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Color critical hypergraphs and forbidden configurations.

Lovász proved that

$$|\mathcal{E}| \le \binom{n}{k-1}$$

for a 3-color critical k-uniform hypergraph. We prove

Theorem 1. *Let $\mathcal{E} \subseteq \binom{[m]}{k}$ be a k-uniform set system on $|X| = m$ Let us fix an ordering $E_1, E_2, \ldots E_t$ of $\mathcal{E}$ and a prescribed partition $A_i \cup B_i = E_i$ ($A_i \cap B_i = \emptyset$) for each member of $\mathcal{E}$. Assume that for all $i = 1, 2, \ldots, t$ there exists a partition $C_i \cup D_i = X$ ($C_i \cap D_i = \emptyset$), such that $E_i \cap C_i = A_i$ and $E_i \cap D_i = B_i$, but $E_j \cap C_i \neq A_j$ and $E_j \cap C_i \neq B_j$ for all $j < i$. Then*

$$t \le \binom{m}{k-1} + \binom{m}{k-2} + \ldots + \binom{m}{0}$$

Theorem 1 was motivated by the following. Let F be a $k \times l$ 0-1 matrix, then $\mathrm{forb}(m, F)$ is the maximum n such that there exists an $m \times n$ *simple* matrix A such that no column and/or row permutation of F is a submatrix of A. Let K_k denote the full $k \times 2^k$ simple 0-1 matrix.

Theorem 2. *Let F be contained in $F_B = [K_k \,|\, t \cdot (K_k - B)]$ for an $k \times (k+1)$ matrix B consisting of one column of each possible column sum. Then* $\mathrm{forb}(m, F) = O(m^{k-1})$.

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