Multi-way analysis of single-molecule fluorescence microscopy data

Supervisors: Cyril Ruckebusch (U Lille), Peter Dedecker (KU Leuven)

Fluorescence microscopy can provide structural characterization and dynamic information about complex biological systems. Previously limited to a spatial resolution of a few hundred nanometers due to the diffraction limit resolution barrier, recent developments of single molecule fluorescence localization microscopy techniques -exploiting both the spatial and temporal dimensions of the fluorescence signals- have allowed to achieve spatial "super-"resolution of ~10 nm. Yet, these techniques do not provide chemical contrast and thus the obtained images only show a glimpse of the much larger complexity of the investigated samples. A better characterization of the biological behaviors and functionalities at the nanoscale can be achieved though imaging techniques for which additional measurements modes or dimensions are added to the original ones, resulting in what are generally called multiway data. It is well-established in chemometrics that the holistic analysis of multiway data provides much richer information compared to just combining the results individually obtained analyzing the data obtained for each of the aforementioned dimensions. However, the complexity resides now in the analysis of multidimensional, highly multiplexed images and strongly overlapping signals. The proposed thesis work will aim at showing the potential of multiway approaches in the context of single-molecule fluorescence microscopy imaging. To this end, multilinear approaches will be developed to characterize strongly mixed and spatially overlapped signals of individual fluorescence species. Relevant systems of different complexities and various measurement dimensions (like spectral fingerprinting or lifetime information) will be explored to show that a better description of the structure and phenomena can be accomplished by the application of these approaches.

The candidate should be highly motivated, enthusiastic and opened to interdisciplinary work and international collaborations. The position is equally shared between U. Lille and KU Leuven, both universities offering an ideal environment and top-level equipments. From October 2020, the PhD applicant will join a 36 months bi-national PhD Program and will ultimately receive diploma from both universities. Candidates should hold a master in, chemistry, physics or equivalent and have strong interest in data/image analysis, spectroscopy and/or microscopy.

Contacts: Cyril.Ruckebusch@univ-lille.fr or Peter.dedecker@kuleuven.be