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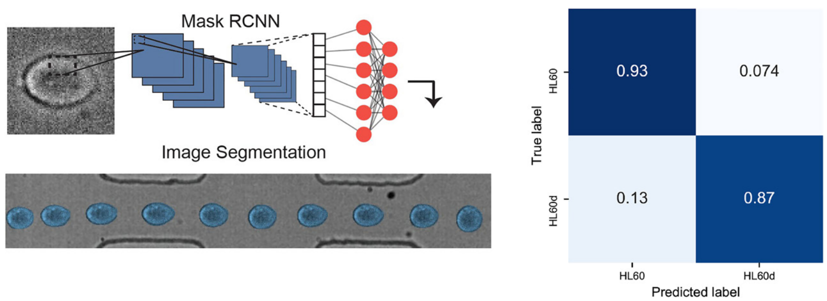
Deep learning models and microfluidics experiments sort cells by mechanical properties, dynamics



A cell's function is inherently tied to its mechanical properties, so measuring these characteristics can aid with cell identification. For example, red and white blood cells traveling through the bloodstream into smaller vessels need to be able to deform and squeeze through tight passages.

Measuring mechanical properties has been done with atomic force microscopes, but this technique is slow. Microfluidics has emerged as an alternative, faster method in recent years.

Combs et al. took the microfluidics method one step further, conducting experiments to measure a cell's deformation over time and using a deep learning network for classification based on mechanical properties alone.

The team created a dataset with untreated cells and two other categories of cells, which were treated to make them either squishy or stiff. All cells were identical in size.

"We are interested in identifying a mechanical fingerprint as a function of time," said author Zuzanna Siwy. "That mechanical fingerprint is obtained by subjecting to the cell to nonlinear forces to observe how the cell is breathing, in other words, compressing and relaxing."

Using traditional machine learning techniques, the researchers sorted the cells in silico into the three populations. They progressed to a recurrent neural network with images of the cells from a high-speed camera as the sole input.

The deep learning network increased classification accuracy by 15 percent compared to traditional machine learning techniques. That corresponds to a five-fold enrichment in cells, which is important for sorting if there are very few cells in a population.

The authors aim to conduct the classification *in situ* and move from this supervised task to characterizing unknown cell types.

Source: "Deep learning assisted mechanotyping of individual cells through repeated deformations and relaxations in undulating channels," by Cody Combs, Daniel D. Seith, Matthew J. Bovyn, Steven P. Gross, Xiaohui Xie, and Zuzanna S. Siwy, *Biomicrofluidics* (2022). The article can be accessed at https://doi.org/10.1063/5.0077432.