

Background and Problem Statement

In computer science, managing and analysing relational data efficiently is crucial, especially in fields like network analysis and geographical information systems. [1] This report discusses a C++ implementation designed to address a problem rooted in graph theory—specifically, the grouping of connected coordinates on a grid.

Main Purpose

The primary objective was to develop a C++ program capable of identifying and categorizing groups of connected points from given coordinates. This involves determining both direct and indirect connections among points specified in an input file.

Methods

My solution employs a graph data structure, where vertices represent grid points and edges denote connections based on input data. It implements a breadth-first search (BFS) algorithm to traverse the graph and identify connected components, ensuring comprehensive coverage of all potential connections between points, whether direct or indirect.

Each connected component identified by the BFS is a group of points that are directly or indirectly related. After identifying these components, they are sorted, the sorting process prioritizes components based on their size from largest to smallest, and for components of equal size, by the lexicographical order of the points' coordinates. I chose this approach for their proven effectiveness in identifying connected components, which is crucial for accurately grouping and categorizing points based on connectivity.

Results

The solution demonstrates excellent performance and produce the correct output. The memory usage is efficient, with both current and peak memory usages, indicating implementation is in a way that manages the resources effectively. This efficient resource utilization highlights the effectiveness of the chosen algorithms and data structures, ensuring that the program not only meets functional requirements but also excels in performance metrics.

Conclusion

The program effectively meets the requirements, demonstrating the ability to manage and categorize data efficiently. Its application extends beyond academic exercises, offering tools for complex problem-solving in professional fields that require detailed relational data analysis. Future work could focus on integrating more advanced algorithms and adapting the program to interface with other software, broadening its utility in practical and commercial applications.

[1] "The datapine Blog," Datapine, 18 04 2024. [Online]. Available: <https://www.datapine.com/blog/data-analysis-methods-and-techniques/>.