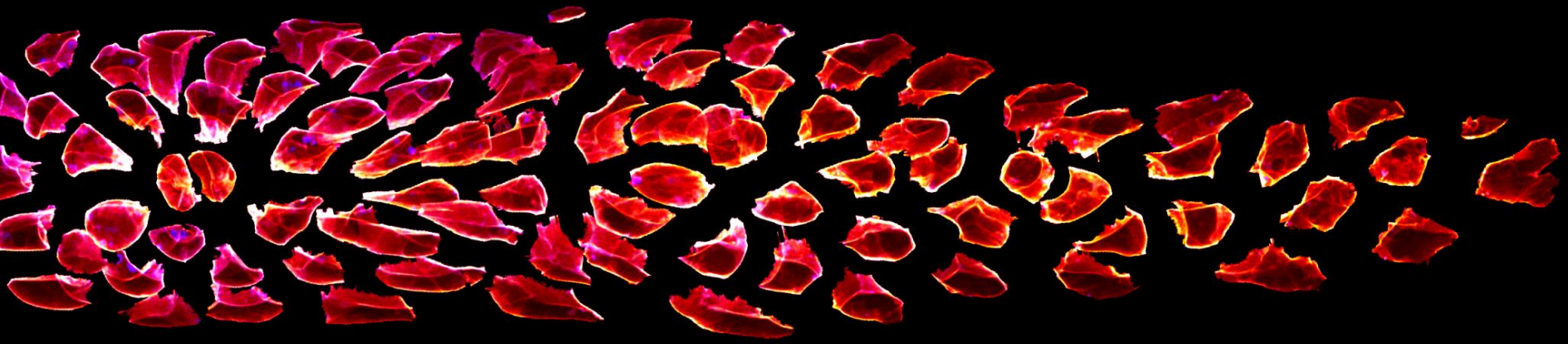
Bonus Lecture! Yay!

EMBL Bio-IT/ALMF Course

Image Analysis with Python 2018

Sessions 3 – 5



Jonas Hartmann

Gilmour group, EMBL Heidelberg

Agenda

- Parameter optimization
- Smart microscopy
- Object tracking
- Machine learning for segmentation
- More machine learning

Parameter Optimization

Parameter Optimization

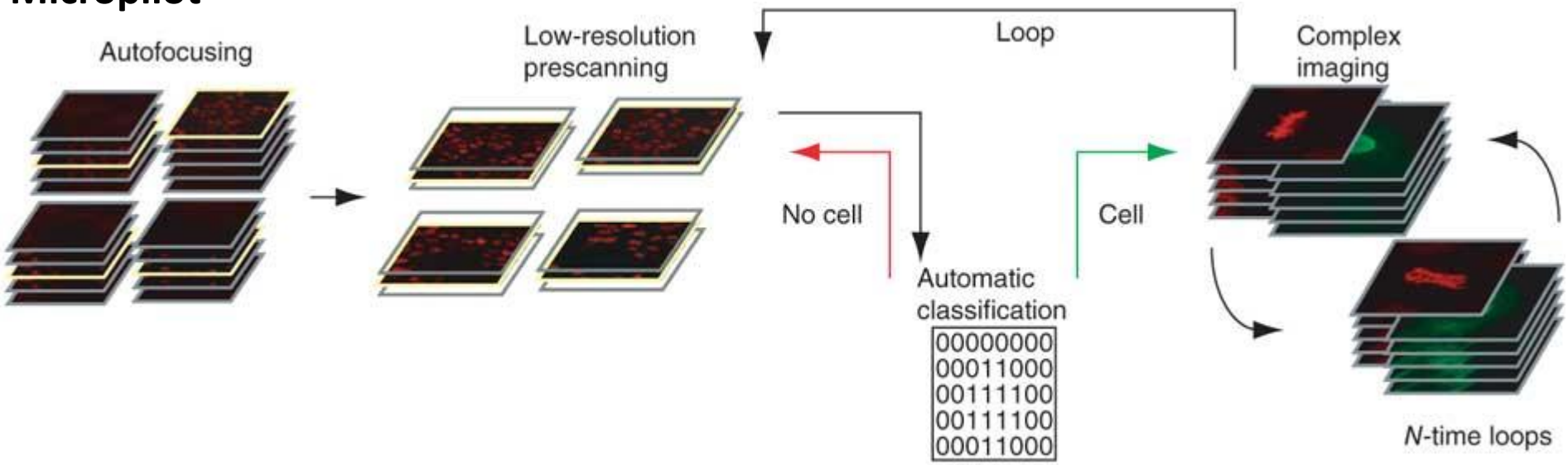
- **Selecting parameters is important but difficult!**
  - **Examples: *sigma, SE size, morphology params, DT sigma, min_distance, ...***
  - **Option 1: Use reasoning based on 'limits'**
  - **Option 2: Trial and error**
    - **This can be automated!**
      1. **Create some manual gold standard segmentations**
      2. **Automatically screen through 100s of parameter combinations**
      3. **This becomes feasible by using the compute cluster**
      4. **Tobias Rasse (ALMF) is developing a framework for this at EMBL!**

Smart Microscopy

Smart Microscopy

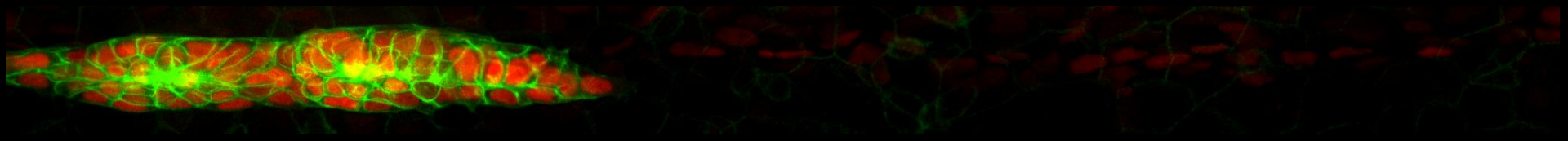
- Direct coupling of microscopy and image analysis
- Example 1: Region Of Interest (ROI) detection
  - Identify ROI in low-res high-FOV image
  - Instruct microscope to acquire ROI in high-res

