I/O-Efficient Algorithms for Contour-line Extraction and Planar Graph Blocking

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Abstract

For a polyhedral terrain Σ, the contour at z-coordinate h, denoted by C_h, is defined to be the intersection of the plane $z = h$ with Σ. In this paper, we study the contour-line extraction problem, where we want to preprocess Σ into a data structure so that given a query z-coordinate h, we can report C_h quickly. This is a central problem that arises in geographic information systems (GIS), where terrains are often stored as Triangular Irregular Networks (TINs). We present an I/O-optimal algorithm for this problem which stores a terrain Σ with N vertices using $O(\frac{N}{B})$ blocks, where B is the size of a disk block, so that for any query h, the contour C_h can be computed using $O(log_B N + |C_h|/B)$ I/O operations, where $|C_h|$ denotes the size of C_h.

We also present an improved algorithm for a more general problem of blocking bounded-degree planar graphs such as TINs (i.e., storing them on disk so that any graph traversal algorithm can traverse the graph in an I/O-efficient manner), and apply it to two problems that arise in GIS.