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Palacký University Olomouc

AI-Driven Plant Sensing

Jan Zdražil, 26.03.2025

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- AMULET

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Problems for AI in Plant Science

- **Data Variability:** Inconsistent data due to diverse sources and conditions
- **Data Scarcity:** Lack of high quality, labelled datasets
- **Environmental Control:** Requires precise control of all factors
- **Resource intensive:** Expensive to create and maintain controlled env.
- **Multimodal Data:** Need to integrating various data types

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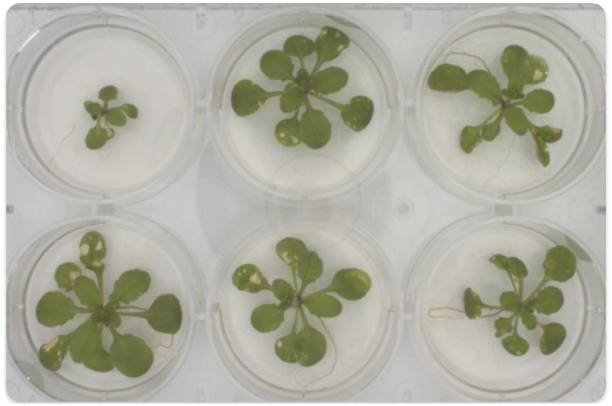
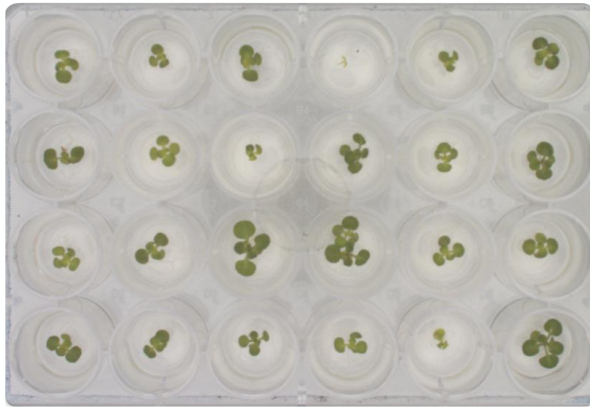
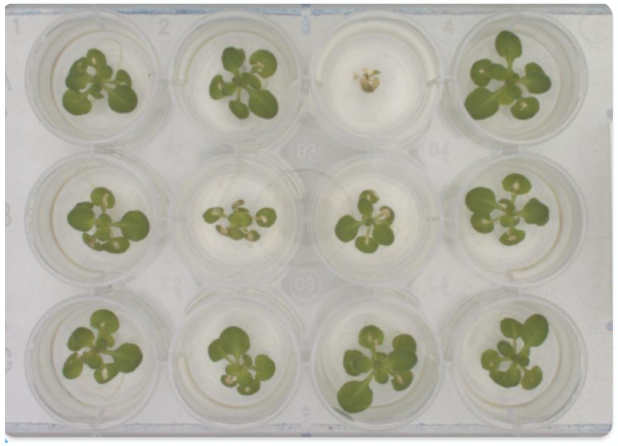
Data Gathering & processing

