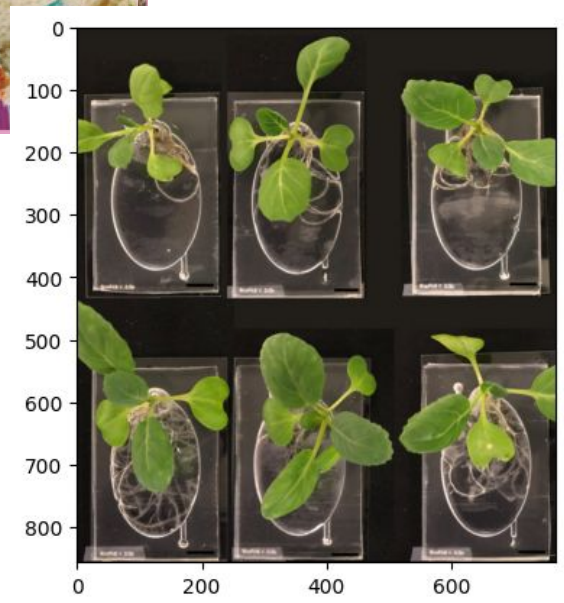

Frequency Distribution of Height of 25 Students
Data Source: Center of Rural Studies, UVM, 2004
Frequency
0
1
2
3
4
5
6
0
0
2
2
5
5
4
4
2
1
54-56
56-58
58-60
60-62
62-64
64-66
66-68
68-70
70-72
72-74
Height in Inches

Image Histogram



Color



Same as binary and grayscale, it uses *m x n* matrices, but instead…

How would you represent a color pixel?

… we need a triplet to code a color pixel, therefore dimension is *m x n x 3*;

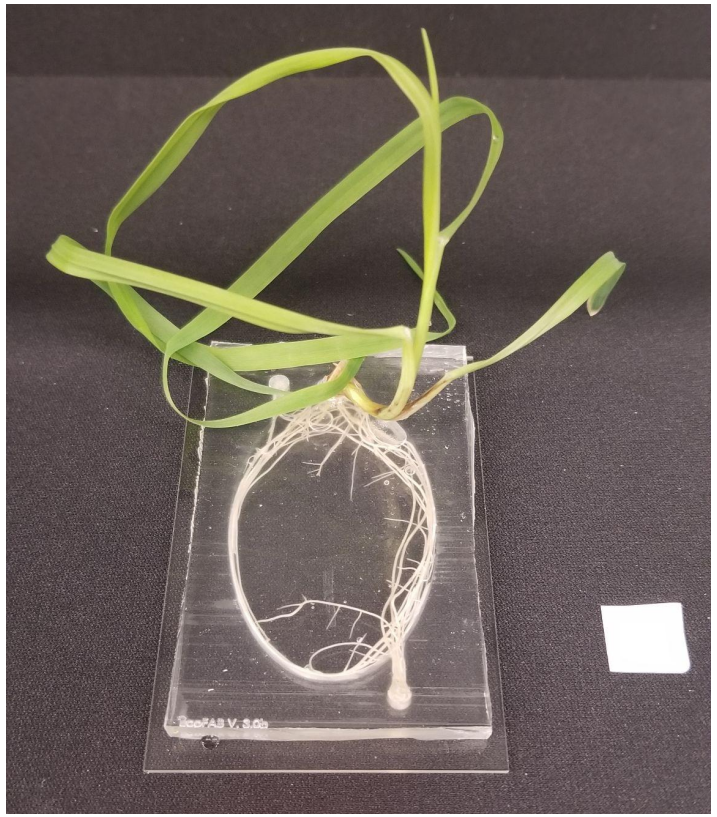
The image on the left is constructed by combining 3 matrices (aka channels):