Micropilot

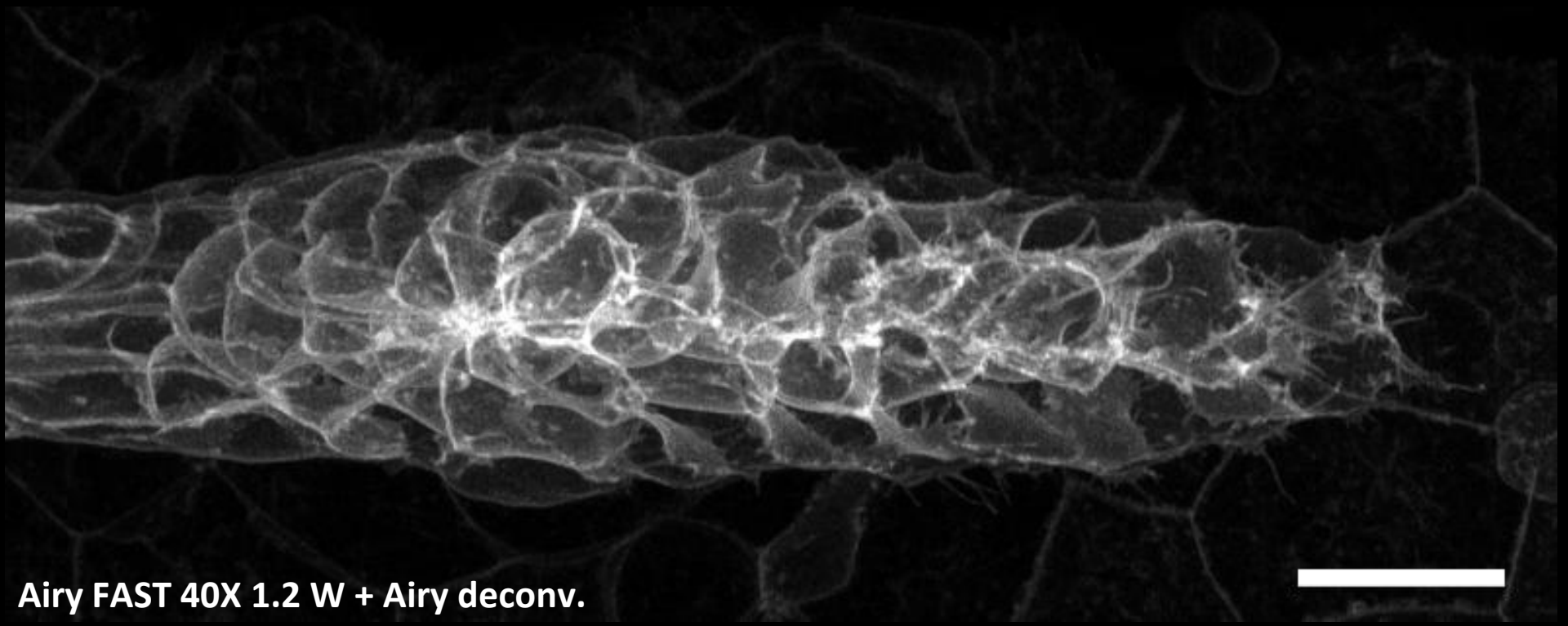


Published 2011 in Nature Methods by Ellenberg & Pepperkok groups

Smart Microscopy



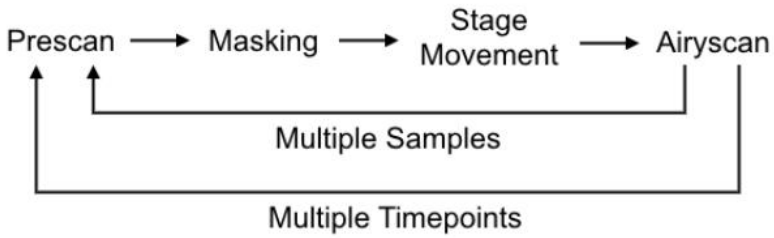
VoX Spinning Disk 40X 1.2 W

