Detection of overlapping cells in microscopic scans of GFP brain tissues

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Problem Description

- Cell detection/annotation is an image processing problem
- Traditionally done manually with high accuracy
- With the large amount of data in Gigapixel images, it is not feasible to do it manually
- Deep learning and other conventional methods give upto only 92% performance, which is not sufficient.
- Multi stage method using DT and ridge filters to get an estimate of cell centres gave 97% accuracy.
- Our problem is to replicate stage 1 of this paper

Samples

Total 8 images

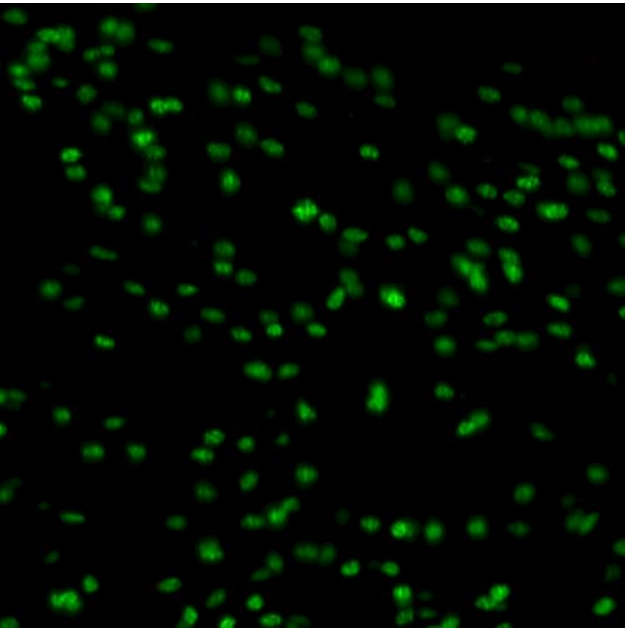
1 - Dense (without enhancement, enhanced, ground truth) (3 images)

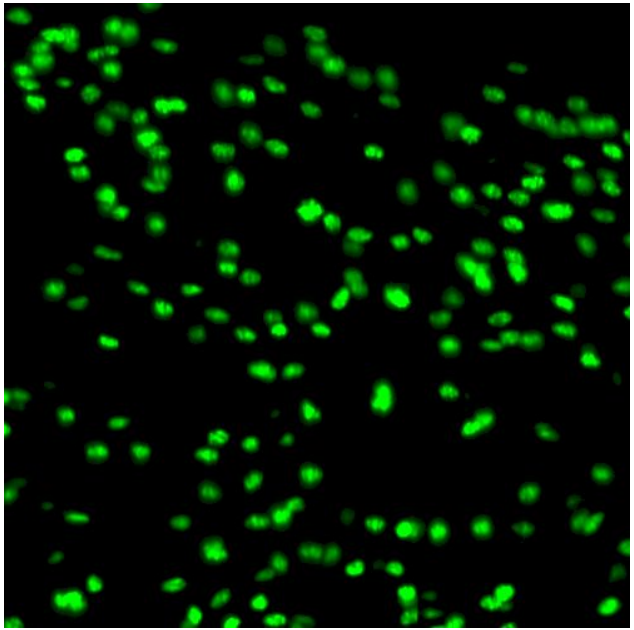
2 - Overlapping (without enhancement, enhanced, ground truth) (3 images)

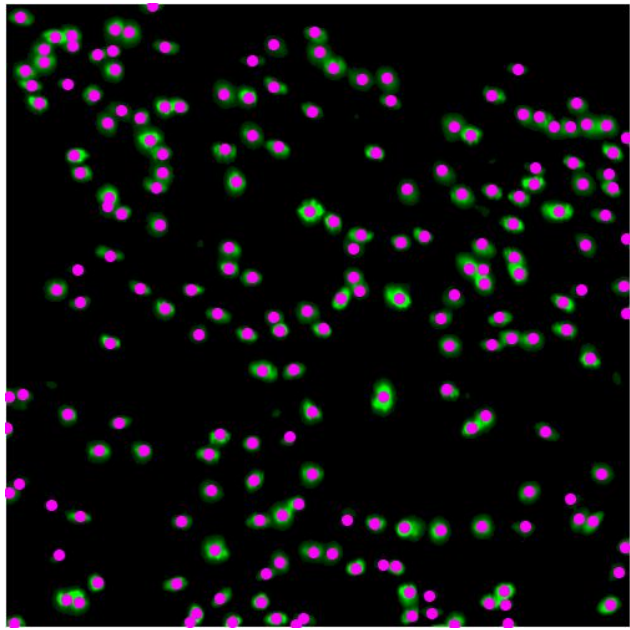
3 - s12 (enhanced, ground truth) (2 images)

