INSTANCE SEGMENTATION USING OPEN-SOURCE DEEP LEARNING MODELS FOR BIOLOGICAL STRUCTURES

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Precise segmentation is vital in fields like biomedical imaging, but challenges remain due to biological complexity, imaging artifacts, and algorithm limits. This work aims to improve segmentation quality by merging open-source deep learning (DL) tools to reduce manual annotation time.

The article presents a comparative analysis of four deep learning-based bioimage processing methods. Those models represent the current state-of-the-art results, and cover a range of most widely-used segmentation approaches.

InstanSeg is an efficient, portable, and user-friendly embedding-based segmentation algorithm which uses a lightweight modified U-Net backbone [1]. StarDist predicts a star-convex polygon for every pixel, and thus efficiently handles situations of crowded cells [2]. Cellpose predicts heat diffusion from instance centroids, offering high accuracy across diverse image types and resolutions [3]. CellSeg1, built on the Segment Anything Model (SAM), generalizes well and achieves effective segmentation using just one training image [4].

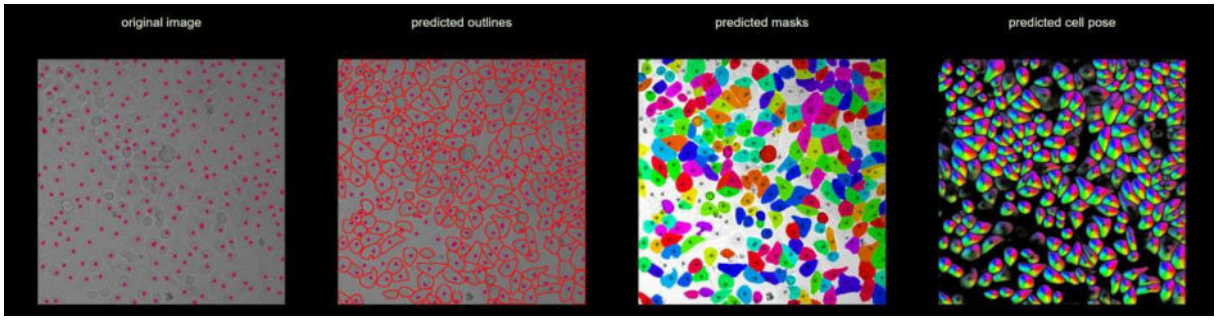

Figure 1 – Segmentation masks received from pretrained Cellpose model on a target dataset image

As shown in Fig. 1, pretrained models demonstrate high performance and are likely to achieve strong results in real-world tasks after preprocessing images and fine-tuning on target data.

References (translated):

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2. Uwe Schmidt, Martin Weigert, Coleman Broaddus, Gene Myers, Cell Detection with Star-convex Polygons, 2018.
3. Carsen Stringer, Michalis Michaelos, Marius Pachitariu, Cellpose: a generalist algorithm for cellular segmentation, 2021.
4. Peilin Zhou, Bo Du, Yongchao Xu, CellSeg1: Robust Cell Segmentation with One Training Image, 2024.