

Trainable Weka Segmentation: a tool for machine-learning-based image segmentation

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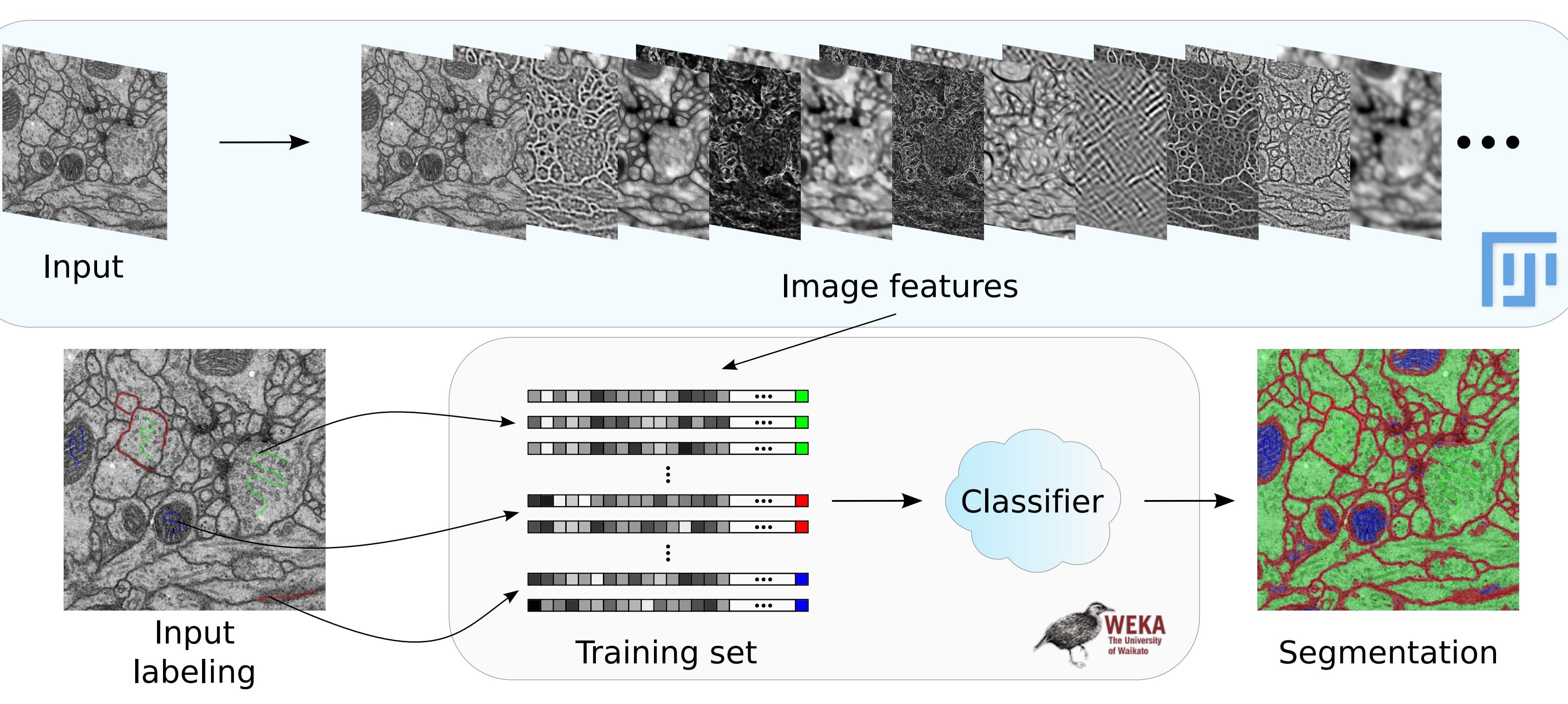
I. Introduction

- The problem of image segmentation, i.e. partitioning an image into multiple segments, remains unsolved.
- In recent years, methods incorporating machine learning techniques into the process have emerged as powerful tools, improving the accuracy of detected boundaries or labeled areas.
- We propose a wide bridge between the machine learning and the image processing worlds.
- We benefit from combining two of the most popular and powerful platforms of each respective field: the Fiji toolkit, mainly used for biomedical image processing but with a wider spectrum; and the Waikato Environment for Knowledge Analysis (WEKA) suite.
- Integrated in the same graphical interface, they provide a novel and completely open-source framework to use, evaluate, combine and compare any available learning algorithm to perform general-purpose image segmentation. The source and binary code is completely available and runs on any modern computing platform.



