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Mutually Orthogonal Latin Squares with Large Holes

Euler's 36 Officers Problem looks for orthogonal Latin squares of order 6. Such squares do not exist; however, a pair of incomplete orthogonal Latin squares of order 6 does exist. Such squares result if we allow a common 2×2 empty subarray of each square. We then avoid using a common two symbols in any row or column with an empty cell and make a natural extension to orthogonality. In general, this definition of incomplete mutually orthogonal Latin squares further extends to any order v, any hole size n, and any number of squares t, denoted $t{-}IMOLS(v;n)$. It is a straightforward observation that $v \geq (t+1)n$ in order for such an object to exist. While such sets of squares have been previously explored for small values of t, we demonstrate an asymptotic result for the existence of $t{-}IMOLS(v;n)$ for general t requiring large holes, which we develop from our results on incomplete pairwise balanced designs.