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Higher Inclusion Matrices

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Abstract:

Let $n \geq r \geq s \geq 0$. The higher inclusion matrix $M_s^r(\binom{[n]}{r})$ is a $\{0,1\}$-matrix whose rows are indexed by all r-element subsets of $[n] := \{1, 2, \ldots, n\}$ and and columns are indexed by all s-subsets of $[n]$ and the entry corresponding to an r-set R and an s-set S is 1 if $S \subseteq R$ and 0 otherwise. Gottlieb's theorem from 1966 states that $M_s^r(\binom{[n]}{r})$ has the rank $\min\{\binom{n}{r}, \binom{n}{s}\}$ over $\mathbb{Q}$. Keevash asked how many rows one has to delete from $M_s^r(\binom{[n]}{r})$ to reduce its rank by 1. We answer his question for large n and study some generalizations of this problem. Joint work with Codruţ Grosu and Tibor Szabó.

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