6x Plate

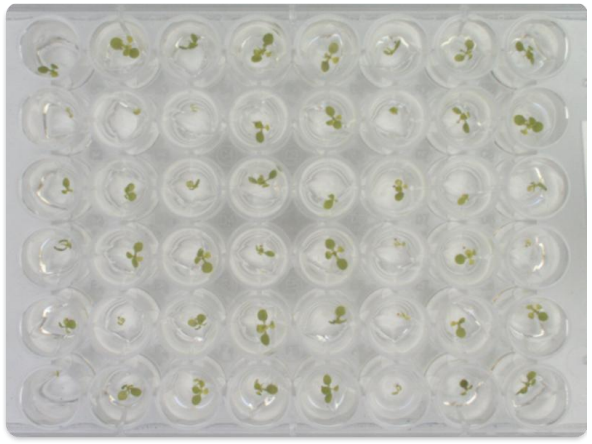


24x Plate





12x Plate



48x Plate

Tabular data

AREA_PX	PERIMETER	ROUDNESS	RMS	SOL
21372	1638	0.112	0.353	14.8
20878	1924	0.098	0.489	24.8
30829	1689	0.199	0.612	11.6

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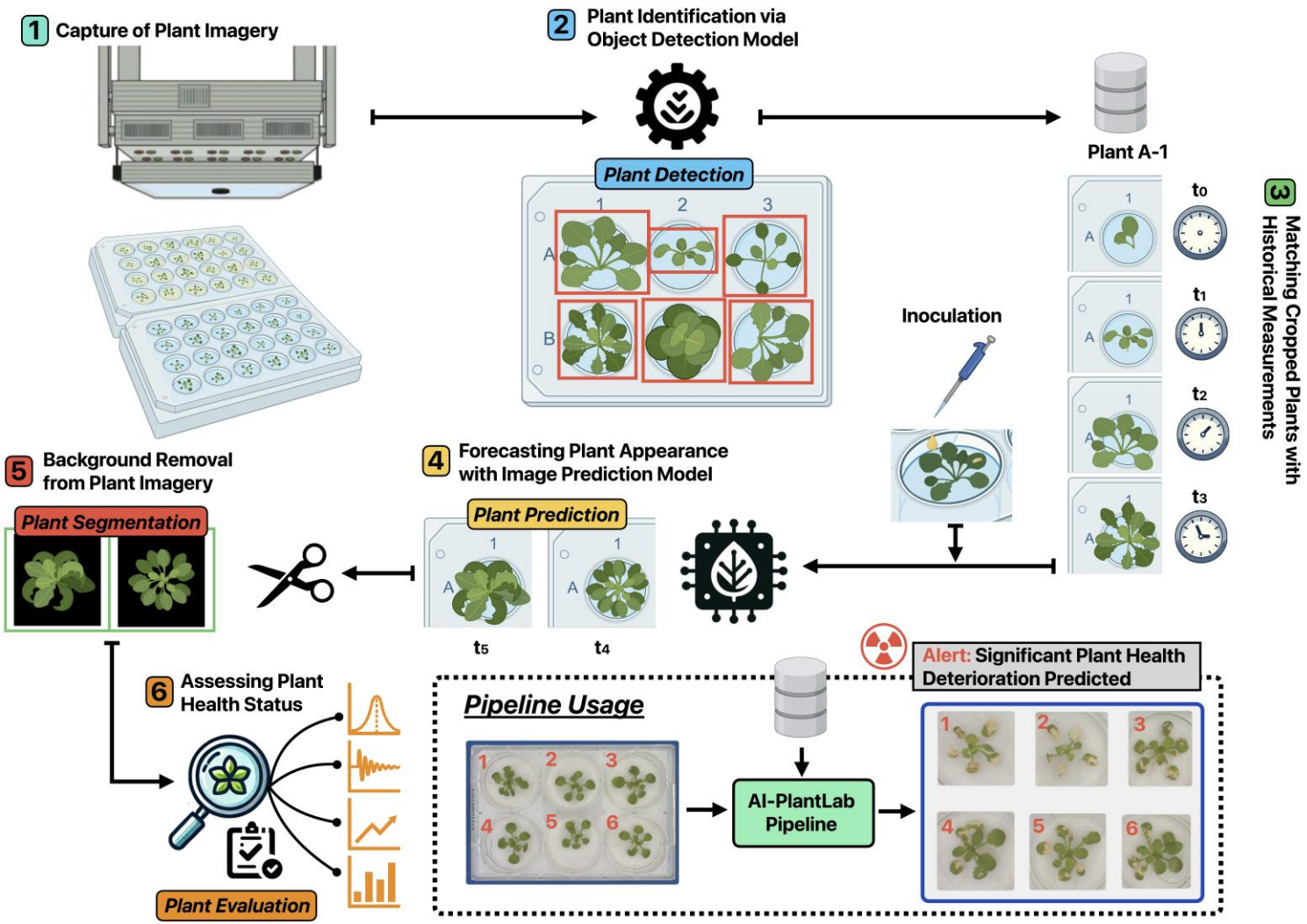
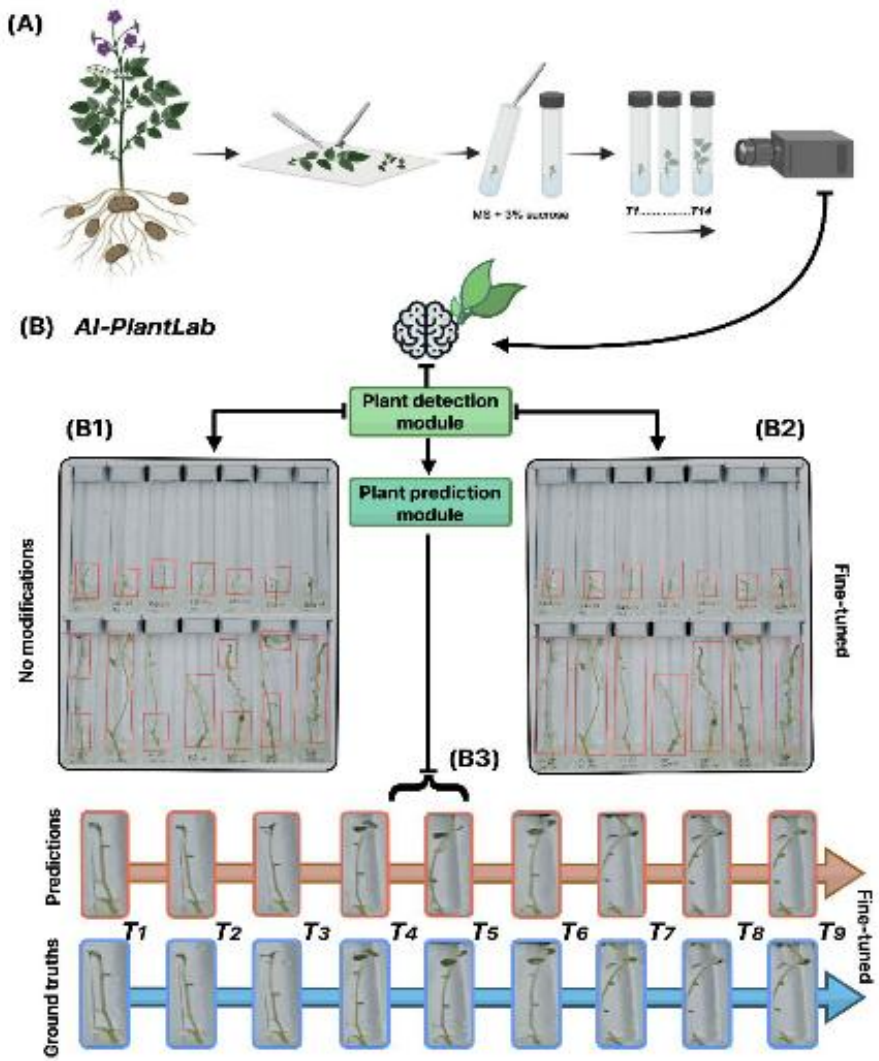
AMULET





Adaptable and **MU**lti-task machine **L**earning for **E**ndless phenotyping **T**rait prediction

