

Sketch Worksheets

You-Try-It Demonstration Strand

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1. Abstract

Sketch worksheets are a new kind of sketch-based education software designed to facilitate spatial learning. Each worksheet represents a particular exercise, which the student does on a computer. Students get feedback, based on automatic comparison of their sketch with a hidden solution sketch. A software gradebook, which uses scoring rubrics in the solution sketch, is intended to help instructors in grading. Sketch worksheets have been used in classroom experiments with college students and with middle-school students. They are domain-independent, requiring only that the exercise involves visual distinctions that the software can understand. This session will provide hands-on experience with sketch worksheets, and with the authoring environment that is used to make them. Participants will be guided through making a simple sketch worksheet themselves, using the authoring environment built into CogSketch, the underlying software. (CogSketch has been developed by the NSF-sponsored Spatial Intelligence and Learning Center, and is freely available on-line.)

2. Context and Motivation

Our goal is to show participants how sketch worksheets operate, and how they can be created, so that they can explore using them in their own classrooms or experiments.

3. Background and Pre-Existing Work

Sketch worksheets [1,2] are built on top of CogSketch [3], an open-domain sketch understanding system. By open-domain, we mean that it does not rely on domain-specific vocabulary or recognition techniques. Instead, it models aspects of human visual processing, so that, ideally, the software sees sketches in ways that are similar to the way people see them (e.g. [4,5]). A model of human analogical matching is used to compare a student's sketch with one or more solution sketches, with feedback provided based on differences perceived in them. CogSketch is being developed by the Spatial Intelligence and Learning Center, both as platform for cognitive science research and for developing new kinds of educational software.

4. Overview and Impact

After a very brief introduction to CogSketch, we will walk participants through the basic CogSketch tutorial, followed by having them work through a pre-existing sketch worksheet (i.e. one of the worksheets used by fifth graders in a unit on the circulatory system). Then we will walk participants through the process of creating their own sketch worksheet using the authoring environment. We will provide some sample topics, but we will also encourage participants to come up with their own ideas for sketch worksheets that we can help them with. Tablets will be

provided, but we invite participants to bring their own Windows tablets if they prefer, but if you do this, please do install CogSketch in advance [6].

5. References

[1] Yin, P., Forbus, K., Usher, J., Sageman, B. and Jee, B. (2010). Sketch Worksheets: A Sketch-based Educational Software System. *Proceedings of the 22nd Annual Conference on Innovative Applications of Artificial Intelligence*.

[2] Forbus, K., Chang, M., McLure, M., and Usher, M. (2017) The Cognitive Science of Sketch Worksheets. *Topics in Cognitive Science*.

[3] Forbus, K., Usher, J., Lovett, A., Lockwood, K., & Wetzel, J. (2011). CogSketch: Sketch understanding for Cognitive Science Research and for Education. *Topics in Cognitive Science*. 3(4), pp 648-666.

[4] Lovett, A., & Forbus, K. (2011) Cultural commonalities and differences in spatial problem solving: A computational analysis. *Cognition* 121, pp. 281-287.

[5] Lovett, A. and Forbus, K. (2017). Modeling Comparison and Abstraction during Visual Problem-Solving. *Psychological Review*. 124 (1): 60 DOI: 10.1037/rev0000039.

[5] <http://www.qrg.northwestern.edu/software/cogsketch/index.html>