ON THE ROLE OF FEEDBACK SIGNALS:
A COMPUTATIONAL MODEL FOR RESOLVING LOCAL AMBIGUITY IN VISION
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To understand a role of feedback signals in the visual cortex, we have developed a computational model which performs image interpretation in degraded environments; Given a degraded image, the model try to find the best interpretation of bounding contours. The interpretation is represented by the distributed pattern of activity in a tree-structured graph consisting of a large number of units. The bottom level of the graph is the pixel process, corresponding to the actual digitized image. Successively higher levels correspond to the images in coarser scales, each concerned with a small piece of information. The model is based on stochastic grammars, which can accommodate a priori information at multiple levels of a knowledge hierarchy. Given a degraded picture, we seek the image that maximizes the posterior distribution where maximization is performed via dynamic programming. This is a powerful theoretical framework provided by S. Geman & K. Manbeck (1993) where they demonstrated potential advantages of the model-based hierarchical approach over purely bottom-up or top-down alternatives in recognition. Since they imposed sufficient contextual constrains, some nodes need to have more than 100,000 states when experimented with a 256×256 image. We have developed a simplified version of this model with weak constraints in which each node has two states. By this, the computational operations are greatly reduced. The capability of the model to perform image interpretation has been investigated. We demonstrate that damages of feed-back signals affect noise removal and boundary-finding, indicating a role of the feedback signals. Obviously it does not directly address the question of whether analogous processes operate in visual cortex. However, the model seems to provide a framework for studying how the signals carried by cortical neurons could be used to resolve local ambiguity in images.

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