Pipelining with ilastik

Anna Kreshuk

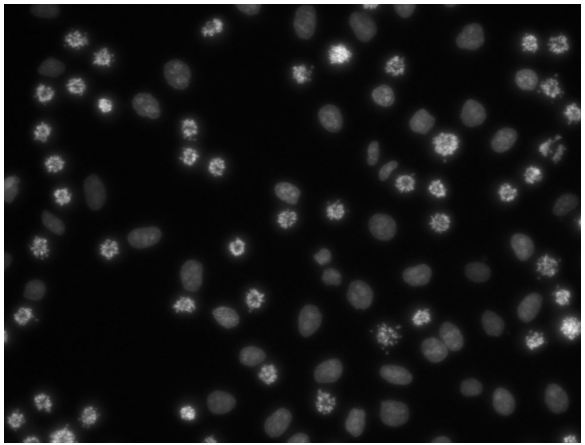
Outline

- Introduction
  - Machine learning
  - ilastik workflows
- Headless ilastik
  - Native
  - Fiji and Knime
- Workflows with ilastik
- AOB

Machine learning

How?

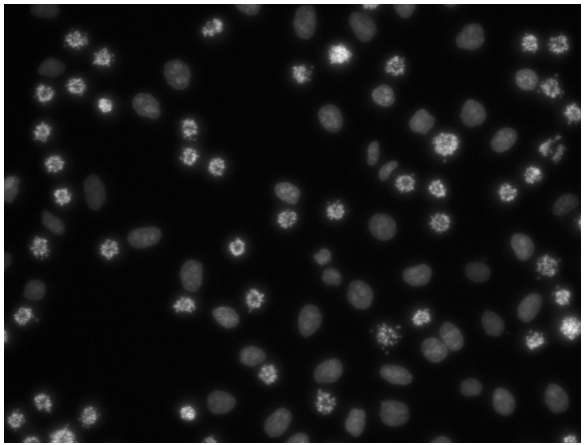
Cells vs background segmentation



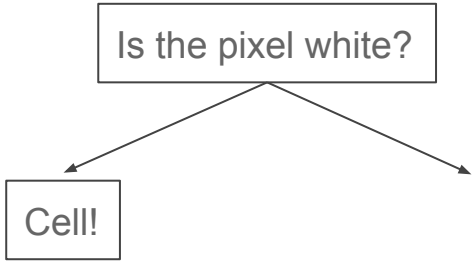
[Image: Gerlich Lab]

How?

Cells vs background segmentation

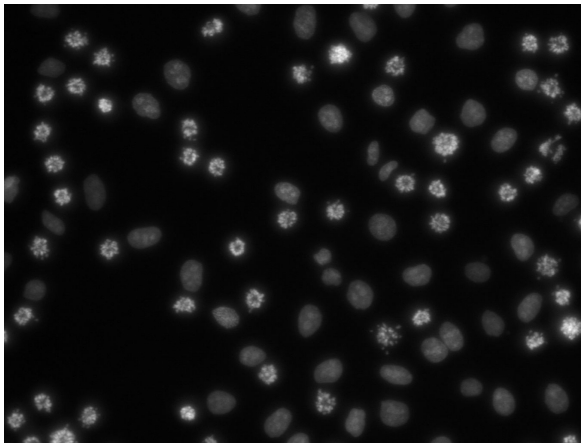


[Image: Gerlich Lab]

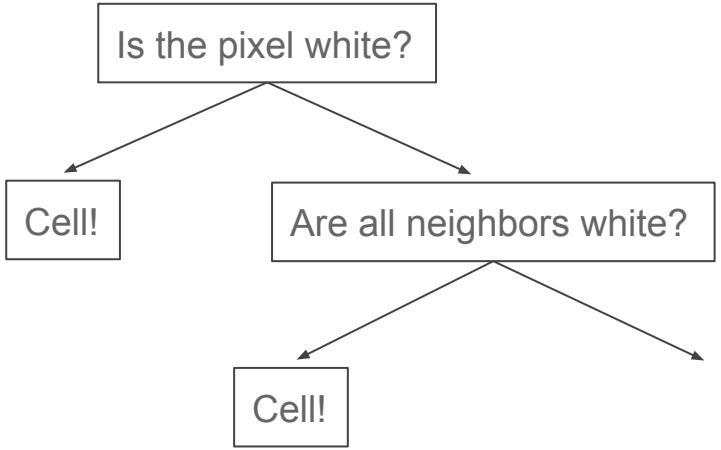


How?

Cells vs background segmentation

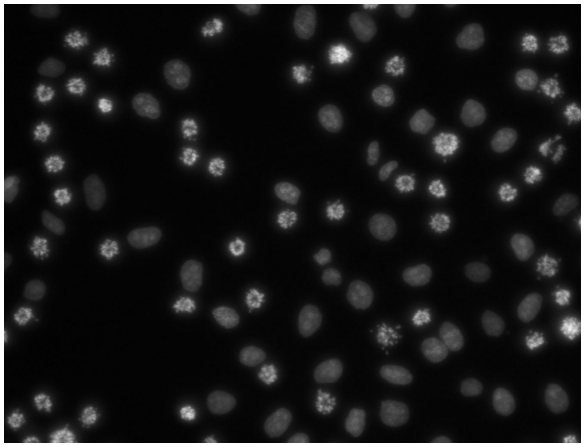


[Image: Gerlich Lab]

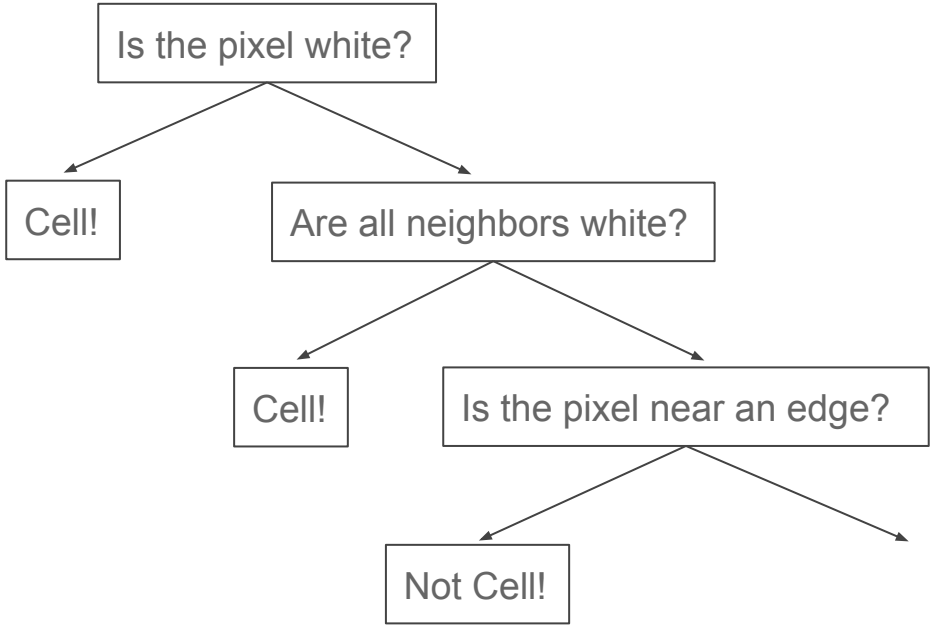


How?