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Pipeline Outputs

Object Detection

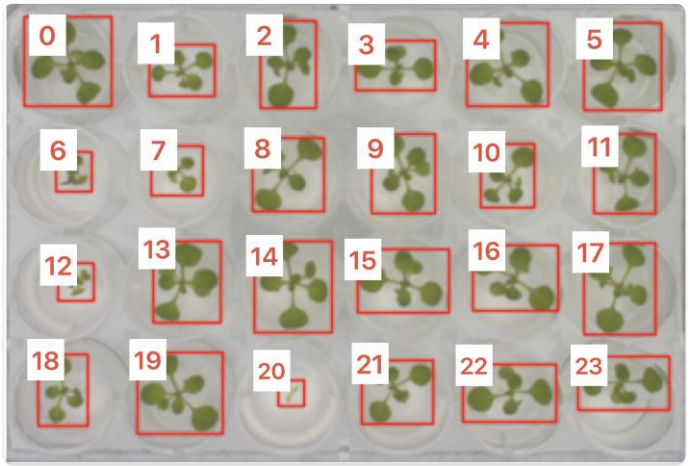


Image Segmentation

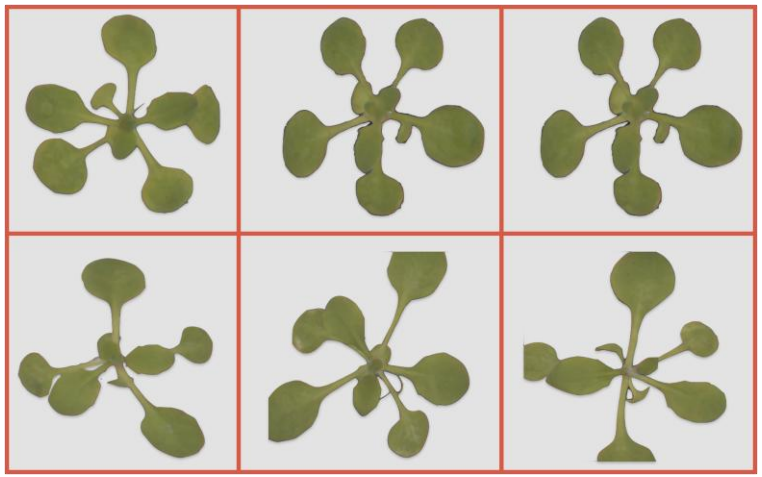
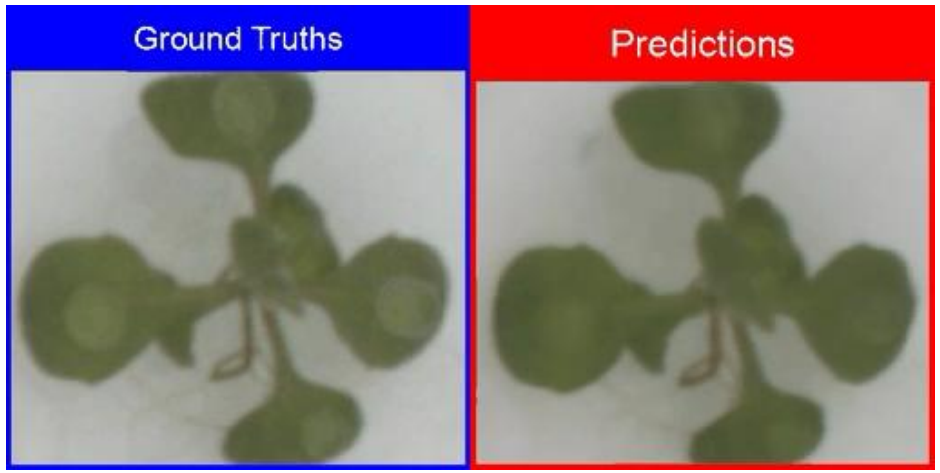


Image Prediciton



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Summary

Plant Detection

Status	Image Count	Plate Type	Foil Presence	Est. num. of plants
Infected	387	6	✗	2322
Infected	235	12	✓	2820
infected	259	24	✓	6216
Non-infected	42	24	✗	1008
Non-infected	840	24	✓	20160
		Estimated plant ∑32526		

Plant Prediciton

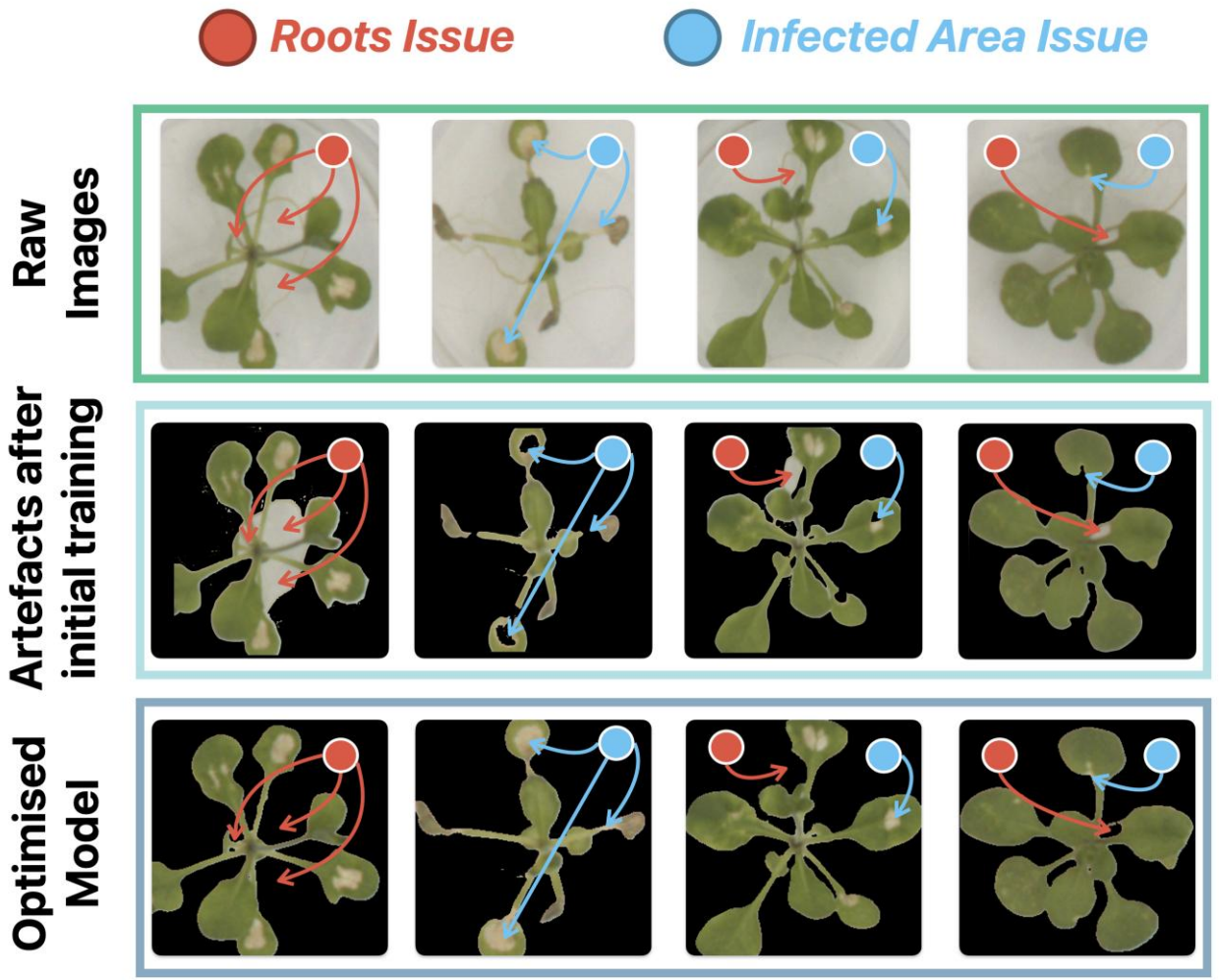
Status	Image Count	Plate Type	Time Step [h]	Est. num. of plants
Infected	32	6	0	192
Infected	32	6	3	192
Infected	32	6	6	192
Infected	32	6	9	192
Infected	32	6	12	192
Infected	32	6	24	192
Non-infected	60	6	0	360
Non-infected	60	6	3	360
Non-infected	60	6	6	360
Non-infected	60	6	9	360
Non-infected	60	6	12	360
Non-infected	60	6	24	360
		Estimated plant ∑3312		

