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How the brain escapes the curse of dimensionality

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Our visual system recognizes objects so effortlessly that we tend to overlook the computational complexity of the task. In fact, object recognition requires classifying images, which can be viewed as data points in the very high-dimensional space of all possible images. If the probability density of images were uniform over this space such task would be exponentially hard in the number of dimensions (pixels in an image). Object recognition is tractable only because the probability density of natural images concentrates on locally low-dimensional structures called manifolds. However, the mechanism with which the brain learns such manifolds is unknown. Here, we propose a theory for learning data manifolds using biological hardware. We postulate a principled objective function and derive an optimization algorithm implemented by fast (electrical activity) and slow (synaptic plasticity) dynamics in neural networks. Our theory is a step towards understanding the brain and building artificial intelligence.