Cells vs background segmentation

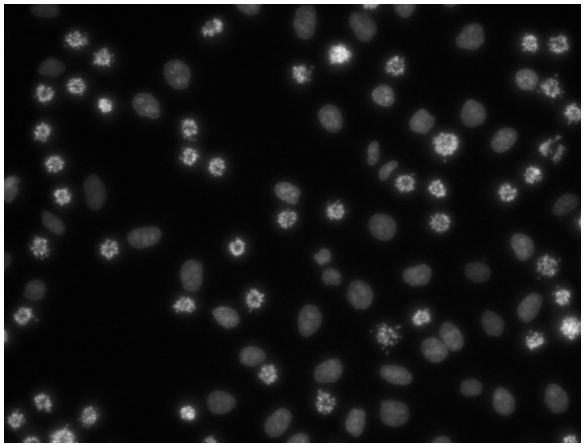


[Image: Gerlich Lab]

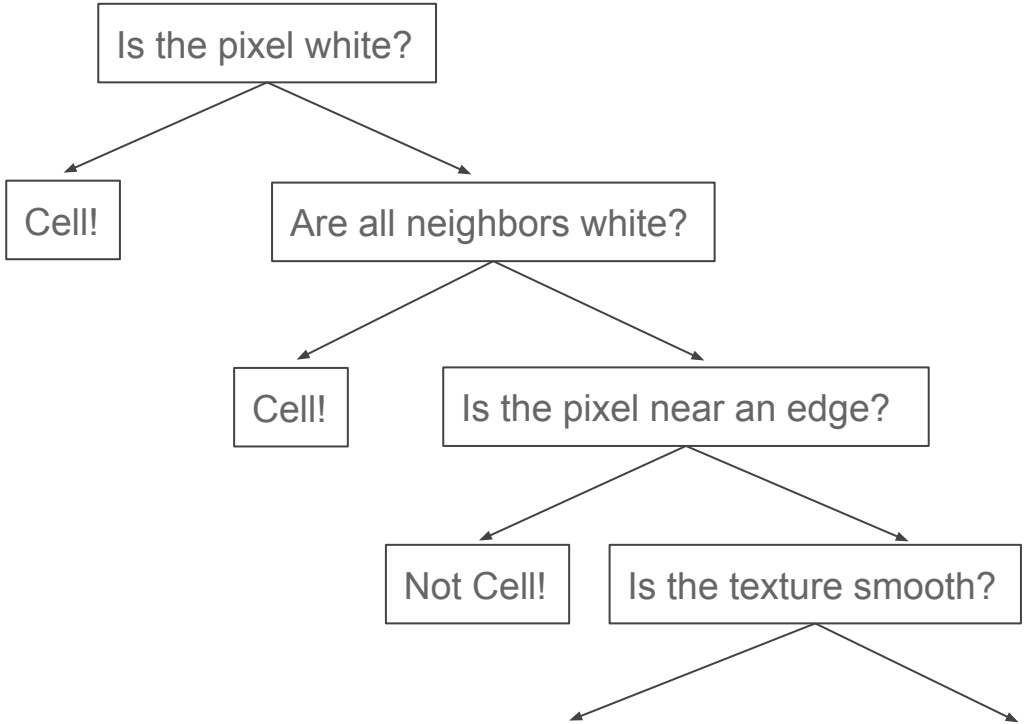


How?

Cells vs background segmentation

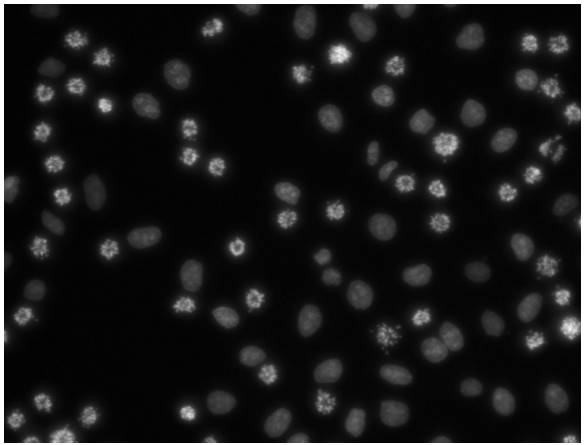


[Image: Gerlich Lab]

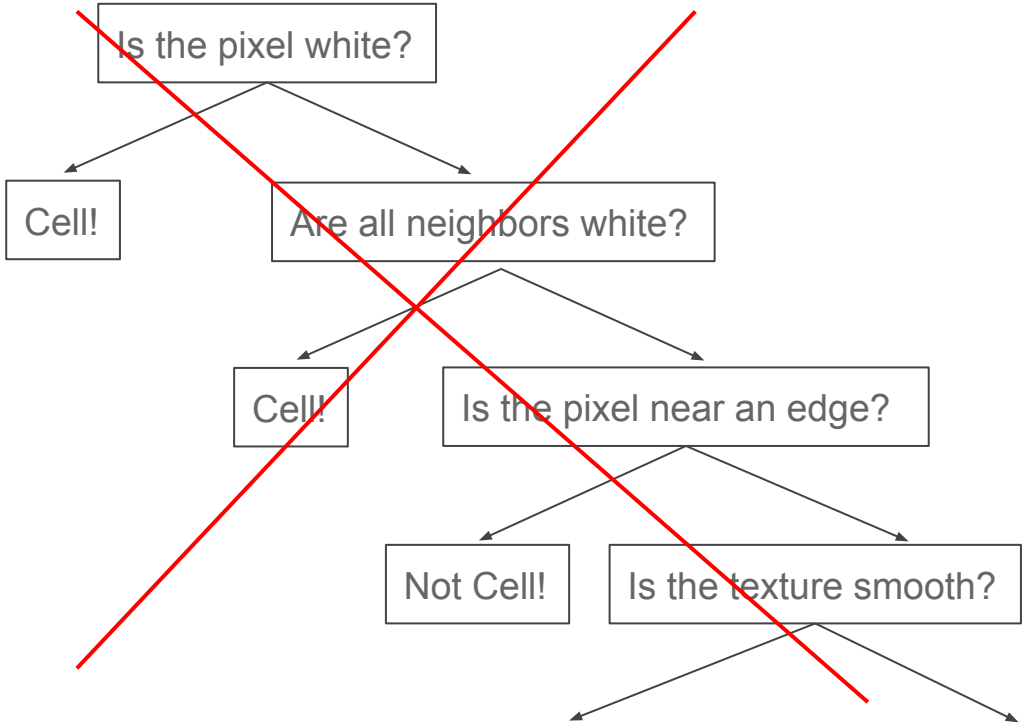


How?

Cells vs background segmentation

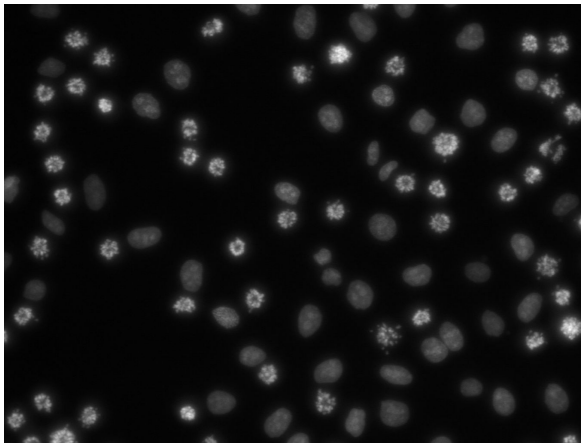


[Image: Gerlich Lab]



How?

