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Open-domain sketch understanding for AI and Education

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Sketching is a natural way for people to interact with each other. When we sketch with another person, the interaction is fluid and wide-ranging, despite most of us not being artistically inclined. Unfortunately, today's sketch understanding systems, as useful as they can be, fall far short of this ideal. Most sketch understanding software equates understanding with recognition. But today's recognition algorithms only work in narrow domains, and even so tend to require frequent correction. They can be made to work for some highly stylized subsets of domains, e.g., electronic schematics, molecular diagrams, but they do not scale to most topics in education (e.g., geoscience, biology) where sketching would be useful. To make sketch-based educational software that can be used wherever people sketch in learning, we must break out of the restriction to narrow domains, and broaden our definition of understanding to include more human-like visual processing, spatial reasoning, and conceptual understanding of what is being depicted.

This talk will describe how a team of AI researchers, cognitive psychologists, learning scientists, and educators is attempting to build the intellectual and software infrastructure needed to achieve more human-like sketch understanding software. We are creating CogSketch, an open-domain sketch understanding system that will serve as both a cognitive science research instrument and as a platform for sketch-based educational software. These missions interact: Our cognitive simulation work leads to improvements which can be exploited in creating educational software, and our prototype efforts to create educational software expose where we need further basic research. CogSketch incorporates a model of visual processing and qualitative spatial representations, facilities for analogical reasoning and learning, and a large common-sense knowledge base. Our vision is that sketch-based intelligent educational software will ultimately be as widely available to students as graphing calculators are today.

I will start by describing the basics of open-domain sketch understanding and how CogSketch works. Some cognitive simulation studies using CogSketch will be described, to illustrate that it can capture aspects of human visual processing. The potential use of implicit, software-gathered measures of expertise for assessment will be discussed, based on a recent experiment with sketching in geoscience. Two educational software prototyping efforts will be described. The first, worksheets, provides a simple way to see if students understand important configural relationships, e.g., the layers of the Earth. The second, the Design Buddy, is intended to help students learn how to communicate via sketching in the context of learning engineering design.

While CogSketch is a work in progress, the current prototype is publicly available, and we seek community feedback and collaboration. CogSketch can be downloaded at http://www.spatiallearning.org/projects/cogsketch_index.html.