*Wang, Jiaxin, Renninger, Heidi, & Ma, Qin. (2023). StoManager1: Automated, High-throughput Tool to Measure Leaf Stomata Using Convolutional Neural Networks (v.0.8.6). Zenodo. https://doi.org/10.5281/zenodo.7686022*

# *StoManager1: Automated, High-throughput Tool to Measure Leaf Stomata Using Convolutional Neural Networks*

Select or type in image input & output path — Step1

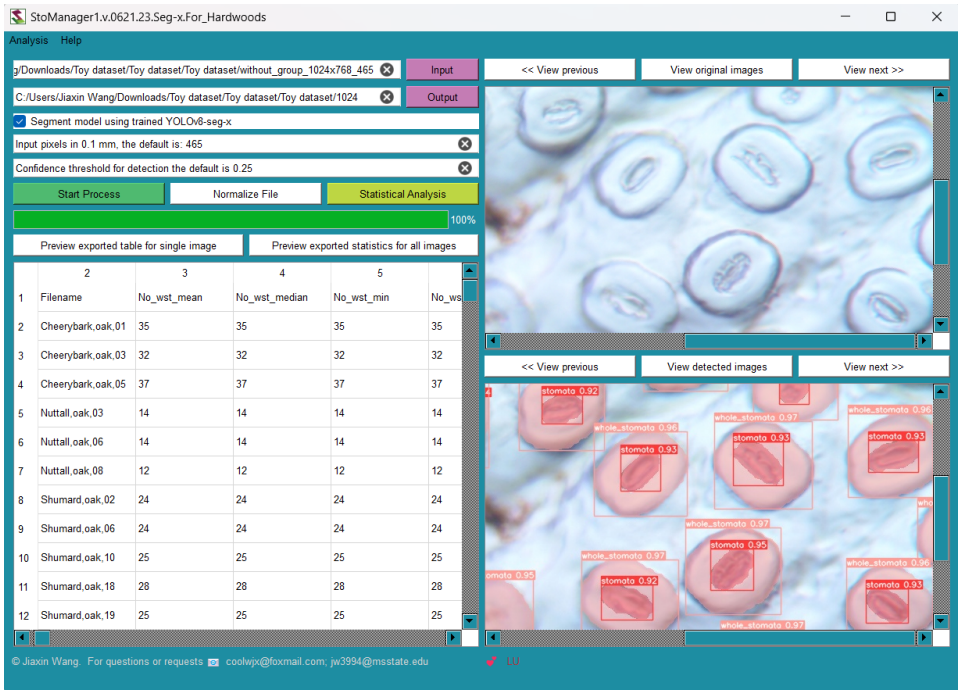
Step2 — Select models and set images resolution info and give the threshold for detection

Press start process — Step3

Step4 — Do Statistical analysis

View the table and image output — Step5

- Feed image that has stomata in it.
- Use independent paths for input and output
- GPU version works 30-40 times faster than CPU version, to fully use it you must have a GPU with cuda11.7 installed correctly.
- More training will be conducted to enhance the capability for more species.




Schematic diagrams of model training processes (a), detection workflow (b), and segmentation model pipeline for stomatal metrics measuring (c, d, e, f, g).

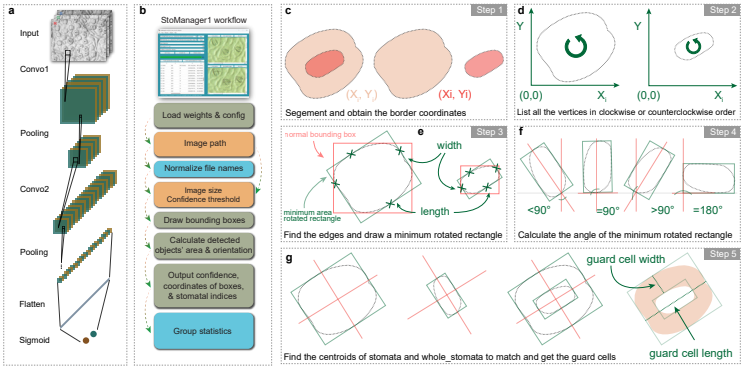



**Table 2.** Metrics of "stomata", "whole_stomata", and guard cell measured by StoManager1.

| Ouput variables | Defination | Unit |
|---|---|---|
| ori_img_shape | original image shape, e.g., (1024, 768) | NA |
| class_wst | class of whole_stomata, e.g., "1" | NA |
| number_wst | total number of whole_stomata | NA |
| index_wst | index of whole_stomata | NA |
| box_w_wst | bounding box width of whole_stomata | pixels |
| box_h_wst | bounding box height of whole_stomata | pixels |
| area_wst | area of whole_stomata | $\mu m^2$ |
| width_wst | width of whole_stomata | μm |
| length_wst | length of whole_stomata | μm |
| var_area_wst | variance of whole_stomata area | NA |
| var_width_wst | variance of whole_stomata width | $\mu m^2$ |
| var_length_wst | variance of whole_stomata length | $\mu m^2$ |
| centroid_wst | centroid of whole_stomata | NA |
| class_st | class of whole_stomata, e.g., "0" | NA |
| number_st | total number of stomata | NA |
| index_st | index of stomata | NA |
| box_w_st | bounding box width of stomata | pixels |
| box_h_st | bounding box height of stomata | pixels |
| area_st | area of stomata | $\mu m^2$ |
| width_st | width of stomata | μm |
| length_st | length of stomata | μm |
| var_area_st | variance of stomata area | NA |
| var_width_st | variance of stomata width | $\mu m^2$ |
| var_length_st | variance of stomata length | $\mu m^2$ |
| centroid_st | centroid of stomata | NA |
| guardCell_length | guard cell length | μm |
| guardCell_width | guard cell width | μm |
| guardCell_area | guard cell area | NA |
| guardCell_angle | orientation of guard cell | degree (°) |
| var_angle | variance of stomatal orientation | degree (°) |
| var_width_guardCell | variance of guard cell width | NA |
| var_length_guardCell | variance of guard cell length | NA |
| var_area_guardCell | variance of guard cell area | NA |
| wst_density | whole_stomata density in each image | stomata/$mm^2$ |
| ratio_area_st_to_gc | ratio of stomata area to guard cell area | $\mu m^2/\mu m^2$ |
| ratio_area_to_img | ratio of the sum of all whole_stomata area to image area | $\mu m^2/\mu m^2$ |
| SEve | stomatal evenness index | NA |
| SDiv | stomatal divergence index | NA |
| SAgg | stomatal aggregation index | NA |

## What's new in this version?

1. *Substantially improved group analysis speed.*
2. *Updated line-edit default text. Fine-tuned weights for Hardwoods.*
3. *Enhanced detection capacity for blurred images.*
4. *Implement segment mdoels for directly measuring stomatal metrics.*
5. *Enhanced version with more stomatal metrics measured with theoretical algorithms!!*
6. *Increased Stomata indices such as stomatal evenness index, stomatal divergence index, and stomatal aggregation index.*