An Efficient Deep Learning Model For Single-Cell Segmentation And Tracking In Time-Lapse Microscopy

Tech ID: 33633 / UC Case 2024-780-0

BACKGROUND

Time-lapse microscopy allows for direct observation of cell biological processes at the single-cell level with high temporal resolution. Quantitative analysis of single-cell time-lapse microscopy requires automated segmentation and tracking of individual cells over several days. Precise segmentation and tracking remain challenging because cells change their shape, divide, and show unpredictable movements.

Researchers at UC Santa Cruz applied recent advances in the application of deep-learning models to the analysis of cellular images. The result was a deep-learning-based model and a user-friendly software, termed DeepSea, that automates both the segmentation and tracking of individual cells in time-lapse microscopy images.

TECHNOLOGY DESCRIPTION

DeepSea is a deep-learning model designed to automate the segmentation and tracking of single cells in time-lapse microscopy images, specifically tailored for phase-contrast imaging. The DeepSea software excels in capturing cellular dynamics such as cell division, mitosis, and morphology with high precision. It has been particularly effective in analyzing cell size regulation in embryonic stem cells, showcasing its potential for advancing cellular biology research.

DeepSea distinguishes itself from existing solutions by being highly efficient and fast, while maintaining superior accuracy compared to traditional models. The model is specifically tailored for phase-contrast imaging, a common but challenging modality where existing solutions have been less effective. Unlike other models that focus solely on cell segmentation or tracking, DeepSea integrates both functionalities, offering a streamlined and more efficient approach to cellular data analysis. This allows DeepSea to successfully quantify a wide array of cellular biological features, including but not limited to cell division

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OTHER INFORMATION

KEYWORDS

microscopy, time lapse microscopy, phase contrast microscopy, deep learning, imaging software, cellular imaging

CATEGORIZED AS

- **Imaging**
  - Software

RELATED CASES

2024-780-0

cycles, mitosis, morphology, and cell size, providing a comprehensive solution for researchers in the field.

Key features:

Data Preprocessing: Importing time-lapse microscopy images, particularly phase-contrast images, and pre-processing them to be compatible with the deep-learning model.

Trainable Segmentation: Utilizing a deep-learning algorithm that is capable of being trained on different cell types to perform high-precision segmentation of individual cells in each image frame.

Trainable Temporal Tracking: Sequentially tracking the segmented cells over multiple time frames to observe changes in cellular biological features like cell division, mitosis, and morphology.

Feature Quantification: Extracting and quantifying key cellular features from the segmented and tracked cells, such as cell size, morphological characteristics, and division cycles.

Output and Analysis: Providing comprehensive analytics and visualizations to facilitate further biological interpretation or to serve as input for other computational biology methods.

APPLICATIONS

- Time lapse microscopy
- Phase contrast imaging

ADVANTAGES

Efficiency and Speed: Designed to be more efficient and faster than traditional models, DeepSea allows for quick data processing and analysis, which is crucial for time-sensitive biological studies.

Versatility: The model can be trained on various cell types, making it highly adaptable to different research needs.

High Accuracy: Through its deep-learning algorithms, the model maintains a high level of accuracy in segmentation and tracking tasks, thereby enhancing the reliability of the analysis.Integrated Approach: Unlike other models focusing only on either segmentation or tracking, DeepSea provides an integrated solution that streamlines the analysis process.

Phase-Contrast Specialization: The model is specially tailored to work with phase-contrast imaging, filling a gap in existing solutions for this widely used but challenging imaging modality.

INTELLECTUAL PROPERTY INFORMATION

Patent Pending

RELATED MATERIALS

- DeepSea is an efficient deep-learning model for single-cell segmentation and tracking in time-lapse microscopy - 06/26/2023

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