Discrete Spatiotemporal Data Extension for PostgreSQL

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Background and Limitations: Traditional spatial extensions in PostgreSQL (e.g., PostGIS) primarily support static 2D geometries and lack efficient mechanisms for managing high-dimensional, dynamic, and multi-modal spatiotemporal data such as point clouds, trajectories, and meshes. These limitations hinder their application in modern scenarios requiring real-time updates, cross-modal queries, and large-scale data fusion.

Objectives: We have already developed core modules in C++ for discrete spatiotemporal data processing, including data preprocessing, index construction, efficient query algorithms, and incremental update mechanisms. This project does not require re-developing these functionalities from scratch. Instead, the main goal is to package the existing codebase into a PostgreSQL Extension, enabling SQL-embedded access to advanced spatiotemporal functionalities.

Additionally, a demo system will be built based on this extension, showcasing an integrated discrete spatiotemporal data management platform. This system will serve as a foundational layer for spatiotemporal data fusion, supporting diverse downstream applications such as urban analytics, autonomous navigation, and environmental modelling.

Learning Tasks: (1) Extension Engineering: Integrate the existing C++ modules into PostgreSQL as an extension, including interface wrapping and catalog integration, based on the completed functional code. (2) SQL Embedding: Expose key functions (e.g., st_insert, st_query_range, st_knn, st_update) to SQL for seamless use in relational workflows. (3) System Demonstration: Develop a demo that showcases the system's ability to manage and query discrete spatiotemporal data, highlighting its role as a unified spatiotemporal data foundation for future tasks.

Expected Results: (1) A fully functional **PostgreSQL Extension** built upon the existing C++ codebase. (2) A **demo submission to a top-tier database conference** (e.g., SIGMOD) showcasing the extension's capabilities.

Required Techniques: C/C++, PostgreSQL Extension Development, SQL Interface Design, System Integration, Benchmarking, Linux/Bash.