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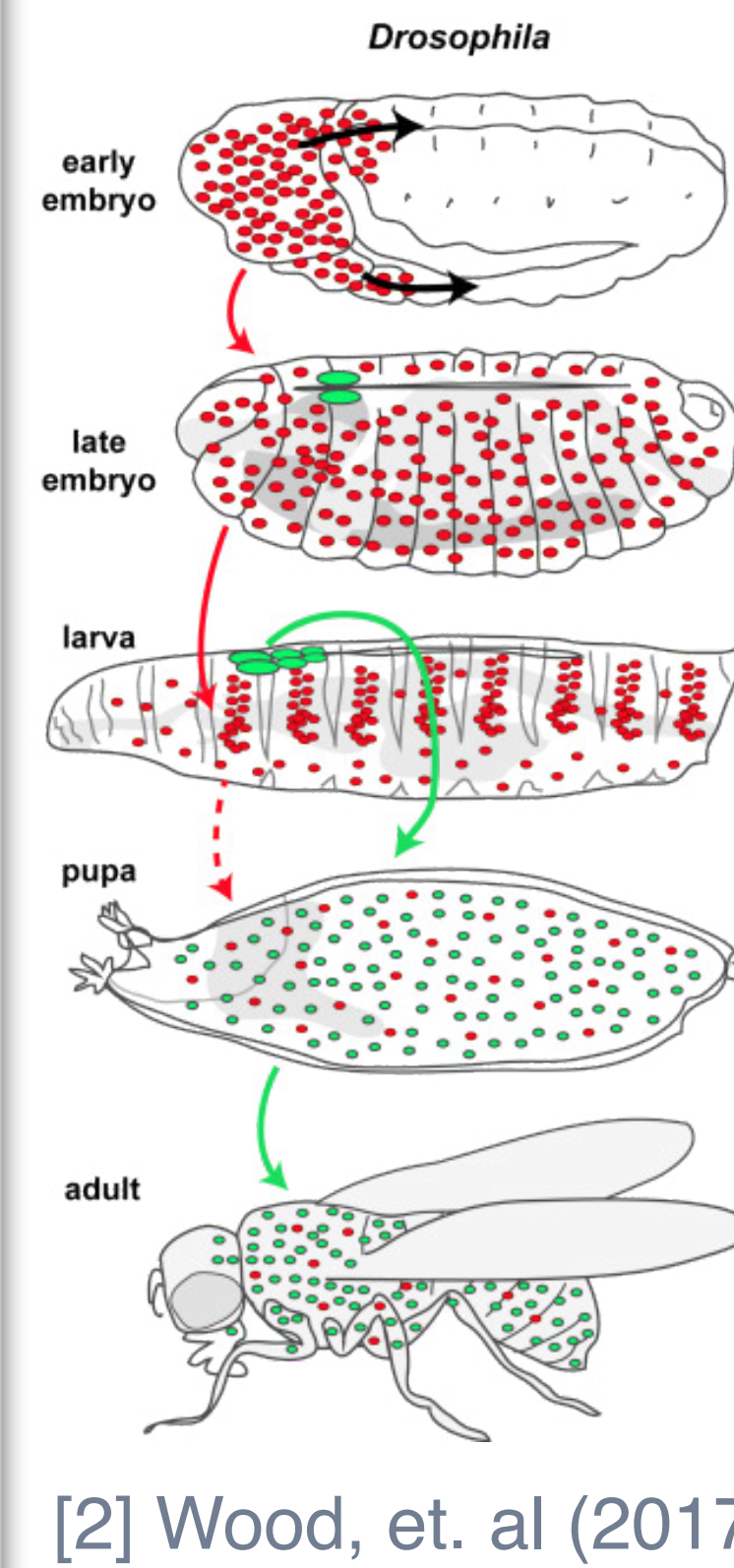
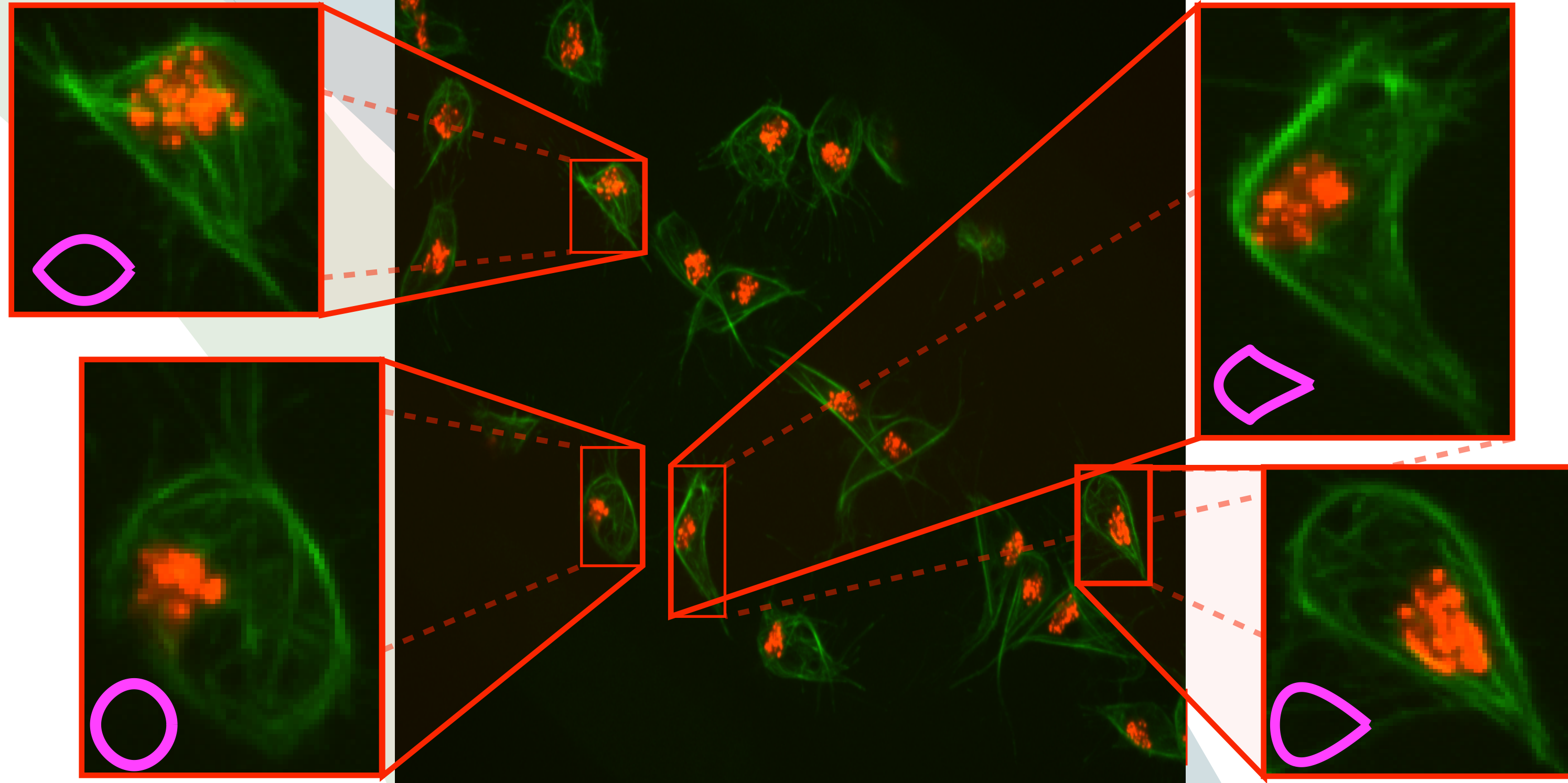
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Shape Analysis and Tracking of Migrating Macrophages

