Web- Based Deep Segmentation Tools for Phenotyping

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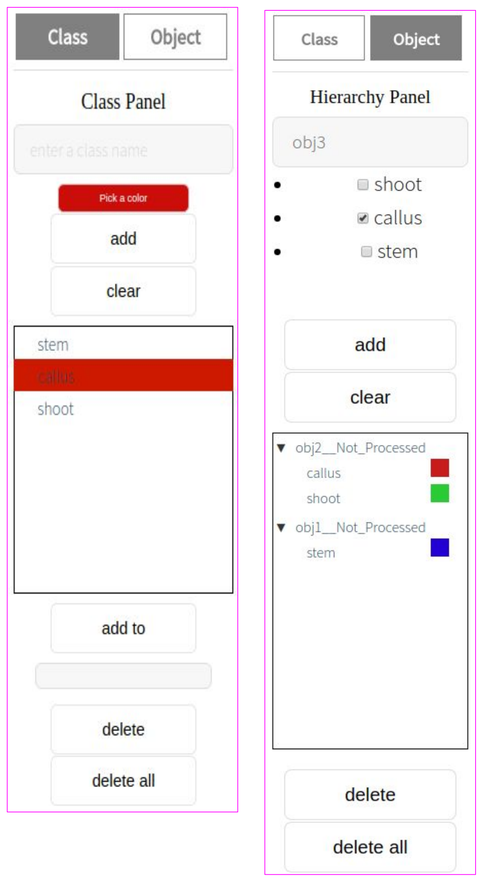
Motivation

- Quantifying phenotypes of complex biological tissues, such as during in vitro regeneration, is slow and imprecise. Machine vision methods can give a major improvement, but need a user friendly interface (GUI) for annotation of tissues of interest
- Non-web-based IA (image annotation) tools rely on installation and configuration, often difficult to use
- Existing web-based IA tools, i.e. LabelMe[1], Labelbox[2], are expensive and time-consuming to annotate objects at pixel-level accuracy
- Deep learning method is the state-of-art method for segmentation, it is expected to be more efficient and robust to obtain pixel-level annotations

Image Annotator

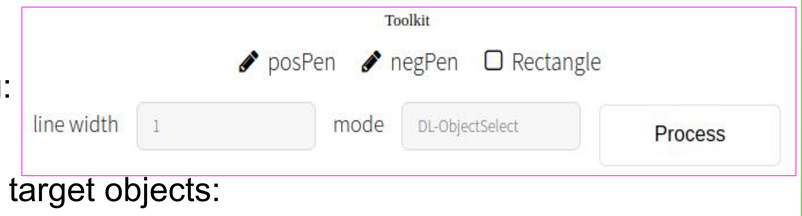
class/object configuration



- **Class Panel**: User can specify the names of the classes
- **Hierarchy Panel**: User can specify objects and the classes (parts) they belong to
  - Add multiple classes into an object.
  - Use “add to” to directly add classes.

Toolkit

- Two pens for drawing: *posPen* and *negPen*
- Two modes to annotate target objects:
  - **DL-ObjectSelect mode**[3], draw positive strokes inside one object and negative strokes outside, the UI then automatically generate precise edges along labeling result.
  - **Manual mode**, mark objects by directly painting on them.



