On the minimum distance and covering radius of irredundant orthogonal arrays

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An orthogonal array (OA), denoted by OA(M, n, q, t), is an $M \times n$ matrix over an alphabet of size q such that every selection of t columns contains each possible t-tuple exactly M/q^t times. An irredundant orthogonal array (IrOA) is an OA with the additional property that, in any selection of $n - t$ columns, all resulting rows are distinct. IrOAs were first introduced by Goyeneche and Życzkowski in 2014 to construct t-uniform quantum states without redundant information. Beyond their quantum applications, we focus on IrOAs as a combinatorial problem. Using a characterization of IrOAs via their minimum distance we prove that for any linear code, either the code itself or its Euclidean dual forms a linear IrOA. In the special case of self-dual codes, both the code and its dual yield IrOAs. Moreover, we construct new families of linear IrOAs based on self-dual, Maximum Distance Separable (MDS), and MDS-self-dual codes. Finally, we establish bounds on the minimum distance and covering radius of IrOAs.