deepCLEM:

A new Deep-Learning-based Platform for Label-Free Correlative Light and Electron Microscopy

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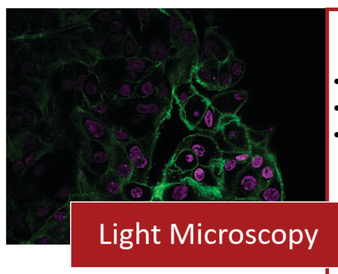
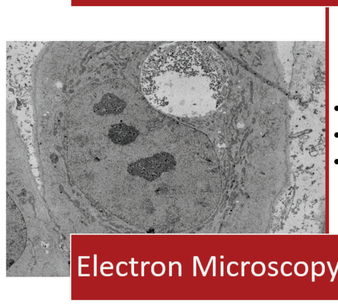
Motivation

Multi-resolution imaging techniques are crucial for driving new discoveries within the field of biological processes:



Light Microscopy

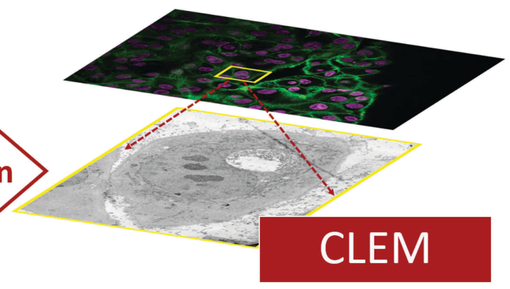
- Cellular dynamics and function
- Multi-color labelling
- Lower resolution



Electron Microscopy

- Nanometer-scale resolution
- Cellular ultrastructure
- ↓artifacts in sample preparation

Image Correlation



CLEM

- Powerful multi-resolution technique
- Functional & structural information in the same sample
- Application in several fields in life sciences

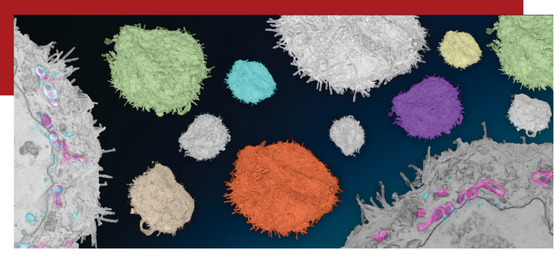
- Time-consuming workflows
- Use of fluorescent markers
- Risk of sample contamination & cell damage
- High levels of expertise. Manual annotation

Fluorescence Microscopy drawbacks:

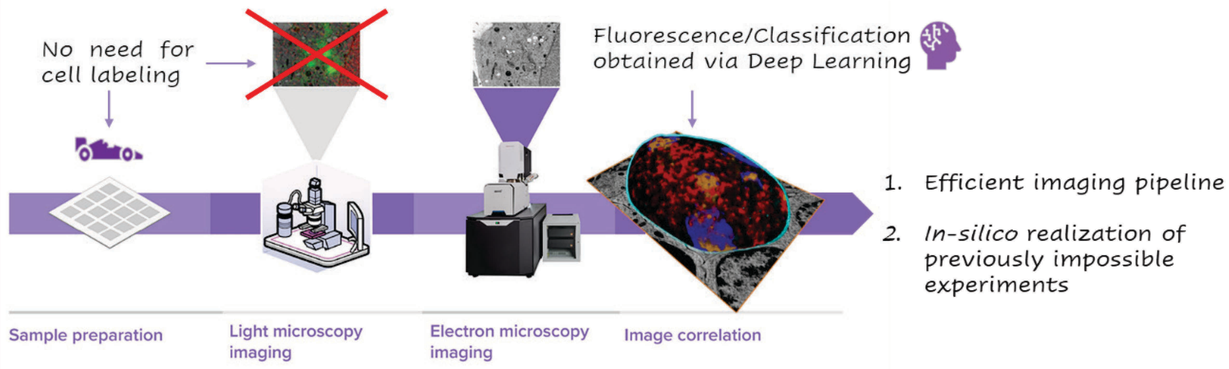
- Limited number of labeled structures
- Conventional fluorescent probes are incompatible with classical EM
- Loss of ultrastructural integrity of cells

Objectives

- The increase of the yield of CLEM data for the study of cell infection.
- The enabling of new kinds of experiments where fluorescent labeling is not practical or feasible.



