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New explicit binary constant weight codes from Reed–Solomon codes ☆

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Binary constant weight codes have important applications in various topics and have been studied for many years. Optimal or near-optimal binary constant weight codes of small lengths have been determined. In this paper we propose an improvement of the Ericson–Zinoviev construction of binary constant weight codes from q-ary codes. By applying this improvement to Reed–Solomon codes, some new or optimal binary constant weight codes are presented. In particular new binary constant weight codes $A(64, 10, 8) \geq 4112$ and $A(64, 12, 8) \geq 522$ are constructed. We also give explicitly constructed binary constant weight codes which improve the Gilbert and the Graham–Sloane lower bounds asymptotically in a small range of parameters. Some new binary constant weight codes constructed from algebraic-geometric codes by applying our this improvement are also presented.

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1. Introduction

A binary constant weight (n, d, w) code is a set of codewords in $\mathbf{F}_2^n$ such that
1) every codeword is a vector of Hamming weight w;
2) the Hamming distance $wt(\mathbf{x} - \mathbf{y})$ of any two codewords $\mathbf{x} \neq \mathbf{y}$ is at least d.

Binary constant weight codes have important applications in various topics (see [3, 8,9]). In coding theory to determine the maximal possible size $A(n, d, w)$ for binary constant weight (n, d, w) codes is a classical problem which has been studied by many authors, we refer to [10,7,1,2,6,13]. For these small values of d, w and lengths $n \leq 65$ or $n \leq 78$, the previous best known lower bounds for $A(n, d, w)$ have been given in [13]. For the upper bounds of $A(n, d, w)$ we refer to the Johnson bound (see [10,6]).

Johnson upper bound. *If* $n \geq w > 0$ *then* $A(n, d, w) \leq [\frac{n}{w}A(n-1, d, w-1)]$ *and* $A(n, d, w) \leq [\frac{n}{n-w}A(n-1, d, w)]$. *Thus we have*

$$A(n, 2\delta, w) \leq [\frac{n}{w}[\frac{n-1}{w-1}[\cdots[\frac{n-w+\delta}{\delta}]\cdots].$$

The following lower bounds are the most known lower bounds for binary constant weight codes (see [7]).

Gilbert type lower bound. $A(n, 2d, w) \geq \dfrac{\binom{n}{w}}{\Sigma_{i=0}^{d-1}\binom{w}{i}\cdot\binom{n-w}{i}}$.

Graham–Sloane lower bound. *Let* q *be the smallest prime power satisfying* $q \geq n$ *then*

$$A(n, 2d, w) \geq \frac{1}{q^{d-1}}\binom{n}{w}.$$

However the binary constant weight codes in the Gilbert type lower bound are not constructed explicitly and the argument gives only an existence proof. The binary constant weight codes in the Graham–Sloane lower bound were not explicitly given, since one has to search at least q^d codes to find the desired one (see [7], page 38).

In [5] a construction of binary constant weight codes from general q-ary codes was given. This construction was then applied to algebraic-geometric codes (see [11]) for giving asymptotical improvement on the Gilbert type lower bound of binary constant weight codes. In this paper we propose an improvement of the Ericson–Zinoviev construction of explicit binary constant weight codes from general q-ary codes. Then this improvement is applied to Reed–Solomon codes and algebraic-geometric codes. Some new or optimal binary constant weight codes are given. In particular two new better binary constant weight codes than [13] are presented. We also give explicit binary constant weight codes which improve Gilbert and Graham–Sloane lower bounds asymptotically.