Recovering the template of a system with position uncertainty

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May 14, 2005

Abstract

Invariance or constancy is a hallmark of visual processing. Linear response-classification methods such as reverse correlation used in physiology and classification-images used in visual psychophysics are thought to be incapable of recovering the front-end matched filter or template of a visual processing stage whose response does not depend on the position, size, or orientation of a target, but is otherwise linear. We showed by simulation that the associated template of a system insensitive to target positions could be recovered using linear response-classification methods, provided that a strong-enough signal is embedded in the noise used to elicit responses. The average of the noise patterns associated with the miss trials, with the embedded signal removed, reveals the template, while that associated with the false-alarm trials provides an estimate of the extent of the position uncertainty or constancy. To demonstrate the practicality of our method, we performed two analogous signal-in-noise experiments with human observers. In Exp. 1, subjects were to discriminate between the letters "o" and "x" . In Exp. 2, subjects were to detect the presence of "o" . For both experiments, the target could appear in any position within a field of Gaussian white noise. The contrast of the target was adjusted continuously using an adaptive procedure to maintain a response accuracy of 75%. After each trial, the noise pattern used was shifted (with wrap-around) so as to center the presented signal. We showed that classification images obtained using the shifted noise patterns reach a sufficiently high SNR within 10,000 trials, which is comparable to a typical classification-image experiment run without position uncertainty. *Support Contributed By: NIH/NEI 1R03EY016391-01*