Understanding plant vulnerability to stressors with automated image analysis

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THE ISSUE

In plant biology, the **manual scrutiny** of **visible symptoms** of stress can be:

- **challenging**
- **time-consuming**
- **error-prone**

THE GOAL

Train a machine learning algorithm to **automatically detect** plant stress levels based on **morpho-physiological data** with a sufficient level of **accuracy** (> 0.7)

THE APPROACH

1. Feature extraction

NaCl solution

50 mM 150 mM

A. thaliana

200 mM

P. vulgaris

100 mM

P. sativum

NON-DESTRUCTIVE

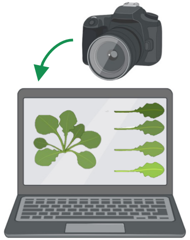
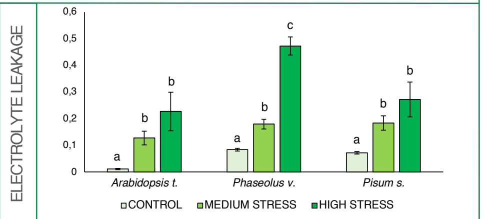


image analysis
(manual + automated)

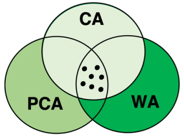
DESTRUCTIVE

1. ELECTROLYTE LEAKAGE
2. FRESH + DRY WEIGHT
3. RELATIVE WATER CONTENT

2. Data visualization



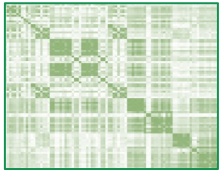
3. Feature selection



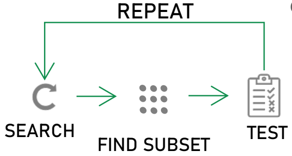
a. Principal Component Analysis
b. Correlation Analysis
c. Wrapper Algorithm

a.

b.



c.



THE OUTCOMES

4. Classification models

2-CLASS (A): NO, YES

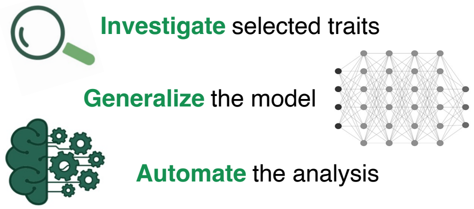
3-CLASS (B): NO, MEDIUM, HIGH

	FULL DATASET	SELECTED FEATURES		IMPROVEMENT
MODEL A stress presence	**83,3%** accuracy (n=89)	**96,7%** accuracy (n=3)	Random Forest	**+ 16%**
MODEL B stress level	**73,3%** accuracy (n=89)	**90%** accuracy (n=4)	Random Forest	**+ 17%**

KEY RESULTS

- Creation of a **dataset** for salt-stressed species and selection of **functional traits** with high predictive power in terms of stress detection
- Best performance of the models using the full dataset, but **sufficient accuracy** was obtained even when considering **only** automatic **image-derived traits** (0.68)

WHAT'S NEXT ?



Investigate selected traits

Generalize the model

Automate the analysis