Using Machine Learning to Optimize how Microscopes Detect Infectious Disease

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Deep learning algorithms offer a powerful means to automatically analyze the content of medical images. However, many biological samples of interest are difficult to resolve with a standard optical microscope. Here, we use a convolutional neural network (CNN) not only to interpret images, but also to re-design the physical layout of the microscope itself, which helps us optimize what it can capture. To achieve this goal, we merge an optical model of image formation into the pipeline of a CNN, which allows us to simultaneously determine an ideal illumination and lens arrangement to highlight important sample features during image acquisition, along with a set of convolutional weights to process the detected images post-capture. We explore how this paradigm can enable new optical designs for gigapixel-scale imaging of biological specimens.