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On the Fine-Grained Complexity of Small-Size Geometric Set Cover and Discrete k-Center for Small k

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Abstract: We study the time complexity of the discrete k-center problem and related (exact) geometric set cover problems when k or the size of the cover is small. We obtain a plethora of new results:

- We give the first subquadratic algorithm for \emph{rectilinear discrete 3-center} in 2D, running in $\tilde{O}(n^{3/2})$ time.
- We prove a lower bound of $\Omega(n^{4/3-\delta})$ for rectilinear discrete 3-center in 4D, for any constant $\delta > 0$, under a standard hypothesis about triangle detection in sparse graphs.
- Given n points and n \emph{weighted} axis-aligned unit squares in 2D, we give the first subquadratic algorithm for finding a minimum-weight cover of the points by 3 unit squares, running in $\tilde{O}(n^{8/5})$ time. We also prove a lower bound of $\Omega(n^{3/2-\delta})$ for the same problem in 2D, under the well-known APSP Hypothesis. For arbitrary axis-aligned rectangles in 2D, our upper bound is $\tilde{O}(n^{7/4})$.
- We prove a lower bound of $\Omega(n^{2-\delta})$ for Euclidean discrete 2-center in 13D, under the Hyperclique Hypothesis. This lower bound nearly matches the straightforward upper bound of $\tilde{O}(n^{\omega})$, if the matrix multiplication exponent ω is equal to 2.
- We similarly prove an $\Omega(n^{k-\delta})$ lower bound for Euclidean discrete k-center in $O(k)$ dimensions for any constant $k \geq 3$, under the Hyperclique Hypothesis. This lower bound again nearly matches known upper bounds if $\omega = 2$.
- We also prove an $\Omega(n^{2-\delta})$ lower bound for the problem of finding 2 boxes to cover the largest number of points, given n points and n boxes in 12D\@. This matches the straightforward near-quadratic upper bound.

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