



A Novel Statistical Approach to Analyze Image Classification

Sophie Langer

(University of Twente)

29/01/2025, 4:15 pm

Department of Statistics, Ludwigstr. 33, Room 144

and online via Zoom ([Link](#))

(Meeting-ID: 631 1190 7291; Password: StatsCol)

Convolutional neural networks (CNNs) excel in image recognition, showcasing remarkable performance in face recognition, medical diagnosis, and autonomous driving. However, their reliability remains a concern due to the lack of robust theoretical foundations. Establishing a solid statistical framework is essential before we can fully analyse CNNs from a theoretical perspective. Current interpretations treat image classification as a high-dimensional classification problem with each pixel value being an independent variable. Function recovery in high dimensions lead to slow convergence rates, known as the curse of dimensionality. Consequently, CNN classifiers show worse performance with increased pixel count, contradicting empirical observations. In this talk, I will present a novel statistical approach that reconceptualizes images not as high-dimensional entities but as highly structured objects. Within one class, objects arise from different geometric deformations, including shifts, scales, and orientations. The goal of the classification rule is then to learn the uninformative deformations, resulting in faster convergence rates for higher dimensions, i.e., a higher resolution of the image. This new perspective not only provides novel approximation and convergence guarantees for deep learning-based image classification, but also redefines our perception of image analysis, bridging theory with practice.

About the Speaker:

Sophie Langer is an associate professor in the statistics group at University of Twente. She holds a PhD from the Technical University of Darmstadt. Her research focuses on the mathematical understanding of deep learning, combining statistical and computational aspects, with particular focus on deep learning in image classification. She is also interested in analysing optimisation schemes and regularisation methods used in deep learning's training such as dropout and SAM. Sophie is an associate editor of the Electronic Journal of Statistics and the Journal of Statistical Planning and Inference.