Cells vs background segmentation

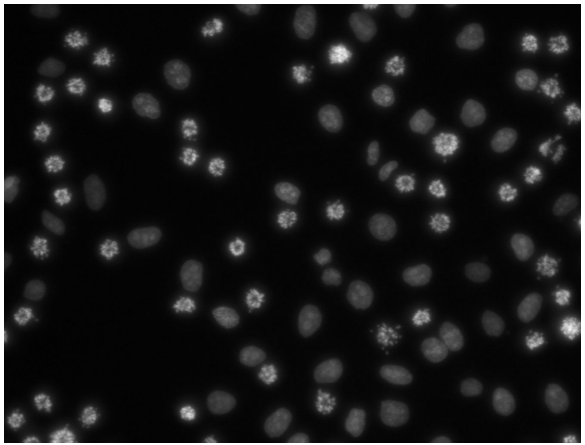


[Image: Gerlich Lab]

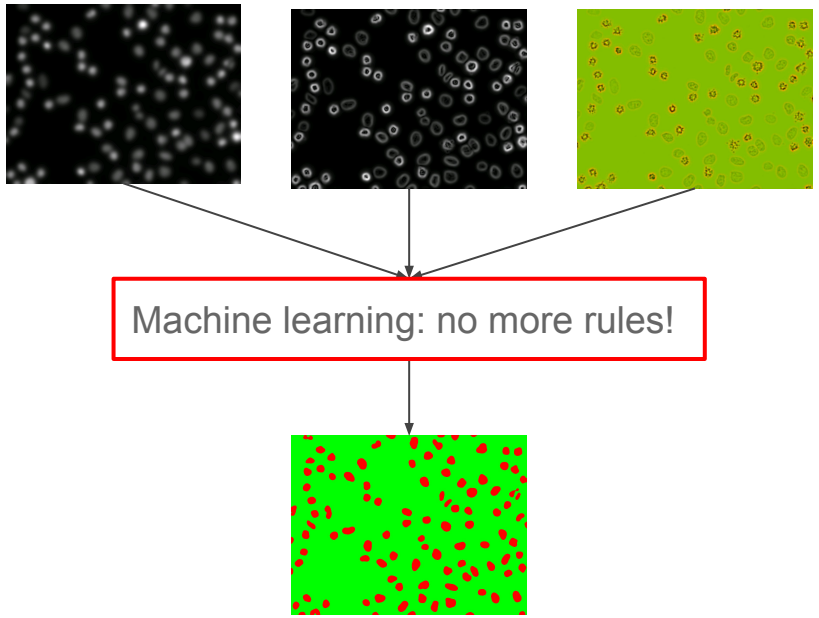
Machine learning: no more rules!

How?

Cells vs background segmentation

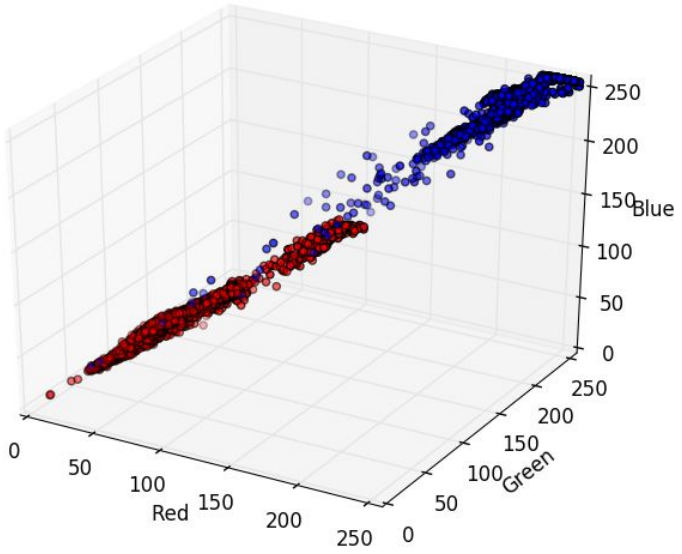


[Image: Gerlich Lab]



Machine learning

Find a separating surface in the multidimensional feature space

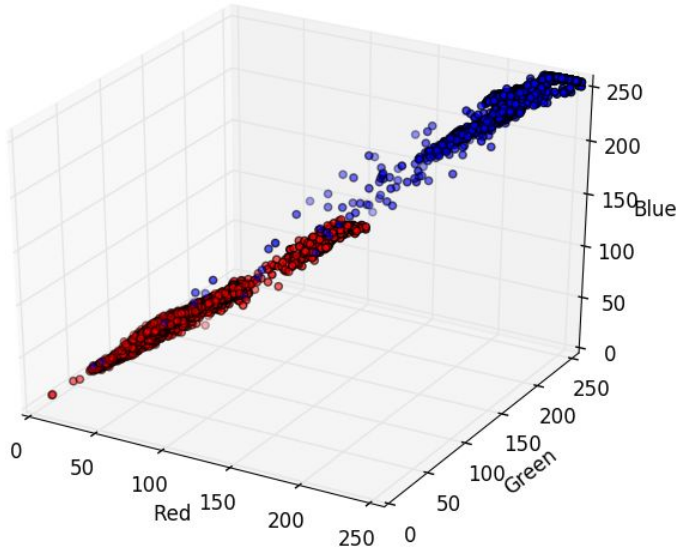


Machine learning

Find a separating surface in the multidimensional feature space

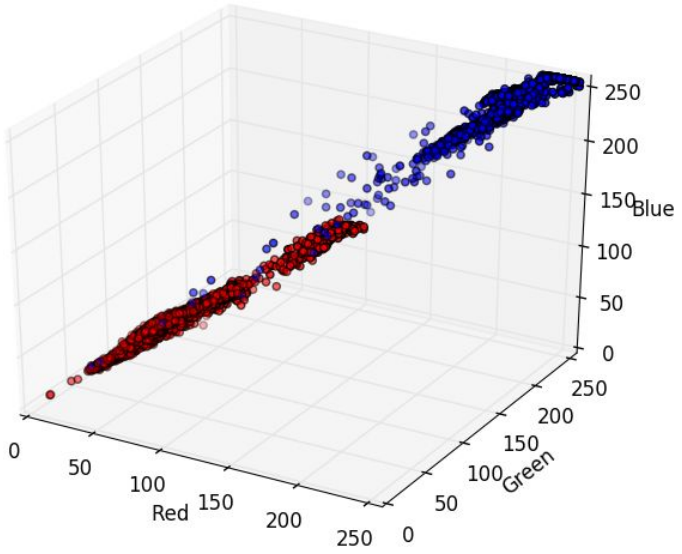
What does it separate?