csv and mat files also provided for every image

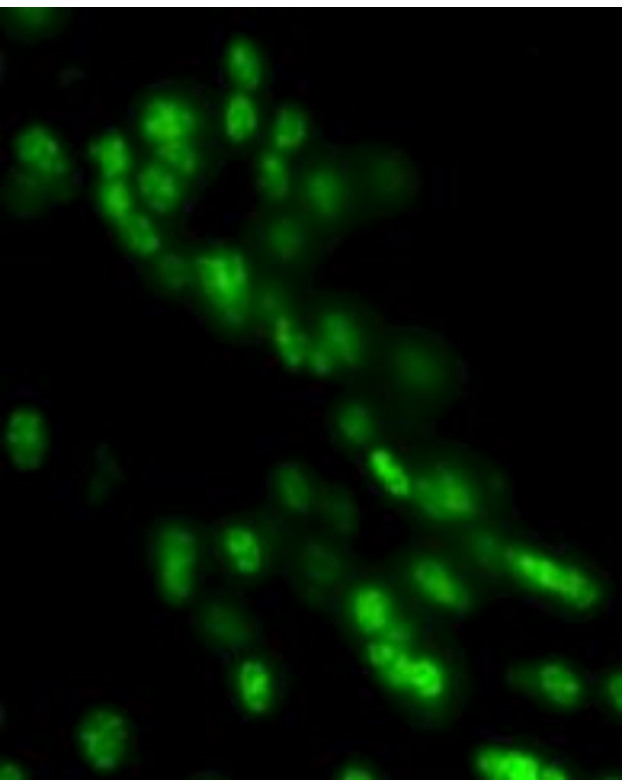
Dense

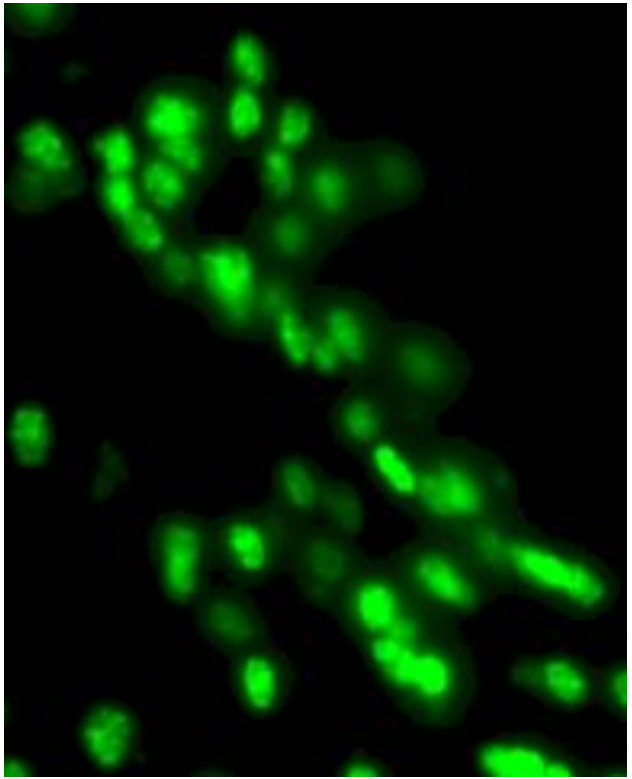


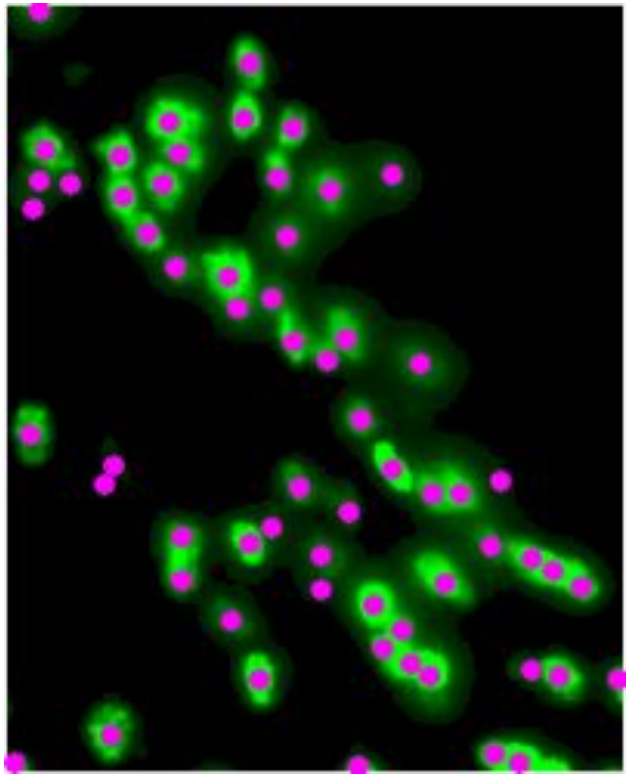




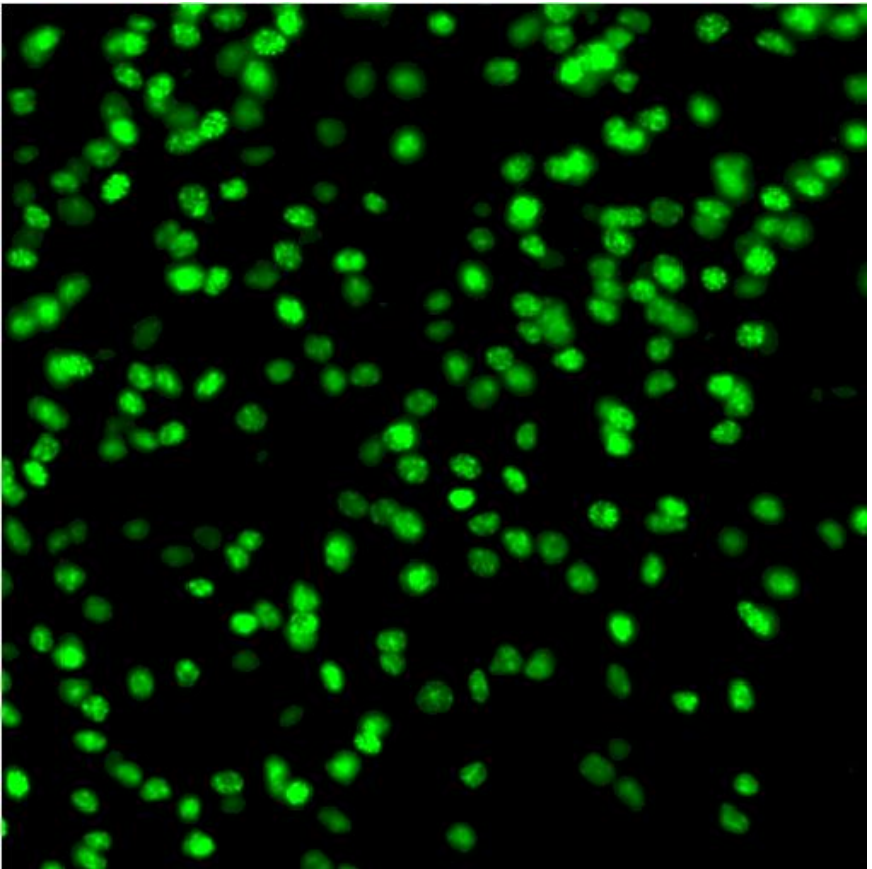
Overlapping

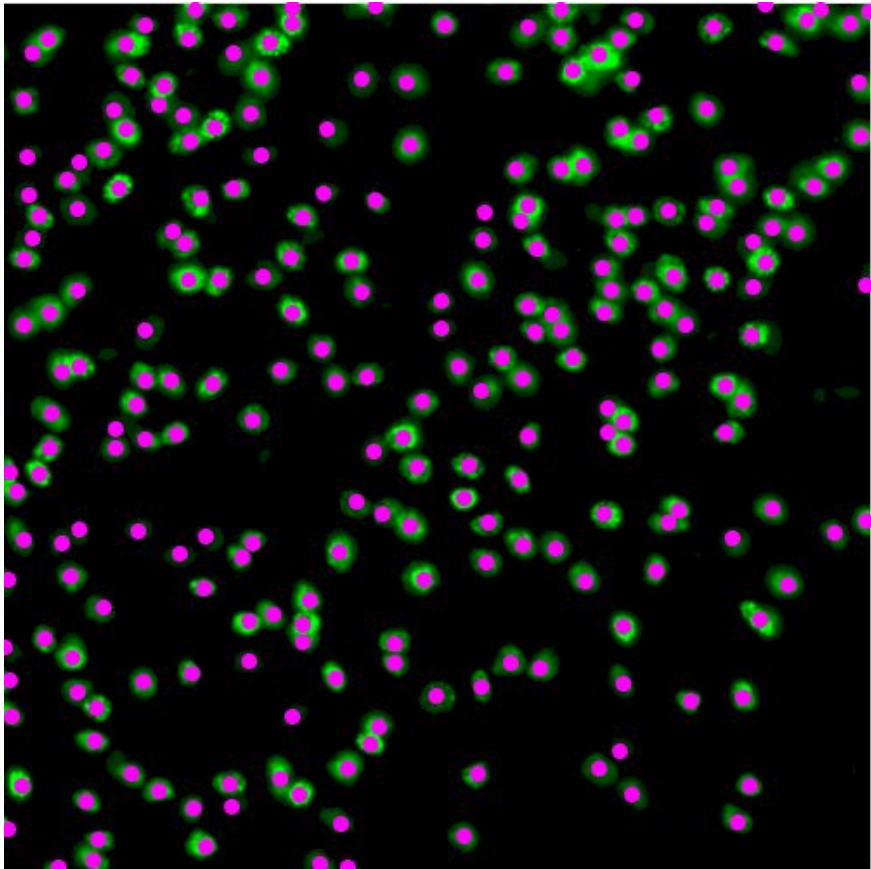






s12





Overview of phase 1

- Obtain a foreground region (FGR) using thresholding
- Get a distance transform (DT) on a Binary FGR
- Get a modulated distance transform (MDT) for better peaks
- Do a vessel filter on the mDT to get ridge lines
- Get the local maxima / peaks on the ridge lines
- Merge nearby local maxima
- Combine Bifurcation points and merged local maxima to get the phase 1 estimates for cell centres

