AI analyzes cell movement under the microscope

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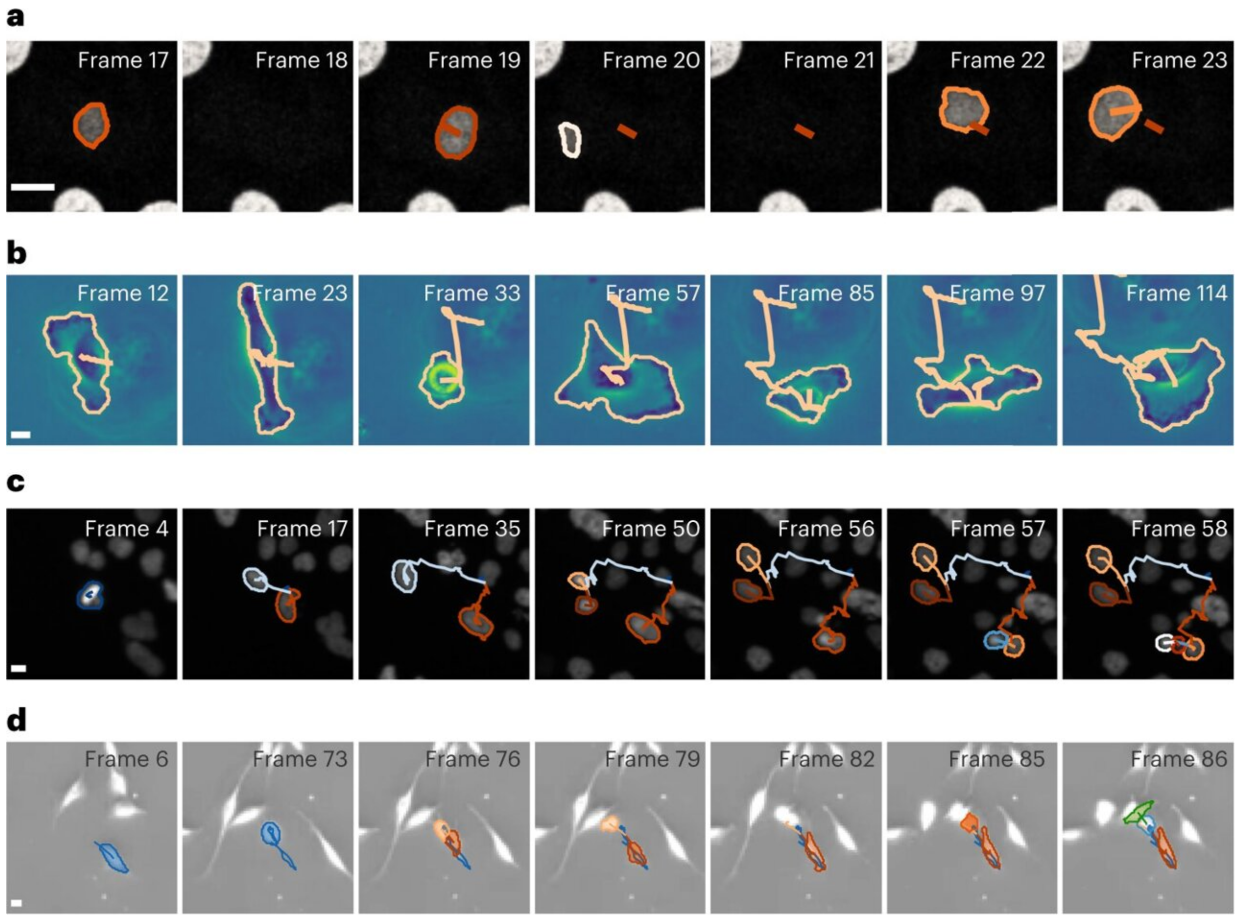

MAGIK reliably links trajectories in various experimental scenarios. a, Confocal microscopy of green fluorescent protein (GFP)-transfected GOWT1 mouse stem cells. MAGIK achieves an F_1 score of 99.8% and TRA = 99.2% despite the fact that the cells frequently leave the field of observation. Scale bar, 10 µm. b, Phase-contrast imaging of glioblastoma-astrocytoma U373 cells on a polyacrylamide substrate. MAGIK reaches an F_1 score of 99.8% and TRA = 100% even though the cells greatly change shape over time. Scale bar, 10 μm. c, Epifluorescence imaging of HeLa cells stably expressing histone H2b–GFP. MAGIK achieves an F_1 score of 98.8% and TRA = 98.4% despite the dense sample and frequent mitosis and collisions. Scale bar, 10 μm. d, Phase-contrast imaging of pancreatic stem cells on a polystyrene substrate. MAGIK obtains an F_1 score of 99.3% and TRA = 98.5% despite high cell density, elongated shapes, pronounced cell displacements and a significant number of division events. Scale bar, 10 μm. Interrupted trajectories correspond to cases where cells left the field of view or missed segmentation in the image sequence. All videos belong to the dataset of the 6th Cell Tracking Challenge. Credit: *Nature Machine Intelligence* (2023). DOI: 10.1038/s42256-022-00595-0

The enormous amount of data obtained by filming biological processes using a microscope has previously been an obstacle for analyses. Using artificial intelligence (AI), researchers at the University of Gothenburg can now follow cell movement across time and space. The method could be very helpful for developing more effective cancer medications.

Studying the movements and behaviors of cells and biological molecules under a microscope provides fundamental information for better understanding processes pertaining to our health. Studies of how cells behave in different scenarios is important for developing new medical technologies and treatments.

"In the past two decades, optical microscopy has advanced significantly. It enables us to study biological life down to the smallest detail in both space and time. Living systems move in every possible direction and at different speeds," says Jesús Pineda, doctoral student at the University of Gothenburg and first author of the scientific article in *Nature Machine Intelligence*.

Mathematics describes relationships of particles

Advancements have given today's researchers such large amounts of data that analysis is nearly impossible. But now, researchers at the University of Gothenburg have developed an AI method combining graph theory and neural networks that can pick out reliable information from video clips.

Graph theory is a mathematical structure that is used to describe the relationships between different particles in the studied sample. It is comparable to a social network in which the particles interact and influence one another's behavior directly or indirectly.

"The AI method uses the information in the graph to adapt to different situations and can solve multiple tasks in different experiments. For example, our AI can reconstruct the path that individual cells or molecules take when moving to achieve a certain biological function. This means that researchers can test the effectiveness of different medications and see how well they work as potential cancer treatments," says Jesús Pineda.

AI also makes it possible to describe all dynamic aspects of particles in situations where other methods would not be effective. For this reason, pharmaceutical companies have already incorporated this method into their research and development process.

More information: Jesús Pineda et al, Geometric deep learning reveals the spatiotemporal features of microscopic motion, *Nature Machine Intelligence* (2023). DOI: 10.1038/s42256-022-00595-0

Provided by University of Gothenburg