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Elucidating the Cognitive Anatomy of Representation Systems

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Abstract

We present a framework to assess the relative cognitive cost of alternative representational systems for problem solving. The framework consists of 19 cognitive properties of representational systems, which are distributed across 4 dimensions (registration, semantic encoding, inference, and solution) and three scales of granularity (symbol, expression, and sub-representations). It examines components and processes spanning the internal mental representation and external physical display, and also addresses heterogeneous representations of problems. We provide functions to evaluate the cost of each cognitive property by examining, for example, types of matches between display symbols and concepts, the arity of relations, or the depth of solution trees. The cognitive costs for each property are combined to estimate the overall cognitive cost, and hence the relative effectiveness, of a representation. The framework's development is motivated by our goal of engineering an automated system that will select representations suited to specific classes of problems for individual users.