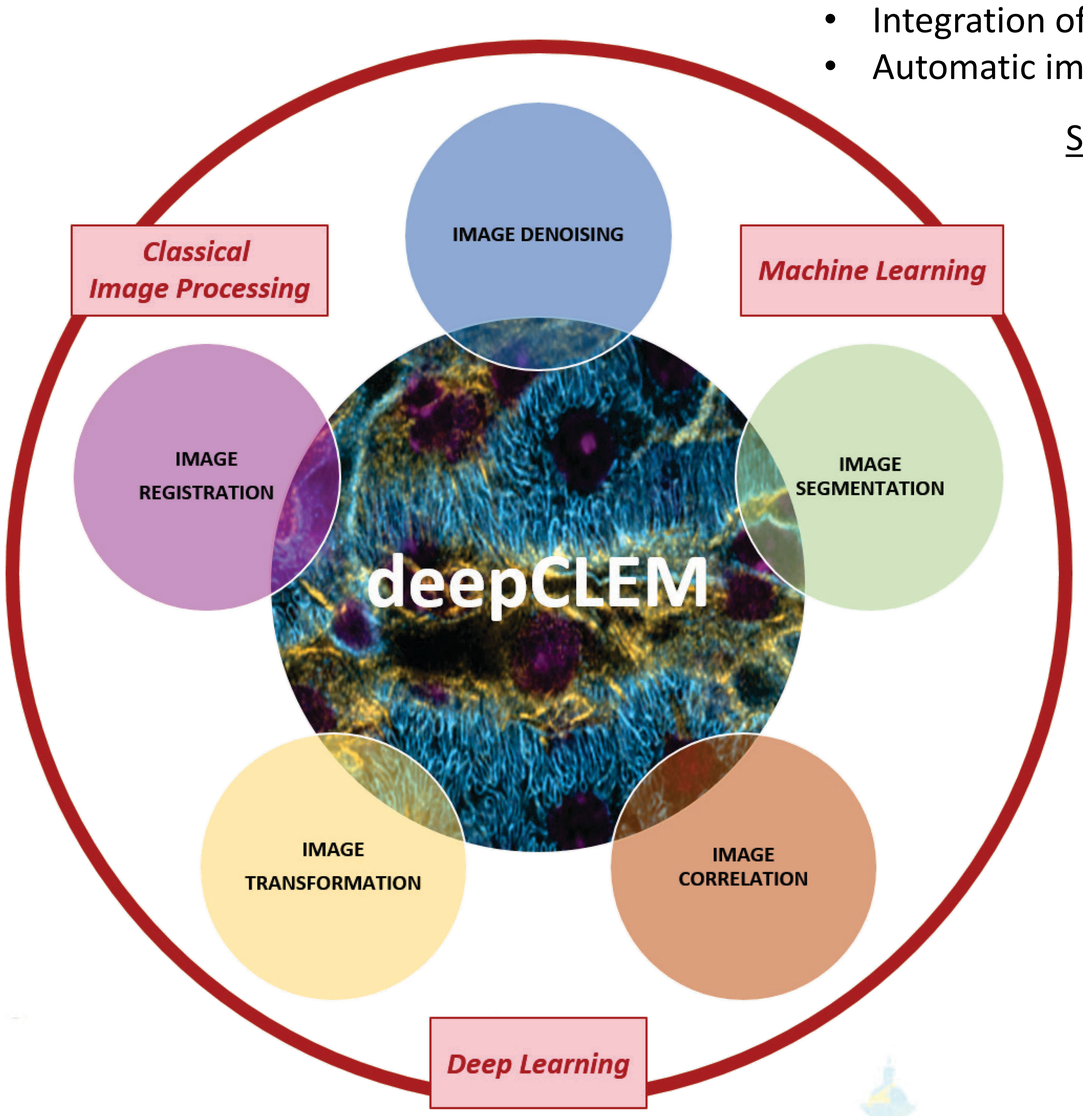
- To develop deep learning tools for a **completely label-free CLEM**
- To improve the accuracy, speed, and scalability of CLEM
- To ensure compatibility with different non-invasive LM techniques
- To reduce the risk of artifacts during the sample preparation



Methodology

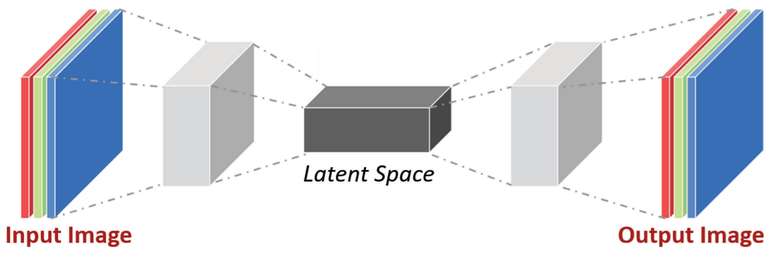
deepCLEM Workflow:

- Combination of Electron Microscopy, label-free 3D Light Microscopy and computational techniques
- Integration of classical image processing techniques, Machine Learning and Deep Learning tools
- Automatic image annotation and correlation processes



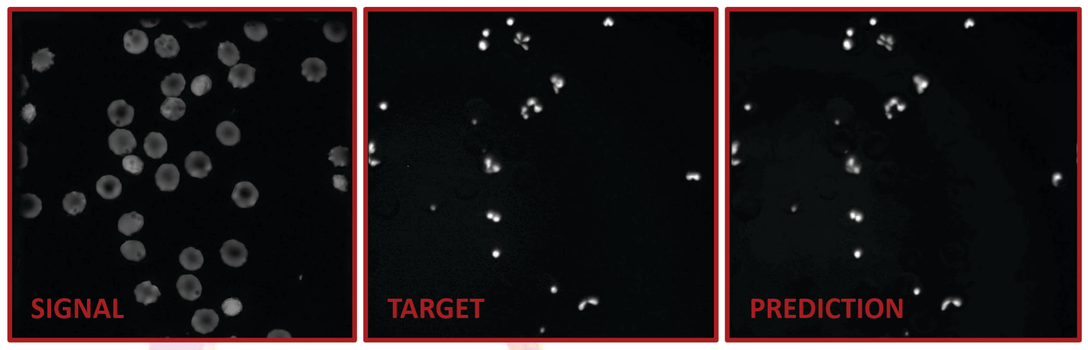
Stages of development:

1. Efficient DL models capable of identifying different cell structures from different label-free microscopy images.
2. High-throughput pipeline for the multimodal microscopy image correlation.
3. Validation of the deepCLEM generalizability for the identification of cell structures.
4. Use deepCLEM to study structure-function relationships in infectious pathogens.



Different architectures

Preliminary results: Detection of RBCs infected by the parasite *Babesia Divergens*



github.com/deepCLEM

Acknowledgments

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