Plant Segmentation

Status	Num. of Plants	Manually labeled	Labeled by model	Verified
Infected	2298	✓	✗	✓
Non-infected	1008	✓	✗	✓
Infected	546	✗	✓	✓
Non-infected	545	✗	✓	✓
		Estimated plant ∑4397		

Plant Evaluation

Status	Num. of Plants	Manually labeled	Verfied	Statistic
Infected	2298	✓	✓	See fig S1



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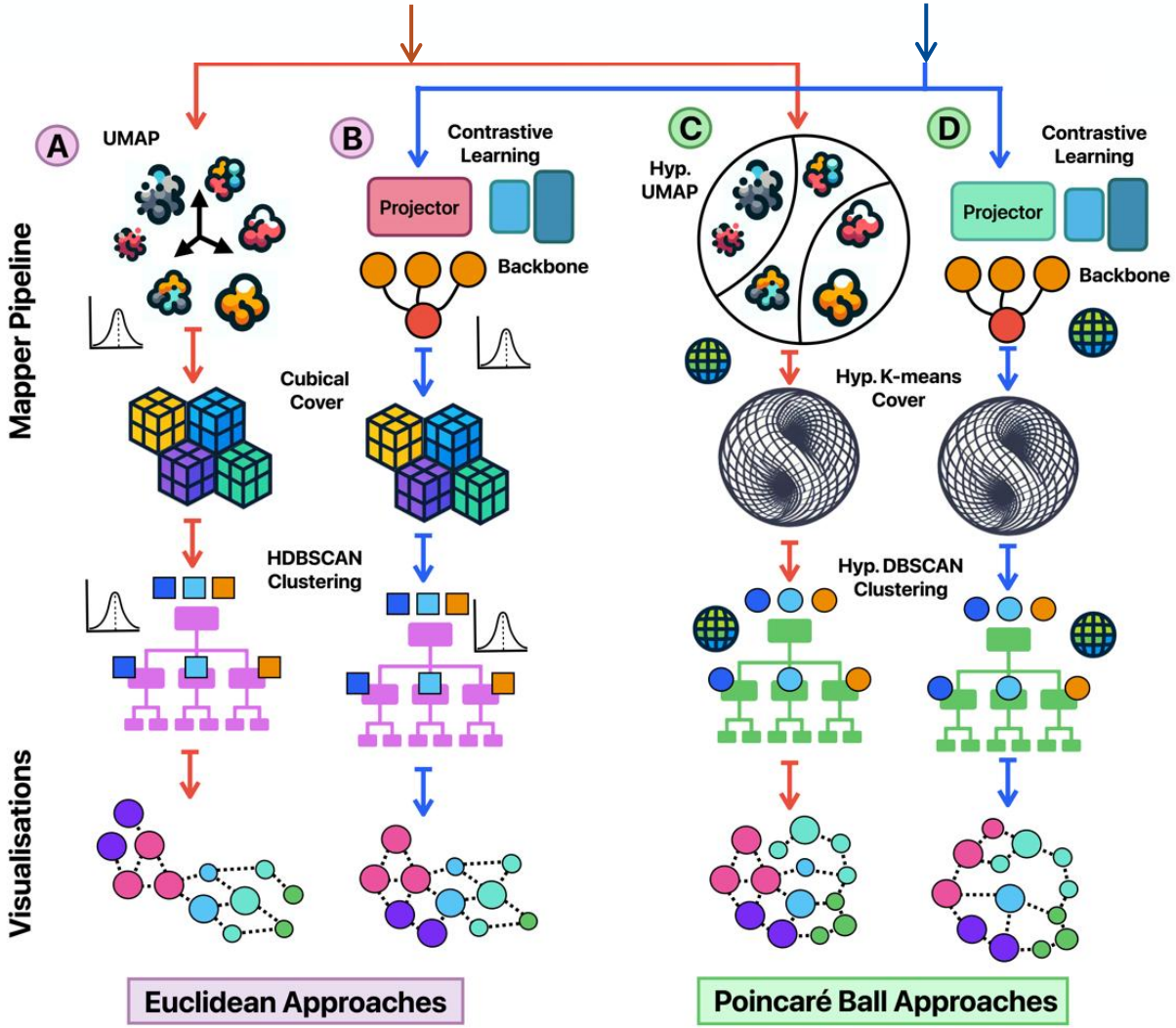
Mapper v1.



