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Algebraic Theoretic Properties of the Non-Associtive Class of (132)-Avoiding Patterns of Aunu Permutations: Applications in the Generation and Analysis of Linear Codes.

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Abstract: *Williem H. Haemers (2011) reported that the adjacency matrix of a graph can be interpreted as the generator matrix of a binary code [1]. This paper aims at Establishing yet another interplay between the already existing Application of the known (132) –Avoiding class of AUNU Numbers in Eulerian Graphs [2], in coding theory (generation of cyclic codes) with length* $n=5$ *and dimension* $k=4$ *[3], and the construction of a general linear code of size* $M=8$ *with* $n=5$ *and* $k=3$*.This is achievable first, by considering the three adjacency matrices constructed using the subsets* C_1, C_2 *and* C_3 *of* $\pi_A(132)\times\Omega_5$ *as in [2]. Next , we choose arbitrarily a row each from the three adjacency matrices and form a new matrix say G. The so formed matrix G is then interpreted and proven to be a generator matrix for a general linear code of size* $M=8$ *and length ,* $n=5$ *where all possible combinations of the basis codewords is carried out using summation Modulo 2. And the minimum distance of such a codes so `generated is known to be* $d=2$ *.*

Keywords: *Adjacency Matrix, AUNU numbers, Codeword, linear Codes, Code length, Generator Matrix, Dimension, Hamming (minimum) distance.*

I. Introduction:

The adjacency matrix of a graph can be interpreted as the generator matrix of a binary code or as the incidence matrix of a design [1]. The special class of the (132) *and* $(123)-$ avoiding class of permutation patterns was first reported by Ibrahim A.A and Audu M.S (2005) where some group and graph theoretic properties of these numbers were identified. Since then, this special class of permutation patterns had continued to enjoy a wide range of applications in various areas of Discrete Mathematics and beyond.

A useful application of this patterns in graph theory (Eulerian graphs) was exposed in [2]. The Author had in [3] base on the statement in [1] attempted to use the adjacency matrices obtained in [2] to generate a class of cyclic codes of block length, $n=5$. Graph theory and Coding theory had in recent times, proven to be interesting areas of research by both Mathematicians and Computer Scientists. While Graph theory is generally concerned with the formulation of interconnection networks, the first paper on graph theory is said to be concerned with the formulation of a network for the crossing of the Kongsberg bridges [Euler, 2005]. Eulerian circuits have also of recent been reported to have found approach to the problem of DNA fragment assembly [2]. Coding theory on the other hand is concerned with the study of methods for efficient and accurate, storage and transfer of information from one place to another [3]. Claude Shannon's paper titled "A Mathematical theory of Communication" in the early 1940s signified the beginning of coding theory. The theory had found wide application in areas such as, in the minimization of noise in compact disc recordings, data transfer from one electronic device to another, transmission of data through a distance source such as weather and communication satellites e.tc. Coding theory had witnessed tremendous growth with the generation and analysis of some important and practical codes such as, Hamming codes, Hadamard codes, BCH codes, Reed Muller codes, Reed Solomon codes, Golay codes e.t.c [7].

The class of linear codes is one of the most widely applicable and practical class of codes studied due to their easy encoding and decoding schemes. A code is said to be Linear if its code words forms a vector space. In this paper, we use the Adjacency Matrices of subsets C_1, C_2 *and* C_3 *of* $\pi_A(132)\times\Omega_5$ as in [2] to form a generator Matrix G for a linear code C with size $M=8$ *and length* $n=5$. The zero codeword and all non-zero code words of the code are enumerated.

II. Methodology:

We consider the adjacency matrices constructed as in [2] using subsets $C_1, C_2 \text{ and } C_3 \text{ of } \pi_A(132)\times\Omega_5$ as follows;

$$A=\begin{bmatrix}1&1&1&0&0\\1&1&1&0&0\\1&1&1&0&0\\1&1&1&0&0\\1&1&1&0&0\end{bmatrix}$$

Adjacency Matrix for subset $C_1 \text{ of } \pi_{(132)\times\Omega_5}$

$$B=\begin{bmatrix}0&1&1&1&0\\0&1&1&1&0\\0&1&1&1&0\\0&1&1&1&0\\0&1&1&1&0\end{bmatrix}$$

Adjacency Matrix for subset $C_2 \text{ of } \pi_{(132)\times\Omega_5}$

$$C=\begin{bmatrix}0&0&1&1&1\\0&0&1&1&1\\0&0&1&1&1\\0&0&1&1&1\\0&0&1&1&1\end{bmatrix}$$

Adjacency matrix for subset $C_3 \text{ of } \pi_{(132)\times\Omega_5}$

III. Formation Of The Generator Matrix:

Remark: Observe that the rows of matrix B which are all equal are a cyclic shift of the rows of matrix A and those of C are, a cyclic shift of the rows of B respectively.

Now, let G be the required generator matrix, then;

i. Take an arbitrary row of A to be the first row of G.

ii. Take an arbitrary row of B to be the second row of G.

iii. Take an arbitrary row of C to be the third row of G.

Then G becomes the matrix given by

$$G=\begin{bmatrix}1&1&1&0&0\\0&1&1&1&0\\0&0&1&1&1\end{bmatrix}.$$

Defination: By the Row Space of G, we mean a linear Code C whose basis is compose of the rows of G **.**

lamma:

$$For\ any\ subset\ S\ of\ F_2^n, the\ code\ C=\langle S\rangle\ generated\ by\ S\ consist\ precisely\ of\ the\ following\ words:$$
$$the\ zero\ word, all\ words\ in\ S\ and\ all\ sums\ of\ two\ or\ more\ words\ in\ S.[5; pp\,31]$$

IV. Findings:

The matrix G so formed above is a generator matrix for a linear Code C, where C is the row space of G and has the following code words;

$C = \{00000, 01001, 10010, 11100, 01110, 00111, 10101, 11011\}$.

This code is clearly seen to have minimum (Hamming) distance $d = 2$.

V. Conclusion:

This paper has opened yet another chapter in the applications of the graph theoretic properties of this special class of the $(132)-$avoiding permutation patterns in the construction (generation) of the linear class of Codes.

VI. Recommendation:

Further research on suitable decoding schemes and algorithms for the linear Codes so form and generalizations on the generation (construction) of linear codes with larger values of n is recommended.

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