User labels, aka training data



Machine learning

Find a separating surface in the multidimensional feature space



Images: Google neural network playground

Let’s look at an example

ilastik

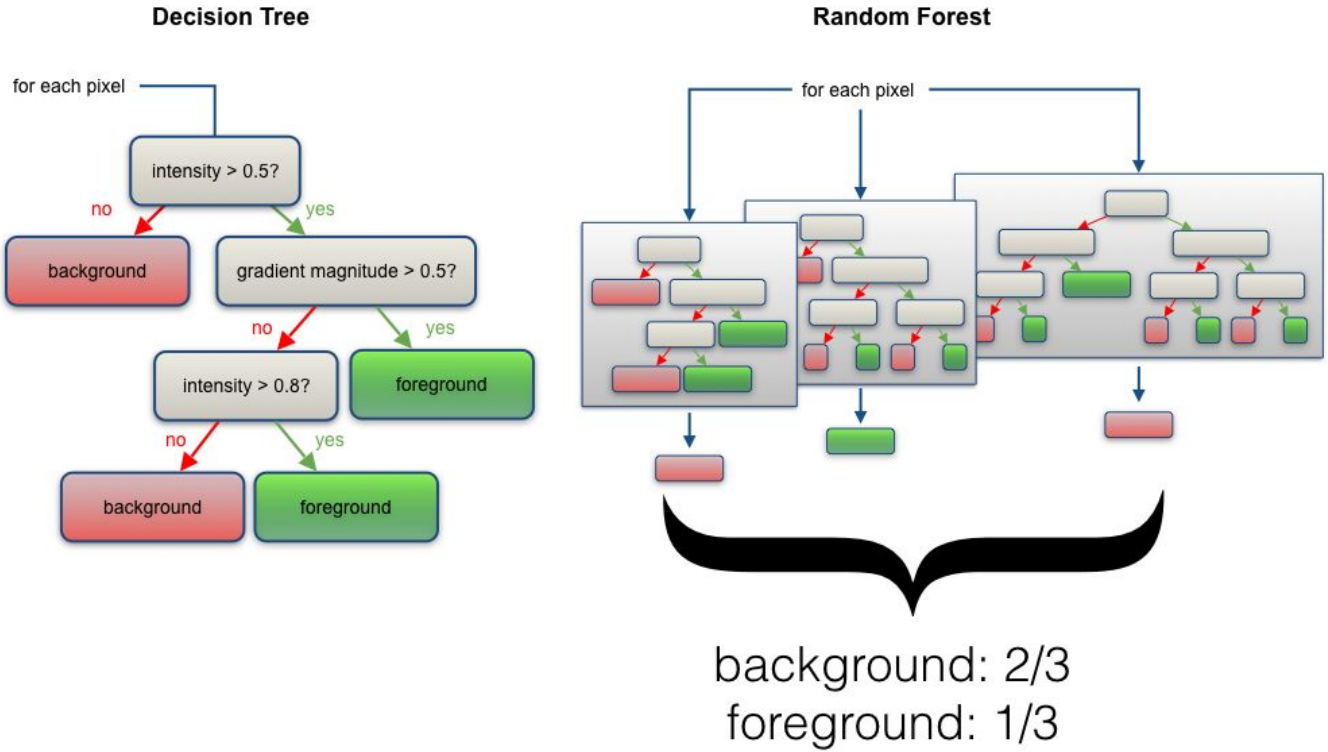
Interactive learning and segmentation toolkit

Developed since 2011

1000s of users, 100s of citations

Workflows for different bioimage analysis tasks

Random Forest in a nutshell



Journal of Machine Learning Research 15 (2014) 3133-3181 Submitted 11/13; Revised 4/14; Published 10/14

Do we Need Hundreds of Classifiers to Solve Real World Classification Problems?

Manuel Fernández-Delgado MANUEL.FERNANDEZ.DELGADO@USC.ES
Eva Cernadas EVA.CERNADAS@USC.ES
Senén Barro SENEN.BARRO@USC.ES
CITIUS: Centro de Investigación en Tecnoloxías da Información da USC
University of Santiago de Compostela
Campus Vida, 15872, Santiago de Compostela, Spain

Dinani Amorim DINANIAMORIM@GMAIL.COM
Departamento de Tecnologia e Ciências Sociais- DTCS
Universidade do Estado da Bahia
Av. Edgard Chastinet S/N - São Geraldo - Juazeiro-BA, CEP: 48.305-680, Brasil

Editor: Russ Greiner

Abstract

We evaluate **179 classifiers** arising from **17 families** (discriminant analysis, Bayesian, neural networks, support vector machines, decision trees, rule-based classifiers, boosting, bagging, stacking, random forests and other ensembles, generalized linear models, nearest-neighbors, partial least squares and principal component regression, logistic and multinomial regression, multiple adaptive regression splines and other methods), implemented in Weka, R (with and without the caret package), C and Matlab, including all the relevant classifiers available today. We use **121 data sets**, which represent **the whole UCI** data base (excluding the large-scale problems) and other own real problems, in order to achieve significant conclusions about the classifier behavior, not dependent on the data set collection. **The classifiers most likely to be the bests are the random forest** (RF) versions, the best of which (implemented in R and accessed via caret) achieves 94.1% of the maximum accuracy overcoming 90% in the 84.3% of the data sets. However, the difference is not statistically significant with the second best, the SVM with Gaussian kernel

Beyond pixels

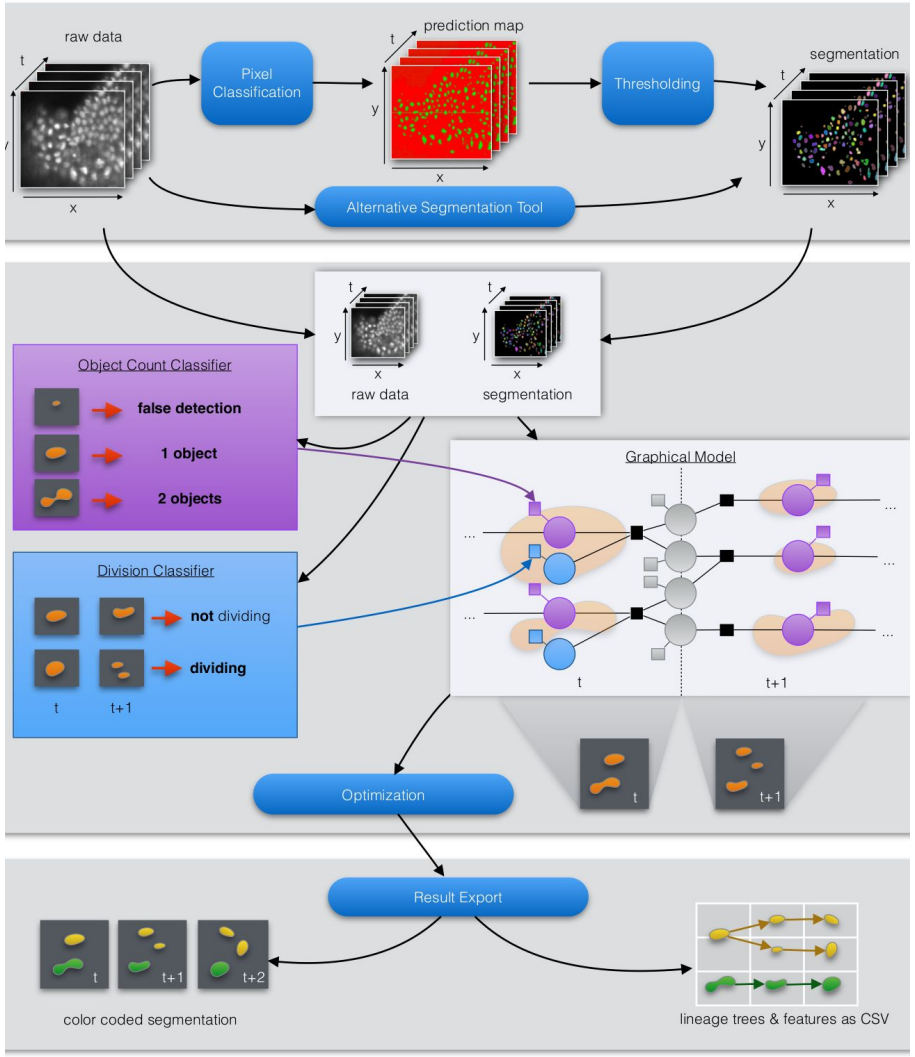
Connect pixels of the same class into objects

Classify objects

Example...

