Representation and Reasoning for Spatial Data Based on the Connection Patterns of Regions

Kazuko TAKAHASHI and Takao SUMITOMO
School of Science&Technology, Kwansei Gakuin University,
2-1, Gakuen, Sanda, 669-1337, JAPAN

Qualitative Spatial Reasoning(QSR) is a method that treats images or figures qualitatively, by extracting the information necessary for a user's purpose. In most QSR systems, spatial relations of objects such as regions and lines are represented using predicates, and axioms on these predicates are introduced. In these systems, if the abstraction is too coarse and sufficient information is not given, they are not applicable for practical problems. For example, in the figure below, there are several cases in which the relative positional relation of the field and the tree make. These figures cannot be distinguished unless the information of the overlapping/connection patterns of areas is given. On the other hand, if the abstraction is refined, lots of predicates and axioms are required in order to distinguish figures at the detail level, which follows that the system is not feasible and hard to implement.

We propose a new framework called PLCA, which provides a symbolic representation for the figure in two-dimensional plane, that focuses on the connections between regions. It is based on the simple objects: points(P), lines(L), circuits(C) and areas(A). The entire figure is represented as a combination of these objects. Pairs of areas, circuits or lines never cross, every pair of areas is either point-connected, line-connected of disconnected, and the entire space is covered with the areas. Symbolic representation enables compact information at the level that is suitable for the user's purpose and allows rapid processing. We need not care about the completeness of the system, since PLCA is not based on axiomatic systems. Its simple, clear data structure makes the system easy to implement and feasible.

For a figure that consists of a set of regions in two-dimensional plane, there exists a corresponding PLCA expression, and for a PLCA expression that satisfies a particular condition, there exists a figure in two-dimensional place. We define operations of integration/division of an area(s) on a PLCA expression. These operations preserve the consistency of the expression, and they correspond to the real actions on figures. We add the attributes to each object and make an attributed PLCA. The operations of area integration/division on an attributed PLCA correspond to the alteration of the classification level of objects. Semantic spatial reasoning can be executed on an attributed PLCA.