Tested changes on stage 1 cell centers

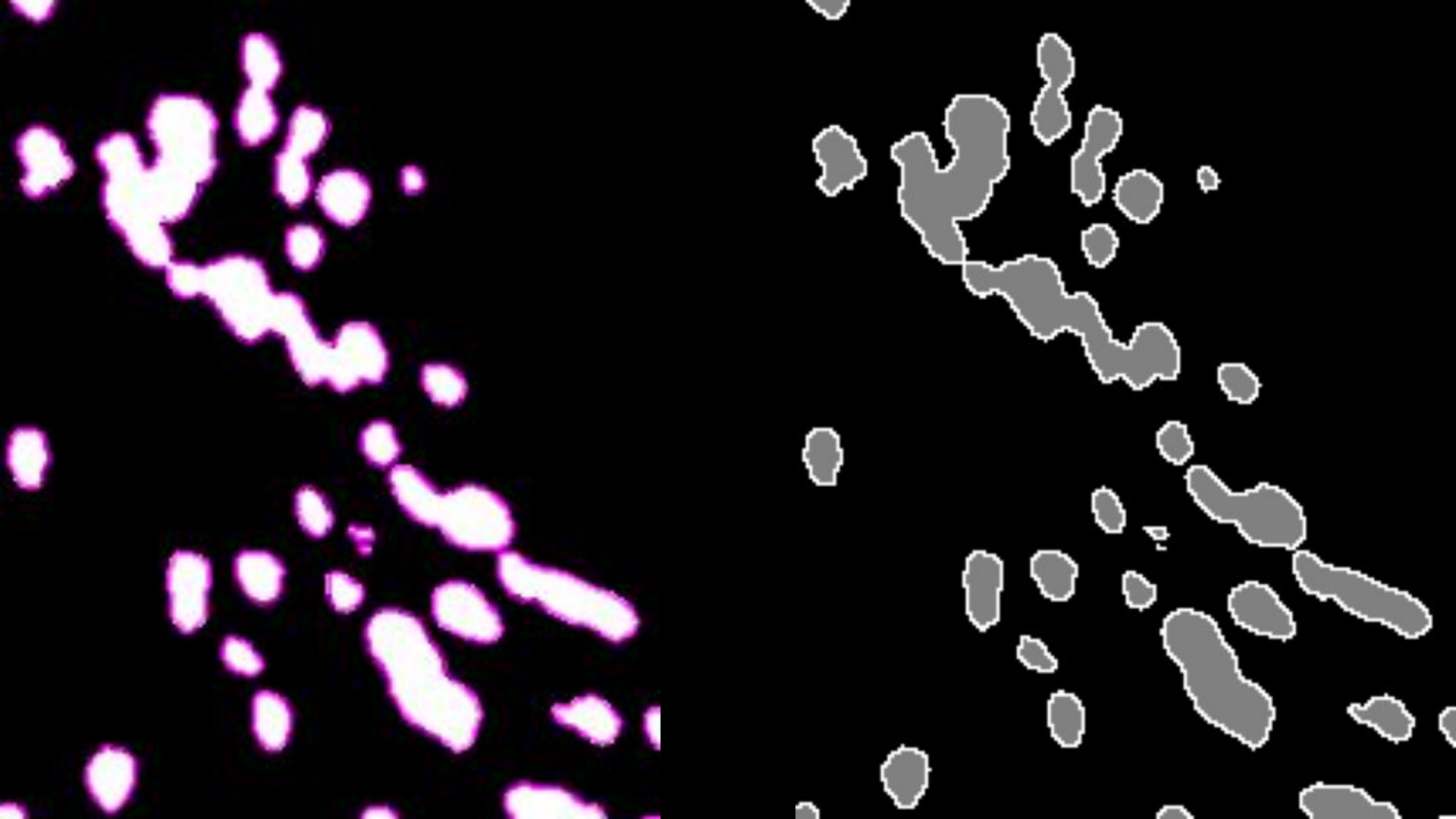
- An optimization based method to improve the cell center detections from stage 1
- We take a region of size m×m around the centers from stage 1
- Improve it by fitting an ellipse using local optimization
- The ellipses are of the form

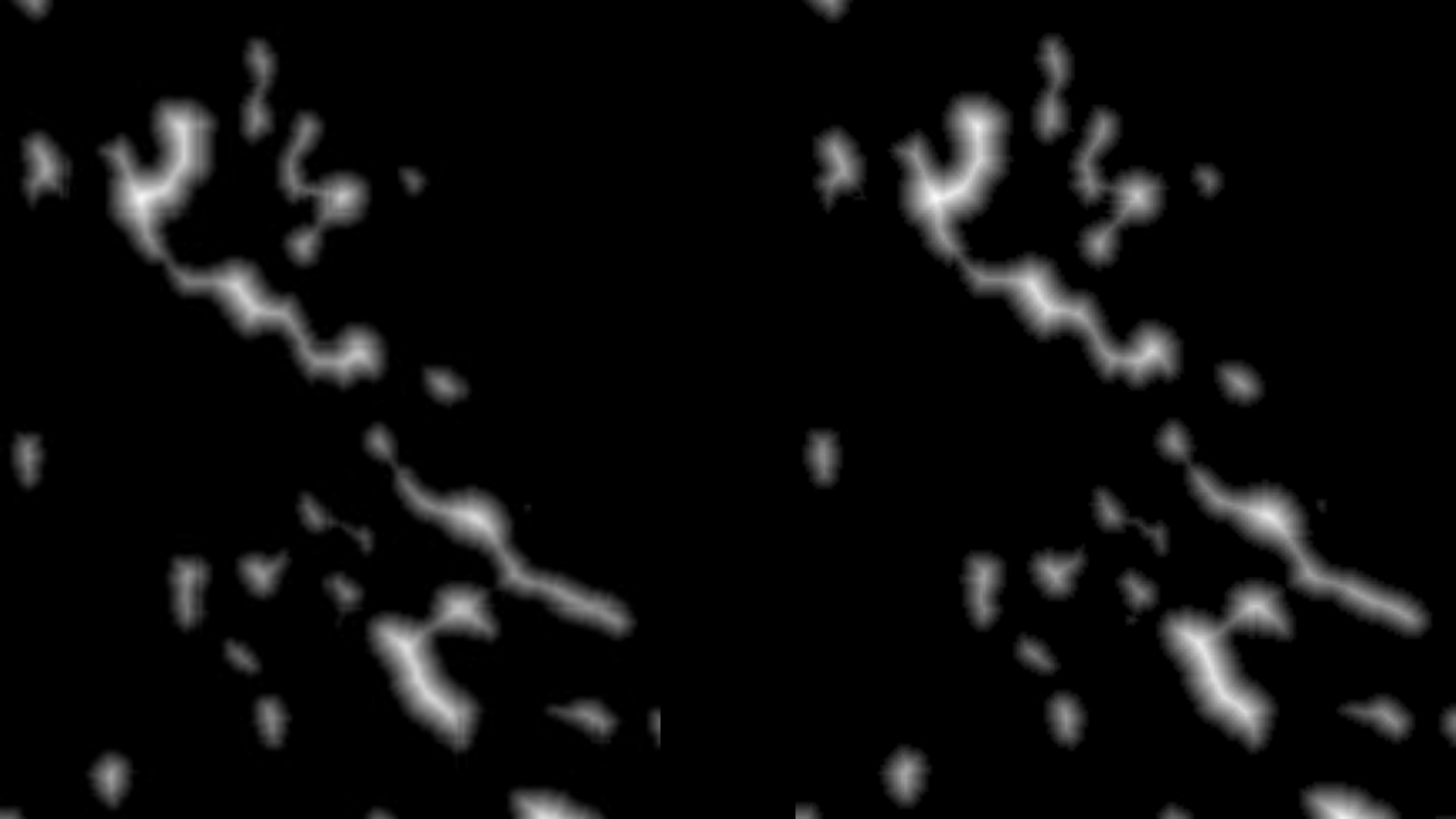
$$\frac{(xcos\theta - ysin\theta)^2}{a^2} + \frac{(ycos\theta + xsin\theta)^2}{a^2(1-e^2)} = 1$$