Beyond objects

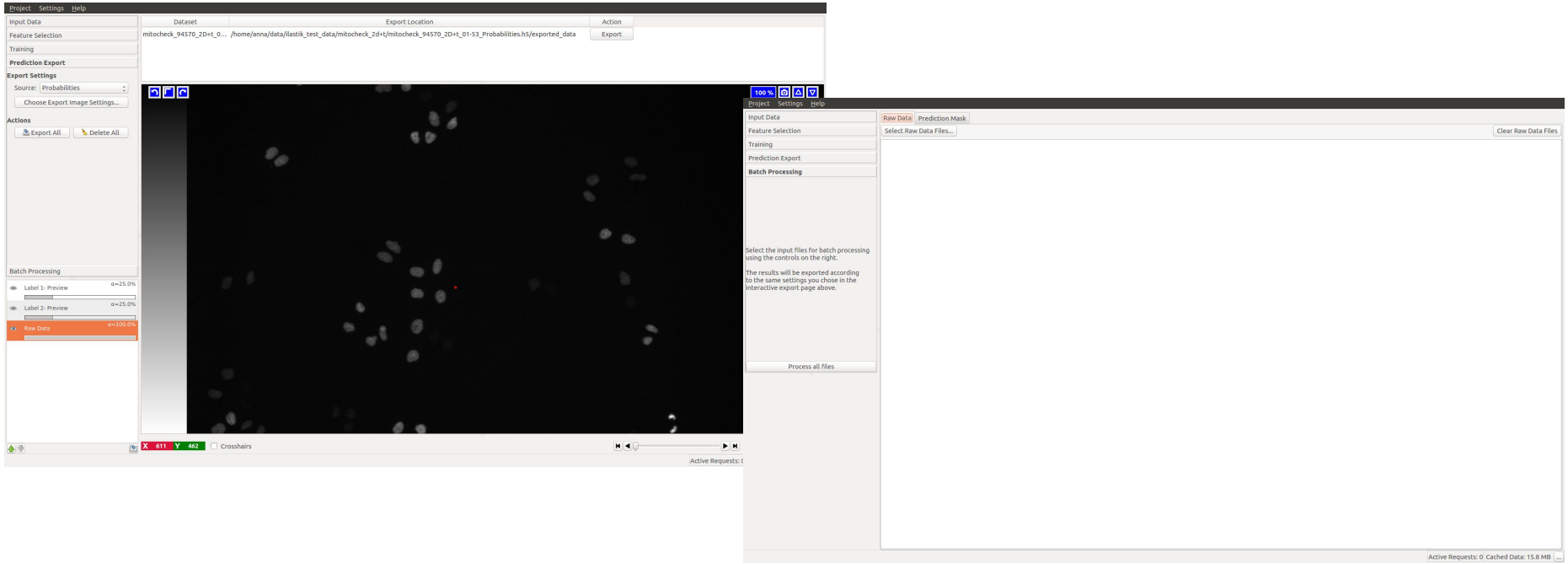
Pixels → objects → tracks



Headless mode

It is trained. Now what?

- GUI - add more images to the batch processing applet



Headless interface

Run from the command line

```
$ cd ilastik-1.1.7-Linux
$ ./run_ilastik.sh --headless
```

```
$ ./ilastik-1.1.7-OSX.app/Contents/ilastik-release/run_ilastik.sh --headless
```

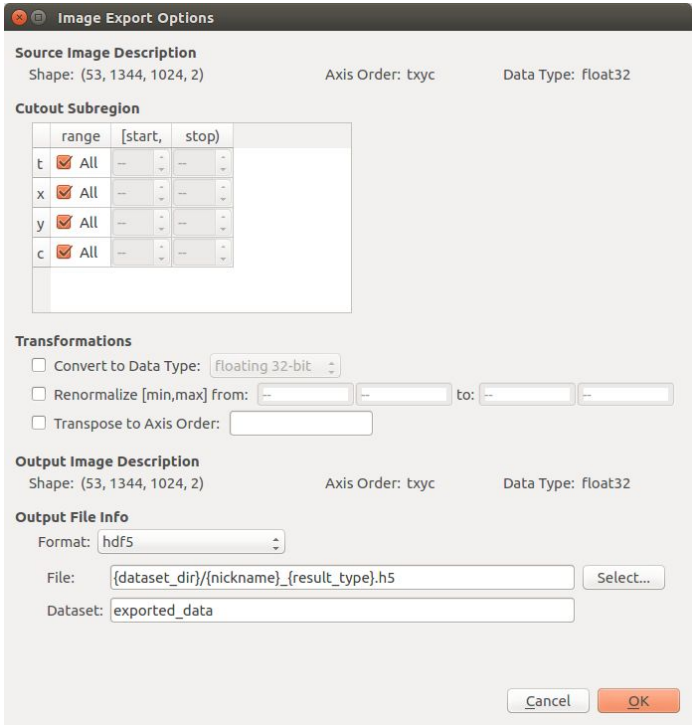
```
$ cd "\Program Files\ilastik-1.0"
$ .\ilastik.bat --headless
```

Arguments

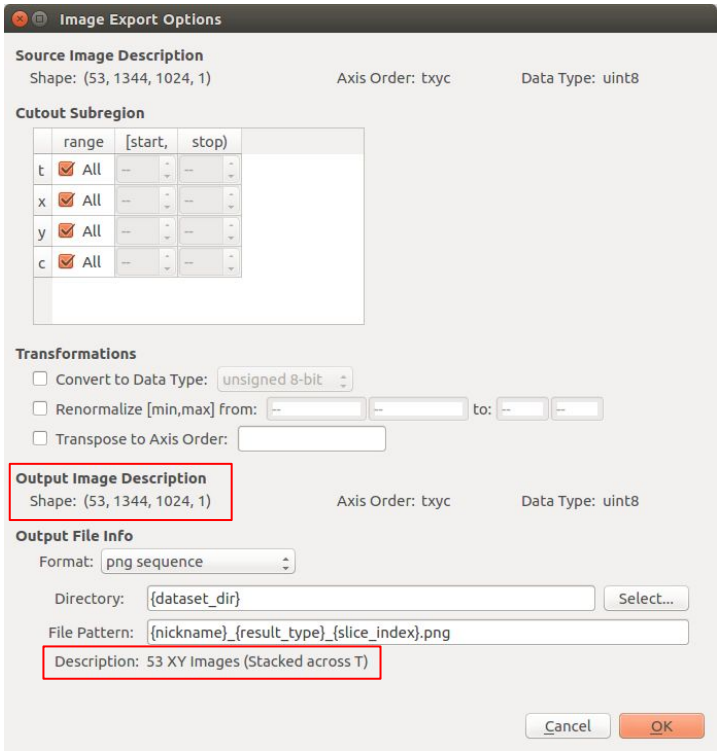
- Project file - the project you trained
- Files to process
  - Separate files: `./run_ilastik.sh --headless --project MyProject.ilp` **`file1.png file2.png`**
  - Or stacks: `./run_ilastik.sh --headless --project MyProject.ilp` **`"my_big_stack*.png"`**

