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# Mathematical framework for Topological relationships between ribbons and regions

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## Abstract

In a map, there are different relationships between spatial objects, such as topological, projective, distance, etc. Regarding topological relations, if the scale of the map is changed and if some spatial objects are generalized, not only the shapes of those objects will change (for instance a small area becomes a point and then disappear as scale diminishes), but also their topological relations can vary according to scale. In addition, a mathematical framework which models the variety of this category of relationships does not exist. In the first part of this paper, a new topological model is presented based on ribbons which are defined through a transformation of a longish rectangle; so, a narrow ribbon will mutate to a line and then will disappear. Suppose a road running along a lake; at some scales, they both appear disjoint whereas at some smaller scales, they meet. So, the topological relations mutate according to scale. In this paper, the different components of this mathematical framework are discussed. For each situation, some assertions are defined which formulate the mutation of the topological relationships into other ones when downscaling.

*Keywords:* Topological relationships, ribbon topology, visual acuity, Ribbon-Region relation, downscaling.

## 1. Introduction

When somebody is saying « this road runs along the sea », what are exactly the spatial or geographic relations which are concerned? Sometimes, either the road touches the sea or a small beach is located between the road and the sea, etc. From a mathematical point of view, mostly there is a disjoint relation between the road and the sea whereas for people the relation is different. In addition, when one is reading a map, according to scale, the topological relation can be different, disjoint or meet. So, topological relations can vary according to scale. Suppose a decision-maker wants to create a new motorway running along a lake with the help of a computer. Taking this consideration into account, any reasoning system will generate difficulties because the spatial relations hold differently: any conceptual framework dealing with spatial relationships must be robust against scales.

Another problem comes from mathematical modeling of streets and rivers. Often, they are considered as linear objects even if they have some widths or areas. By considering a road as a line or as an area, topological relationships can be different. In order to solve this problem, the concept of ribbon will be developed. Depending on the scale, or more exactly on visual acuity and granularity of interest, a ribbon

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