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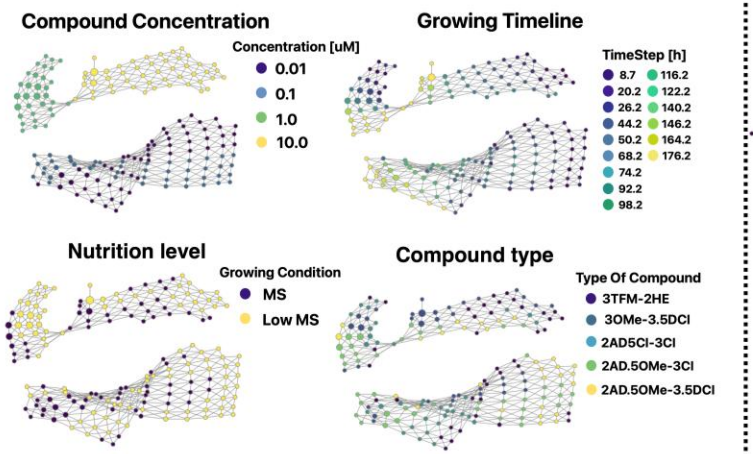
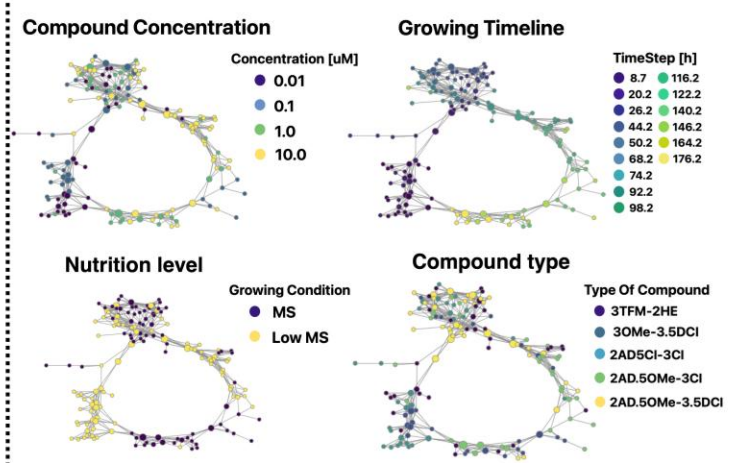
Understanding data Patterns

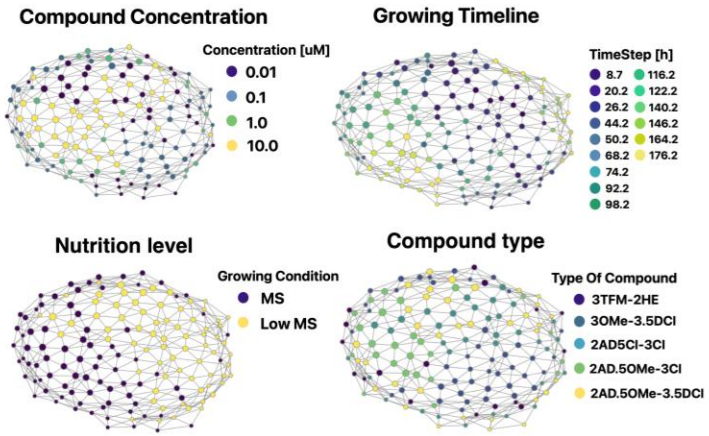
(A) Descriptors Vis. Euc.



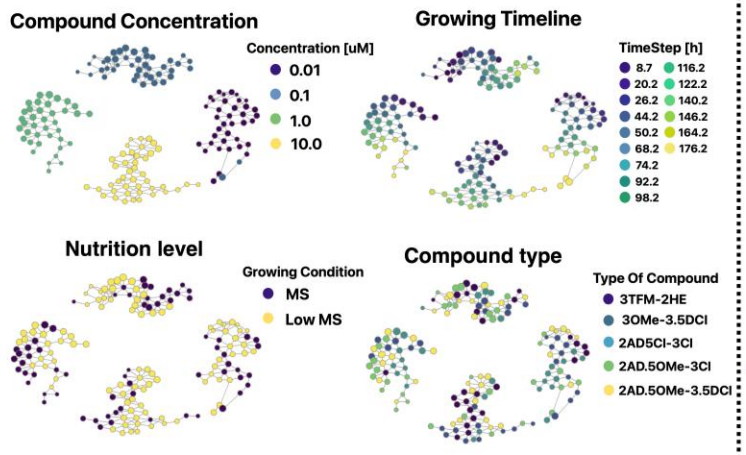
(B-1) Image SIMCLR Vis. Euc.



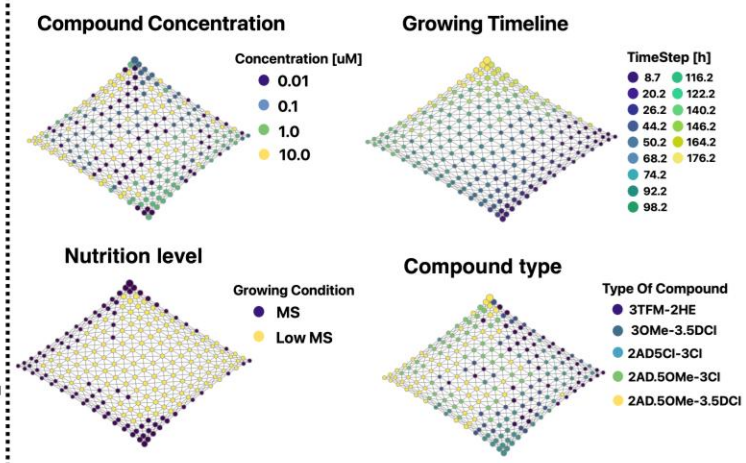
(D-2) Image SIMCLR Vis. Poin.



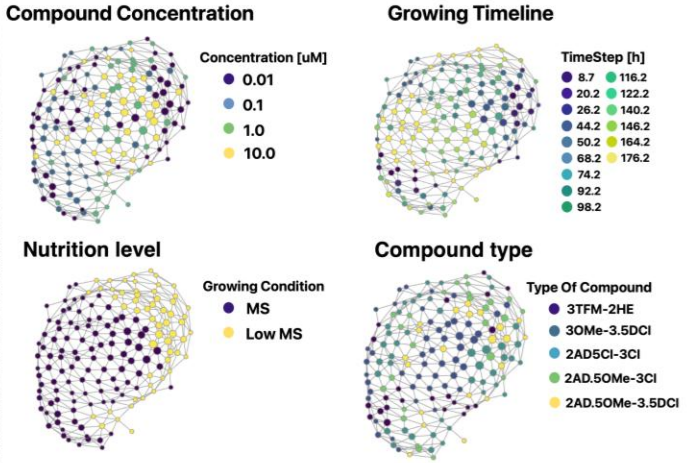
(C) Descriptors Vis. Poin.



(B-2) Image BYOL Vis. Euc.



(D-2) Image BYOL Vis. Poin.



