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Dynamic Maintenance of Half-Space Depth and Contours

Half-space depth (or Tukey depth) is one of the most commonly studied data depth measures because it enjoys many desirable properties for data depth functions (in both the sample and continuous cases). The data depth contours bound regions of increasing depth. For the sample case, there are two competing definitions of contours: the rank-based contours and the cover-based contours.

In this talk, I will present three dynamic algorithms for maintaining the half-space depth of points and contours: the first maintains the half-space depth of a single point in a data set in $O(\log n)$ time per update (insertion/deletion) and overall linear space. A corollary of this result will be a strong structural result on the behavior of dynamic cover-based contours near data points, which is of independent interest. By maintaining a data structure for each data point, I will present an algorithm for dynamically maintaining the rank-based contours in $O(n \cdot \log n)$ time per update and overall quadratic space. Finally, the third dynamic algorithm maintains the cover-based contours in $O(n \cdot \log^2 n)$ time per update and overall quadratic space.