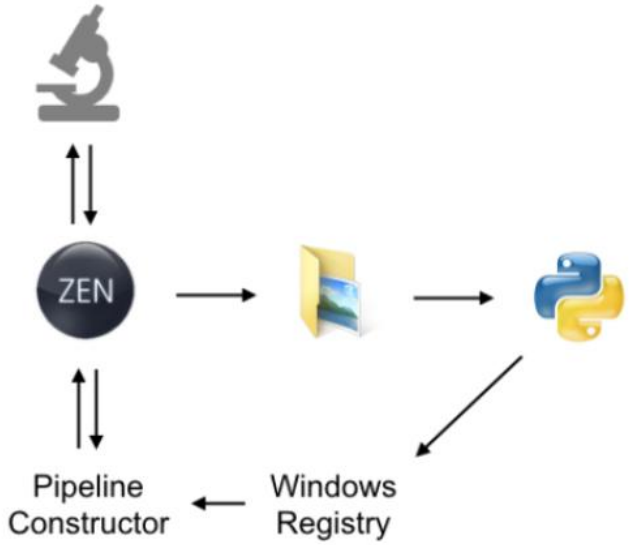


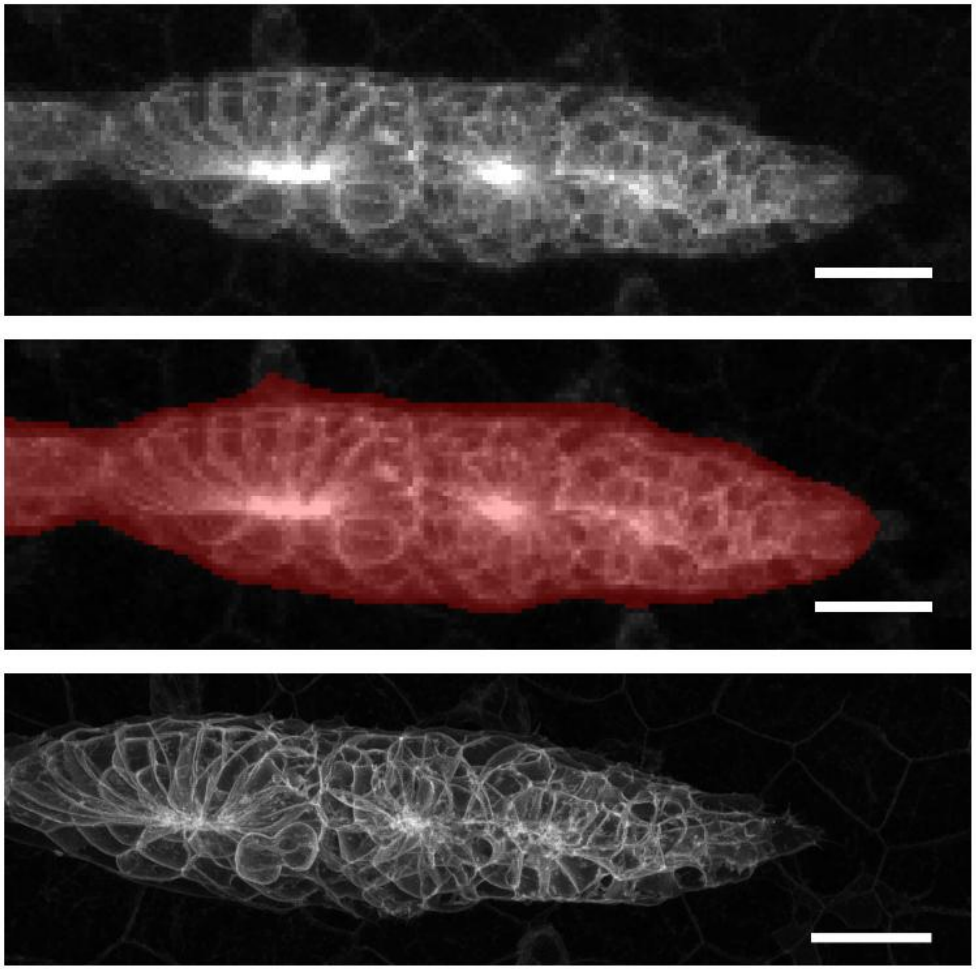
Airy FAST 40X 1.2 W + Airy deconv.

Smart Microscopy

- **Direct coupling of microscopy and image analysis**
- **Example 2: Live object tracking**

