***Title:*** ***Resolving Bleached Emitters Using Iterative Localization by Deep-learning***

***Supervisor:*** *Dr Marwa Mahmoud (mmam3@cam.ac.uk)*
***Co-supervisor/advisor:*** Dr John Danial – Department of Chemistry, University of Cambridge

***Summary:***

Conventional optical microscopy cannot resolve any two fluorescent objects closer than 200 nanometres apart due to the diffraction limit of light. Super Resolution Microscopies (SRM), a set of techniques developed since 2006, are capable of breaking this limit to reach outstanding spatial resolutions between 1 and 10 nanometres. The conception of SRM has enabled the observation of cellular organization with perfect precision and was awarded the 2014 Nobel Prize in Chemistry. Amongst the popular SRM technologies is Stochastic Optical Reconstruction Microscopy (STORM). Although powerful, STORM has a few challenges as it requires: 1. High-power lasers which are hard to integrate into an existing microscope by a non-expert. 2. Specific fluorescent labels which can be hard to attach to a biological sample. 3. Continuous exchange of liquid surrounding the biological specimen. 4. Long acquisitions exceeding 1 hour per sample.

This project is aimed at developing a novel SRM technique – based on deep learning – that is quicker, faster and easier-to-implement. The technique will rely on the bleaching (or loss of fluorescence) of the molecules constituting a sample which occurs as a result of exposure to low-to-medium light levels. Bleaching occurs to all fluorescent labels, does not require any liquids and can be achieved in a few minutes.

This project will first develop simulated dataset based on experimental data samples to produce a ground-truth dataset to be used for training and testing. The main aim is to implement a machine learning model based on auto-encoders deep learning architectures to transform a stack of bleaching samples into their super-resolved equivalents. The models are expected to be evaluated on the synthesized and experimental data.

***Project:*** ***Automatic Detection of Face Touch and Self-adaptors in Infants***

***Supervisor:*** *Dr Marwa Mahmoud (mmam3@cam.ac.uk)*
***Co-supervisor/advisor:*** Dr Staci Meredith Weiss and Prof Mark Johnson – Department of Psychology, University of Cambridge

***Summary:***

Birth is the single most dramatic change in environment in the lifetime of the human brain, triggering a rapid period of reorganization in neuronal functions and motor activity. Building upon fetal exploration of their own bodies and the womb milieu, infants navigate their novel visual environment and exploit their maturing physical capacities. Quantitatively measuring change and development of these activities (limbs movements and hand-to-face touches) helps to analyse continuity in prenatal and postnatal motor activity. The objective is to better understand and verify theories of ontogeny, influenced by developmental biology, systems, and ecological-evolutionary models.

Using a dataset of a longitudinal, multi-cultural sample of prenatal ultrasounds and infant videos, the project aims to develop machine learning models for automatic detection of body parts, face touch and self-adaptors in infants. Current body detection and tracking models are mostly trained and tested on adults. This project aims at developing computer vision models that work on infants, leveraging previous work on adult human behaviour modelling. The project will aim to define and automatically detect behaviour descriptors and the produced models will be evaluated against manual labelling of infants' behaviour provided by experts.