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# Coarse graining to capture ”relevant” information in biological systems

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Biological systems must selectively encode partial information about the environment, as dictated by the capacity constraints at work in all living organisms. For example, we cannot see every feature of the light field that reaches our eyes; temporal resolution is limited by transmission noise and delays, and spatial resolution is limited by the finite number of photoreceptors and output cells in the retina. Classical efficient coding theory describes how sensory systems can maximize information transmission given such capacity constraints, but it treats all input features equally. Not all inputs are, however, of equal value to the organism. Our work quantifies whether and how the brain selectively encodes stimulus features, specifically predictive features, that are most useful for fast and effective movements. We have shown that efficient predictive computation starts at the earliest stages of the visual system, in the retina. We borrow techniques from statistical physics and information theory to assess how we get terrific, predictive vision from these imperfect (lagged and noisy) component parts. In broader terms, we aim to build a more complete theory of efficient encoding in the brain, and along the way have found some intriguing connections between formal notions of coarse graining in biology and physics.

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