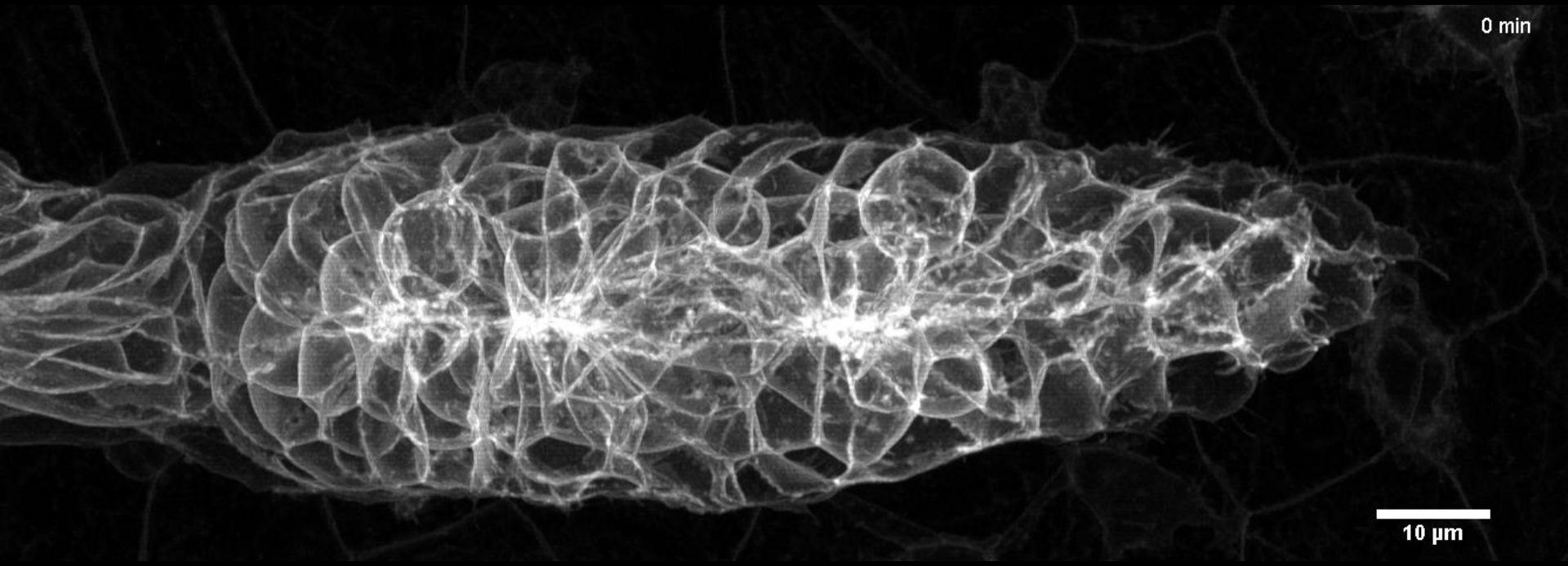






Scale bars: 15µm

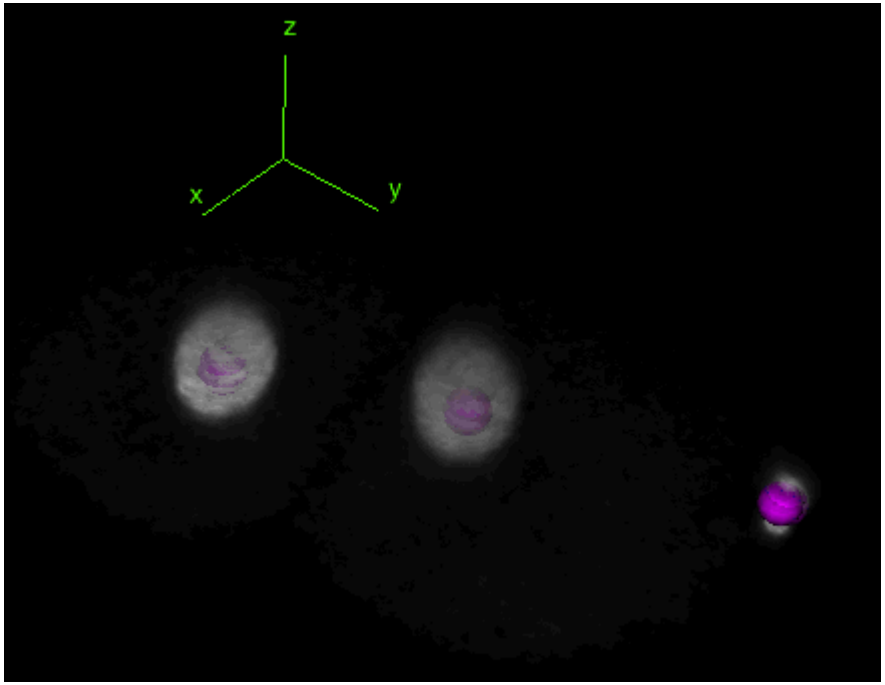
Smart Microscopy



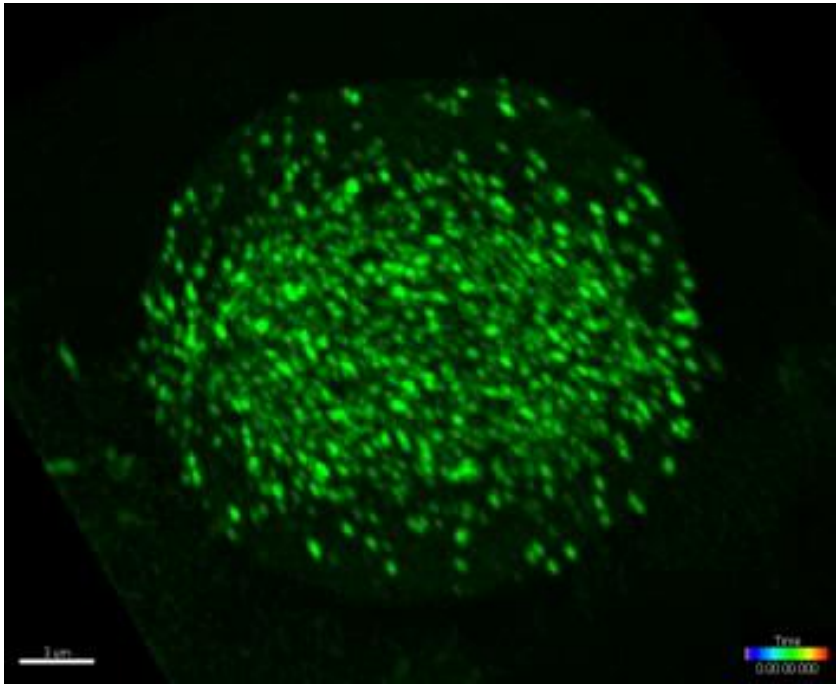
Object Tracking

Object Tracking

- **Assign each labeled object at time *t0* a corresponding object at *t1***
  - **Approach: segment independently, then link objects (by optimization)**
  - **Linking based on: space, movement, object properties**
  - **Easier for small *δt***
  - **Challenges: poor segmentation, overlapping objects, dividing/merging objects**



