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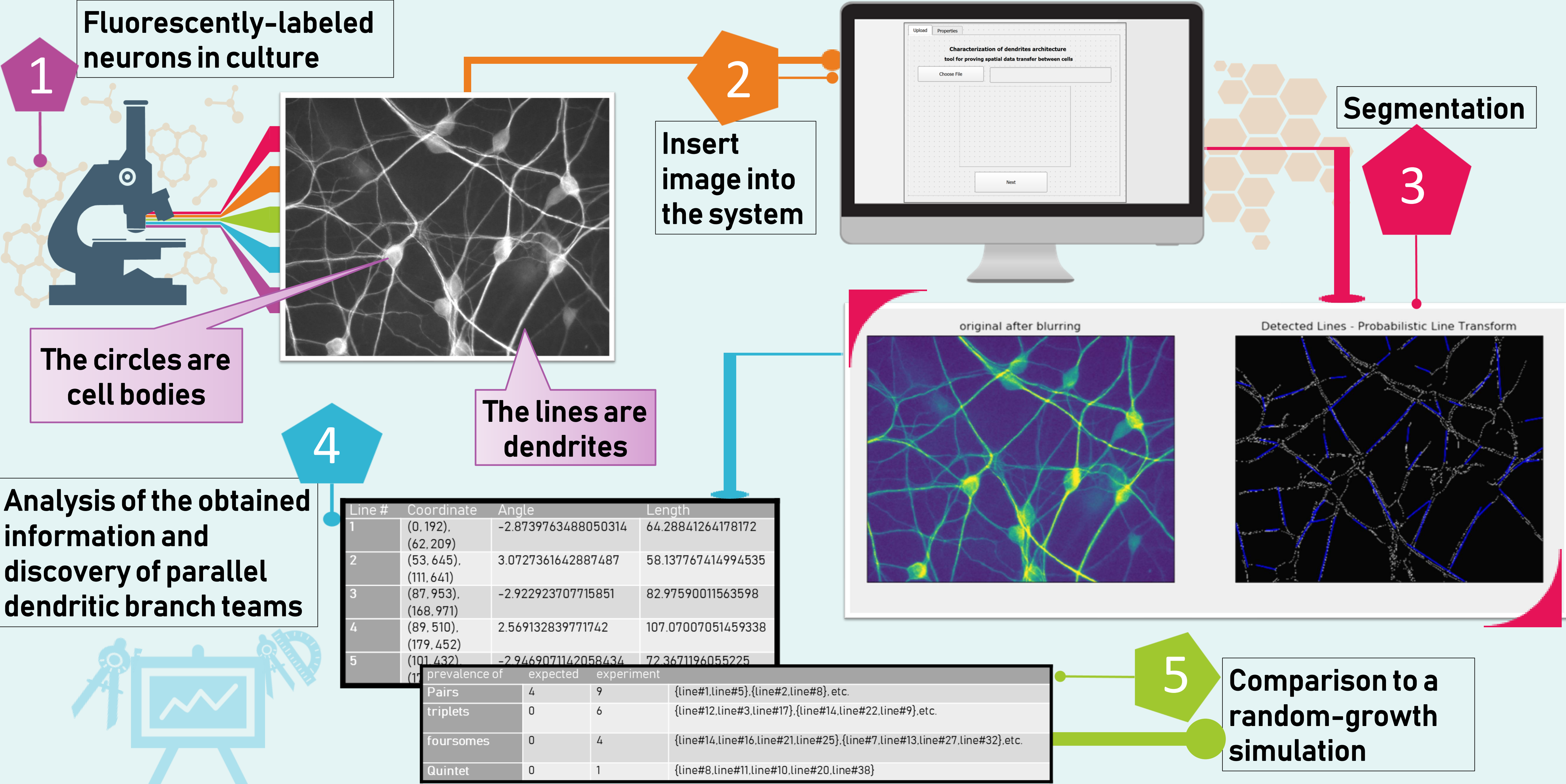**ARIEL UNIVERSITY** / Department of Computer Science and Mathematics

Automatic identification of parallel growth among neuronal dendritic branches

The structure of neuronal dendritic trees

plays a role in the activity of neuronal networks. In culture, the ramification of dendrites determines the ratio - parallel vs. unparallel growth - among neighboring dendritic branches. Our hypothesis is that this ratio is non-random. To test that we developed automatic quantification of the ratio in the neuronal networks and compared its value to that generated by combinatorial random growth simulation of dendritic branches.

In this project,

we introduce a new technique, that allows direct measurement of dendrite morphology from fluorescence images of dendritic networks. We use segmentation to distinguish dendritic branches from the image background and accumulate a database on the spatial direction of each branch. The database is then used to calculate the prevalence of pairs, triplets, foursomes etc. of parallel dendritic branches.

1 Fluorescently-labeled neurons in culture

The circles are cell bodies

The lines are dendrites

2 Insert image into the system

Characterization of dendrites architecture
tool for proving spatial data transfer between cells

Segmentation

3

original after blurring — Detected Lines - Probabilistic Line Transform

4 Analysis of the obtained information and discovery of parallel dendritic branch teams

Line #	Coordinate	Angle	Length
1	(0, 192), (62, 209)	-2.8739763488050314	64.28841264178172
2	(53, 645), (111, 641)	3.0727361642887487	58.137767414994535
3	(87, 953), (168, 971)	-2.922923707715851	82.97590011563598
4	(89, 510), (179, 452)	2.569132839771742	107.07007051459338
5	(101, 432),	-2.9469071142058434	72.3671196055225

prevalence of	expected	experiment	
Pairs	4	9	{line#1,line#5},{line#2,line#8}, etc.
triplets	0	6	{line#12,line#3,line#17},{line#14,line#22,line#9},etc.
foursomes	0	4	{line#14,line#16,line#21,line#25},{line#7,line#13,line#27,line#32},etc.
Quintet	0	1	{line#8,line#11,line#10,line#20,line#38}

5 Comparison to a random-growth simulation

How Does the segmentation Work?

We used OpenCV methods for detecting lines through the following steps:
1. Determining the properties for the detection
2. Blurring the image and turning it into a binary image
3. Now the system finds the lines using **Probabilistic Hough Transform technique** and **Canny Edge Detector algorithm**, marks them and produces full lines' information.

The results

show that occurrence of parallel growth of real dendritic branches is dramatically more frequent than the value found in the combinatorial random simulation, indicating that such type of growth is not random.

What's more?

The developed system can be used to identify branch-branch junctions, as they influence neuronal activity, as well as for accumulating biological data from other cell types, and perhaps even from tissues.

The project is a part of a manuscript in preparation.