Process Paper

Spatial Reasoning and Reasoning with Images

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"I want to leave the writing of this page behind." Even when talking about an abstract event in time, space pops up in metaphors to show us how important it is for humans.

One of the reasons of the importance of space is its epistemical multiplicity. Different senses, vision and touch among others, give spatial inputs to humans. In the early days of AI, vision was believed to be one of the easiest subfields, but as researches started to approach the problem systematically they soon realized the variety of very complex problems involved in machine vision.

It is possible to think of spatial reasoning as the field of studies on representations of space, inferences concerning space and interactions with space. Some of the areas in which most of the research has been carried out in spatial reasoning are: geographical information systems (GIS), vision, robotics, diagrammatic reasoning and reasoning with images. Also in the following areas spatial reasoning often plays a role: computer aided design (CAD), natural language processing (NLP), industrial design and visual languages.

Depending on the task, we have different types of spatial reasoning. Important dichotomies are: qualitative and quantitative, absolute and relative, point based and region based, symbolic and non symbolic.

In my opinion, the first step in spatial reasoning is the choice of the ontology, because there is no general or definitive answer to the question: What ontology of space should I choose?

Since my interest in spatial reasoning arises from the need of reasoning with images (eventually images that come from some human design process—like maps or engineering projects), the current problem that I am investigating concerns a suitable ontology of space for reasoning with images.

This lead me to analyze work that has been done in Mereotopology[1]. This field dates back to the work of Whitehead in the late twenties and was revitalized by Clarke's papers in the early eighties. Much research has followed recently, a nice and clean axiomatization of Mereotopology is the one provided in [1].

Since this theory is not rich enough to express most of the concepts involved in an image, I think that it should be enriched with morphological predicates, to enhance the possibility of talking about shape, size, and distance. Others have took similar directions, for example the RCC calculus [3] for regions has been extended with a convex hull operator.

Therefore the intuition that I am currently following is: *mereotopology + morphology = a theory for images?*

At a later stage in the project, once the ontology has been defined, it is my intention to analyze how to move from raw images towards spatial representations, and what are possible interplays between image processing and spatial reasoning. This will bring into the research scope deep understanding of the structure of images [2], generalization of image processing techniques (like mathematical morphology and grouping algorithms), and identification of spatial relations that are relevant to enable spatial reasoning. Test application will be mainly targeted in the fields of GIS and robotics.

[1] Mereotopology comes from the composition of mereology and topology, being the first the theory of "part-whole" relation and the latter the usual mathematical discipline.

References

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