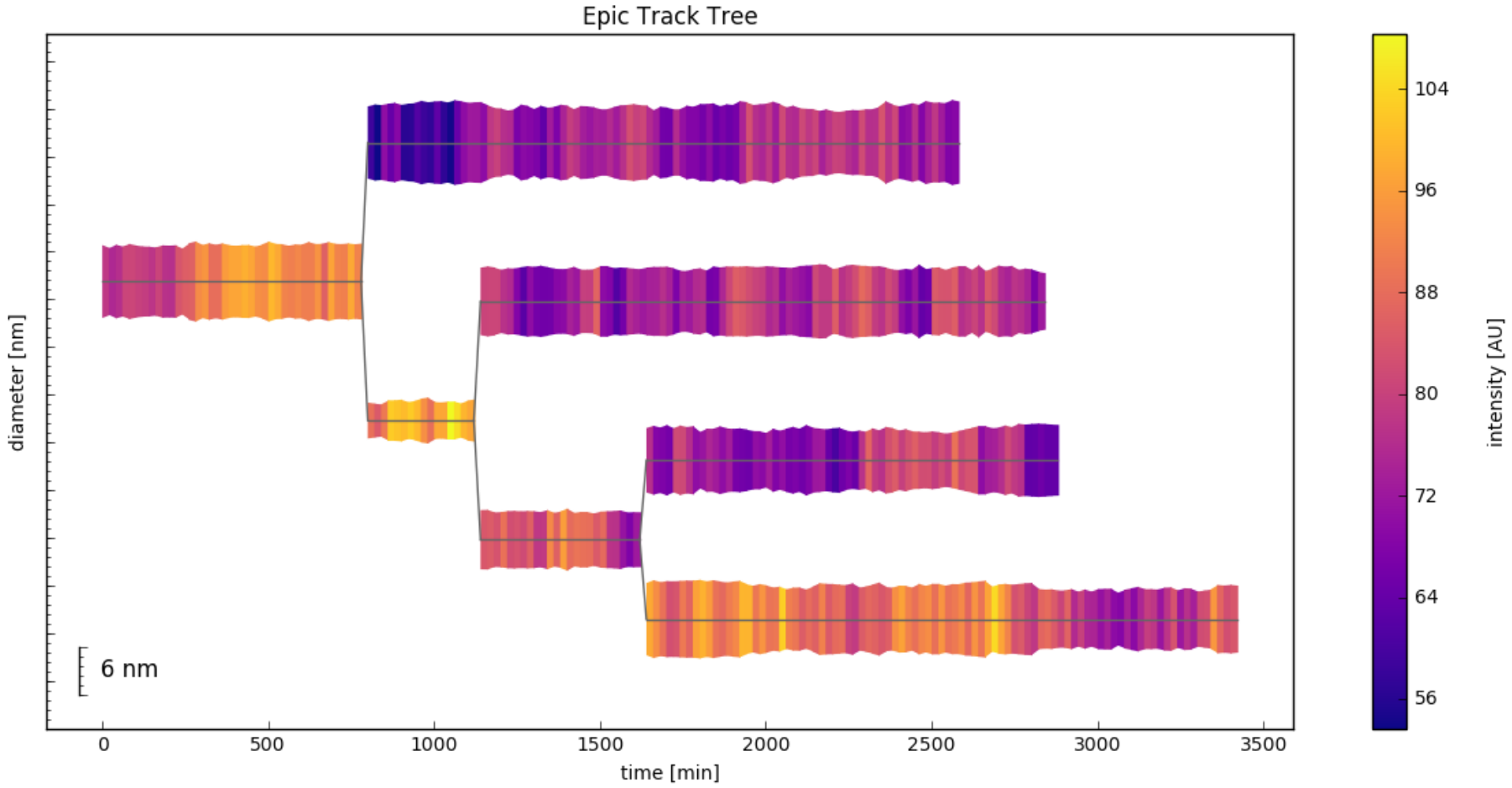
From Fiji's TrackMate plugin



From Eric Betzig's group

Object Tracking

- **Assign each labeled object at time *t0* a corresponding object at *t1***



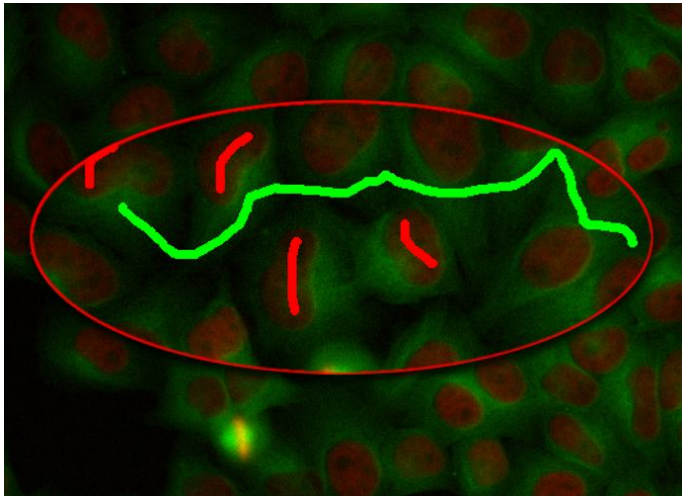
See github.com/WhoIsJack/TrackTree

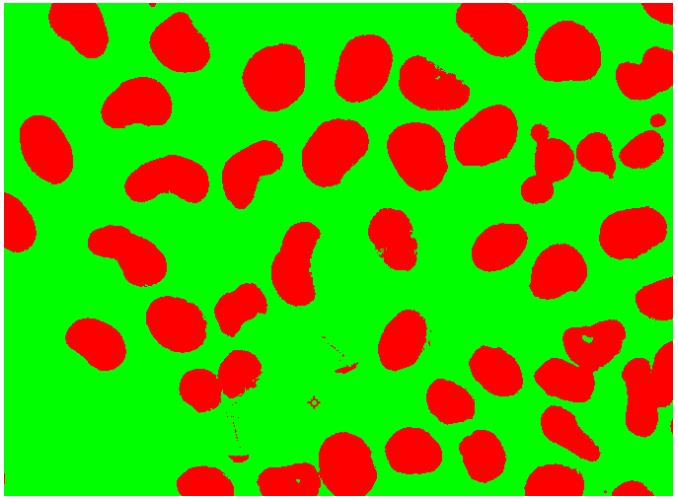
Machine Learning for Segmentation

Machine Learning for Segmentation

- **Goal: foreground-background detection by machine learning**
  - **This is a classification task: classify pixels into groups**
  - **Approach: supervised learning**
    - **Manually label example pixels**
    - **Extract features (intensity, neighborhood, …)**
    - **Train classifier, e.g. random forest**
    - **Make prediction for all other pixels**

