Biomedical Applications of Machine Learning in Imaging Flow Cytometry

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Abstract:

Imaging flow cytometry (IFC) bridges a critical gap in biomedical analysis by combining the high - throughput statistical power of conventional flow cytometry with the spatial and morphological insights of traditional microscopy. While conventional flow cytometry provides rapid quantification of fluorescence intensities, it completely lacks spatial resolution. Conversely, microscopy offers rich spatial and structural details but suffers from low throughput and operator bias. IFC overcomes these limitations by capturing high-resolution, multi-channel images of hundreds of thousands of individual cells in continuous fluid flow.

The massive, multi-dimensional datasets generated by IFC present a significant analytical challenge, which is now being solved through machine learning (ML) and deep learning algorithms. By leveraging automated feature extraction and neural networks, ML - driven IFC enables pixel-level analysis to detect subtle morphological changes, intracellular biomarker localization, and complex cell-to-cell interactions. In my presentation I will give several examples from our work, including Golgi fragmentation analysis and viral infection cycle studies. Ultimately, integrating machine learning with imaging flow cytometry transforms massive visual datasets into objective, high-throughput diagnostic insights, establishing a powerful new paradigm for automated discovery and clinical diagnostics.