PhD thesis: stochastic geometry for deep learning

Deep learning lies at the origin of a technical revolution in many research fields, including image analysis and computer vision. Nevertheless, its success raises several theoretical and practical issues. The mechanisms leading to results surpassing the state of the art largely remain unexplained from a theoretical perspective. In addition, deep learning techniques rely on large annotated databases. The availability of such databases constitutes a significant concern regarding the practical use of these methods.

The use of simulated data to address these challenges constitutes a recent and promising research trend [3--5]. Stochastic geometry [1, 2] is a mathematical discipline that studies random spatial patterns. It is closely linked to mathematical morphology. The random models developed within this framework are commonly used to model materials microstructures. In this PhD project, our objective is to explore techniques from stochastic geometry to analyze the internal mechanisms involved in deep convolutional neural networks (CNN) and to facilitate the generation of databases aimed at training deep-learning architectures for image analysis tasks.

This PhD thesis will take place at the Center for Mathematical Morphology (CMM) at MINES ParisTech. The CMM is a pioneer laboratory in the field of stochastic geometry. The PhD student will work under the supervision of Bruno Figliuzzi, Santiago Velasco-Forero and Etienne Decencière.

Candidates should send a CV, a cover letter and the grades obtained during the last two years to Etienne.Decenciere@mines-paristech.fr.

References

[1] S. N. Chiu, D. Stoyan, W. S. Kendall, and J. Mecke. Stochastic geometry and its applications. John Wiley & Sons, 2013.

[2] G. Matheron. Random sets and integral geometry, volume 1. Wiley New York, 1975.

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[4] A. Shrivastava. Learning from simulated and unsupervised images through adversarial training. The IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2017.

[5] D. Tuccillo et al. Deep learning for galaxy surface brightness profile fitting. Monthly Notices of the Royal Astronomical Society, 2017.