- Red, Green, Blue

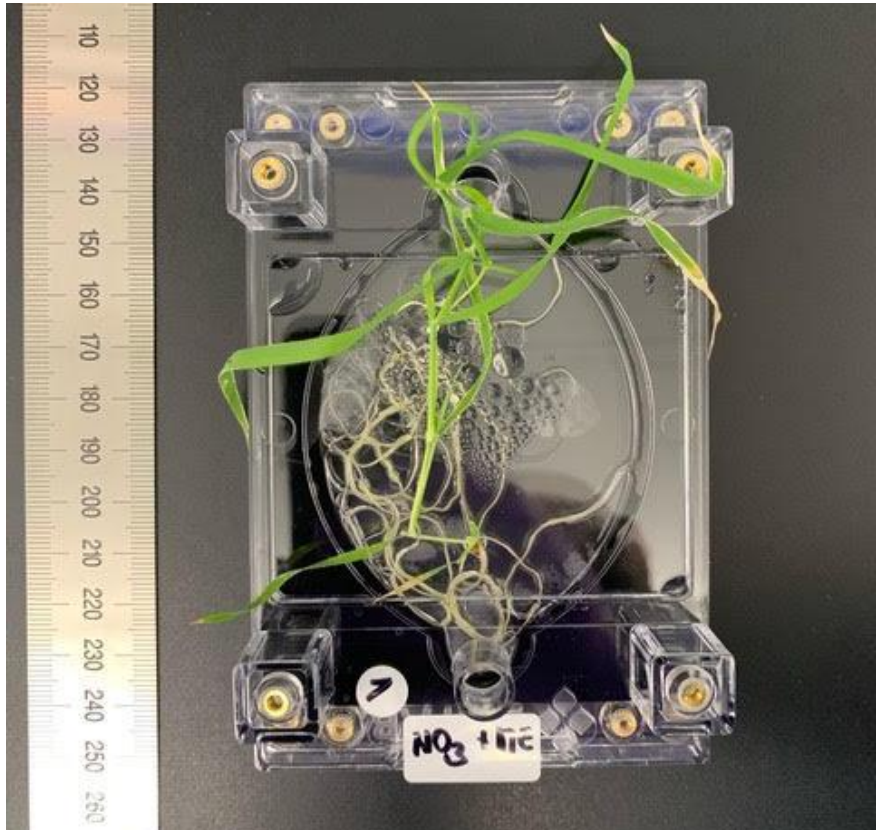
EcoFABs: Ecosystem Fabrication

Controlled laboratory ecosystems for studying plant-microbe interactions

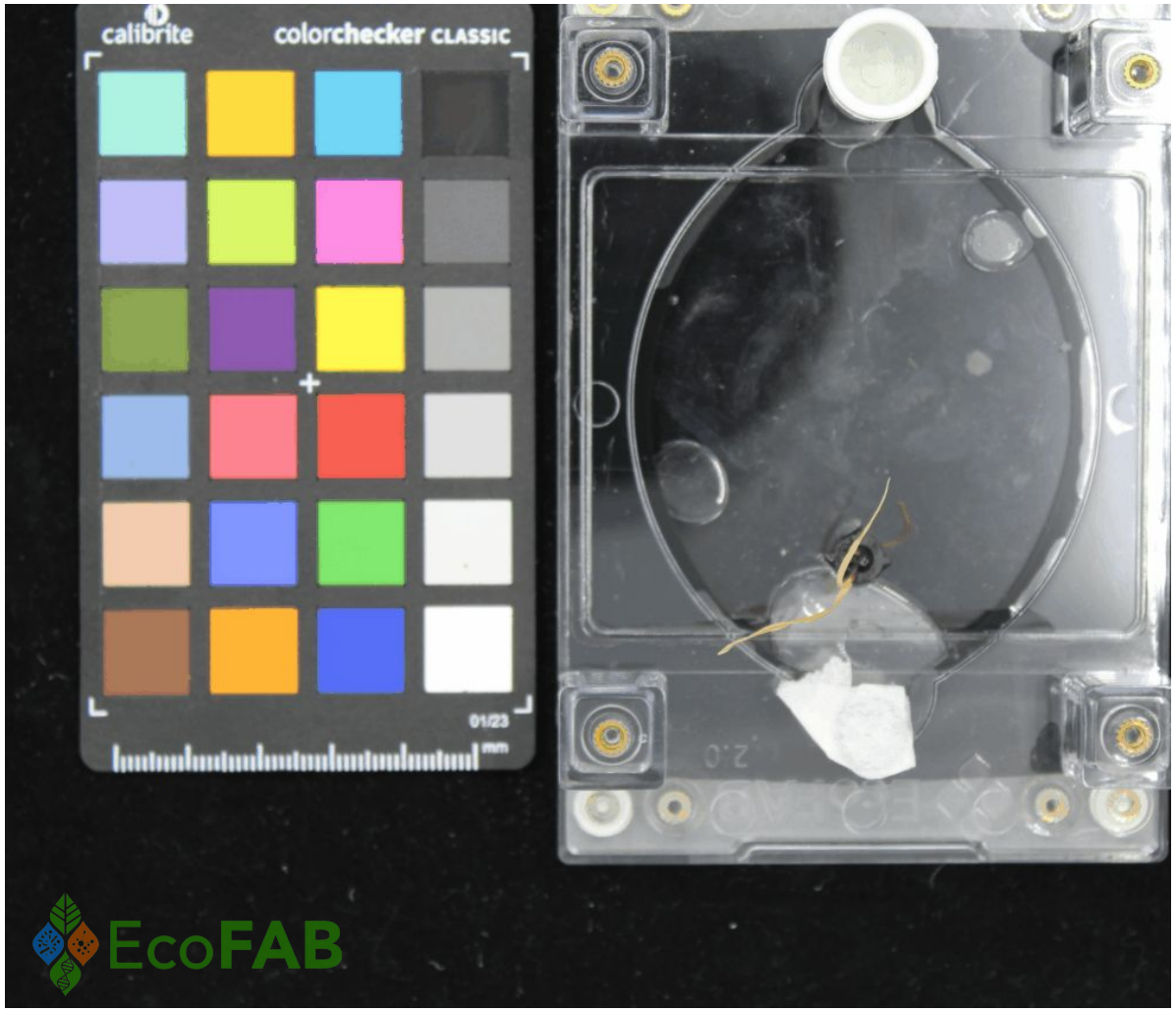
EcoFAB version 1.0



EcoFAB version 2.0



Hands-on



Google colab: https://colab.research.google.com/drive/1OkoYEVa7O3jA8oLcLIXDeX5pSRPTef2d#scrollTo=QB3UPlBcKb51

Requires a gmail account.

SCAN ME