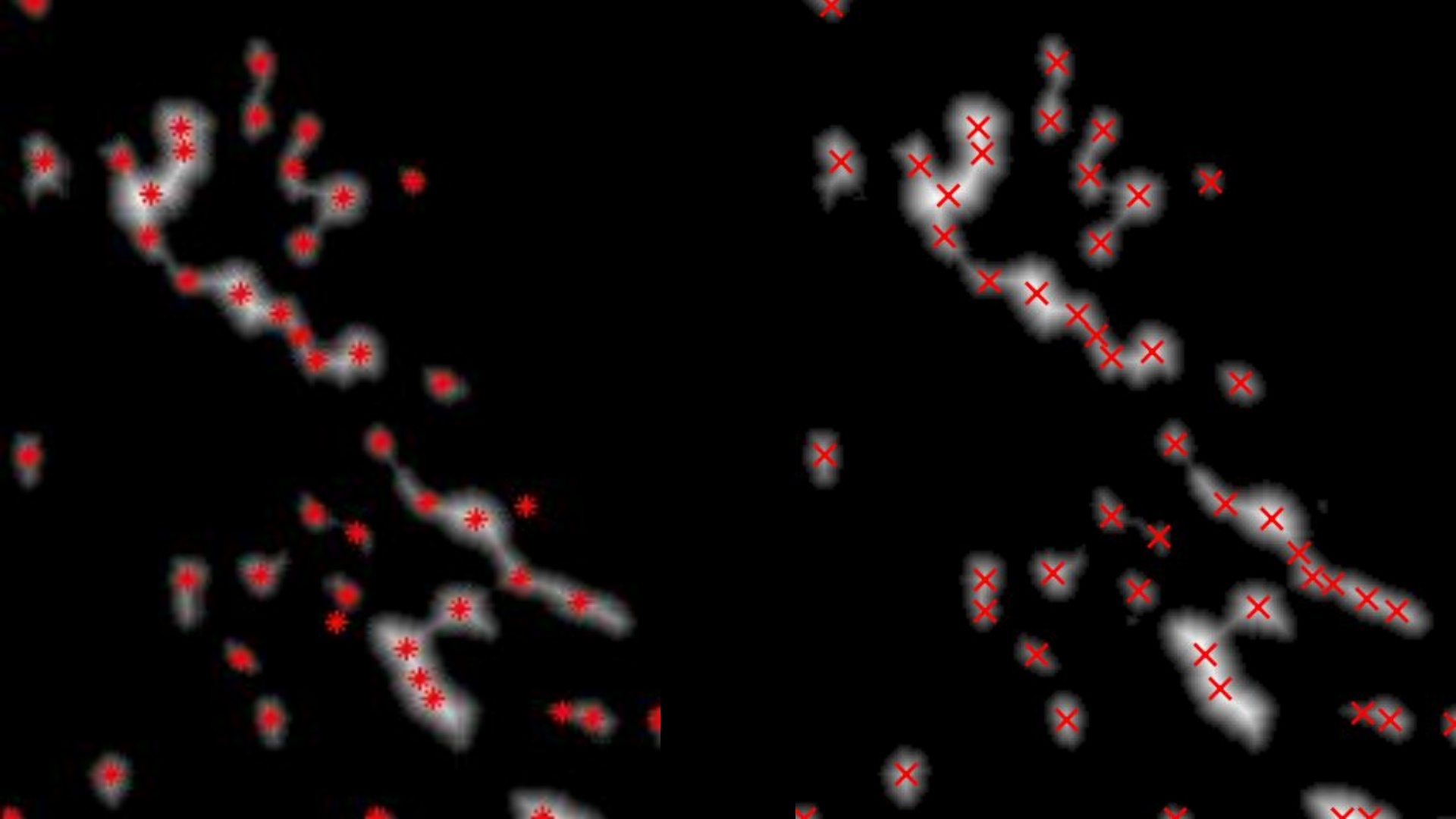
- The centers of the fit ellipse are considered as the improved center