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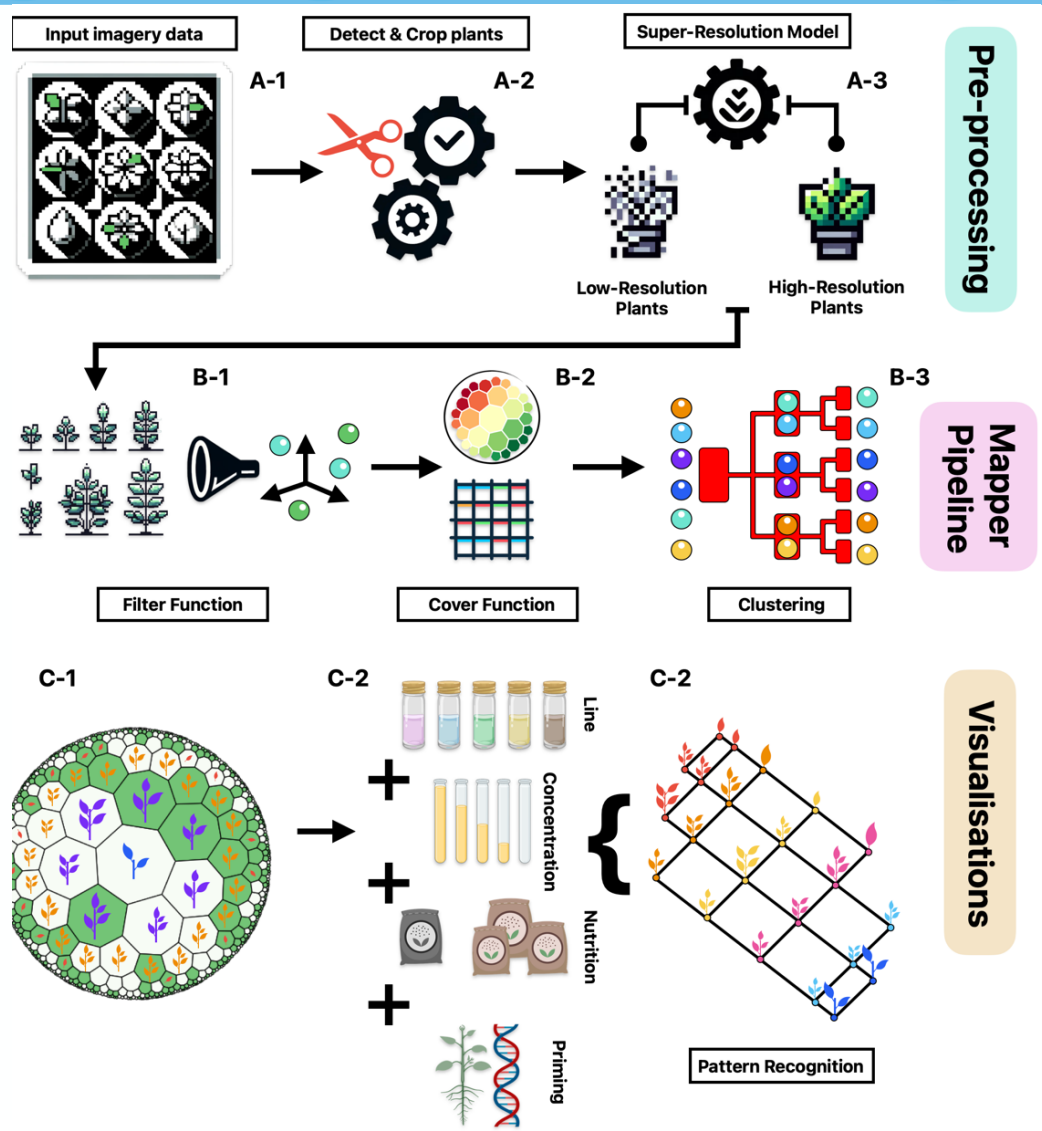
Mapper v2.

- **Bigger dataset ->** 138 223 plants
- **Better biological variety ->** + Priming
- **Improved image resolution ->** SR model
- **Focused on PB space**



