The Syntax vs. Semantics Debate Revisited?

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(Computational Intelligence 9 (4) Nov 1993 pp 366-367, Ed: Nick Cercone and Gordon McCalla, MA: Blackwell. This is a short commentary on "The Imagery Debate Revisited: A Computational Perspective", Janice Glasgow, pp 309-333 in the same volume).

Glasgow's thought-provoking article reminded me of the syntax vs. semantics debates surrounding semantic nets and frames in the 1970s [Brachman and Levesque, 1985]. Her article is based on a fundamental distinction betweeen descriptive and depictive representations, one which I do not believe can be drawn. Glasgow argues that representations such as arrays are *depictive*, as they are spatially analogical to the objects being represented, whereas representations such as propositional logic are *descriptive*, as they merely denote rather than analogically model the spatial entities of interest. This view, though, incorrectly attributes 'depictiveness' to the *syntax* of a representation, whereas in fact it is a property of relationships defined on that representation. An array *on its own* is no more of an image analog than a set of propositions: 'analog-ness' comes from the relations which we define between elements of the representation (eg. "above"), and their correspondence to relations between objects in the real world. Arrays and propositions are thus no different; we can axiomise spatial relations for both representations, and as a result they will both become more, but still equally, analogical to the original image. While there may be a difference in efficiency, Glasgow seems to be arguing more than this; that some representation languages are inherently 'depictive' where as others are not. But 'depictiveness' is conditional on the axioms/relations which the user chooses to define when using a language, be it propositional, array or whatever.

I emphasise this, as it is seductive to draw an array and decide it intuitively 'looks' more like a spatial analog than a set of propositions. But this is a deception, created by the miriad of spatial relationships which the human mind overlays on the (much more impoverished) set of relations which a machine can compute, but which are subconsciously attributed to the machine nonetheless. In fact, all the machine 'knows' are bytes (in physical locations bearing no correspondence to the locations of the objects they represent), and a small set of computations on these.

Of course, there is still an efficiency issue: but this should not be cast as a debate between descriptive vs. depictive representation languages but as between individual formalisms for spatial reasoning. Regarding the particular array formalism which Glasgow advocates, it is attractive in many respects and lends itself to parallel processing techniques. But at the same time treating space (an inherently continu-

ous entity) as discrete, rectangular units may make reasoning about physical processes (also inherently continuous) problematic. While propositional logic may not be the answer, other formalisms for spatial reasoning have already been extensively studied in AI (eg. [Forbus et al., 1991] and [Weld and deKleer, 1990] Chapter 8), computer vision, computer-aided design, graphics, animation and simulation, which may offer more versatile and efficient solutions.

A more important issue is whether spatial information should be preserved at all, and perhaps this what is at the heart of the imagery debate. Psychological evidence indicates that mental imagery is fundamental to thought, and thus a contribution of the imagery debate to AI is to re-emphasise the importance of spatial reasoning. I hope, correspondingly, the computational perspective will highlight that depictiveness is not an intrinsic property of a representational structure, and thus that the question of descriptive vs. depictive representations is ill-defined. Instead, the debate should focus on specific formalisms for spatial reasoning. In this context, array theory may have much to offer.

References

[Brachman and Levesque, 1985] Brachman, R. J. and Levesque, H. J., editors (1985). *Readings in Knowledge Representation*. Kaufmann, CA.

[Forbus et al., 1991] Forbus, K. D., Nielsen, P., and Faltings, B. (1991). Qualitative spatial reasoning: the CLOCK project. *Artificial Intelligence*, 51(1–3):417–471.

[Weld and deKleer, 1990] Weld, D. S. and deKleer, J., editors (1990). *Qualitative Reasoning about Physical Systems*. Kaufmann, Ca.