

# Cognitive Modeling for Diagrammatic Design Assistance

Sven Bertel\*

SFB/TR 8 Spatial Cognition, Universität Bremen, Germany

bertel@sfbtr8.uni-bremen.de, <http://www.informatik.uni-bremen.de/~bertel>

## Research Question

How can human diagram-based spatial problem solving be computationally modeled so that the resulting model can be employed by an adaptive computational system for adequately assisting human spatial reasoning in collaborative human-computer spatial reasoning scenarios?

## Motivation

Human reasoning about spatial environments, spatial configurations as well as design problems often involves external diagrammatic representations such as sketches, drawings, or maps. Frequently, good usage of diagrams is a prerequisite for success in solving such problems; their properties in reasoning have been frequently described, for example with respect to representational and computational issues [6], constrained (i.e. facilitated) reasoning processes [7], or designing [5].

Many spatial and design problem solving scenarios show potential for partial automatization (e.g. by employing constraint satisfaction routines); however, the creation of computational systems to assist humans in carrying out such tasks leads to asymmetric situations as both parts, human and computational, differ in their communication and reasoning faculties. Human intelligence is both the key factor and bottleneck in integrated human-computer reasoning; as a result, predictive cognitive processing models should be included within the computational part to achieve closer and adaptive collaboration and to allow for better assessing current human cognitive parameters (e.g. loads), problem parameters (e.g. complexity), and mental problem solving properties (e.g. preferences in mental model construction and focus) [2].

## Expected Results

Expected are better descriptive, explanatory, and predictive models of mental/diagram-based spatial reasoning within the targeted application domains. These will lead to an increase in knowledge about mental and mental/external reasoning processes involved, explore directions for further steps and research in collaborative human-computer spatial reasoning, and hopefully lead to better performance in computer-assisted human spatial problem solving.

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## Research Methods

Methods include conceptual and computational cognitive modeling of mental spatial reasoning (seen as a problem solving activity) in interaction with an external diagram. With respect to assessing the targeted parameters (loads, focus, preferences in model construction), two approaches will be developed: first, heuristics derived from general reasoning principles (incl. models of common mental/external spatial principles and mechanisms [4], and of domain-dependent problem solving principles and methods, e.g. in aspect-based designing procedures [3]), and second, heuristics based on models of current reasoning focus (e.g. based on tracking of eye movements [1] or diagram-based interactions). Selected aspects have been and will be further empirically evaluated.

## References

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