Visual Cortex and Perceptual Organization: what neurobiology can teach us about visual information processing

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Abstract

The capabilities of biological vision systems remain unmatched for the analysis of visual scenes, for the recognition of wide varieties of objects and features, and generally for the support of visually-mediated behaviours. These capabilities are distributed across nearly half of the primate cortex, an exquisitely structured system of visual areas, cell formations, and connections. In this tutorial I will privide an introduction to the neurobiology of the visual system, and will focus on how the functional architecture appears columnar with rich long-range, horizontal connections.

The structure of this machine supports a range of tasks in early and intermediate-level vision, and I will overview how the structure of this machine can be abstracted into algorithms for boundary detection, texture and shading analysis, color and stereo.

The abstract identification of ideas from differential geometry with cortical architecture is a unifying theme through this tutorial, and the elaboration of intermediate-levels of visual representation provides a challenging contrast to current practices in computer vision. Novel learning algorithms indicate that this structure is available from scene statistics, and suggests how perceptual organization, figure/ground analysis, and Gestalt principles can be integrated into computer vision systems.

Syllabus: Visual Cortex, Differential Geometry, Early Vision, Perceptual Organization, Geometric Harmonics