

Geo-SAL: A Query Language for Spatial Data Analysis

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Abstract

Conventional query languages focus on the retrieval and modification of data from a database to a user or a host program. Queries are usually expected to be relatively uncomplicated, leaving deeper processing functions to specialized host programs.

In contrast with this view, the language SAL [Arnb80] was designed with the goal of being able to support stepwise, in-depth analysis of data, stored and managed as relations in a specially designed statistical database system, Cantor [Kara86].

This paper surveys the design objectives, operators and grammatical structures of Geo-SAL, a successor of SAL being developed for spatial data analysis purposes.

In addition to facilities needed for representation and retrieval of spatial data, Geo-SAL includes primitives and structures which permit the solution of complex, multi-step spatial analysis problems within a coherent, declarative language.

1 Introduction

Researchers interested in the study and design of DBMS's for statistical and scientific applications (SSDBMS) have long been aware of the need for basing the design of such systems on application-specific requirement priorities. These priorities are quite different from those of commercial DBMS's, as well as from those of most "non-standard" DBMS applications, such as engineering or office automation databases [Shos85, Sven88, Witt88]. Spatial analysis database systems should be considered special cases of SSDBMS.

The purpose of this paper is to survey the design objectives, operators and grammatical structures of a declarative (non-procedural) interactive language, to be called Geo-SAL, being developed for a prototype spatial data analysis system. We approach this task by making an effort to synthesize the spatial analysis and SSDBMS requirement perspectives.

This work was performed under contract with a joint project between the National Defence Research Establishment (FOA) and Bofors Electronics AB (BEAB) which is part of a national R & D program in Information Technology in Sweden. A major objective of this project is to design and build a prototype spatial analysis and decision support system as a development of the data analysis system Cantor, designed and built by FOA during the last decade [Kara85, Kara86].

Attempts by several authors to characterize the spatial analyst users' tasks were taken into account, largely by analyzing task lists published in [Berr87, Smit87, Good87, Good90, Toml90]. The main conclusions from this analysis are presented in Section 2.

In Section 3, the structure of SAL is surveyed to provide the necessary background for the new proposal. Also, the major redesign goals are discussed against the background of our experience from practical data analysis applications, both spatial and non-spatial.

In Section 4, we introduce the grammatical structures and some of the spatial operators in Geo-SAL. In addition to facilities needed for representation and retrieval of spatial data, Geo-SAL includes primitives and structures which permit the solution of complex, multi-step spatial analysis problems within a coherent, declarative language.

Finally, in Section 5 we present Geo-SAL solutions to some spatial analysis problems.

2 Spatial analysis and database technology

2.1 Relational database management systems and spatial database applications

It is well known that conventional relational database management systems do not satisfy the requirements of so-called non-standard applications, of which spatial database systems are a special case.

In spatial database applications two shortcomings of the relational model are evident: