

Visual Queries: The Foundation of Visual Thinking

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ABSTRACT

There is no visual model of the world in our heads. Over the past few years the phenomena of change blindness and inattention blindness as well as studies of the capacity of visual working memory all point to the fact that we do not retain much about the world from one fixation to the next. The impression we have of a detailed visual environment comes from our ability to make rapid eye movements and sample the environment at will.

What we see at any given instant in time is determined by what we are trying to accomplish. If we need to find a path through a crowd we see the openings. If we are trying to find a friend we see the faces. We can think of this process of seeing as the execution of a continuous stream of visual queries on the environment. Depending on the task at hand the brain constructs a visual query and we execute a visual search to satisfy that query.

This paper presents an overview of how we think visually with interactive displays. The process can be thought of as constructing and executing queries on displays. The key features of the model are:

1. Problem components are formulated into questions (or hypotheses) that can be answered (or tested) by means of pattern discovery. These are formulated into visual queries.
2. Visual eye-movement scanning strategies are used to search the display.
3. Within each fixation, active attention determines which patterns are pulled from visual cortex subsystems that do pattern analysis.
 - a. Patterns and objects are formed as transitory object files from a proto-pattern space. These are tested against the visual query pattern at a rate of 40 msec/item.
 - b. Only a small number of objects or pattern components are retained from one fixation to the next. These object files also provide links to verbal propositional information in verbal working memory.
 - c. A small number of cognitive markers are placed in a spatial map of the problem space to hold partial solutions where necessary. Fixation and deeper processing is necessary for these markers to be constructed.
4. Links to verbal/logical complex information are activated by icons or familiar patterns, bringing other kinds of information into verbal working memory.

The purpose of the theory is to provide guidelines for the design of visualization interfaces; it is elaborated with from practical visualization problems.