
Uncertainty in, uncertainty out: epistemic variance improves encoding of natural images

Hugo Ladret*¹ and Laurent Perrinet*¹

¹Institut de Neurosciences de la Timone – Aix Marseille Université : UMR7289, Centre National de la Recherche Scientifique : UMR7289, Aix Marseille Université, Centre National de la Recherche Scientifique – France

Résumé

Aleatoric uncertainty characterizes natural images and echoes the epistemic uncertainty ubiquitously found in sensory systems. We propose that the former helps encode the latter, and perform a manipulation of the epistemic uncertainty of a convolutional sparse coding algorithm to do so.

Using a fast method of dictionary generation, we show that encoding oriented features across multiple levels of epistemic uncertainty significantly improves the reconstruction of natural images. Such an encoding scheme balances the distribution of the epistemic uncertainty of the model, which matches the multiple aleatoric uncertainty levels of its input.

Overall, this orientation/uncertainty code is well captured by a Dirac Laplacian function and can be pruned, for any natural image, to obtain additional sparsity boost with minimal image encoding performance loss.

Finally, we demonstrate how hierarchical visual processing can benefit from encoding uncertainty, by training a deep-learning convolutional neural network to classify sparse-coded CIFAR-10 datasets, showing that encoding uncertainty translates into a resilient and reusable representation of naturalistic images.

Overall, this work empirically demonstrates the computational advantage of partitioning epistemic uncertainty in computer vision algorithms.

Mots-Clés: uncertainty, sparse, coding, vision, v1, natural, images

*Intervenant