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Cognitive Vision Systems

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Understanding human vision is an intriguing challenge. Vision dominates our senses for personal observation, societal interaction, and cognitive skill acquisition. Understanding visual perception to such a level of detail that a machine could be designed to mimic it is a long-term goal, and one which is unlikely to be achieved within the next few decades. However, as computers are expected in the next twenty years to reach the capacity of the human brain, now is the time to start thinking about methods of constructing modules for cognitive vision systems.

This lecture outlines computational models for visual cognition. For both biological and technical systems, we are examining which architectural components are necessary in such systems, and how experience can be acquired and used to steer perceptual interpretation. Since human perception has evolved to interpret the structure of the world around us, a necessary boundary condition of the vision system must be the common statistics of natural images. Searching for generality, it is observed that a limited set of physical laws of image formation will impress common statistics on the images offered to the eye as sensory input. The physical laws are largely scene and domain independent, as they cover the universally applicable laws of light reflectance from materials.

The lecture focuses on the physical and statistical constrains in the sensory input, and how this can be exploited to construct cognitive vision systems. Visual cognition may be based on a weak description of the important features in the scene, as long as mutual correspondence between observation and objects in the world is maintained. For such a computational theory, the first few steps will be outlined: visual measurement, invariant representation, and focal attention.