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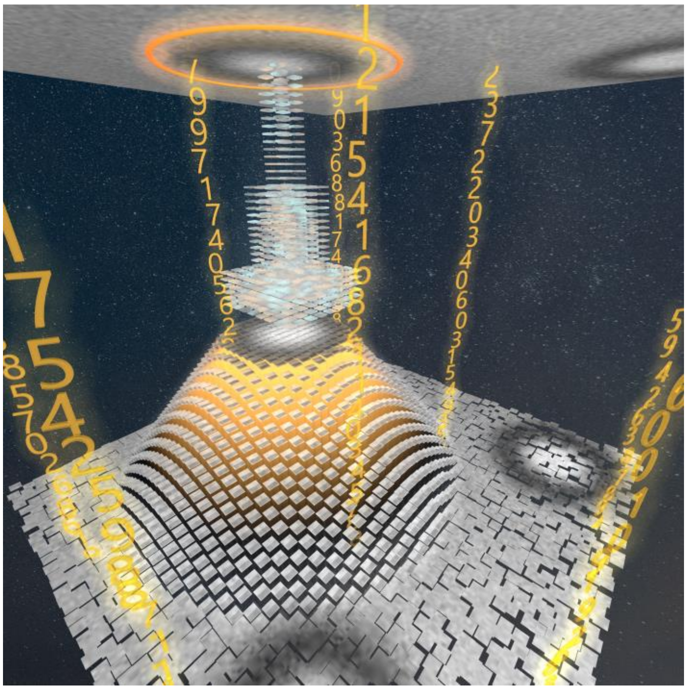
Deep Learning for Particle Tracking



Bakgrund: Particle tracking is a key enabling technology for many diverse applications. In fact, the motion of a microscopic particle is often used as a local probe of its surrounding microenvironment. For example, it is used to measure biomolecular forces, to explore the rheology of complex fluids, to monitor the growth of colloidal crystals, and to determine the microscopic mechanical properties of tissues.
Digital particle tracking was introduced about 20 years ago and is still dominated by algorithmic approaches. These algorithms require the user to give explicit rules to process the image of a particle to obtain its position. For example, some of the most commonly employed algorithms are the calculation of the centroid of the particle after thresholding the image to convert it to black and white, and the calculation of the radial symmetry center of the particle. Their performance degrades severely at low signal-to-noise ratios (SNRs) and under unsteady or inhomogeneous illumination, often requiring significant intervention by the user to reach an acceptable performance, which in turn introduces user bias. In practice, in these conditions, scientists need to manually search the space of available algorithms and parameters, a process that is often laborious, time-consuming, and user-dependent.

Problembeskrivning: The project will consists in developing a fully automated deep-learning network design that achieves subpixel resolution for a broad range of particle kinds, also in the presence of noise and under poor, unsteady illumination conditions, significantly outperforming standard algorithms. In the spirit of open science, we aim to provide a free Python software package, which can be readily personalized and optimized for the needs of specific users and applications.

Arbetssätt: The project will consist of computational work using Python and state-of-the-art machine learning tools such as Keras and TensorFlow, as well as test with experimental data acquired through digital video microscopy. The thesis and presentation can be in Swedish.

Gruppstorlek: 3-6 studenter.

Målgrupp: F, GU-fysik, TM, E, Z, D, IT eller motsvarande.

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