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Tic-Tac-Toe on Designs

The game of Tic-Tac-Toe is well known. In particular, in its classic version it is famous for neither player having a winning strategy. While classically it is played on a 3×3 grid, it is natural to consider the effect of playing the game on richer structures. Playing the game of Tic-Tac-Toe on finite affine and projective planes has been previously studied and in this case the first player has a winning strategy for small orders, but the second player can usually force a draw.

We investigate playing Tic-Tac-Toe on Designs, particularly on BIBDs and Transversal Designs with small block size. We completely solve the case of triple systems, showing that a $TS(v, \lambda)$ is a first player win if and only if $v \geq 5$. Additionally we show that Transversal Designs with small block size are a first player win. Interestingly, we also show that in this case an obvious 'score optimizing' strategy is not sufficient for the first player to win in every case.