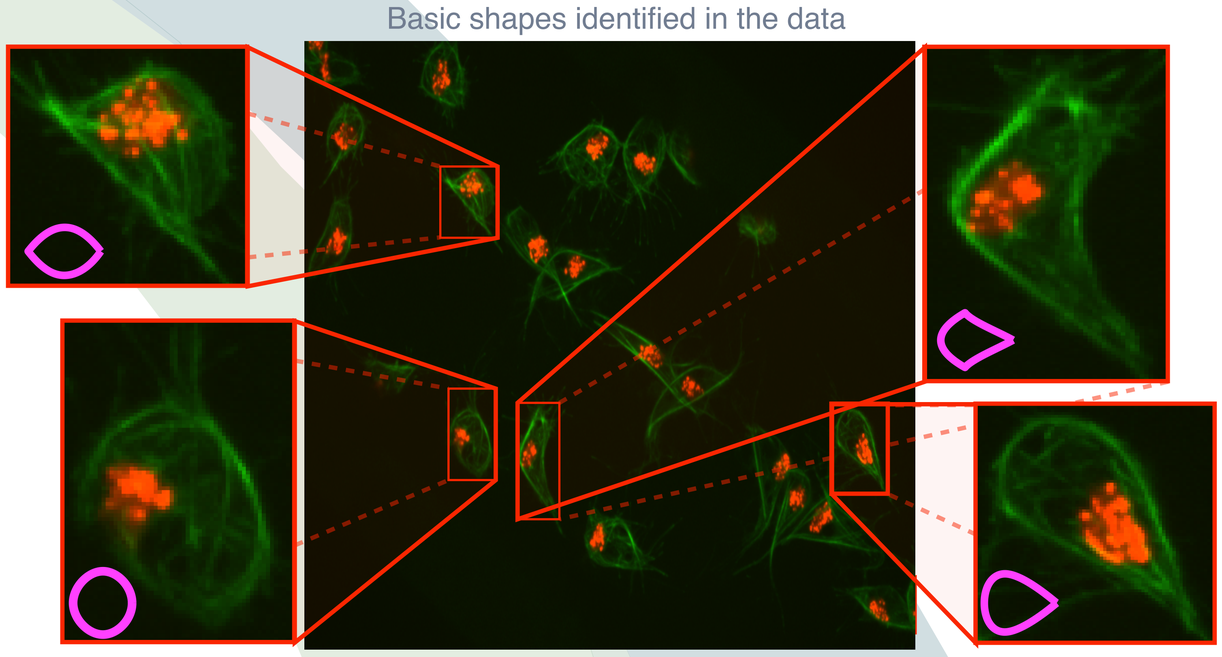
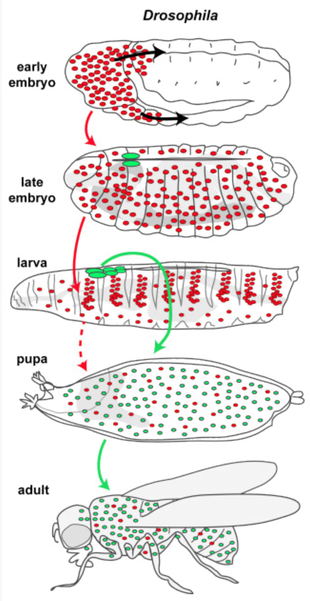
Shape Analysis and Tracking of Migrating Macrophages

(1)José Alonso Solís-Lemus
jose.solis-lemus@city.ac.uk
(2) Brian Stramer
brian.stramer@kcl.ac.uk
(1) Greg Slabaugh
gregrory.slabaugh@city.ac.uk
(1) Constantino Carlos Reyes-Aldasoro
reyes@city.ac.uk

(1) School of Mathematics, Computer Science and Engineering, *City, University of London* (2) Randall Division of Cell & Molecular Biophysics, *King's College London*, UK

