Response-Based Scaling Models the Binding Problem in Top-Down Visual Search

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Mimicking the human mind is paramount in modern research fields such as autonomous vehicle development. The accepted computational model of vision by Miconi et al. (2016) mimics the way humans perform visual search, the process of looking for a specific object in an image, but it cannot recognize color. Here, I present a new computational model of visual search that integrates color features. A novel technique of response-based scaling was developed to solve the binding problem: combining multiple “feature channels” containing distinct feature information. This new model is based directly on biological evidence: information processing and representation within the model mirrors processing and representation in the brain. Specifically, the model focuses on the flow of information from the LGN through area V4 in the visual cortex. To collect data, a set of over 1000 images with well-defined human responses, throughout cognitive science literature, was created and fed through the new model. The model’s performance was measured by counting the resulting attentional fixations: how long it took the model to find the target object. Search speeds as a function of image clutter were calculated. Analyses showed that the new model matched search speeds of humans, with a confidence level of 99%, on a wide variety of search tasks. Additionally, response-based scaling was proven to be necessary due to slower search speeds ($p < 0.01$) in certain cases without response-based scaling. This new system permits for new directions in computer vision, with a variety of applications from security scans to autonomous vehicles.

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