Basics of Conceptual Spaces

Introduction

The notion of conceptual spaces was introduced by Peter Gardenfors. This notion seeks to find geometric ways to represent knowledge. There are two main directions of understanding cognitive processes, which are symbolic and connectionist approaches. The symbolic approach tried to introduce some logic in manipulating with symbols, which might not have any meaning apriori. Thus, the meanings need to be fed into symbolic model. On the other hand, connectionist approach tried to build more complex reasoning systems from elementary units. One way of thinking about conceptual spaces is as a bridge between connectionist and symbolic approaches. A collection of points give rise to certain spaces to act as an input of some symbolic processing methods. One of the main questions of conceptual spaces is emergence and dynamics of conceptual spaces.

Ideas and Methods

Main components of a conceptual space:

- Domain. An underlying space.
- Property. A convex region inside domain.
- Concept. A combination of properties across multiple domains with corresponding salience weights

Operations with concepts:

- Replacement of properties
- Blocking of domains
- Contrast classes

One of the most common ways of constructing conceptual spaces as a collection of convex spaces in d-dimensional Euclidean space. Here dimensions of the underlying Euclidean space correspond to so called ‘quality dimensions’ of underlying information or a concept. The distance between points is calculated using weighted average approach

$$d_E(x,y) = [\sum w_d(x_d - y_d)^2]^{1/2}$$

Discussions

Though theory of conceptual spaces offers great prospects in understanding human cognition and the way knowledge could be effectively represented, the corresponding theory is still at its infancy. There are many suggestions on the way of constructing conceptual spaces, however there is no a universally accepted foundation for construction of conceptual spaces.

Further Reading

- Peter Gardenfors and Mary-Anne Williams, Reasoning about Categories in Conceptual Spaces
- Martha Lewis and Jonathan Lawry, Hierarchical Conceptual Spaces for Concept Combination
- Lucas Bechberger and Kai-Uwe Kuhnberger, Formalized Conceptual Spaces with a Geometric Representation of Correlations

- John Rickard, A Concept Geometry for Conceptual Spaces.