Bern, 14.04.2021

UNIVERSITÄT BERN

Bern Data Science Day 2021 - April 23

Automatic detection, characterization, and classification of local Ca^{2+} release events in cardiomyocytes

DS applications and challenges in Medicine, Natural Sciences, and Engineering

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Abstract

The detection, localization, and classification of local Ca^{2+} release events obtained in cardiomyocytes can be a difficult task that requires a careful inspection of three-dimensional confocal imaging data and several manual steps. We present a novel deep learning-based approach to perform these tasks in a fully automated fashion. Our method relies on a 3D U-Net architecture trained over segmented videos containing fluorescence signals of the cells. We employed data obtained with full-frame confocal imaging of atrial myocytes where subcellular Ca^{2+} events, such as sparks and puffs, are manually annotated, and trained the neural network to infer comparable segmentations as output. Despite the relatively small amount of available data and the challenges that this kind of data exhibit, e.g. the annotations of the videos being prone to subjective biases and the precise boundaries of the local events not being well-defined, we obtained qualitatively promising results. Therefore we believe that machine learning can help the detection and the categorization of local Ca^{2+} release events in different types of cells. Further steps include the acquisition of additional data and the development of a formal quantitative method to evaluate the performance of the presented approach.