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On storage and retrieval of generalized spatial data

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We are developing a prototype high-performance semantic spatial database management system. One type of data in this system is a generalized spatial function — a function from a Cartesian product of several continuous and/or discrete domains into a Cartesian product of powersets of continuous domains and/or discrete domains and/or sets of semantic facts. For example, ocean temperature is a function f from $X*Y*Z*T*O$, where X , Y , Z , and T are the space-time continuum and O is a discrete set of observation stations that reported measurements. $f(x,y,z,t,o)=(s,i)$, where s is a segment of temperatures (e.g., 50 degrees plus or minus 0.01 degrees) and i is a set of semantic facts. Another example is remote photography of ocean color by the SeaWiFS satellite.

The spectrum of problems we have addressed concerning this data type includes:

1. Highly-efficient basic queries, including "inverse" queries (e.g., "Where is the temperature of about 70 degrees?")
2. Compact lossless storage
3. Compact lossy storage, particularly by approximating function values.
4. Efficient complex queries
5. Load balancing between processors and storage units
6. Visual presentation of query results as animated movies. (E.g., if the output of a query is a three-dimensional function, any two of the dimensions are mapped on the screen and the third presented as a frame sequence.)