Order Effects in Abductive Reasoning

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Abduction is the process of constructing a plausible explanation for a set of observations. It is the fundamental type of reasoning in many complex tasks such as scientific discovery, troubleshooting and diagnosis. Many abductive problems require multicausal explanations in which a conjunction of individual hypotheses together explain the data. In our mental-model theory of multicausal abductive reasoning and skill acquisition, abduction is viewed as the sequential comprehension and integration of data into a single situation model (Johnson & Krems, 1994). Comprehension and integration are accomplished using satisficing search. The model has been implemented in Soar.

One prediction of the model is that order of data (e.g., symptoms in diagnostic reasoning) affects the generation of multicausal explanations. In a first experiment 20 subjects were shown a series of input-output data from a technical device. The order of data presentation was systematically varied. The subjects had to construct a causal explanation for the data using previously acquired causal knowledge that enables subjects to predict the behavior of the device given any input to the device. Results showed that explanations for previously viewed data systematically constrained explanations for new data. Experienced problem solvers were more affected by order of data presentation than novices.

In a second experiment 10 subjects were shown all the data at once, instead of sequentially. The sequence of data interpretation therefore was subject-paced and subject-guided. It could again be shown that the multicausal explanation depended on the sequence, and not just the "causal implications" of the evidence.

The results point to a highly sequential nature of applying causal knowledge. The results are also used to evaluate different types of computational models of abductive reasoning with regard to psychological plausibility. A computational-model implemented in the Soar architecture will be outlined that fits the empirical constraints. It will be compared to "quasi-normative models" like set-covering and the Theory of Explanatory Coherence (Thagard, 1989).

References

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