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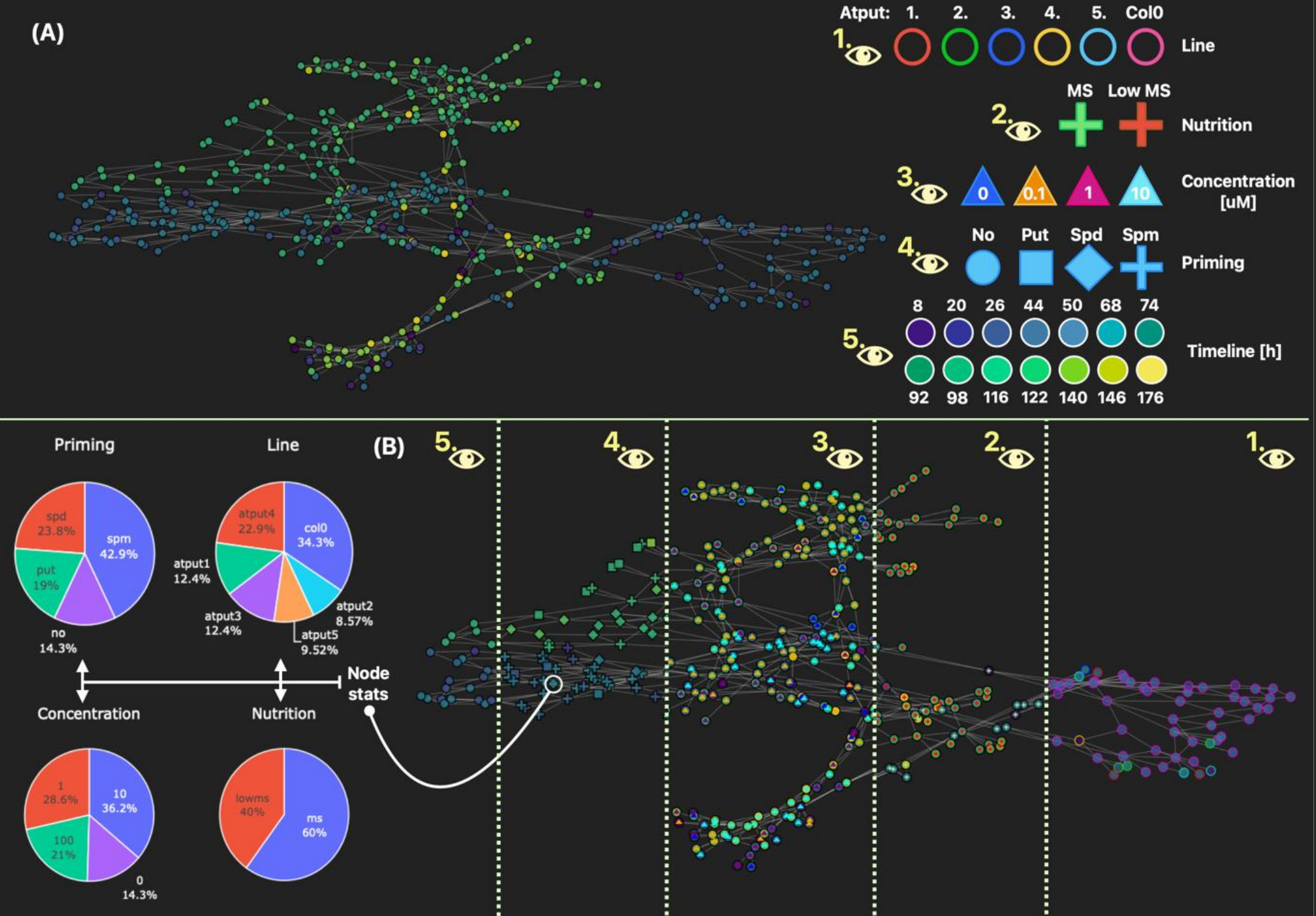
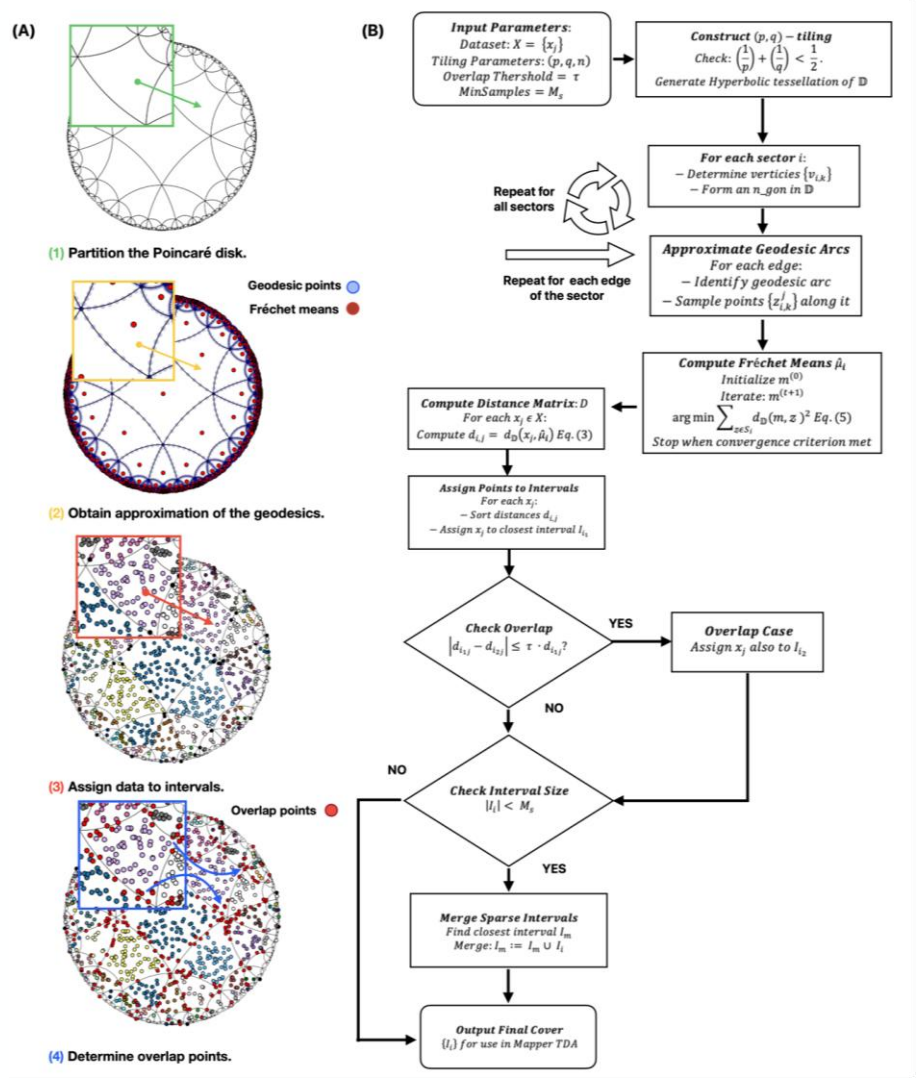
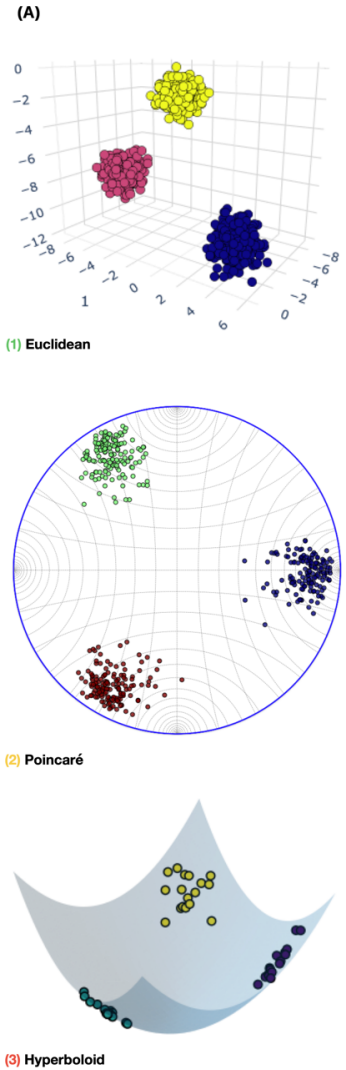
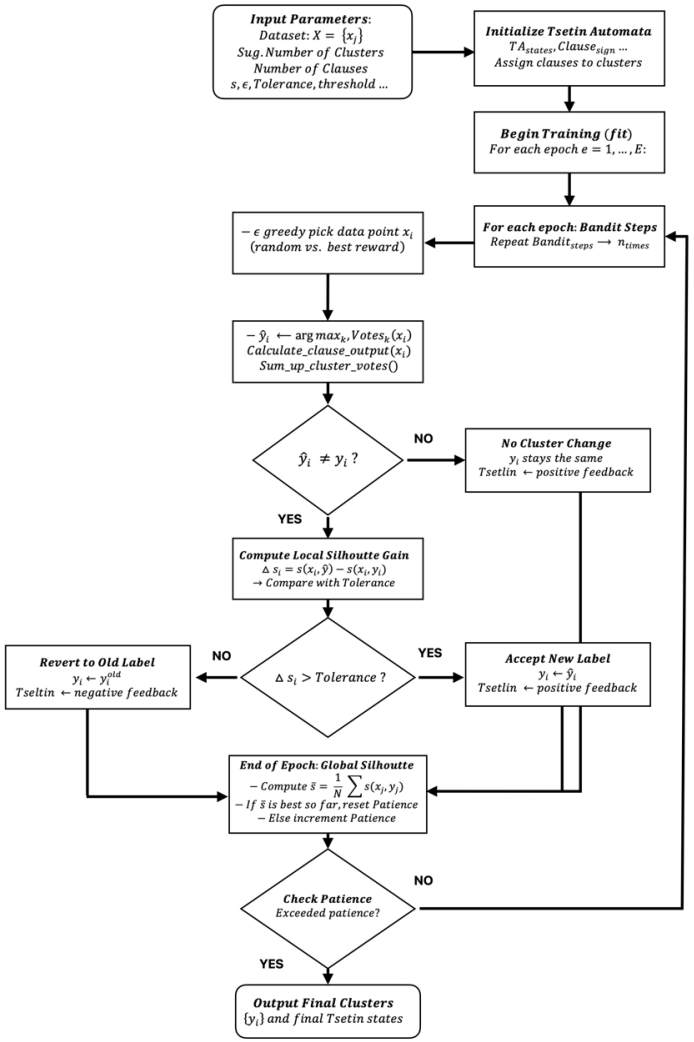