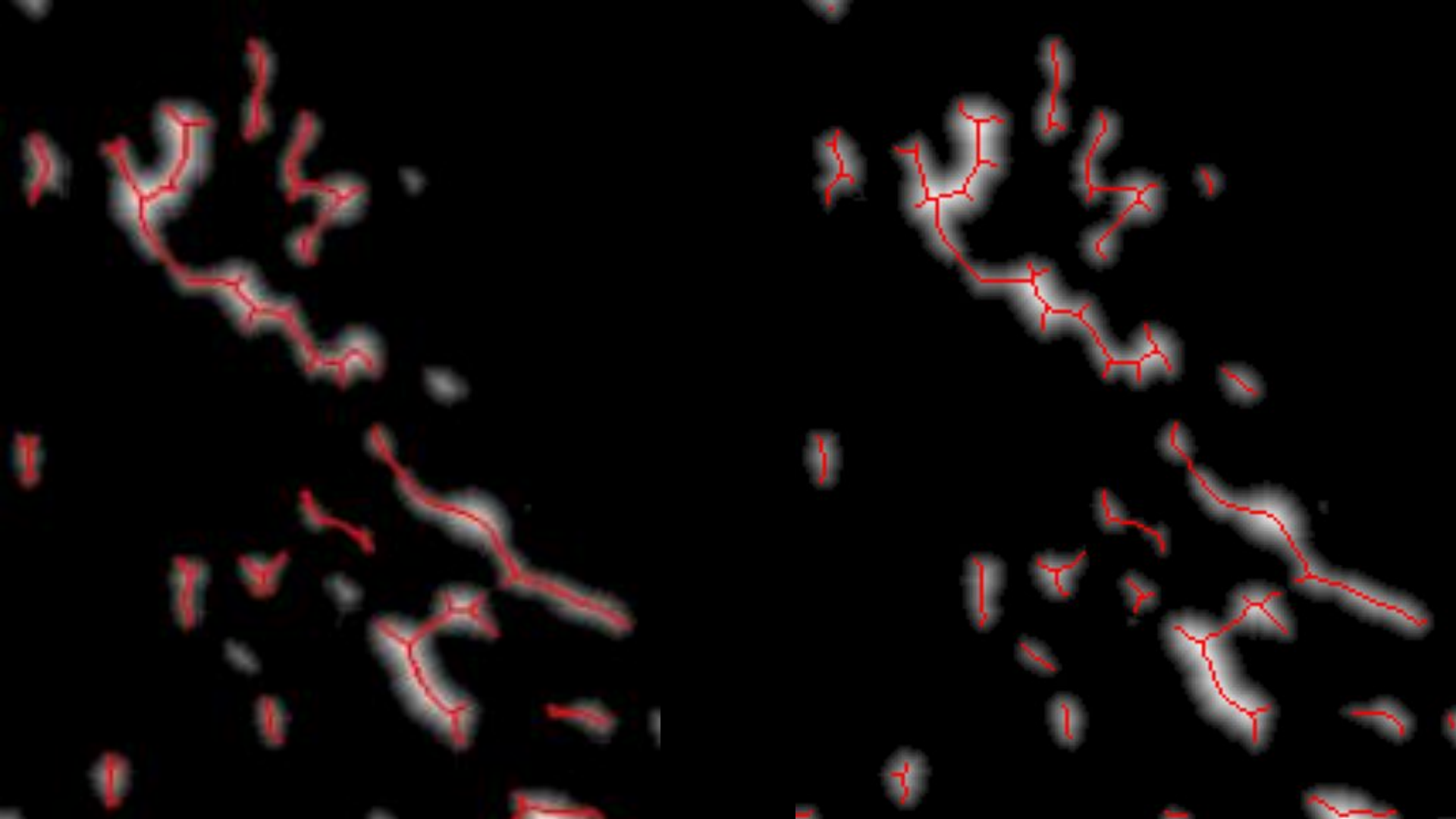
Results compared to the paper in the next few slides