Basic shapes identified in the data



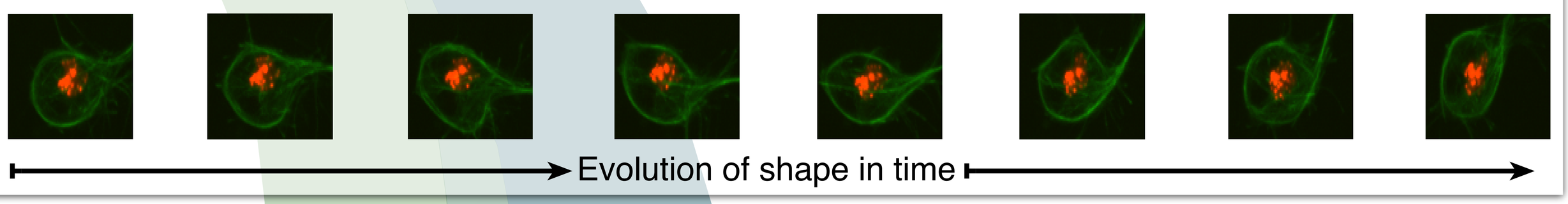


[2] Wood, et. al (2017)

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 Iis constructed by calculating inner point angles alongside the boundaries of an object.



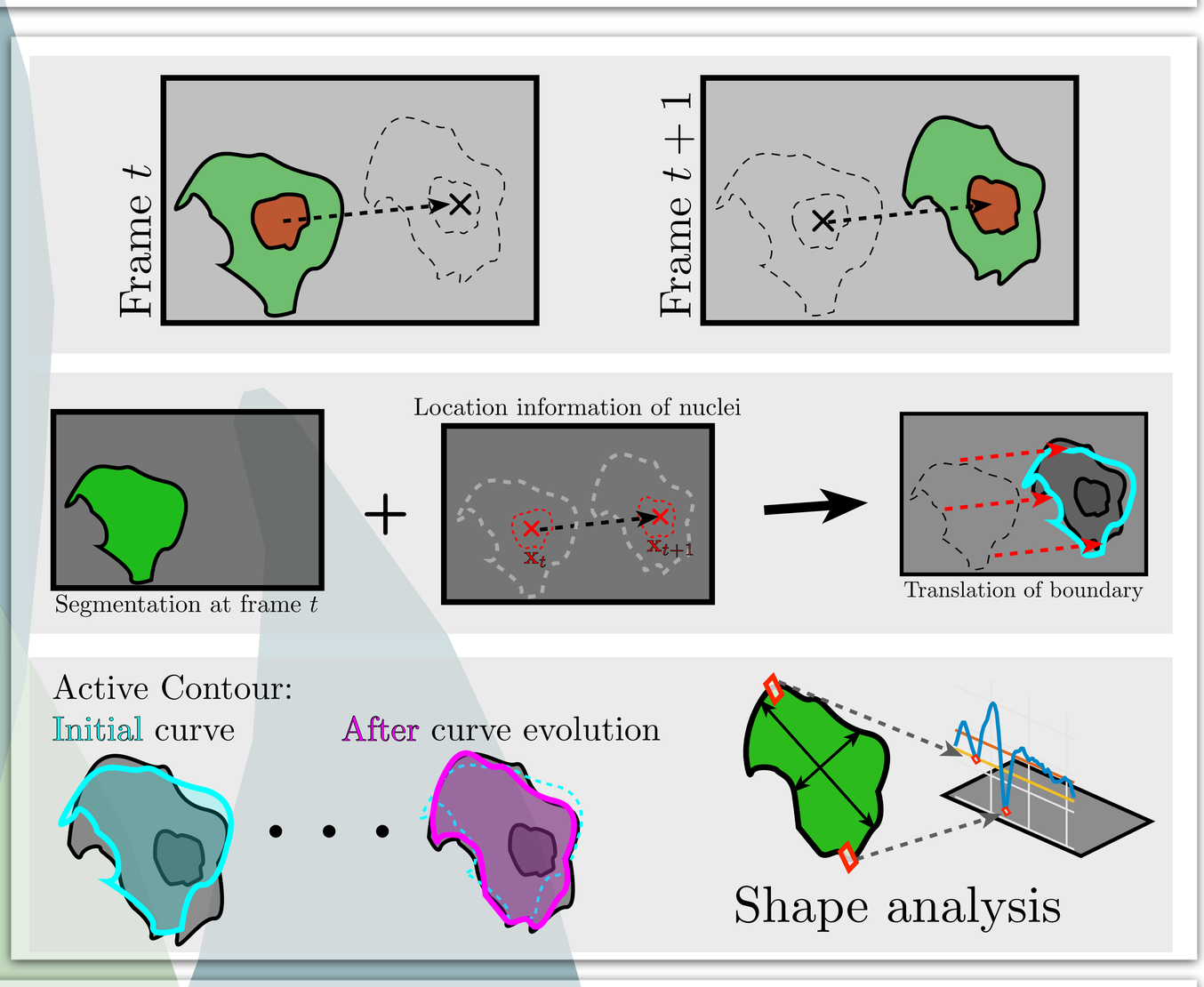
Data & Methodology

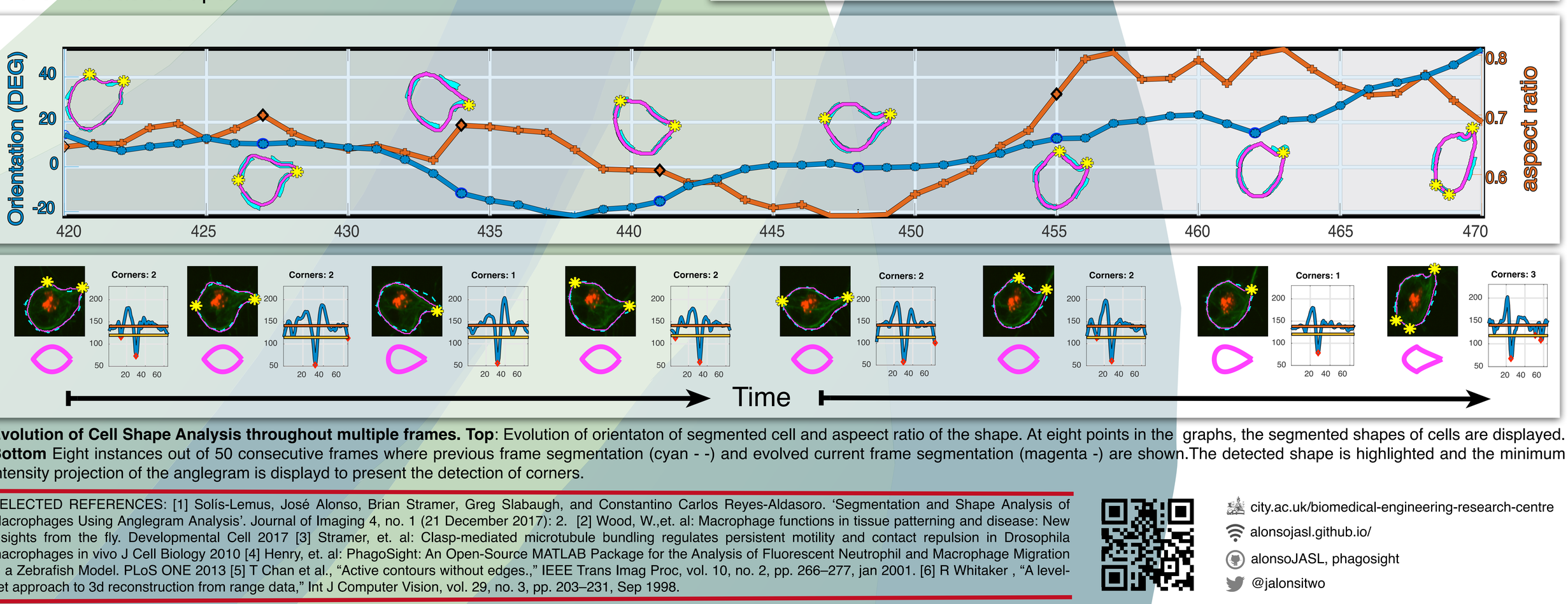
- **Synthetic data** was generated to test the corner detection algorithm and fluorescently labelled **images of macrophages** were used.
- The **methodology** allows observation of shape variations as the cells migrate. The **main functionality** is a framework in which the algorithm identifies and 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 orientaton of segmented cell and aspeect 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 displayd 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.

city.ac.uk/biomedical-engineering-research-centre
alonsojasl.github.io/
alonsoJASL, phagosight
@jalonsitwo