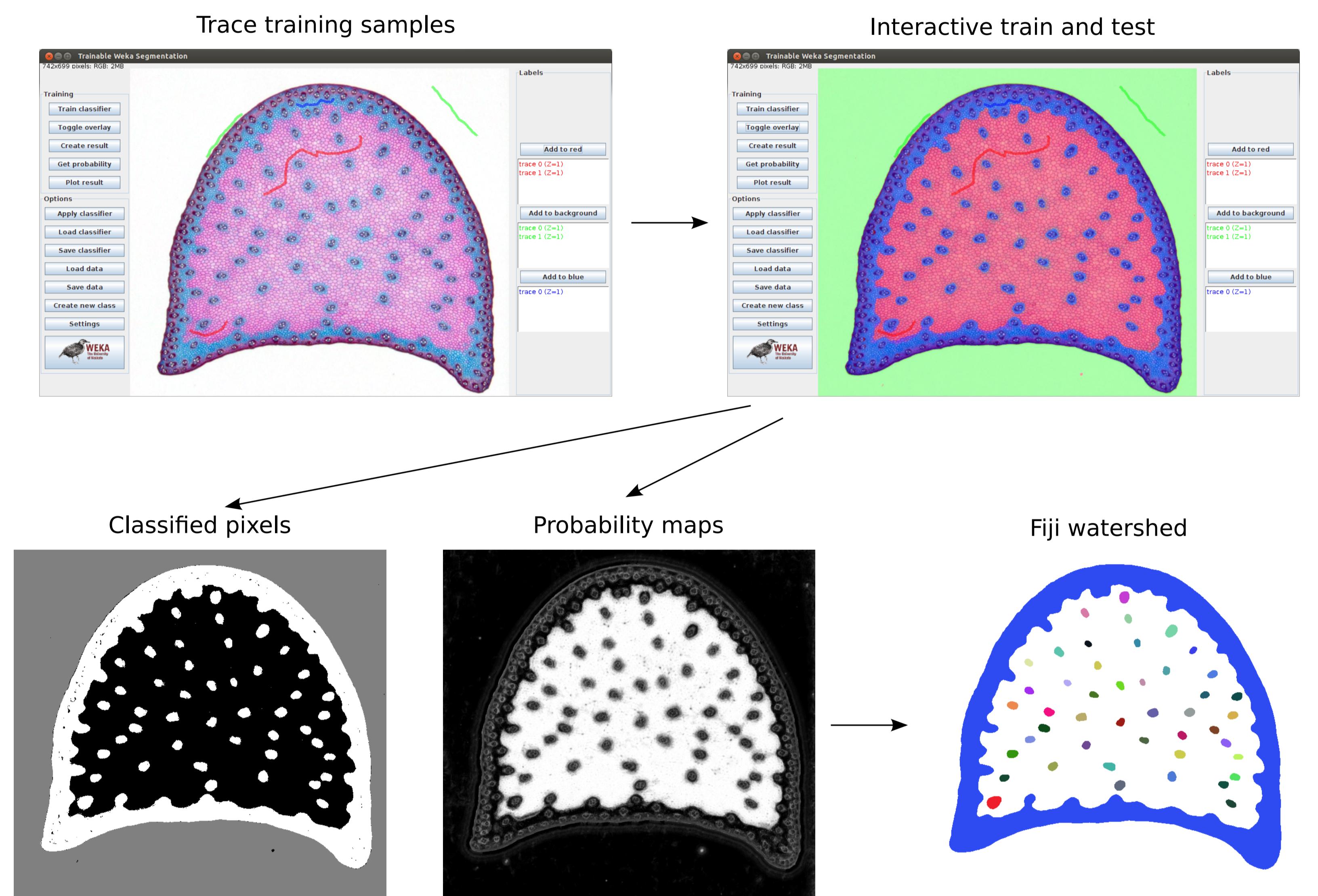
2. Machine learning based segmentation

- Extract image features using pre-defined and custom filters at different scales:
 - Border detectors:** Laplacian, Sobel, difference of Gaussian, Hessian eigenvalues, Gabor, etc.
 - Texture filters:** minimum, maximum, median, mean, variance, entropy, structure tensor, etc.
 - Noise reduction filters:** Gaussian blur, bilateral, Anisotropic diffusion, Kuwahara, Lipschitz, etc.
 - Membrane detectors** and other custom filters.
- Convert each pixel to a feature vector compatible with WEKA.
- Use supervised and unsupervised learning routines to **classify** (or **cluster**) each vector.



