



Introduction

Thinking with Diagrams

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One of the central insights offered to cognitive science by artificial intelligence research is the importance of problem representation when creating effective implementations of intelligent behaviour. This is mirrored in experimental psychology by studies demonstrating that the form in which a problem is presented can make structurally identical problems either very easy or very difficult to solve (Hayes and Simon 1977). Diagrams are an interesting artefact for this reason – their purpose is purely to modify the representation of problem situations. Furthermore, diagrams are not easily amenable to the methods that have been used to investigate other varieties of human markings. They are not linguistic in the way that speech and written text tend to be. Neither are they pictorial representations. This means that neither linguistic nor perceptual theories are sufficient to completely explain their advantages and applications.

Meanwhile, diagrammatic representations are becoming more common in everyday human experience. Bit-mapped computer displays have encouraged the use of diagrams in human-computer interaction. Improved publication technologies, especially the PostScript language, have provided the means for standardised reproduction of diagrams. Modern thought has already been greatly influenced by the ability to publish conventional pictorial illustrations in books (Ivins 1953; Ferguson 1992), and it seems that the widespread facility to create and interact with diagrams will encourage new styles of literacy in a similar fashion.

Despite this observation, there is substantial scepticism regarding the value of diagrams. The Speaker of the British House of Commons, Betty Boothroyd, rebuked an M.P. in 1994: “I have always believed that all Members of this House should be sufficiently articulate to express what they want to say without diagrams” (The Guardian 1994). Similar suspicion was directed toward analytical mathematics 200 years ago (Mehrtens et al. 1981), and to symbolic logic 100 years ago (Mineau et al. 1993). Ironically,

many logicians and mathematicians are now in their turn sceptical regarding the formal status of diagrams, even if they have advantages when used for teaching or creative exploration. Much of this scepticism may be attributable to the fact that diagrams themselves are usually regarded as a tool, rather than a useful object of study in their own right (a statement that was true of mathematics itself at one time). Of course diagrams are not universally beneficial; many are badly designed or badly used. This is a further reason why the study of diagrams is overdue – as a theoretical contribution to the practical questions faced by information designers.

The papers presented in this special issue address these questions of representation, reasoning and application of diagrams. The nature of diagrams is considered by Shimojima, who reviews the philosophical positions that have been proposed regarding the distinction between diagrams and text, and by Stenning and Lemon, who discuss the logical and psychological properties that result from this nature. Olivier provides a complementary view, considering the status of diagrams when used as a machine representation rather than as a mental representation. Cheng, Lowe and Scaife present a range of studies considering the effects on human performance that result from using diagrams, and this approach is extended in the remaining papers into three investigations of specific areas of activity: Blackwell, Good, Whitley and Petre on the use of diagrams in computer programming, Brna, Cox and Good on diagrams in educational contexts, and Do and Gross on the use of diagrams by architects.

These review articles follow from work that has been presented at two AAAI symposia on Diagrammatic Reasoning in the USA, and three meetings on the topic of Thinking with Diagrams in the United Kingdom. The authors also draw on far broader academic traditions, however – in philosophy, computer science, education, architecture and many other disciplines. A useful introductory collection of early work, that defines many central concerns in thinking with diagrams, has been published by AAAI press (Glasgow et al. 1995). It is also possible to contact current research groups through the Diagrammatic Reasoning web site, accessible at <http://uhavax.hartford.edu/Diagrams/> and mirrored at <http://www.hcrc.ed.ac.uk/gal/Diagrams/>.

Acknowledgements

I am very grateful to all of the authors, whose patience with the process of assembling such a comprehensive review of the field has resulted in a valuable resource in this special issue.

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