Choosing Colors for Map Display Icons Using Models of Visual Search

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Objective: We show how to choose colors for icons on maps to minimize search time using predictions of a model of visual search.

Background: The model analyzes digital images of a search target (an icon on a map) and a search display (the map containing the icon) and predicts search time as a function of target-distractor color distinctiveness and target eccentricity.

Method: We parameterized the model using data from a visual search task and performed a series of optimization tasks to test the model's ability to choose colors for icons to minimize search time across icons. Map display designs made by this procedure were tested experimentally. In a follow-up experiment, we examined the model's flexibility to assign colors in novel search situations.

Results: The model fits human performance, performs well on the optimization tasks, and can choose colors for icons on maps with novel stimuli to minimize search time without requiring additional model parameter fitting.

Conclusion: Models of visual search can suggest color choices that produce search time reductions for display icons.

Application: Designers should consider constructing visual search models as a low-cost method of evaluating color assignments.

Keywords: quantitative modeling, optimization, histogram backprojection, interface design, CIELAB

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INTRODUCTION

Color coding reduces search time for items on visual displays (Phillips, 1979; Van Laar & Deshe, 2002; Williams, 1967; Yeh & Wickens, 2001). Color codes exist for certain types of items (Dent, 1990; Harvey, 2008), such as on maps, where icons representing the locations of emergency services are usually red. A person searching for a first-aid station on a map that employs this color code can restrict his or her search to red icons only, thereby reducing search time. For other icons, color code conventions may be nonexistent. The goal of this study is to determine what colors a designer should assign these icons to minimize search time.

Our current project shows how to use a model of visual search to choose colors for icons on maps. We first review color-coding guidelines and describe the factors that determine visual search performance. Then, we describe how to construct a quantitative model that incorporates those factors and fits data from an experiment (Experiment 1) in which participants search for colored icons on maps. We show that the model provides a strong fit to the Experiment 1 data, indicating that the model can predict search times for specific colored icons.

Next, we describe a procedure for choosing the optimal color assignment for a set of icons on a map. The optimization algorithm facilitates consideration of a very large number of possible color assignments to find the model-predicted optimal assignment. We test the parameterized model's ability to choose colors for icons on maps to optimize for a number of characteristics. First, we show how to choose color assignments to minimize average search time across icons when some icons are considered more important than others. We test the predicted optimal designs with human observers (Experiment 2) and conclude that this approach can facilitate search for important icons at the expense of search for other icons.