Axial localisation of single particles using machine learning

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Standard techniques of three-dimensional single particle tracking use asymmetric point spread functions to encode axial position in the image of a single point emitter. Online or post-processing algorithmically converts the bead images into axial positions using *a priori* knowledge of the system. We present an agnostic and flexible machine learning approach which requires no *a priori* optical system information to accurately predict axial bead positions. We show that a neural network can achieve axial resolution of <5% when trained using real astigmatically aberrated epifluorescence bead data. The technique is applied to an airy-light-sheet system with no PSF altering optics to localise particles with <5% error. The neural network is sufficiently small such that live processing is viable, whilst flexible enough to model typical optical systems.

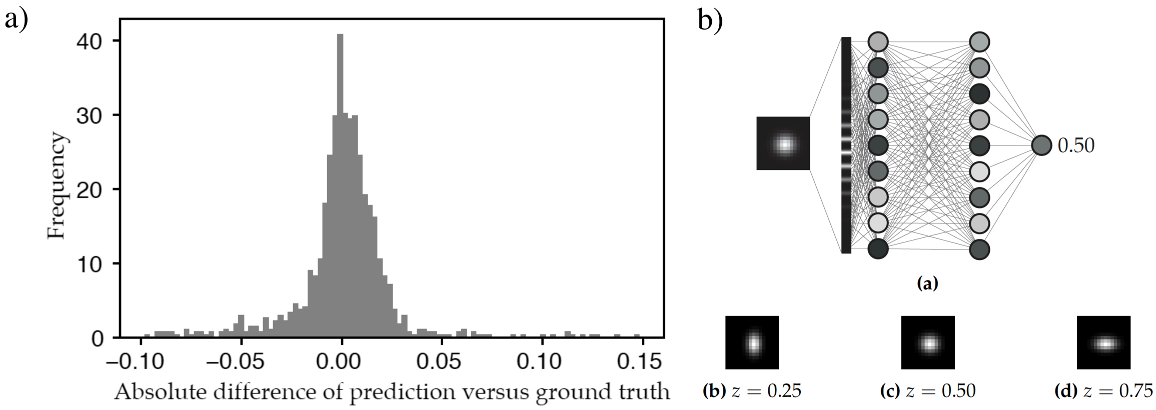

Figure 1. a) Shows the absolute error distribution of a neural network predicting axial bead positions from raw bead images. b) Illustrates how a neural network can be trained and applied to the axial localisation of bead images.