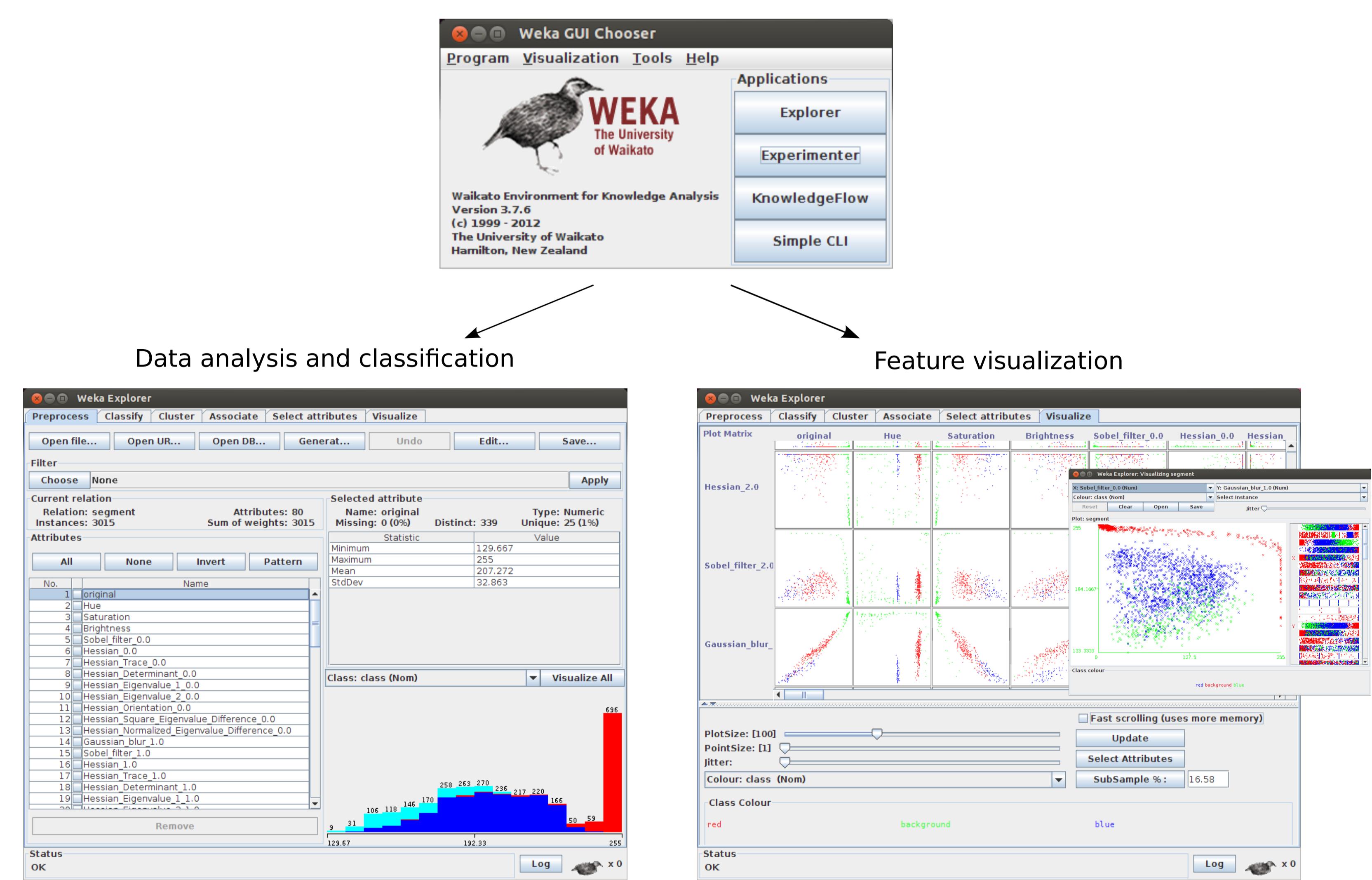
3. Intuitive Graphical User Interface

- For basic users:
 - Interactive training-testing until achieving satisfying segmentation.
 - User-defined classes (background/foreground, parts of cells, etc.).
 - Results presented as final segmented areas or probability maps.



- For advanced users:

- Access to all available WEKA classifiers and clusterers.
- Feature selection.
- Direct interaction with WEKA and Fiji toolboxes.
- Evaluation of all methods performance.



4. Library use

- ImageJ macro language compatible.
- GUI and methods are separate.
- Easy integration with other plugins and scripts.

References

- [1] M. Hall, E. Frank, G. Holmes, B. Pfahringer, P. Reutemann, and I.H. Witten. The weka data mining software: an update. *ACM SIGKDD Explorations Newsletter*, 11(1):10–18, 2009.
- [2] Johannes Schindelin, Ignacio Arganda-Carreras, Erwin Frise, Verena Kaynig, Mark Longair, Tobias Pietzsch, Stephan Preibisch, Curtis Rueden, Stephan Saalfeld, Benjamin Schmid, Jean-Yves Tinevez, Daniel James White, Volker Hartenstein, Kevin Eliceiri, Pavel Tomancak, and Albert Cardona. Fiji: an open-source platform for biological-image analysis. *Nature Methods*, 9:676–682, June 2012.