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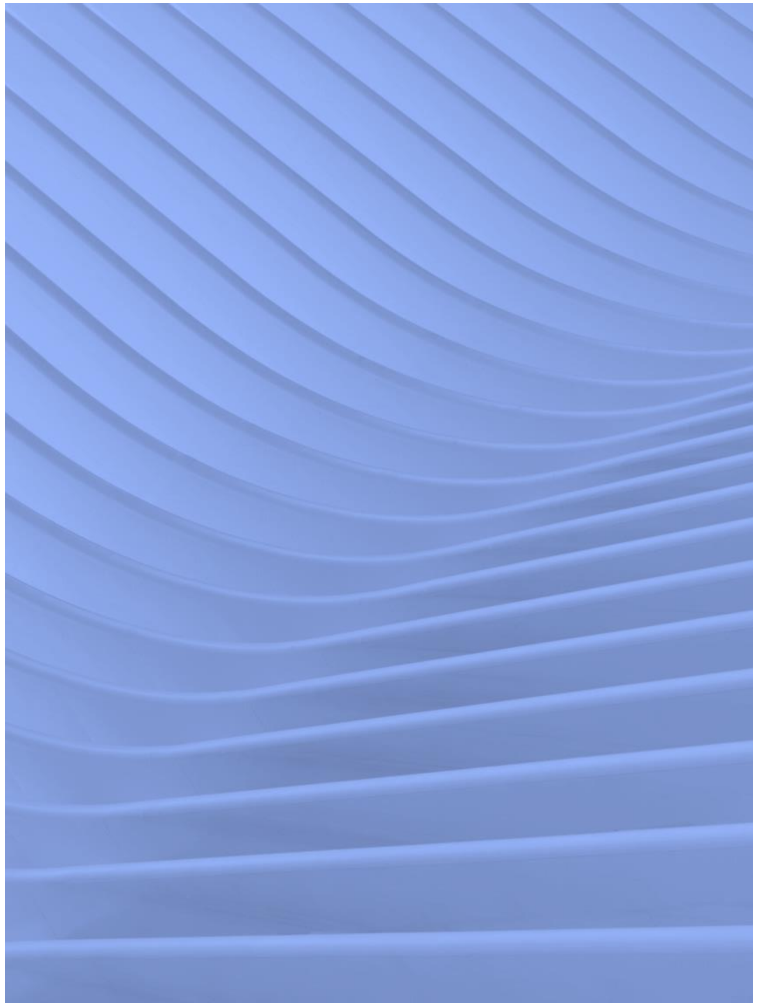
«Ensembles of optimal binary sequences of length 2^{2n}»

A N Leukhin, V I Bezrodnyi, A A Voronin, A S Merzlyakov, N V Parsaev

Problem statement



The problem of constructing ensembles of optimal binary sequences of arbitrary period is of great practical importance and urgency, as the electromagnetic spectrum is becoming increasingly congested. The solution to this problem will allow designers of asynchronous wireless communication systems to overcome this congestion, by using ensembles of sequences tailored to their system requirements.

This work aims to develop a systematic method for constructing ensembles of sequences with optimal correlation with arbitrary period. Optimality can be strict, or asymptotic, as the period tends to infinity. The problem is of fundamental importance in information theory, with wide-ranging applications to wireless communications, navigation, radar, digital watermarking, and related fields.

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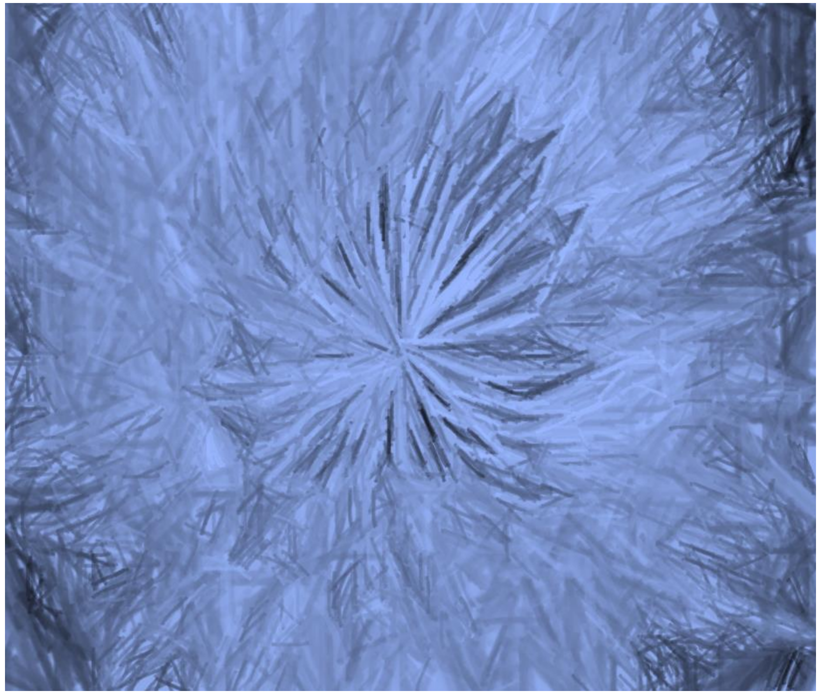
Solution methods



- We divide a sequence of length 2^{2n} in 2^n words of length 2^n. The idea is to generate an ensemble of sequences, then compute all possible proper decimations for the sequences and calculate the CCF of the ensemble.
- We include some example calculations for generating sequences of length N=16. In the following subsections, we show the results of several computations.
- Let us consider a periodic binary sequence

$$a = [a_1 a_2 a_3 a_4 a_5 a_6 a_7 a_8 a_9 a_{10} a_{11} a_{12} a_{13} a_{14} a_{15}] = [B_0 B_1 B_2 B_3]$$

- Let us consider the element decimation in the form

$$a_n{}^{(d)} = a_{dn \bmod N}$$

- The sequence formed by the element decimated by d and cyclic shifted by s is

$$a_{n+N-s \bmod N} = a_n{}^{(d)}$$

- We restrict the first initial block to be in the form . The equation system which should be solved is

$$a_0{}^{(1)} = a_0{}^{(7)} = [B_0 B_1 B_2 B_3]$$
$$a_{s1}{}^{(11)} = a_{s2}{}^{(13)} = [B_0 B_3 B_2 B_1]$$

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Results

- In this work we have presented a construction for families of length 16 that meet WBE exactly. The exhaustive search of binary sequences with period N=16 give us 194 non-equivalent binary sequences which different combinations could formed next set of non-equivalent ensembles:
- 8 non-equivalent ensembles of size L=4 and PSL=4
- 48 non-equivalent ensembles of size L=3 and PSL=4
- 8 non-equivalent ensembles of size L=2 and PSL=4
- This work is the first step to develop a systematic method for constructing ensembles of sequences with optimal correlation with arbitrary period. Construction of families of 8 sequences of length 64 are underway and it is conjectured that families of 16 sequences of length 256 exist, however the search for them is computationally intensive.

Contacts

A N Leukhin, V I Bezrodnyi, A A Voronin, A S Merzlyakov, N V Parsaev

Mari State University

E-mail: leukhinan@list.ru