Democratising deep learning for microscopy with ZeroCostDL4Mic

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Deep Learning (DL) methods are powerful analytical tools for microscopy and can outperform conventional image processing pipelines. Despite the enthusiasm and innovations fuelled by DL technology, the need to access powerful and compatible resources to train DL networks leads to an accessibility barrier that novice users often find difficult to overcome. Here, we present ZeroCostDL4Mic, an entry-level platform simplifying DL access by leveraging the free, cloud-based computational resources of Google Colab. ZeroCostDL4Mic allows researchers with no coding expertise to train and apply key DL networks to perform tasks including segmentation (using U-Net and StarDist), object detection (using YOLOv2), denoising (using CARE and Noise2Void), super-resolution microscopy (using Deep-STORM), and image-to-image translation (using Label-free prediction - fnet, pix2pix and CycleGAN). Importantly, we provide suitable quantitative tools for each network to evaluate model performance, allowing model optimisation. In my laboratory, we use ZeroCostDL4Mic to study cancer cell migration during the different metastatic cascade stages.

In particular, we :
1. Use CARE, Noise2VOID, and DecoNoising to improve our noisy live-cell imaging data.
2. Use StarDist and Cellpose together with TrackMate to automatically segment and track migrating cells. In particular, we teamed up with Dr Tinevez to bring deep learning elements to the popular ImageJ plugin TrackMate.
3. Use DRMIME to register microscopy images. In particular, images of tumour cell-injected zebrafish embryos.
4. Use StarDist to score the ability of cancer cells to adhere to endothelial cells automatically.
5. Use pix2pix to predict fluorescent labels from brightfield images acquired at high speed.

Altogether, this talk will highlight the ZeroCostDL4mic platform and showcase how we employ various DL networks, via ZeroCostDL4mic, to accelerate our image analysis and enhanced scientific outcomes using multiple of our projects as examples.