

## Master Thesis / HiWi

# Synthetic Cellular Video Generation using Denoising Diffusion Probabilistic Models

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## Background

Deep learning based cell segmentation and tracking algorithms aid medical experts in the analysis of cellular behaviour and diagnosis. However, the data required to train those models are usually scarce due to privacy concerns and the data annotation process being labor intensive. In order to overcome this scarcity, generative models are being widely used by researchers in recent years. Denoising Diffusion Probabilistic Models (DDPMs) are currently the top performing models in this domain. This thesis focuses on generating fully synthetic, realistic cellular microscopy videos using DDPMs.

## Tasks

- Literature review on Diffusion Models
- Getting familiar with the existing pipeline and recreating the previous results

Plus a subset of the following tasks:

- Investigating different ways to generate texturally consistent cells over time
- Experimentation on different datasets and different cell types
- Potentially extending the model from 2D to 3D to generate 3D+t videos
- Quality assessment of the generated synthetic data using metrics like FID, FVD, IS, etc.

## Required Qualifications

- Strong programming skills (Python, C++, or a comparable programming language)
- Deep learning and machine learning experience
- Basic skills in Bash Unix shells
- Version control (e.g. Git, GitHub, GitLab)
- Familiarity with libraries such as Pytorch, Pytorch Lightning, Numpy

## What We Offer

Our institute has state-of-the-art IT infrastructure that can quickly handle computationally intensive tasks. As a supervisor, I will accompany and guide the work, through regular meetings and discussions with you. At the end of the thesis/HiWi job, there is a potential to publish your work in a top-tier conference. If you are interested, feel free to contact me via the following email [Rueveyda.Yilmaz@lfb.rwth-aachen.de](mailto:Rueveyda.Yilmaz@lfb.rwth-aachen.de) including your latest CV and the transcript of grades.

