KEX-project 2025, KTH Applied Physics - Biophysics

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Deep learning-based image analysis for microwell assay

Background: Microscopy-based single-cell and organoid technologies can provide valuable insights of human immune cell responses. One important part of the immune response is direct killing of tumor transformed cells or virus infected cells. This can be done by a few cell types of white blood cells like T cells, natural killer (NK) cells or macrophages. The process of cell killing can be understood by performing live cell imaging followed by automated image analysis. In the last few years, machine learning technologies for single-cell analysis has become a very active area of research. We are currently using microchip-based live cell imaging combined with deep learning (DL) networks to quantify various cellular responses at single cell resolution to better understand the dynamics of immune responses.

Project: We are looking for enthusiastic and motivated students who enjoy working as part of a team as well as independently to help us develop our DL-based image analysis pipeline including cell detection, tracking and analysis of cell behaviour. DL networks, for example one focused on image segmentation to obtain cell shape, will be trained based on the data from our microwell-based imaging system (Figure 1). In this project, you are expected to have basic knowledge of programming and problem-solving skills. You will use standard DL networks and implement approaches to solve challenging cell image analysis problems.

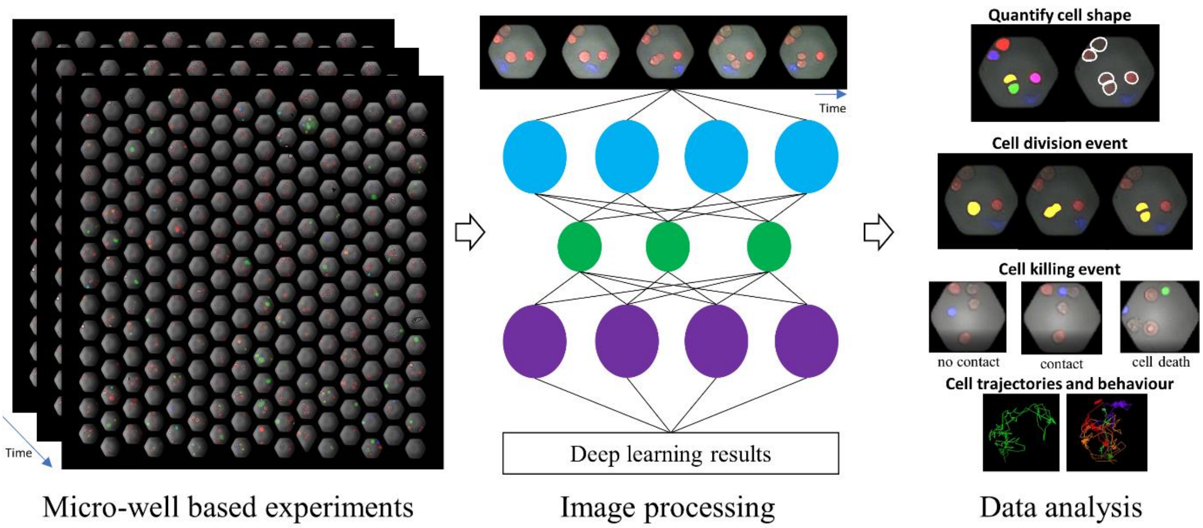

Figure 1. An example of single-cell experiment using NK cells (blue) and tumor target cells (red) in a multi-well microplate. We use the microwells to confine cells and follow interactions of interest over time, and conduct image processing followed by analysis. In image processing, we select specific image channels and time series data to train various DL networks. With the detection and tracking results from DL, we can quantify the shape of cells and various cell events to analyse cell behaviour. Note that in the data analysis part, cells of interest based on our DL results are color-coded and their status such as NK-target cell contact, cell death after contact as well as NK cell trajectories can be used in the analysis of immune responses.