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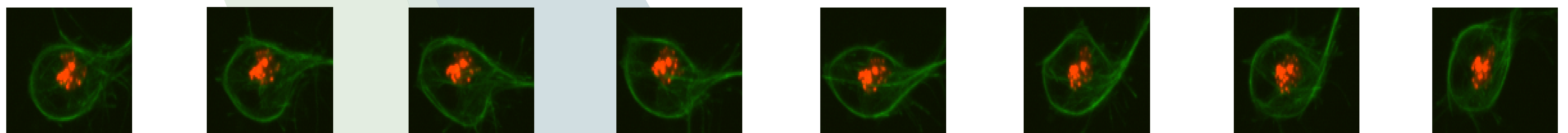
Basic shapes identified in the data



Abstract

This work describes an algorithm to observe **cell** shape variation **associated with migration**. The algorithm iteratively segments, tracks and analyses the shape of macrophages in ***Drosophila melanogaster* embryos**. Analysis of shape, including the number of **corners or pointy edges**, rely on a novel approach to finding *junctions*, the **anglegram matrix**.

The **anglegram** [1] IS a multiscale angle variation 2D matrix. It is constructed by calculating inner point angles alongside the boundaries of an object.



Evolution of shape in time

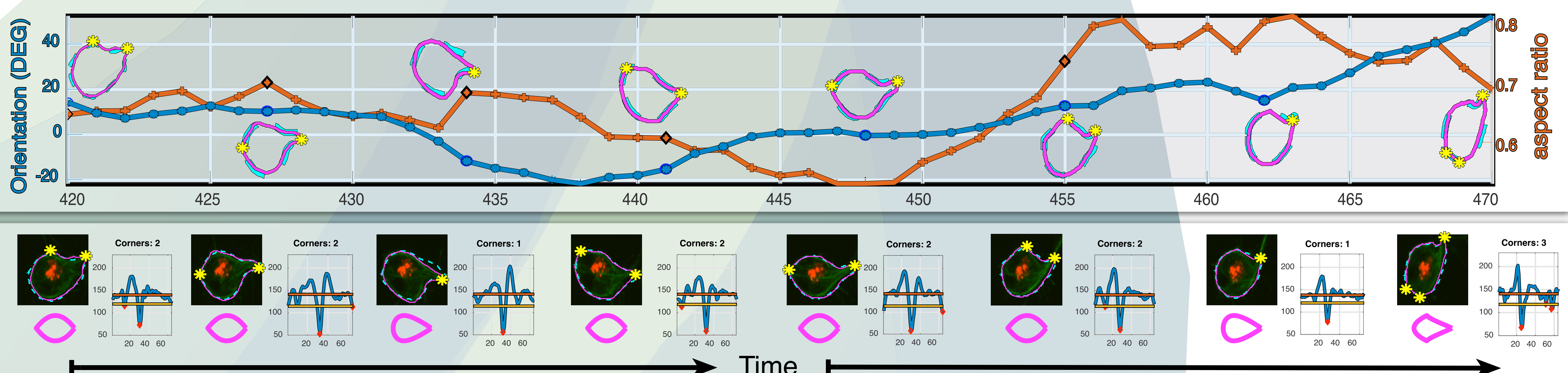
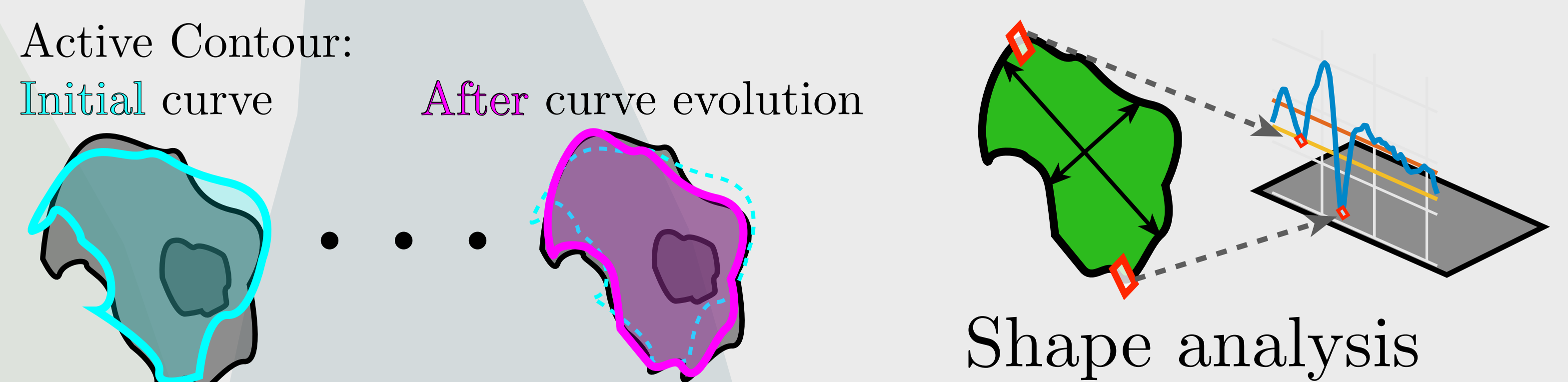
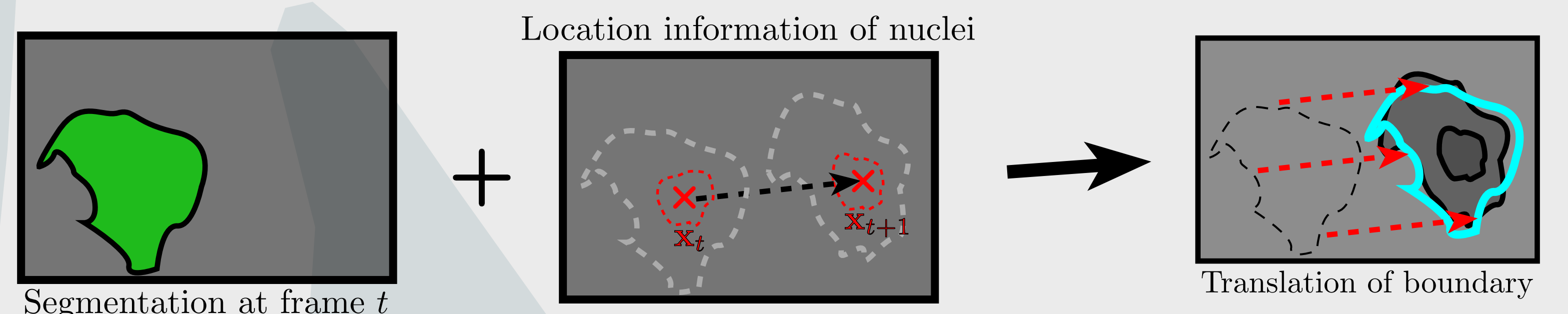
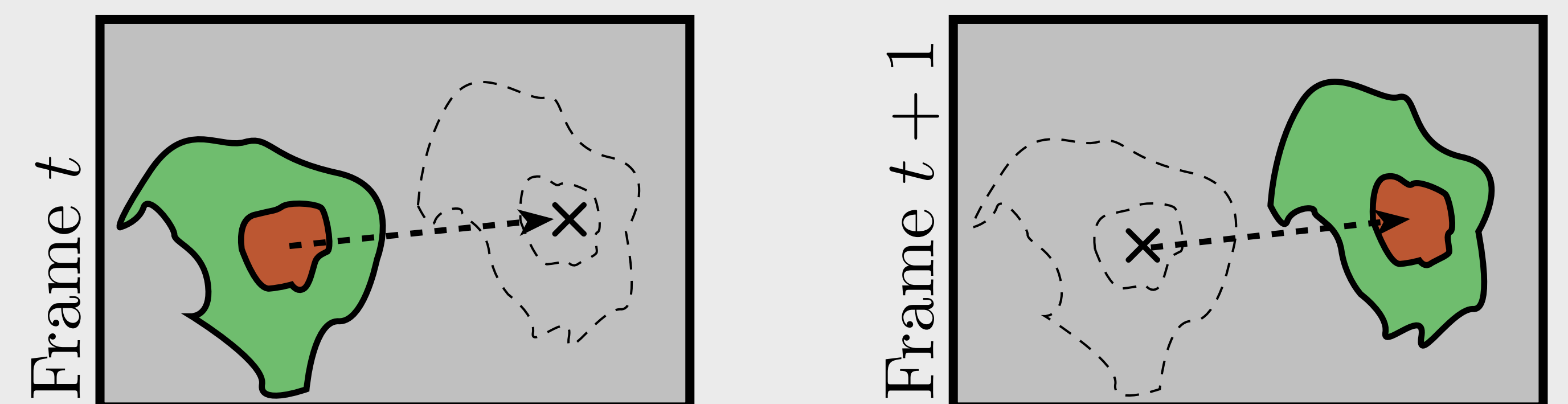
Data & Methodology

