Contribution ID: **5** Type: **Contributed talk**

Fractional Helly theorem for Cartesian products of convex sets

Tuesday, 21 December 2021 15:00 (25 minutes)

Helly's theorem and its variants asserts that for a family of convex sets in Euclidean space, local intersection patterns influence global intersection patterns. A classical result of Eckhoff in 1988 provided an optimal fractional Helly theorem for axis-parallel boxes, which are Cartesian products of line segments. Answering a question raised by Barany and Kalai, and independently by Lew, we generalize Eckhoff's result to Cartesian products of convex sets in all dimensions. Namely, we prove that, given $\alpha \in (1 - \frac{1}{t^d}, 1]$ and a finite family of Cartesian products of convex sets $\prod_{i \in [t]} A_i$ in $\mathbb{R}^{td}$ with $A_i \subset \mathbb{R}^d$, if at least α-fraction of the $(d+1)$-tuples in $\mathcal{F}$ are intersecting, then at least $(1 - (t^d(1-\alpha))^{1/(d+1)})$-fraction of the sets in $\mathcal{F}$ are intersecting.

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Session Classification: Session