UNIVERSITÀ DEGLI STUDI DI GENOVA

Scuola di Scienze Matematiche, Fisiche e Naturali

Corso di Dottorato in Fisica
Curriculum BioNanoscienze

Correlative Microscopy through Machine Learning algorithms

Cadidate:
Lisa Cuneo

Advisor:
Prof. Alberto Diaspro

Anno Accademico 2022/2023

Research activity

My research activity deals with the design, implementation and application of machine learning algorithms to microscopy images. The aim is to extrapolate and structure the relevant information contained in the data according to the microscopy technique used to acquire the image and with its drawbacks. In details, my work concerns two different microscopy technique:

- Single-molecule localisation microscopy (SMLM): in this kind of experiments, the presence of background degrades the image quality and contrast, since it can compromise the localisation precision of the single molecules. The aim in this contest is to remove the background so that localisation accuracy improves.

- Fluorescence-Lifetime Imaging Microscopy (FLIM): in this cases a temporal information is acquired during the spatial scanning and used to extrapolate different physical characteristics of the sample. The goal here is to use the temporal information to separate different components in the image without the use of spectral information.

Attended courses

The following table summarises the list of attended courses:

Title	Type	Date	Prof.	Exame
Optical Microscopy at the Nanoscale	PhD	February - March 2021	Diaspro	Done
Biofisica	Master	I semester 2020/2021	Pesce	Done
Convex Optimization	PhD	II semester 2020/2021	Villa	Done
Advanced Optical Fluorescence Microscopy Methods	PhD	May - June 2021	Bianchini	Done
Harmonic Analysis of Scattering Networks	PhD	March - May 2022	Trapasso	Done

Publications

Conference proceedings Technical Digest Series (Optica Publishing Group), paper JTh5A.111
November 2021

An Automated Tool to Analyse 3D Fluorescence Images of Stained Nuclei.
Lisa CUNEO, Francesca BALDINI, Marco CASTELLO, Irene NEPITA, Simonluca PIAZZA, Laura VERGANI, Alberto DIASPRO
DOI:

Conference proceedings Biophysical Journal 121 (3) pp. 476a February 2022

Decrypting nanoscale chromatin architecture alterations implicated in neuroblastoma transformation by optical nanoscopy.
Francesca BALDINI, Isotta CAINERO, Lisa CUNEO, Irene NEPITA, Chantal USAI, Paolo BIANCHINI, Laura VERGANI, Aldo PAGANO, Alberto DIASPRO
DOI:

Conference proceedings Biophysical Journal 121 (3) pp. 362a February 2022

Investigating the role of chromatin compaction at the nanoscale in Hutchinson-Gilford progeria syndrome using expansion microscopy
Chantal USAI, Isotta CAINERO, Lisa CUNEO, Francesca BALDINI, Matteo MARIANGELI, Irene NEPITA, Paolo BIANCHINI, Alberto DIASPRO
DOI:

Presentations at conferences

Apr 10 – 13, 2022 FOM 2022 – Online

Focus On Microscopy 2022.
A wide range of microscopy and microscopy related subjects have been addressed, ranging from the physics of super-resolution, spatial image formation to the advanced use of fluorescent probes in live cellular biophysics.
As a personal contribution I presented a talk with the title *"A deep learning-based method to spectrally separate overlapping fluorophores based on their fluorescence lifetime"*.

Sep. 6 – 8, 2022 PRIMO 2022 – Trieste

Post-graduate Researchers in Inverse Problems, Machine Learning, and Optimization.
As a personal contribution I presented a talk with the title *"Scattering Networks: a tool to remove background in microscopy images"*.

Sep. 11 – 14, 2022 SIBPA 2022 – San Miniato

Società Italiana di Biofisica Pura ed Applicata.
As a personal contribution I presented a talk with the title *"Unmixing overlapping fluorophores through a deep learning method based on fluorescence lifetime"*.

Attended Conferences and schools

Jul. 10-15, 2022   School of Physics "Enrico Fermi" – Varenna, Italy

Multimodal and Nanoscale Optical Microscopy.

Description: Multimodal optical microscopy, Fluorescence microscopy, Non linear optical microscopy, Label free, Mueller matrix optical microscopy, Brillouin microscopy, Polarization microscopy, Three-dimensional microscopy, F methods in microscopy (FRAP FLIM FRET FCS) Lifetime fluorescence, Super resolution, Phototoxicity and photodamage, Optical and magnetic trapping, Image formation, Inverse problems, Bioimage analysis.

Jan. - Feb., 2022   UMI-MIVA Winter School 2022 – Online

Advanced methods for mathematical image analysis.

Description: Introduction to inverse problems and numerical (convex/non-convex, smooth/non-smooth) optimization methods in imaging; supervised and unsupervised learning, deep learning, image classification; statistical inverse problems with application to image restoration and image reconstruction, segmentation, inpainting.

Nov. 30 - Dec. 3, 2021   Nikon Workshop 2021 – Genova, Italy

6th NIC@IIT pratical workshop on advanced microscopy.

Description: The hands-on session will be organized to give basic knowledge on the following topics and the available instruments: STORM (Stochastic Optical Reconstruction Microscopy), SIM (Structured Illumination Microscopy), Confocal Microscopy, ISM (Image Scanning Microscopy), 2PEFM (Two-photon excitation fluorescence microscopy), SHG (Second Harmonic Generation) microscopy, STED (STimulated Emission Depletion) microscopy, FLIM (Fuorescence Lifetime Imaging Microscopy) and FCS (Fluorescence correlation spectroscopy), Label-Free microscopy.

Nov. 22 - 23, 2021   VaMOS Workshop 2021 – Online

Advanced optimization methods for inverse problems & applications to image microscopy.

Description: The purpose of this workshop is to foster international collaborations between the French and the Italian community working on the modelling, the analysis and the algorithmic aspects of imaging inverse problems (such as deconvolution, super-resolution, reconstruction, segmentation and so on), which are often encountered from biologists in the context of image microscopy applications.

Oct. 11 - 13, 2021   PRIMO Workshop 2021 – Online

Post-graduate Researchers in Inverse problems, Machine learning, and Optimization.

Description: The "PRIMO Workshop" offers early-career researchers working on topics within the broad research areas of imaging science, machine learning/deep learning and non linear optimization a stage to share their work and network with peers and future collaborators.