

## INTRODUCTION

- ❖ The quantitative estimation of many plant traits from plant images is primarily based on accurate segmentation of individual leaves.
- ❖ This is a challenging task due to the presence of overlapped leaves and lack of discernible boundaries between them.
- ❖ Current state-of-the-art supervised deep learning algorithms rely on annotations of individual leaf instance, which is time consuming.
- ❖ In addition to the variability in leaf shapes and its arrangement among different plant species limits the broad utilisation of these algorithms.

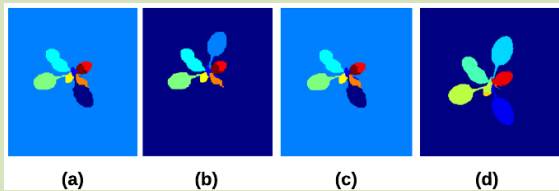
## CONTRIBUTIONS

- ❖ Novel strategy to exploit the global feature of leaf shapes invariant across plant species.
- ❖ Automatic generation of leaf templates for the incorporation of leaf shape knowledge.

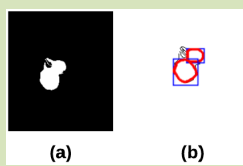
## DATASET

- PRL dataset [5,6].
- The plant phenotyping database [7].
- The Komatsuna dataset [8];
- The Salad dataset [9].

## RESULTS



Selected result with different segmentation method using the seed placement of slice approach (a) Kruskal, (b) Prim, (c) Power-watershed and (d) Random walk.



Sample result of multi-leaf template matching algorithm (a) Modified mask and (b) Output.

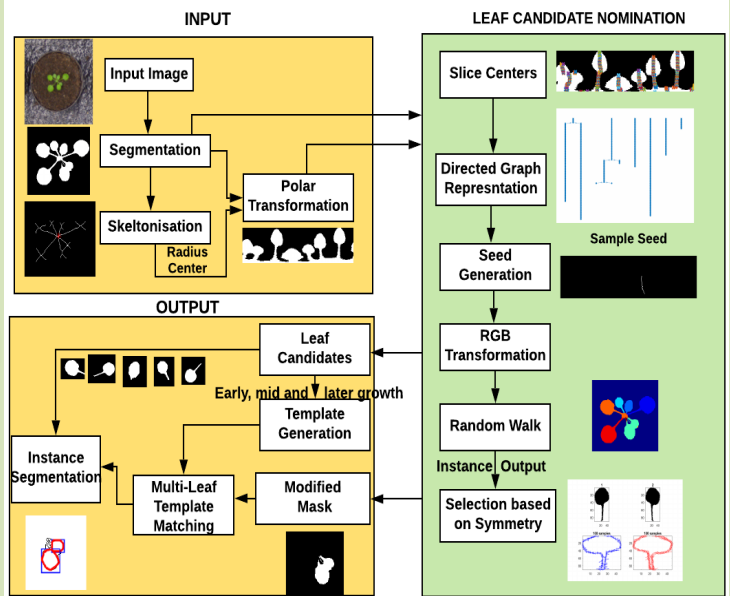
Method	SBD(%)	DiC
IPK	74.2	-1.9
Nottingham	68.0	-3.6
Wageningen	72.8	0.4
MSU	78.0	-2.3
Proposed framework	<b>74.7</b>	<b>-2.5</b>

Segmentation Results on PRL dataset (A1)

## REFERENCES

- H. Scharf, M. Minervini, A. P. French, C. Klukas, D. M. Kramer, X. Liu, I. Luengo, J.-M. Pape, G. Polder, D. Vukadinovic et al., "Leaf segmentation in plant phenotyping: a collation study," *Machine vision and applications*, vol. 27, no. 4, pp. 585-606, 2016.
- X. Yin, X. Liu, J. Chen, and D. M. Kramer, "Multi-leaf alignment from fluorescence plant images," in *IEEE Winter Conference on Applications of Computer Vision*, IEEE, 2014, pp. 437-444.
- Y. Chen, J. Ribera, C. Boomsma, and E. Delj, "PlantLeafSegmentation for estimating phenotypic traits," in *2017 IEEE International Conference on Image Processing (ICIP)*, IEEE, 2017, pp. 3884-3888.
- L. Grady, "Random walks for image segmentation," *IEEE transactions on pattern analysis and machine intelligence*, vol. 28, no. 11, pp. 1768-1783, 2006.
- M. Minervini, A. Fischbach, H. Scharf, and S. A. Tsafaris, "Finely-grained annotated datasets for image-based plant phenotyping," *Pattern recognition letters*, vol. 81, pp. 80-89, 2016.
- H. Scharf, M. Minervini, A. Fischbach, and S. A. Tsafaris, "Annotated image datasets of rosette plants," in *European Conference on Computer Vision*, Zurich, Suisse, 2014, pp. 6-12.
- J. A. Cruz, X. Yin, X. Liu, S. M. Imran, D. D. Morris, D. M. Kramer, and J. Chen, "Multi-modality imagery database for plant phenotyping," *Machine Vision and Applications*, vol. 27, no. 5, pp. 735-749, 2016.
- H. Uchiyama, S. Sakurai, M. Mashima, D. Arita, T. Okayasu, A. Shi-mada, and K.-I. Taniguchi, "An easy-to-setup 3d phenotyping platform for komatsuna dataset," in *Proceedings of the IEEE International Conference on Computer Vision Workshops*, 2017, pp. 2038-2045.
- D. G. Shadrin, V. Kulikov, and M. Fedorov, "Instance segmentation for assessment of plant growth dynamics in artificial soilless conditions," in *BMVC*, 2018, p. 329.

## METHODOLOGY



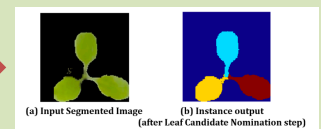
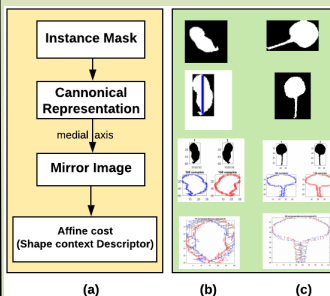
An overview of the proposed framework

### SLICE representation

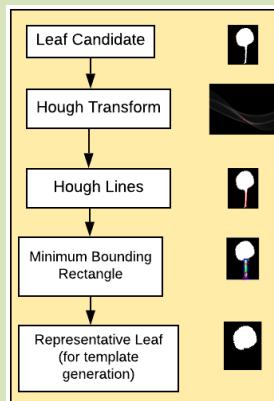


- ❖ To constrain the search of possible leaf candidate regions, firstly the segmented image is transformed into polar coordinates.
- ❖ Given a polar transformed image, we use the slice representation presented to automatically generate small set of seeds.

### Symmetry Quantification



### Extraction of representative leaves



- ❖ The representative shapes from sampled images are used for template generation.
- ❖ Since, the multi-leaf template matching algorithm is rotation and scale sensitive, thus the representative shapes are varied using geometric transformations such as scaling and rotation.
- ❖ This template database with different shapes, size and orientation generated through sampling of time-lapsed images is employed in multi-leaf template matching.