

# HIERARCHICAL SPATIAL REASONING

Andrew U. Frank  
Dept. of Geoinformation  
Technical University Vienna  
frank@geoinfo.tuwien.ac.at

## Abstract

Using hierarchical methods for spatial reasoning is a popular research topic. Hierarchical spatial data structures, especially quadtrees, are used in many implementations of GIS and have proved their efficiency. Operations on hierarchical spatial data structures are effective to compute spatial relations, but do not automatically imply Hierarchical Spatial Reasoning. Hierarchical spatial reasoning is using coarser, less detailed representations to compute an *approximative answer* if the quality of the approximation is sufficient. Hierarchical spatial reasoning is closely related to computing approximative results and estimation of their errors.

This paper explores two spatial reasoning operations and deduces a general definition of 'hierarchical spatial reasoning'. Although the examples are very simple - computation of area and intersection - and applied to a raster representation, the definition appears general. Compared with other definitions it captures much of the essence of hierarchical spatial reasoning. This sets the framework in which general rules when hierarchical spatial reasoning can be employed may be deduced.

Hierarchical data structures are useful for hierarchical reasoning, but they can be transformed to a more efficient 'incremental hierarchical structure', e.g., an incremental quadtree. Then, incremental hierarchical spatial reasoning algorithms use previously computed values to compute the next approximation and are therefore as efficient as a direct calculation with the same error bound.