Ilastik



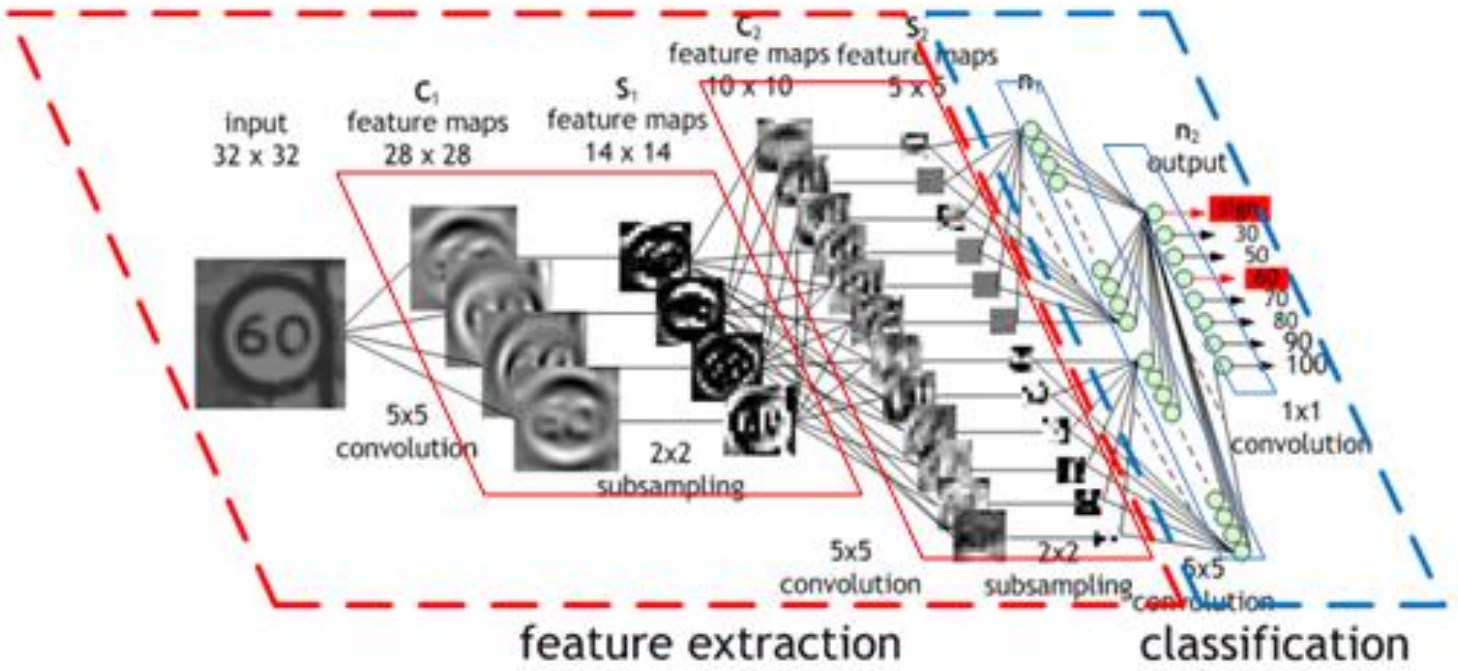


From the Ilastik website

Also useful as `preprocessing` (use probabilities)!

Machine Learning for Segmentation

- **Machine learning in python**
  - **scikit-learn (sklearn)**
- **Deep Learning**
  - **Keras, Tensorflow, PyTorch**



Similar approach (but without neural networks): speak to **Christian Tischer, ALMF**

