Computational model of co-operating covert attention and learning

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This work combines neocortex-like attention and learning in one neural network. Learning tries to form useful representations for the complex entities in the world while attention selects the most relevant ones at each time instant. An essential feature of the model is that attention guides learning.

Desimone and Duncan [1] have proposed a biased-competition model for attention in the cortex. According to this model, global attention emerges from local decisions in all parts of the cortex. The decisions are biased with contextual information, such as top-down expectations. Neurophysiological evidence for the biased-competition model has been presented [2] and computational implementations showing that attention emerges in these kind of networks exist [3]. However, learning is not integrated into the behaviour of these models.

Experience of the animal is known to shape the representations in all levels of cortical hierarchies [4]. Learning occurs mostly from attended targets [5]. Thus, the representational capacity of the network is allocated for relevant objects and features.

Our model combines learning of invariant representations and the biased-competition model. At each time instant, each local part of the network tries to select information that is the most important for being represented. This selection helps in learning, too. If attention succeeds in focusing on coherent targets, learning associations and features becomes feasible, as different objects are separated by attention.

Simulation results show that the system is able to develop coherent selective attention. Neural populations are able to represent a single object even though the inputs contain multiple objects. At the same time, the network learns a hierarchy of invariances corresponding to the statistics of the input data.

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