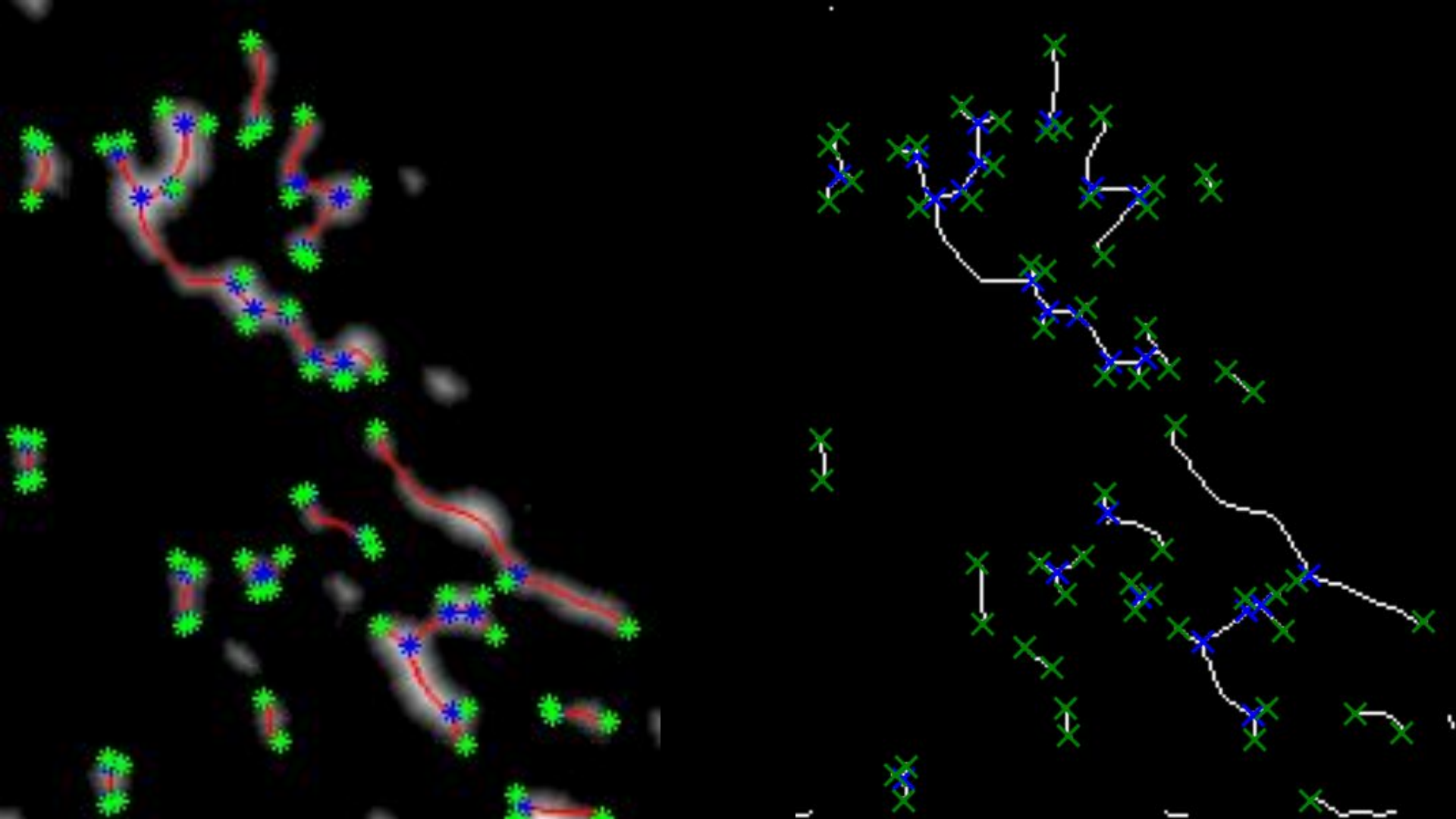
- Binary FGR
- Distance Transform (DT)
- Modulated DT (mDT)
- Merged local maxima
- Ridge Lines
- Ridge lines and Bifurcation + Ridge endings
- All centers from stage 1
- Residual Foreground Map (RFM)

