# Characterisation of liquid crystals via textures: from polarising microscopy to machine learning

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In this tutorial we will discuss a range of methods to characterize liquid crystal phases by their textures. Starting with polarizing microscopy we will show the most characteristic textures of various different phases from nematic to smectic and soft crystals and explain some of their characteristic appearances and defects [1]. Similarly, we will shortly introduce chirality and demonstrate how novel phases such as Blue Phases and Twist Grain Boundary Phases may appear with novel and different textures and defects.
After illustrating how we can verify the structure of some liquid crystal defects [2,3], we will proceed to a short comparison with solid state systems, which often show similar defects as liquid crystals but on a very different length scale. In this context it is also demonstrated that many liquid crystal textures can in fact result from growth via a rather universally employed algorithm called Voronoi diagrams, leading to Voronoi textures [4,5].
At last, we will explore how far modern machine learning algorithms like convolutional networks and inception models can be employed to characterize liquid crystals. A range of examples will be presented from simple transitions involving the nematic phase to more complicated scenarios involving nematic, fluid smectic, and hexatic smectic order [6], and even soft crystal phases. Also, complete phase sequences in chiral liquid crystal with paraelectric, ferroelectric, ferri-, and antiferroelectric phases will be demonstrated to be predictable by machine learning [7]. Advantages and disadvantages of machine learning will be discussed, also in sight of traps to avoid [8].

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