Paper ID: 1570938659

Paper Title: Deep Learning-Based Object Detection and Bacteria Morphological Feature Extraction for antibiotic mode of action study

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Abstract

The increasing prevalence of antimicrobial resistance (AMR), as microorganisms develop resistance to antimicrobial drugs, has emerged as a critical concern in infection treatment, resulting in a rising death toll. Assessing the effect of drugs can provide insights by studying the morphological change of bacteria after drug treatment. However, utilizing conventional techniques such as CellProfiler for long-term and large-scale sample experiments is impractical due to the manual processes involved. To address this challenge, we proposed a deep learning-based object detection model for predicting the type of antibiotic treatment and automatically extracting bacteria morphology. Our model combines YOLOX and two Cascade R-CNNs using weight box fusion to enhance performance. It achieves an mIOU of 0.753 and mAP of 0.699 higher mAP compared to CellProfiler (mAP = 0.218). In addition, we use a computer vision approach to extract bacteria morphological features including cell membrane, DNA, and color intensity to classify the treated antibiotic which achieves comparable performance to CellProfiler (F1-Score = 0.75, 0.79 respectively). We believed our work can be used as an automatic tool to enhance the efficiency of antibiotic prediction and extracting cell profiles for AMR applications. Our code and web application are available at https://github.com/biodatlab/bacteria-detection.