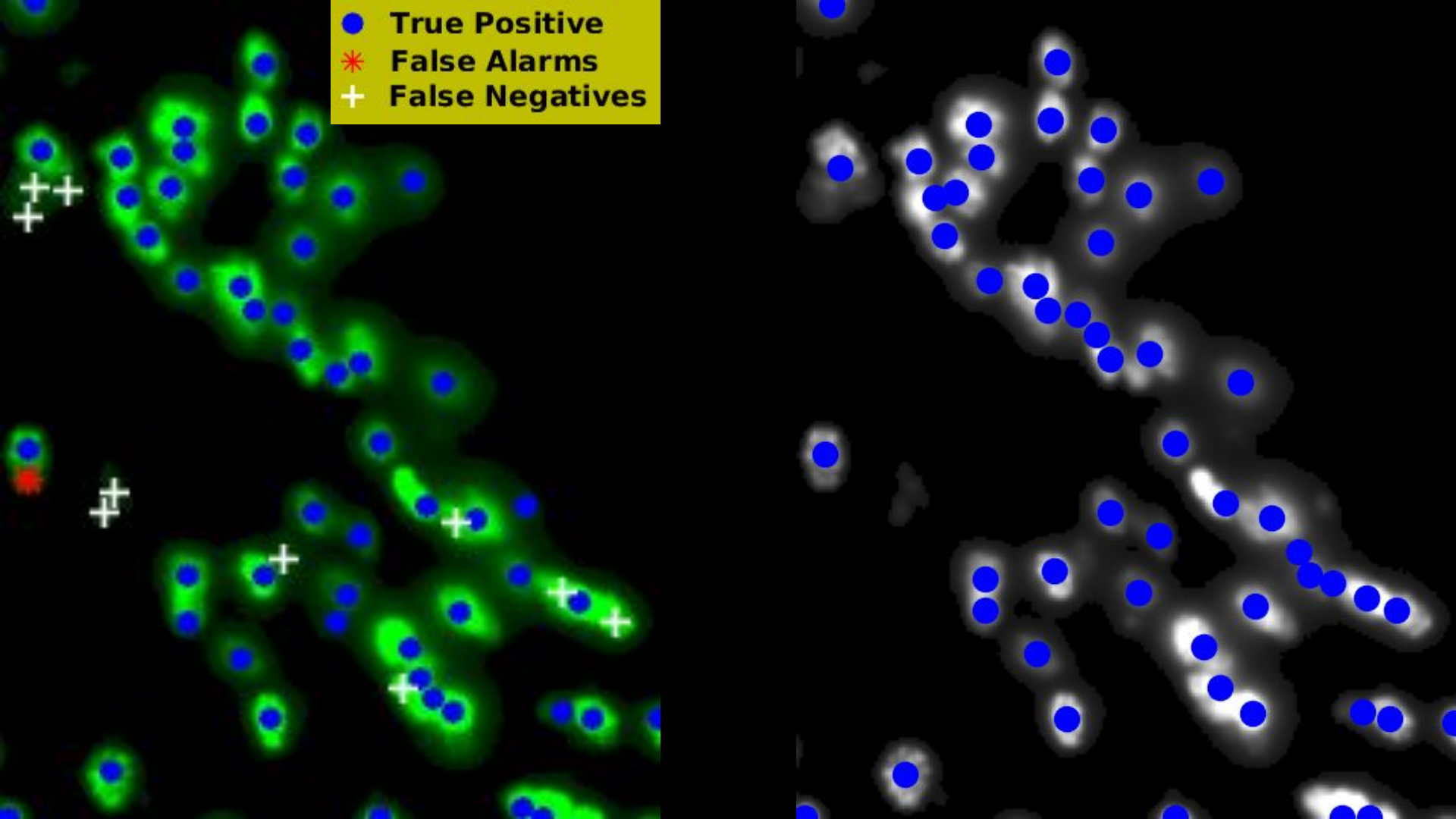


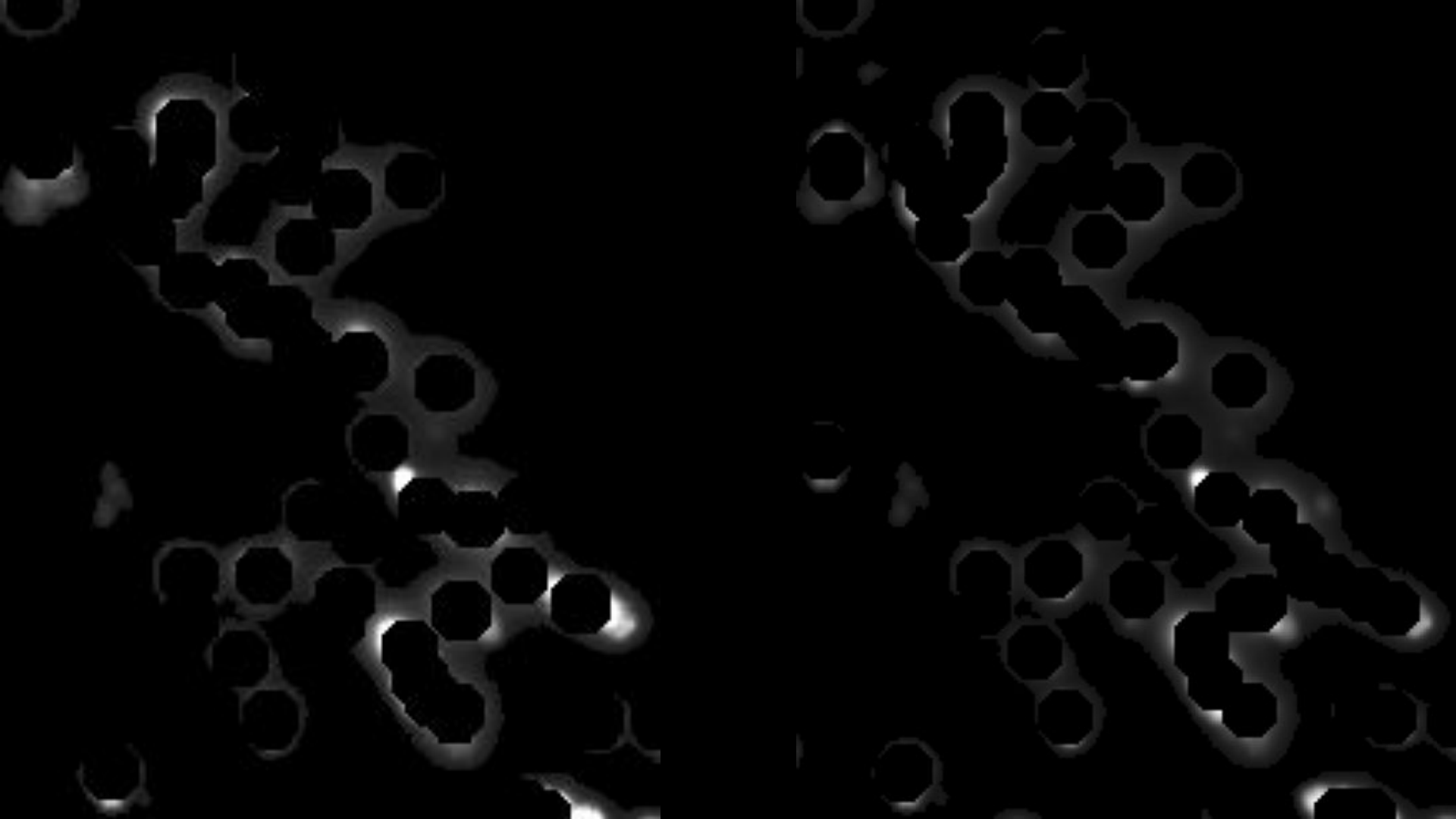









True Positive
False Alarms
False Negatives



Ellipse Fitting

- Approximate illustration of how ellipse fitting works
  a. Detect an ellipse on the full image
  b. No initialization
  c. Global optimization methods were used
  d. Relatively slow process even for small images
- Results when initialized on on stage - 1
  a. local optimisation used
  b. Scales well with large images
  c. Slight improvement on finding centers on some cells