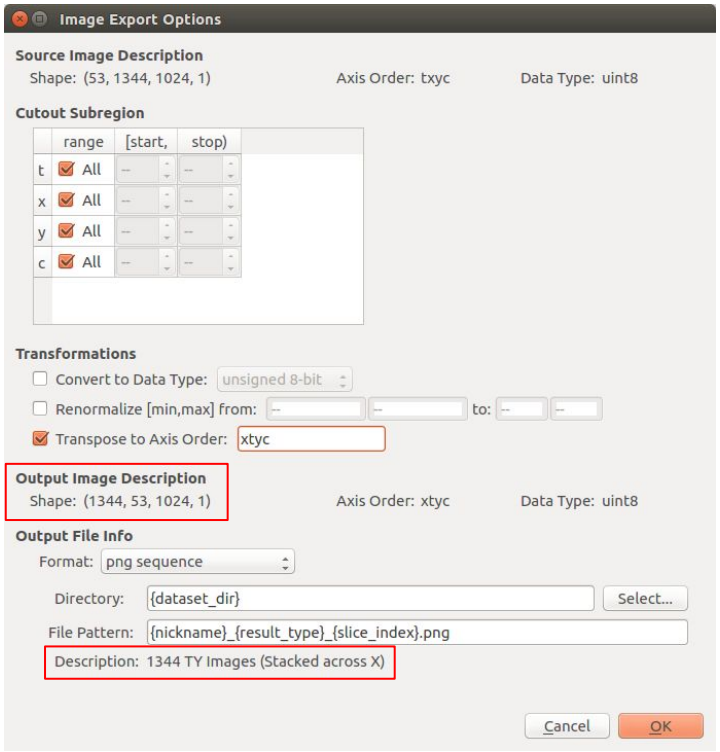
Other options

Same as in the Export Image Options dialog



Exporting a sequence





ilastik project file (.ilp)

HDF5 file: read and edit with standard tools, such as h5py in Python

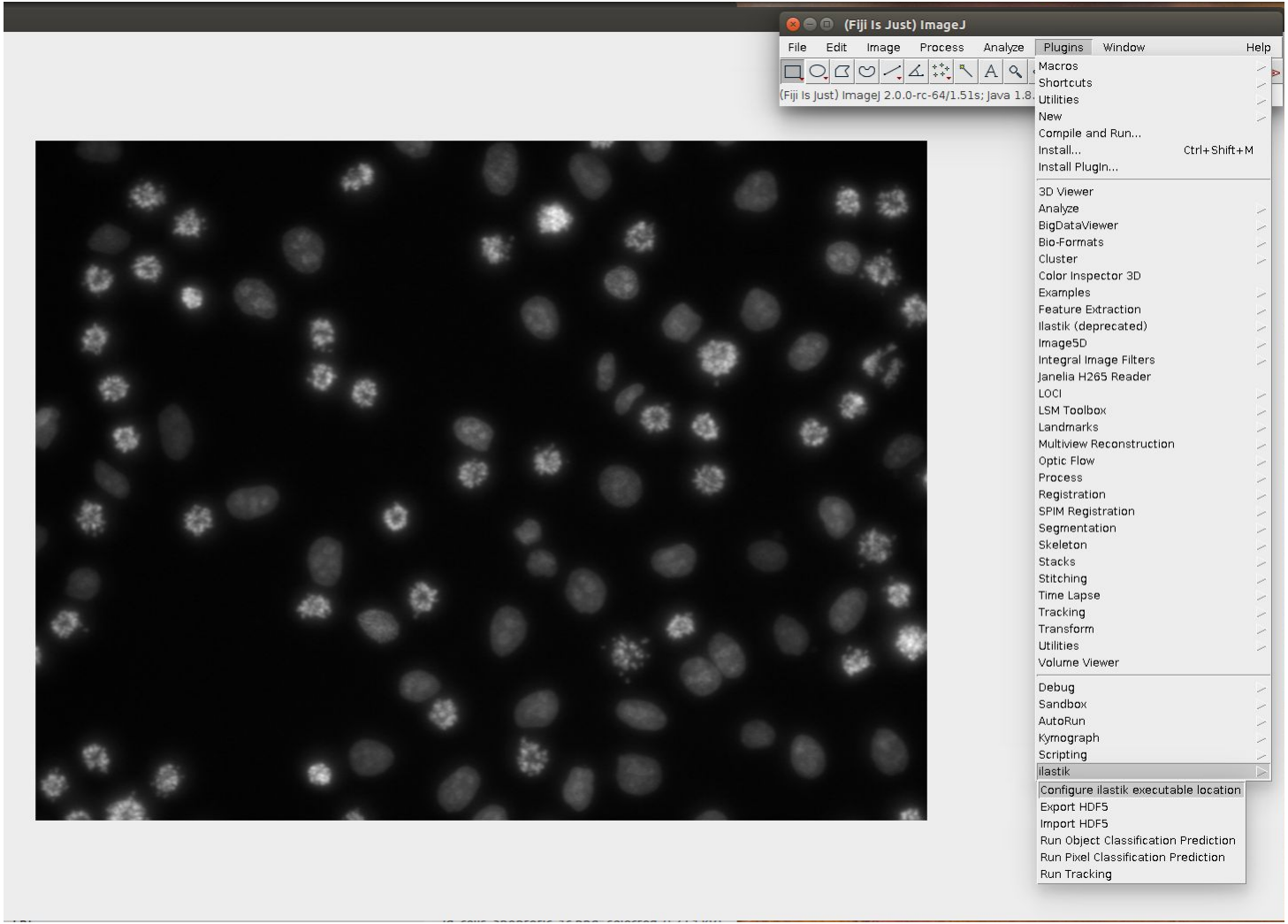
View with HDFView utility

Create new project files for headless benchmarking

Change labels or features and retrain headless with --retrain option

Examples in `ilastik-1.3.0/ilastik-meta/ilastik/bin`

Fiji


(Fiji Is Just) ImageJ
File
Edit
Image
Process
Analyze
Plugins
Window
Help
(Fiji Is Just) ImageJ 2.0.0-rc-64/1.51s; Java 1.8.
Macros
Shortcuts
Utilities
New
Compile and Run...
Install... Ctrl+Shift+M
Install PlugIn...
3D Viewer
Analyze
BigDataViewer
Bio-Formats
Cluster
Color Inspector 3D
Examples
Feature Extraction
Ilastik (deprecated)
Image5D
Integral Image Filters
Janelia H265 Reader
LOCI
LSM Toolbox
Landmarks
Multiview Reconstruction
Optic Flow
Process
Registration
SPIM Registration
Segmentation
Skeleton
Stacks
Stitching
Time Lapse
Tracking
Transform
Utilities
Volume Viewer
Debug
Sandbox
AutoRun
Kymograph
Scripting
ilastik
Configure ilastik executable location
Export HDF5
Import HDF5
Run Object Classification Prediction
Run Pixel Classification Prediction
Run Tracking

