Towards Bayesian based smart microscopy

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Fluorescence microscopy is an incredible toolbox for the investigation of the cellular machinery over multiple length scales. It presents unique advantages such as protein specificity, multi-color, the access to 2D, 3D and whole cell data, from both fixed or live sample, to name a few. This, however, comes at a cost: complex microscopy set ups, with many user definable parameters to set for the image acquisition, and no clear guidelines to do so. This lack of robust framework for the optimization of acquisition parameters often impacts negatively on the output data: image quality deterioration and limited reproducibility are common issues faced by the field. In the face of these limitations, how much can we trust the statistics extracted from these images, independently of the analysis tool used? We propose here a Bayesian based framework for the optimization of acquisition parameters allowing for user-free microscopy acquisition, while insuring the reproducibility of the generated images. It is a first step towards sample specific automated microscopes or "smart microscopes". We will focus on the application of this framework to SMLM relying on a novel real time SMLM simulator that we have developed for its validation.