(A)
Atput: 1. 2. 3. 4. 5. Col0
1. Line
MS Low MS
2. Nutrition
3. 0 0.1 1 10 Concentration [uM]
No Put Spd Spm
4. Priming
8 20 26 44 50 68 74
5. Timeline [h]
92 98 116 122 140 146 176
(B)
Priming
Line
spd 23.8%
spm 42.9%
put 19%
no 14.3%
atput4 22.9%
col0 34.3%
atput1 12.4%
atput2 8.57%
atput3 12.4%
atput5 9.52%
Concentration
Nutrition
Node stats
1 28.6%
10 36.2%
100 21%
0 14.3%
lowms 40%
ms 60%

Cover & Cluster method







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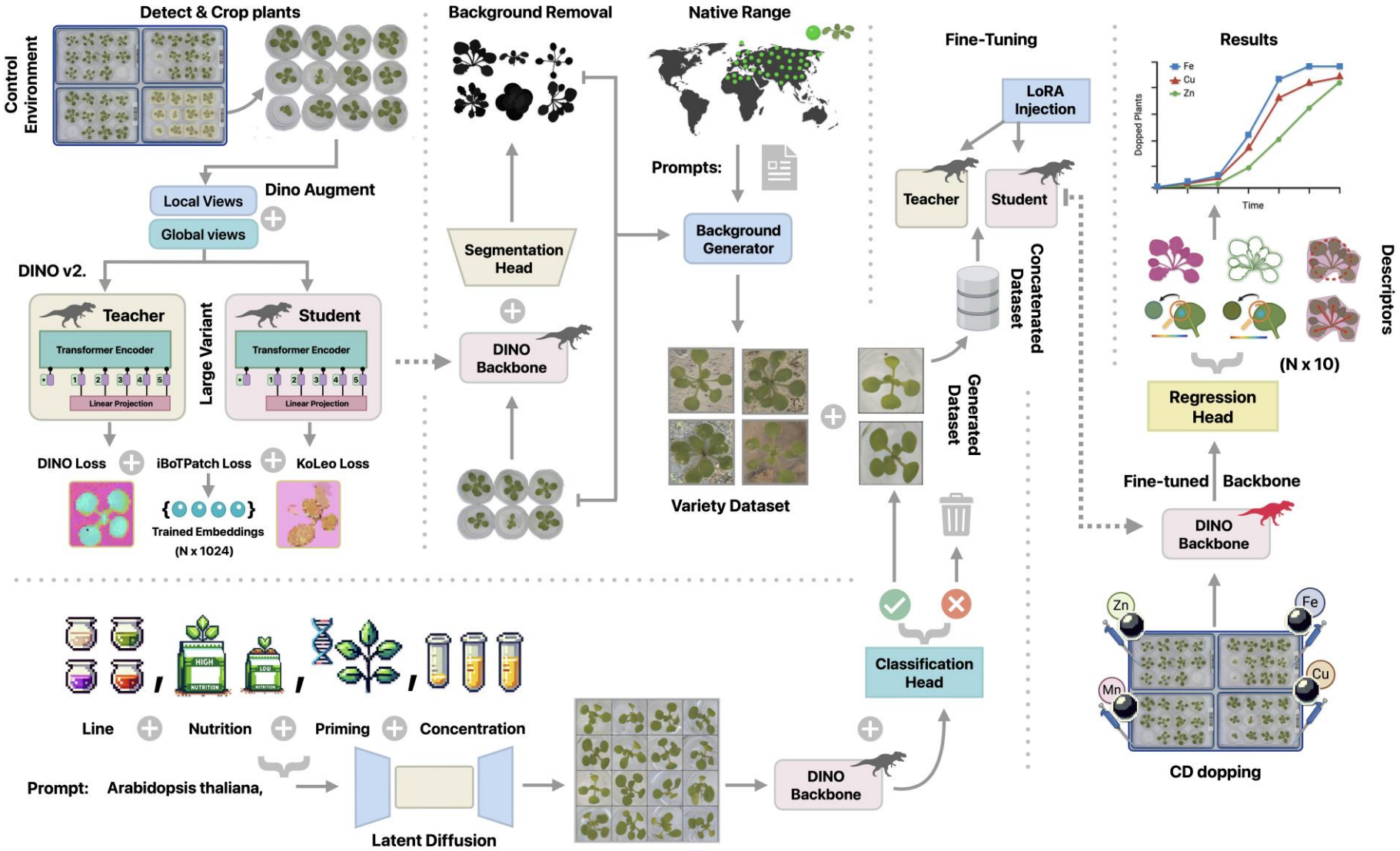
Current work



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