Machine Learning for Segmentation

Machine Learning for Image Analysis

Date: Monday 29 - Wednesday 31 October 2018

Venue: EMBL - EMBL- Heidelberg, Meyerhofstraße, 69117, Heidelberg, Germany

Application opens: Monday May 07 2018

Application deadline: Friday June 15 2018

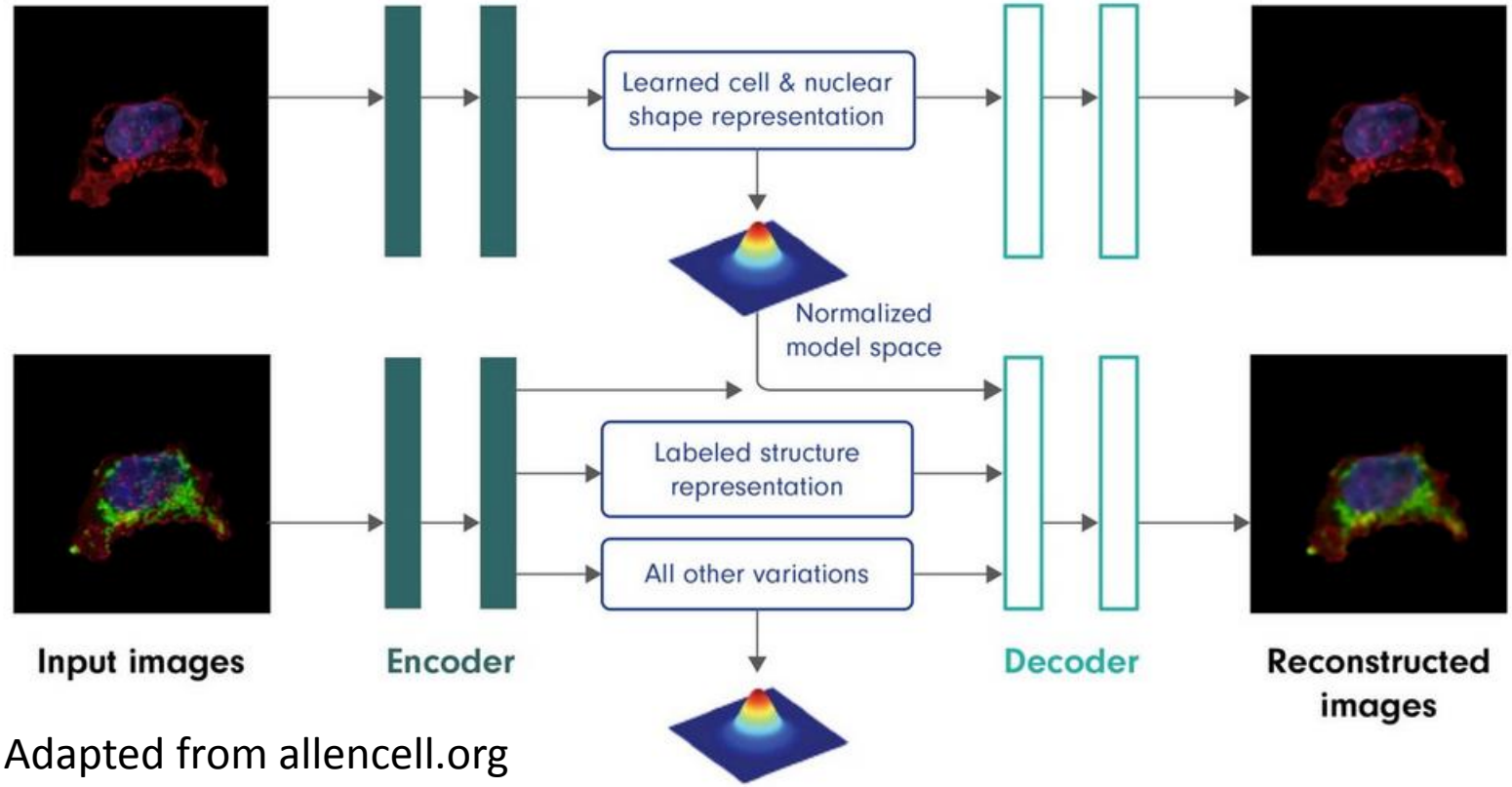
Participation: Open application with selection

This is a blended learning course on Machine Learning for Image Analysis, consisting of three online sessions with associated hands-on exercises prior to the workshop, a three day face-to-face workshop at EMBL Heidelberg and two optional online sessions with associated hands-on exercises after the workshop.

More Machine Learning

More Machine Learning

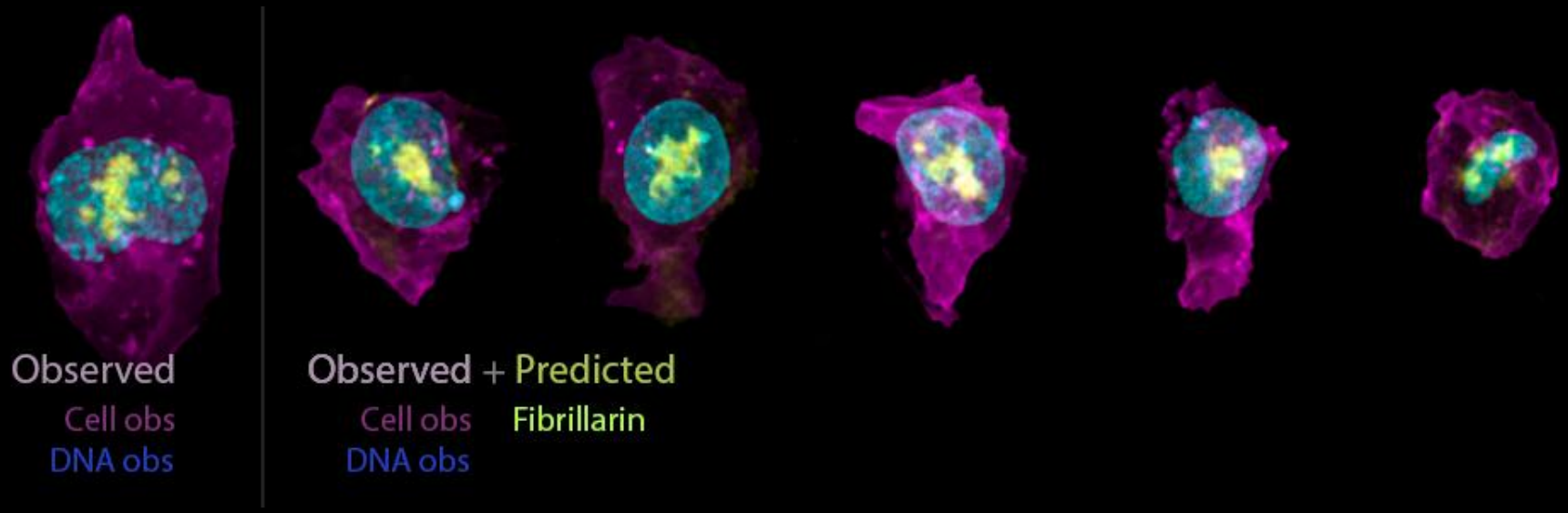
- **Deep neural network autoencoder**
  - **First Learn to reconstruct mem+nuc image from more sparse representation**
  - **Next learn to reconstruct other channels based on mem+nuc**