Knime

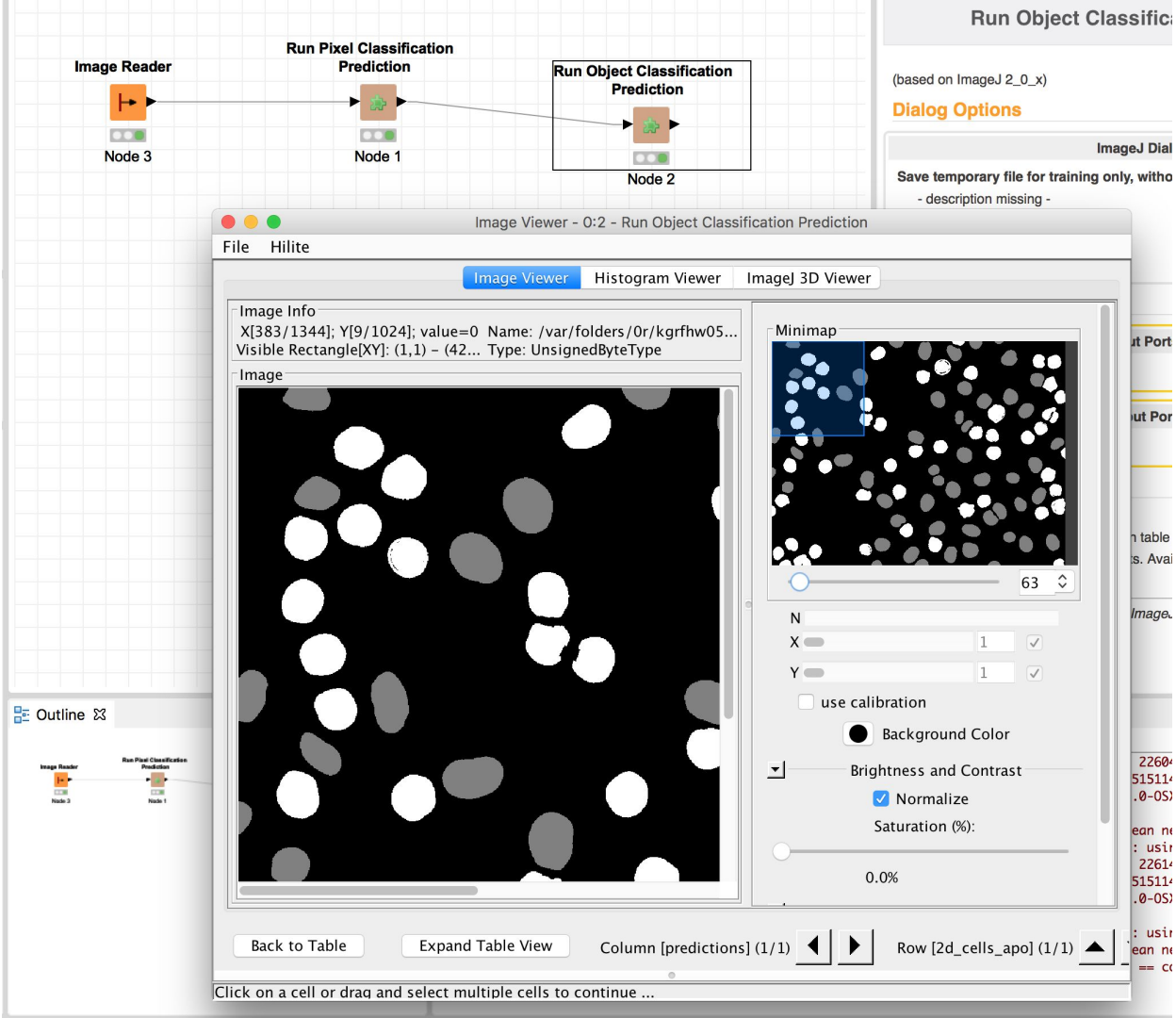
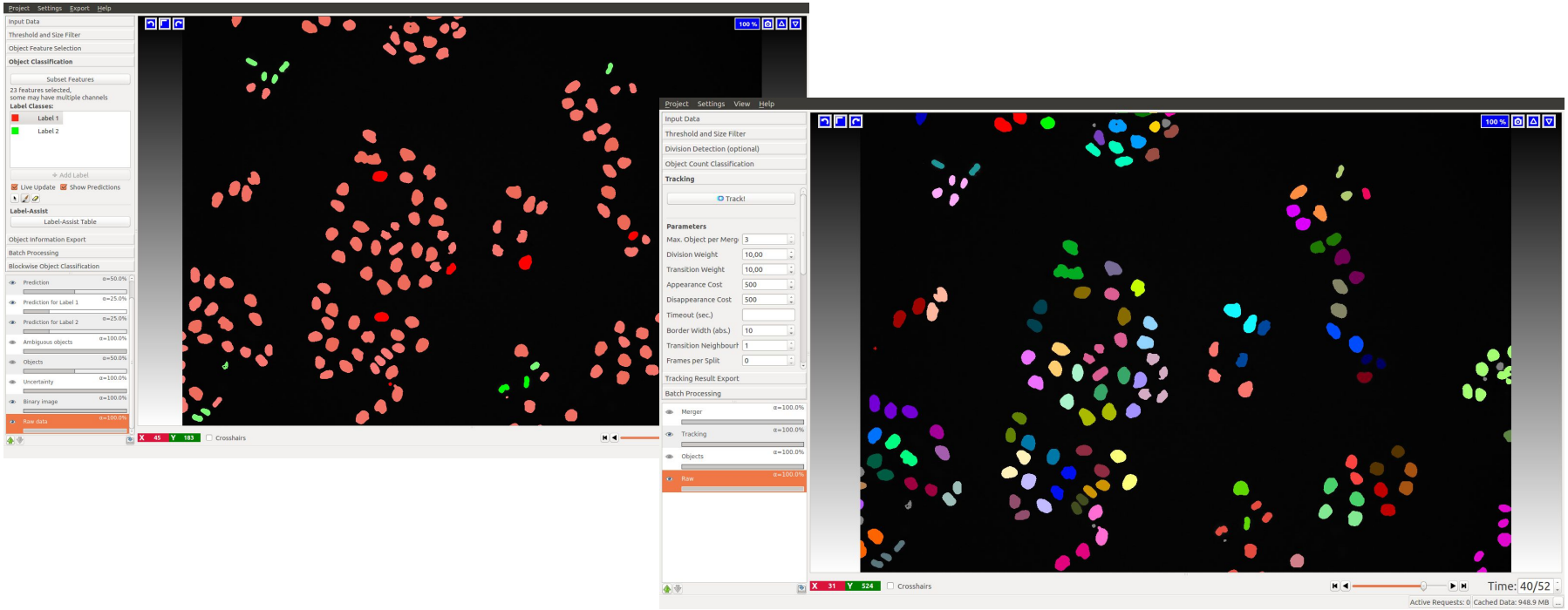


