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# Enhancing single molecule localization microscopy with deep learning

Single-molecule localization microscopy (SMLM) is a powerful super-resolution imaging technique that can image biological structures at near-molecular scales (resolutions down to ~20 nm or better), enabling broad applications in the life sciences. With standard reconstruction methods, SMLM typically requires ~$10^4$-$10^5$ low-resolution frames to generate a single super-resolution image, hence the temporal resolution of SMLM is very poor. To improve this, we previously developed a deep learning approach (ANNA-PALM) that reduces the number of required frames for structures such as microtubules by up to ~100-fold. However, deep learning-based approaches are susceptible to model mismatch, whereby artifacts can arise in case of inconsistencies between training and test data. An obvious approach to alleviate this issue and increase the robustness of deep learning-based methods is to increase the quantity and diversity of training data. Unfortunately, despite the widespread use of SMLM, there is comparatively little sharing of SMLM data in the community, in part for lack of dedicated tools, resulting in a dearth of training data.
To address this challenge, we developed ShareLoc (https://shareloc.xyz), an open platform designed to enable sharing, easy visualization, and reanalysis of SMLM data in accordance with FAIR principles (findable, accessible, interoperable, reusable). Thanks to the Shareloc platform, we retrained ANNA-PALM on a much larger and more diverse data set than our original model. We demonstrate empirically that data sharing through ShareLoc allows to significantly improve the quality and robustness of ANNA-PALM reconstructions when tested on images from a fifth, independent lab. More generally, we expect that ShareLoc will accelerate the development of state-of-the-art analytical techniques and the promotion of reproducible research in the field of SMLM and its numerous applications in biological research.

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