Adapted from allencell.org

More Machine Learning

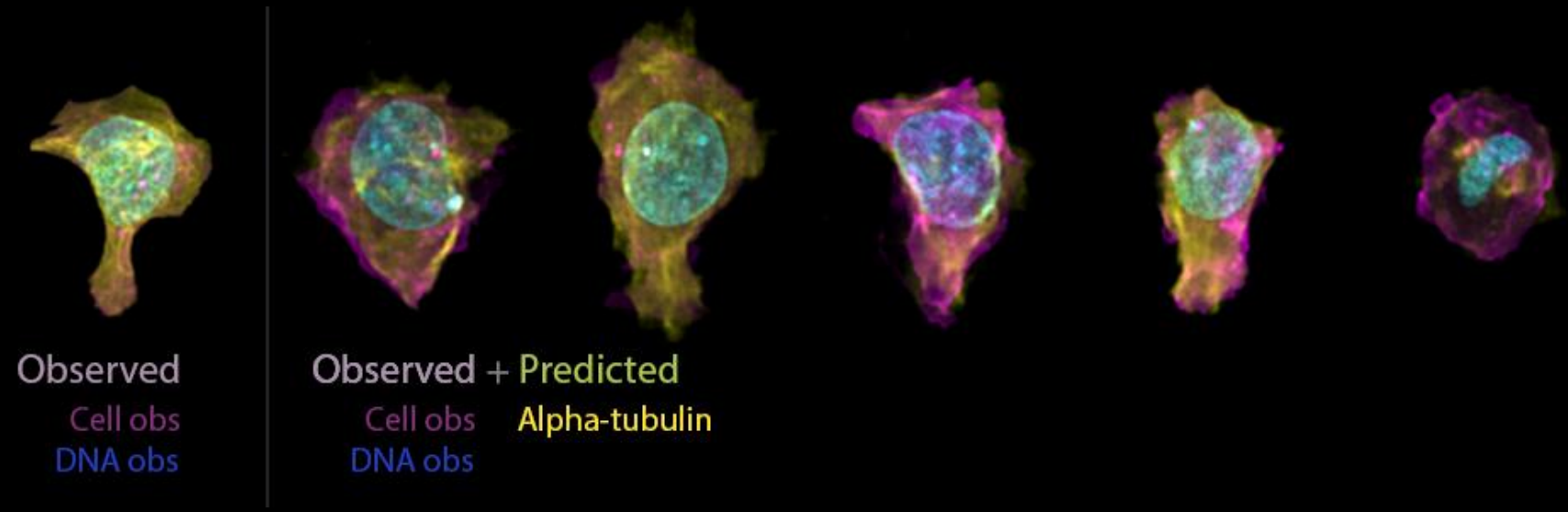
- **Deep neural network autoencoder**



Adapted from allencell.org

More Machine Learning

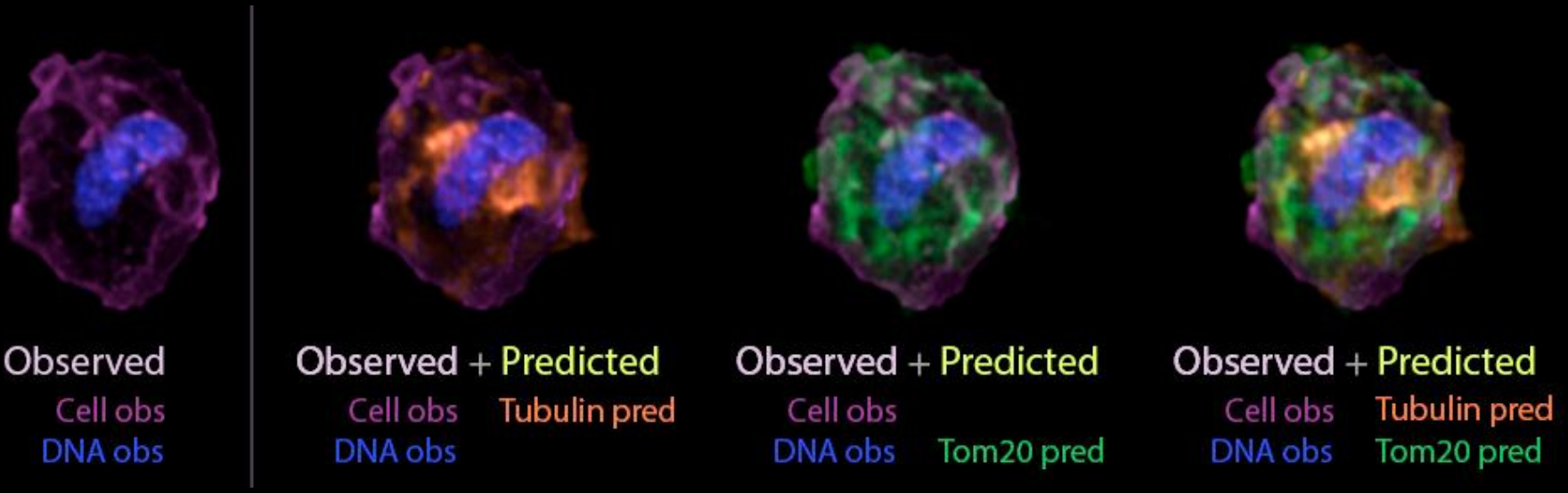
- **Deep neural network autoencoder**



Adapted from allencell.org

More Machine Learning

- **Deep neural network autoencoder**



Adapted from allencell.org

- **Advantages: construction of 'atlases' without feature engineering!**
- **Disadvantages: encoded model is a 'black box'**

That‘s all!

Thanks!

:)