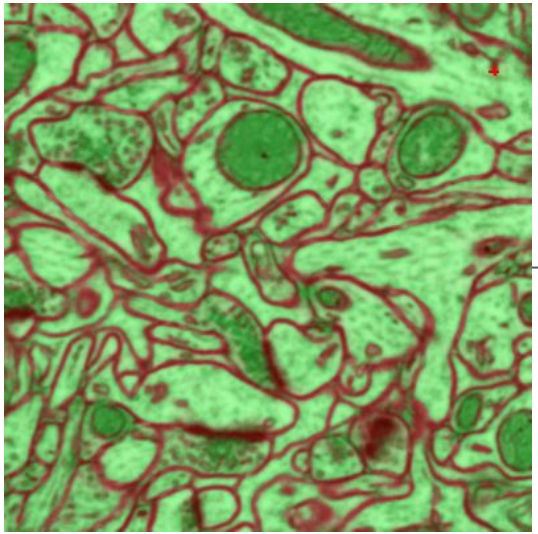
Image Reader
Node 3
Run Pixel Classification Prediction
Node 1
Run Object Classification Prediction
Node 2
Run Object Classific
(based on ImageJ 2_0_x)
Dialog Options
ImageJ Dial
Save temporary file for training only, witho
- description missing -
Image Viewer - 0:2 - Run Object Classification Prediction
File
Hilite
Image Viewer
Histogram Viewer
ImageJ 3D Viewer
Image Info
X[383/1344]; Y[9/1024]; value=0 Name: /var/folders/0r/kgrfhw05...
Visible Rectangle[XY]: (1,1) - (42... Type: UnsignedByteType
Image
Minimap
63
N
X
1
Y
1
use calibration
Background Color
Brightness and Contrast
Normalize
Saturation (%):
0.0%
Outline
Back to Table
Expand Table View
Column [predictions] (1/1)
Row [2d_cells_apo] (1/1)
Click on a cell or drag and select multiple cells to continue ...

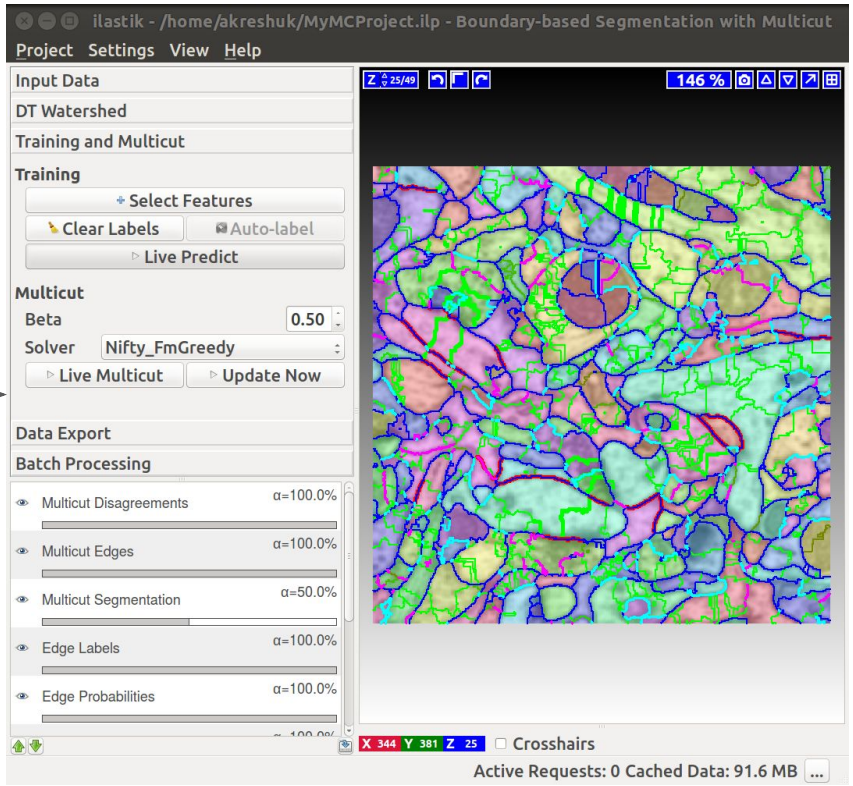
Workflows with ilastik

Object classification and Tracking



Pixel classification and Multicut





Ilastik → Fiji → ilastik

Pixel classification → watershed → object classification

Pixel classification → more features → pixel classification

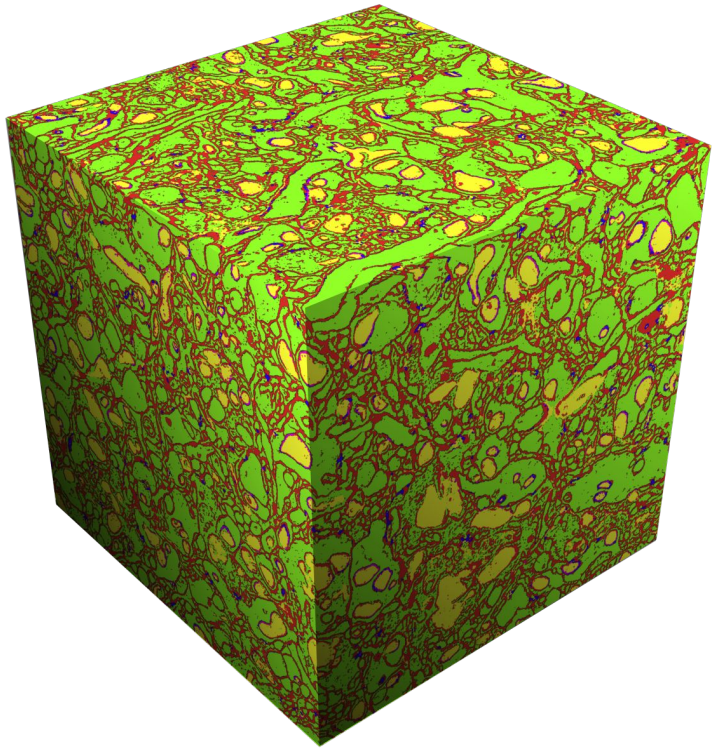
Conclusions

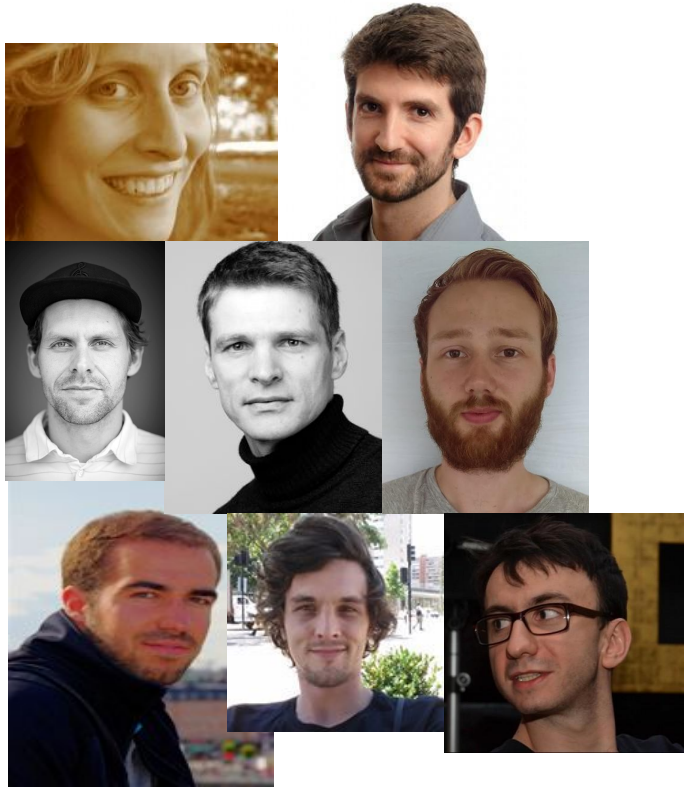
- Machine learning is very powerful
- But it’s not all you need

Conclusions

- Machine learning is very powerful
- But it’s not all you need

- Train interactively, apply anywhere





Thank you!

Download: ilastik.org/download

Development: github.com/ilastik

Contact: team@ilastik.org