

Accepted paper with abstract, SoCG'09

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Optimal In-Place Algorithms for 3-d Convex Hulls and 2-d Segment Intersection

We describe the first optimal randomized in-place algorithm for the basic 3-d convex hull problem (and consequently for 2-d Voronoi diagrams). The algorithm runs in $O(n \log n)$ expected time using only $O(1)$ extra space; this improves the previous $O(n \log^3 n)$ bound by Brönnimann, Chan, and Chen [SoCG'04]. The same approach leads to an optimal randomized in-place algorithm for the 2-d line segment intersection problem, with $O(n \log n + k)$ expected running time for output size k , improving the previous $O(n \log^2 n + k)$ bound by Vahrenhold [WADS'05]. We also point out a simplification of a known optimal cache-oblivious (non-in-place) algorithm by Kumar and Ramos (2002) for 3-d convex hulls, and observe its applicability to 2-d segment intersection, extending a recent result for 2-d red/blue segment intersection by Arge, Mølhave, and Zeh [ESA'08]. Our results are all obtained by standard random sampling techniques, with some interesting twists.