



Chapter XX

Spatial and Topological Data Models

Ying Deng and Peter Revesz
University of Nebraska - Lincoln, USA

Spatial and topological data models are increasingly important in business applications such as urban development planning, transportation and traffic control, decision support in agriculture, pollution and environment analysis, fire and flood prevention, etc. that require handling spatial and topological data more efficiently and more effectively than older models, for example the relational data model. In this survey we compare several alternative spatial and topological data models: the Spaghetti Data Model, the Vague Region Data Model, the Topological Data Model, Worboys' Spatiotemporal Data Model and the Constraint Data Model. We first describe how spatial and/or topological data are represented and give examples for each data model. We also illustrate by examples the use of an appropriate query language for each data model.

THE SPAGHETTI DATA MODEL

The Spaghetti data model (Laurini and Thompson, 1992) is a popular model for representing spatial data that occur in for example Computer-Aided-Design (CAD) (Kemper and Wallrath, 1987) and Geographical Information Systems (GIS) (Worboys, 1995; Zeiler, 1997) applications. The reason why this model is so popular is that there are many efficient algorithms for detecting properties in this model (Preparata and Shamos, 1985). In addition, the Spaghetti model is simple to use and offers in most applications a sufficient approximation to reality. There are several extensions of this model, for example the parametric 2-spaghetti (Chomicki and Revesz, 1999) and the parametric rectangles (Cai et al., 2000) models, which we do not review here.

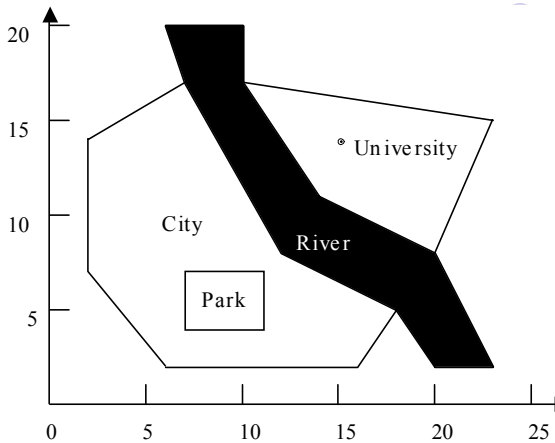
Data Representation

In the Spaghetti model, the information in an n-dimensional space is represented using a set of m-dimensional hyperspaces, with $m < n$. This means that in a two-dimensional plane, we only consider polygons, the boundary of which contain line segments and points. More concretely, we use here (Paredaens, 1995):

- Points, which are represented using their coordinates (x, y) ;
- Graphs, whose data structure is a finite set of pairs of points;
- Polylines, whose data structure is a finite sequence of points;
- Polygons that are represented by non-self-intersecting closed polylines.
- Complex polygons, that can contain holes, which are again complex polygons (up to a finite level);
- Objects are sets of polygons, points or graphs.

Figure 1.1 shows a city with a park and a university through which a river runs. In the Spaghetti model, the figure can be represented by the relation in Table 1.1.

Figure 1.1: An example for Spaghetti model



ARC/INFO Queries

Database systems based on the Spaghetti data model usually provide queries that tell whether two polygons overlap, whether a point lies in a polygon or on a line segment, whether two line segments intersect, whether a polyline self-intersects, whether a polygon is contained in another one, etc. The evaluations or implementations of all these queries are solvable in polynomial time complexity (Preparata and Shamos, 1985).

Table 1.1: Spaghetti representation

ID	(x, y) 's
University	{ (15, 14) }
River	{ (6, 20), (7, 17), (12, 8), (18, 5), (20, 2), (23, 2), (20, 8), (14, 11), (10, 17), (10, 20), (6, 20) }
Park	{ (7, 4), (11, 4), (11, 7), (7, 7), (7, 4) }
City	{ (6, 2), (16, 2), (18, 5), (12, 8), (7, 17), (2, 14), (2, 7), (6, 2) }
City	{ (10, 17), (14, 11), (20, 8), (23, 15), (10, 17) }

Note that a polyline is represented by a sequence of points. Each of the polygons is represented by a sequence of its corner points. To distinguish polylines and polygons the first and the last points of a polygon are the same which means this is a closed curve.

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