國立高雄大學應用數學系

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Error-correcting pooling designs constructed from matchings of a complete graph

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摘　　要：

The model of classical group testing is: given n items, at most d of them are defective, we want to find out all of the defectives using the minimum number of tests that are applied on a subset of these items. In a nonadaptive algorithm, also called a pooling design, one must decide exactly which pools to test before any testing occurs. Pooling designs play an important role in the field of group testing, there are many applications such as blood testing, quality controlling and DNA screening.

Error-correcting pooling design uses (d; z)-disjunct matrices. A binary matrix M is called (d; z)-disjunct if given any d + 1 columns of M with one designated, there are z rows intersecting the designated column and none of the other d columns. A (d; z)-disjunct matrix is called fully (d; z)-disjunct if it is not (d_1; z)-disjunct whenever $d_1 > d$ and it is not (d; z_1)-disjunct whenever $z_1 > z$. Let M(m,m,d) be the 01-matrix whose rows are indexed by all d-matchings on K_{2m} and whose columns are indexed by all perfect matchings on K_{2m}. M(m,m,d) has a 1 in row i and column j if and only if the i-th d-matching is contained in the j-th m-matching.

In this thesis, we study a pooling design M(m,m,d) and find its corresponding error-tolerance capabilities. Our results are divided into three parts: when m-d = 1 (resp. m-d = 2), M(m,m,d) is fully (d; z)-disjunct with z = m (resp. z = $\binom{m}{2}$-d); when m≥d+3 and $1 \leq d \leq \left\lfloor \frac{m}{2} \right\rfloor$, M(m,m,d) is fully (d; 2^d)-disjunct; when m≥d+3 and $\left\lfloor \frac{m}{2} \right\rfloor < d < m$, M(m,m,d) is fully (d; z)-disjunct where $z = O(4^{(2d-m)/3} \cdot 3^{m-d})$.

Keywords: Group Testing, Pooling design, Error-tolerance, Perfect matching