CogSketch Tutorial

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Sketch Understanding for Cognitive Scientists

People sketch, both to work out ideas themselves, and as a way to communicate with each other. Sketch understanding software can be useful for cognitive scientists in three ways:

1. Simulating perceptual and cognitive phenomena, e.g. geometric analogies, learning spatial prepositions (e.g., Figure 1)
2. Gathering and analyzing experimental data, e.g. handwriting, diagrams, maps.
3. Providing a new interaction modality for intelligent tutoring systems and learning environments.
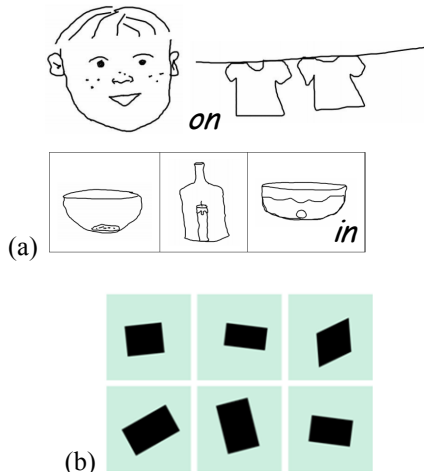

(a)

(b)

Figure 1: A wide range of stimuli for simulation experiments can be entered via CogSketch. Part (a) shows some stimuli from an experiment on learning spatial prepositions (Courtesy: Kate Lockwood), Part (b) shows a stimulus from a visual oddity task (Courtesy: Elizabeth Spelke)

This half-day tutorial will introduce researchers to CogSketch, a publicly available sketch understanding system. Unlike other sketch understanding systems, which focus only on recognition, CogSketch specializes in constructing human-like visual and spatial representations, and tying those to conceptual knowledge. CogSketch is based on the insight that people aren't artists in real-time:

they rely on verbal labels to identify elements in their sketches. The CogSketch interface lets people directly label what they are sketching. This makes CogSketch extremely flexible, unlike recognition-based systems, which require training and are restricted to narrow domains.

CogSketch is designed as both as a research instrument for cognitive science (see Figures 1 and 2), and as a platform for sketch-based educational software (see Figures 3 and 4). CogSketch incorporates visual processing of digital ink, qualitative spatial representations, analogical matching over integrated spatial and conceptual representations, and a large open-source knowledge base. CogSketch is being developed by the NSF-funded Spatial Intelligence and Learning Center (SILC), with feedback from research and education communities.

Intended Audience

This tutorial is intended for cognitive science researchers, including AI researchers, psychologists, and learning scientists who might want to use sketching in their research. Graduate students are welcome. Attendees will gain an understanding of the state of the art in open-domain sketch understanding, and how it might be used to facilitate their research. The CogSketch team and SILC are actively seeking collaborators, whose feedback will play a guiding role in the development of CogSketch.
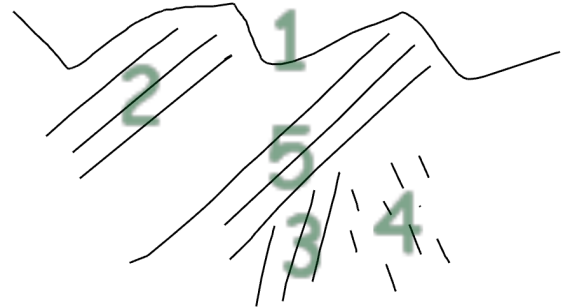

Figure 2: CogSketch records timing data, enabling order of drawing to be easily determined. The numbers above indicate the order in which the participant in the experiment drew the constituents of their sketch.
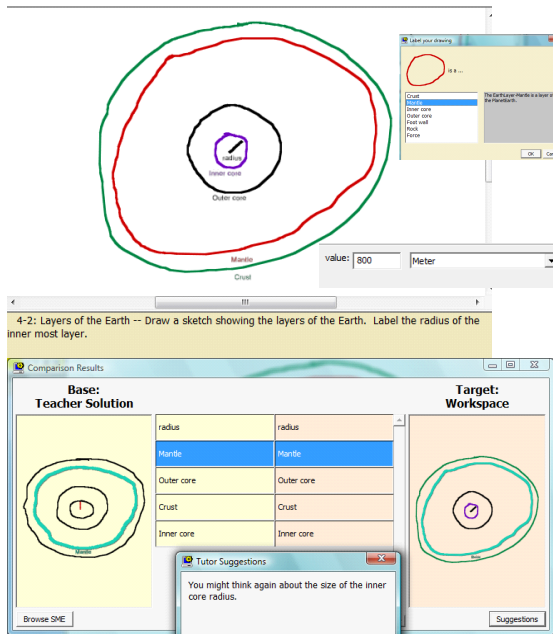
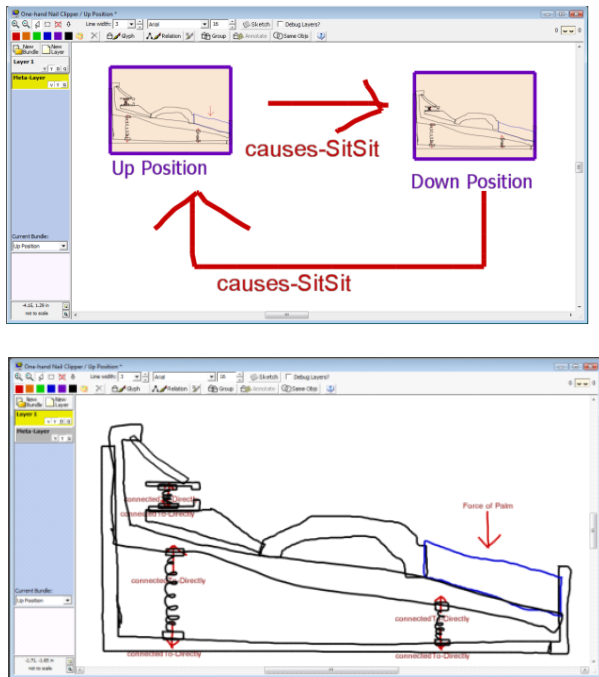Figure 3: Worksheets use analogy and an expert's sketch to provide feedback

Figure 4: Sketches of a student design from an engineering class. The top sketch shows the intended sequence of behaviors, the bottom sketch shows in detail what is supposed to happen in the Up Position.

Outline

The topics that will be covered are:

- Basics of open-domain sketch understanding: Digital ink, conceptual labeling.
- Visual processing in CogSketch: Ink processing, including qualitative spatial representations and grouping. Decomposition and matching of shapes.
- Analogical processing in CogSketch: Basics of structure-mapping, sketch comparison.
- Support for laboratory experiments: Examples of experiments. Copy-and-paste of stimuli from PowerPoint. Accessing timing information.
- Support for education research: The worksheet model and authoring environment, plans for integrating other tutoring facilities.
- Support for computational experiments: Exporting knowledge and ink data, overview of CogSketch API for using its spatial reasoning facilities from other software.

The exact depth coverage for the last three topics will depend on the mix of interests of the attendees.

CogSketch can be downloaded at: http://www.spatialintelligence.org/projects/cogsketch_index.html We encourage participants to bring notebook computers with CogSketch already installed, so they can work through examples if they desire. However, this is not a requirement.