Machine learning to the rescue: robust measurement of director fields and defects in active nematics

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Active nematics are attracting significant attention due to their rich emergent dynamics, which have potential applications in robotics, drug delivery, and materials science. The director field, which measures the direction and degree of alignment of the local nematic orientation, is a crucial characteristic of active nematics and is essential for studying topological defects. However, determining the director field robustly from experimental data is often challenging. We developed a machine learning model for extracting reliable director fields from experimental images of 2D active nematics, enabling accurate topological defects analysis. The approach is robust and highly generalizable to experimental settings different from those in the training data. This machine-learning approach is a promising tool for investigating active nematics and may be generalized to other active matter systems.

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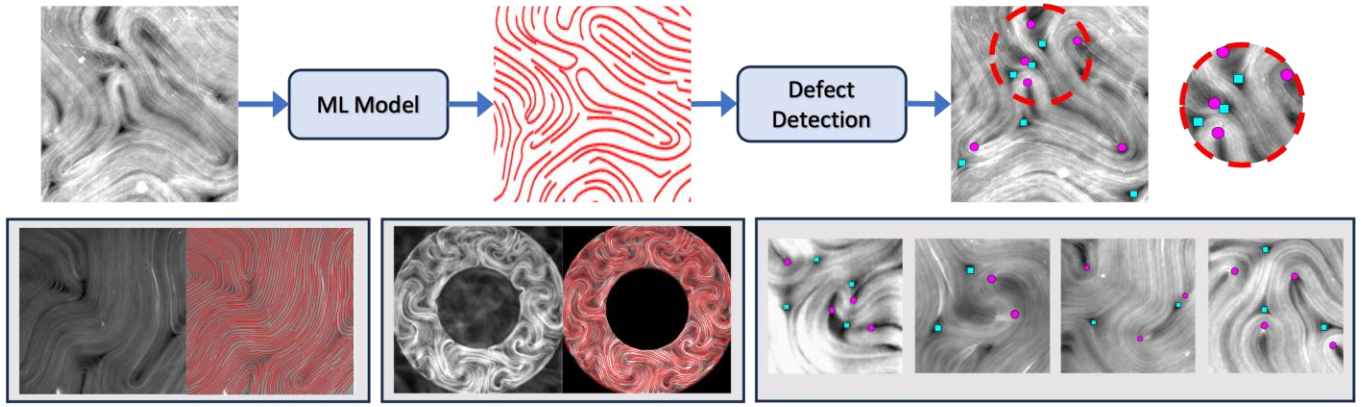

Robust measurement of director fields and defects in active nematics.
A machine learning model was developed to robustly measure the direction and degree of alignment of microtubule bundles in a 2D active nematic. This enabled the robust detection of topological defects, even in situations where the experimental conditions were different from the training data (either different molecular composition or different confining geometries)