Knowledge Navigation for Visual Problem Solving

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For the last several years, our research group has been interested in studying the cognitive foundations for building intelligent assistance agents which help people perform visual problem solving tasks such as medical image diagnosis. This work embraces cognitive issues of human perception and problem solving, representational issues of multimedia-based knowledge, computational issues of managing hypotheses and beliefs, as well as user interface issues of display and interaction techniques.

Previous work in the domain of diagnostic radiology involved extensive analysis of think-aloud reports of radiologists reading and diagnosing single-view chest x-rays. Through these experiments, we learned a great deal about perception and problem solving in this type of task, and found numerous results which proved to be consistent with other researcher's findings. For example: objects were referenced at different levels of abstraction; errors and oversights also occurred at different levels (from perceptual to problem solving); only a small set of descriptive features was articulated; domain knowledge was organized into declarative and procedural context, reasoning was both bottom-up and top-down, and concepts and features were used differently depending on the direction; attention was either captured immediately through a kind of "pop-out", or landmarks were deliberately searched; and expectations played a very strong role in connecting high level problem solving anticipations with lower level plans for looking at the image.

These results were incorporated into a preliminary model of visual interaction (Rogers, 1995a), and aspects of this model have been utilized in two prototype intelligent assistants: one which is designed to help radiologists read chest x-rays (VIA-RAD) (Rogers, 1995b), and one which provides perceptual and problem solving support for human supervision of a remote semi-autonomous robot (teleVIA) (Rogers et al., 1997).

Although technology has changed substantially since the original cognitive experiments were performed, a number of the results appear to have even greater relevance in the current context of multimedia information displays. In the wake of the Internet wave, with its attendant visually oriented displays, there is an even greater need to understand visual interaction so that our intelligent agents will be able to provide even more effective assistance by integrating text, images, enhancements, pictures, graphics and eventually sound and video.

These issues raise a number of questions such as: i) How can the domain concepts be represented and displayed in a way that facilitates both top-down and bottom-up reasoning as needed? ii) Given different types of informational "spaces" related to a visual problem solving task, can we track and identify different types of navigational paths used? iii) Can such paths be related to visual problem solving strategies, and can we determine their effectiveness on performance (e.g., timing and accuracy)?

To answer some of these questions, a series of experiments has been designed in the simpler domain of dog classification, with a view to incorporating the results into the more complex domains such as medical problem solving. The first study looked at the identification of subjects' navigation paths through information panels containing classification hierarchies, feature hierarchies, and supporting picture-plus-text descriptions. From these paths, we may infer particular strategies the subjects use to solve the visual task. Preliminary results from this work indicate the presence of distinct navigation paths, and these findings will be presented together with a discussion of how this work may contribute to the further development of intelligent assistance for visual problem solving.

References

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