- **Synthetic data** was generated to test the corner detection algorithm and fluorescently labelled **images of macrophages** were used.
- The **methodology** allows observation of shape variations as the cells migrate. The **main functionality** is a framework in which the algorithm identifies and separates overlapping and non-overlapping cells. Then for the **non-overlapping** cases, it extracts and tracks the shape with and custom implementation of the Active Contours algorithm [5,6].
- Finally, shape measurements are collected from each extracted shape, including calculation of corners with the

Results & Future Work

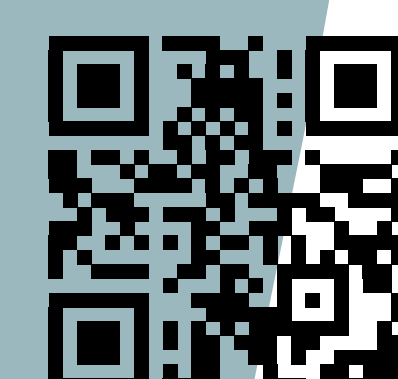
The **main contribution** was to provide a framework for the **consistent tracking of the shape of a cell** and evolution of the shape's parameters. A new implementation of the **anglegram** matrix allowed for the analysis of a single cell with a straightforward identification of corners in the shapes.

Future developments: extending the shape tracking into overlapping cells to disambiguate them; and use the patterns of the anglegrams corresponding to the basic shapes, to classify cells into basic shapes.



Evolution of Cell Shape Analysis throughout multiple frames. Top: Evolution of orientation of segmented cell and aspect ratio of the shape. At eight points in the graphs, the segmented shapes of cells are displayed. **Bottom:** Eight instances out of 50 consecutive frames where previous frame segmentation (cyan - -) and evolved current frame segmentation (magenta - -) are shown. The detected shape is highlighted and the minimum intensity projection of the anglegram is displayed to present the detection of corners.

SELECTED REFERENCES: [1] Solís-Lemus, José Alonso, Brian Stramer, Greg Slabaugh, and Constantino Carlos Reyes-Aldasoro. 'Segmentation and Shape Analysis of Macrophages Using Anglegram Analysis'. Journal of Imaging 4, no. 1 (21 December 2017): 2. [2] Wood, W., et. al: Macrophage functions in tissue patterning and disease: New insights from the fly. Developmental Cell 2017 [3] Stramer, et. al: Clasp-mediated microtubule bundling regulates persistent motility and contact repulsion in *Drosophila* macrophages in vivo J Cell Biology 2010 [4] Henry, et. al: PhagoSight: An Open-Source MATLAB Package for the Analysis of Fluorescent Neutrophil and Macrophage Migration in a Zebrafish Model. PLoS ONE 2013 [5] T Chan et al., "Active contours without edges," IEEE Trans Imag Proc, vol. 10, no. 2, pp. 266–277, jan 2001. [6] R Whitaker, "A level-set approach to 3d reconstruction from range data," Int J Computer Vision, vol. 29, no. 3, pp. 203–231, Sep 1998.



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