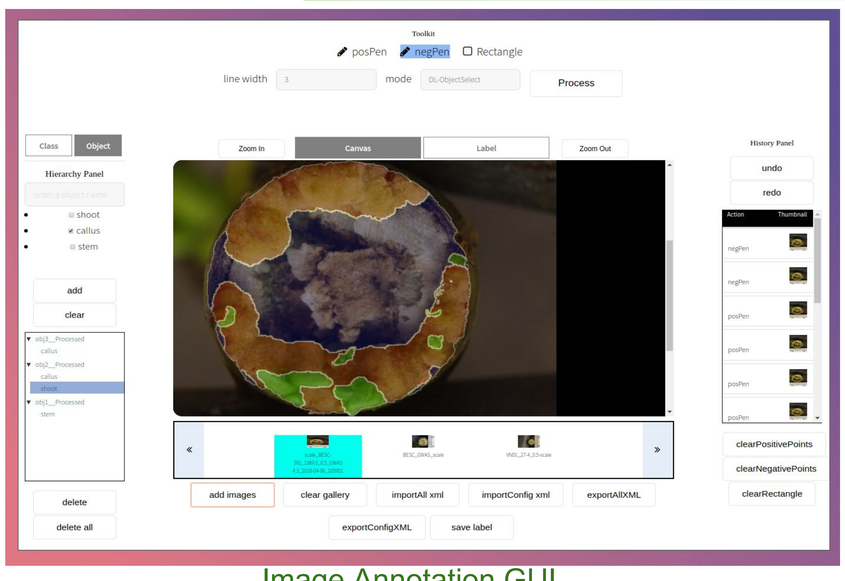
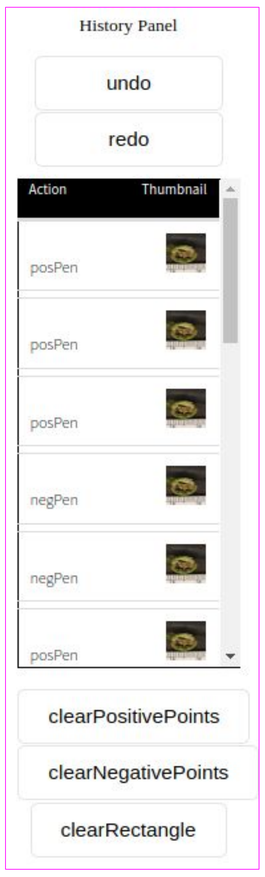
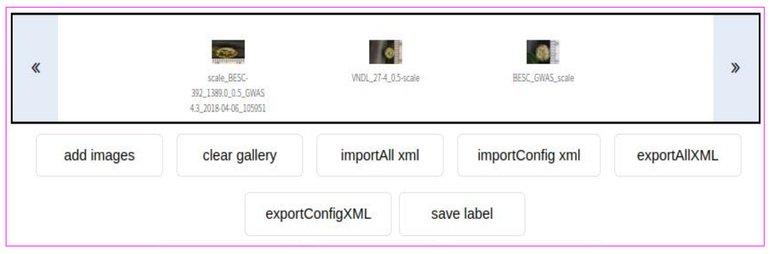


Image Annotation GUI



IO system

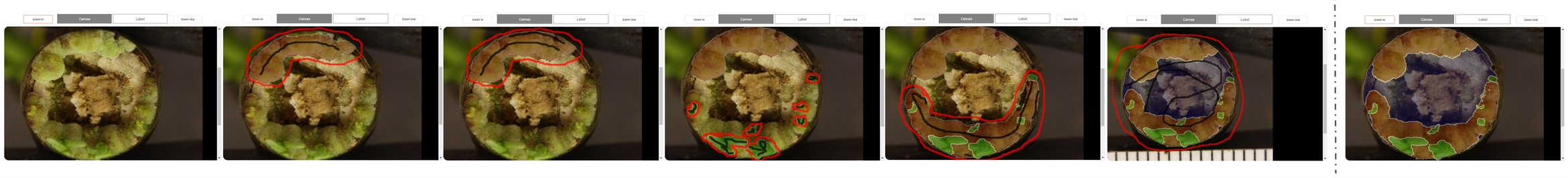


- Load multiple images and view them in the file gallery
- Import and export the configuration of classes and objects
- Save the generated annotation result

History management

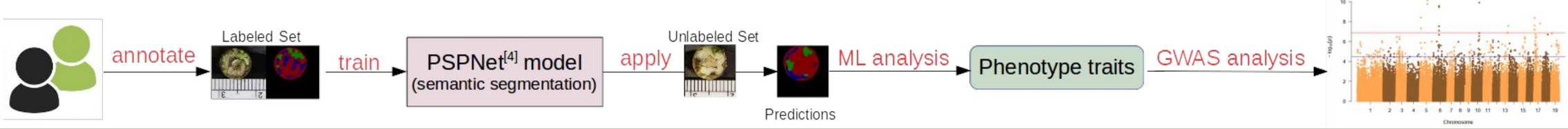
- *Undo* and *redo* previous drawings to retract wrong operations
- Clear all unwanted *posPen* or *negPen* drawing in one click

Example of Annotating one Image



A GWAS Application

1. 103 annotated images from the Image Annotator
2. Trained the PSPNet[4] for semantic segmentation of background, callus, shoot and stem
3. Compute phenotype traits: portion of callus, shoots over stem
4. GWAS analysis: normality and association testing (see poster by Michael Nagle for detailed results on GWAS associations)



Conclusion

- We developed a web-based interactive image annotation tool
  - There is no need to install any software or configure anything.
  - The user can work from anywhere, anytime with any device or platform.
- Our IA tool is integrated with the DL-ObjectSelect[3] algorithm, which is easy to use for object segmentation
- We adopted the IA tool in a GWAS study, which proves to be effective in practice, though improvements in annotation databases and prediction efficiency are still under study

References

[1]. “LabelMe”. Available: http://labelme.csail.mit.edu/Release3.0/
[2]. “LabelBox”. Available: https://www.labelbox.com
[3]. Xu, Ning, et al. "Deep interactive object selection."CVPR. 2016.
[4]. Zhao, Hengshuang, et al. "Pyramid scene parsing network." CVPR. 2017.

Acknowlegement

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