DOI: 10.24996/ijs.2023.64.1.31

ISSN: 0067-2904

On Graph- Syriac Letters Partition

Hadil H. Sami[1*], Mohammed K. Ahmed[2], Ammar S. Mahmood[3]
[1]Department of Mathematics, College of Education, University of Al-Hamdaniya, Mosul, Iraq
[2]Department of Computer Science, College of Education, University of Al-Hamdaniya, Mosul, Iraq
[3]Department of Mathematics, College of Education for Pure Science, University of Mosul, Mosul, Iraq

Received: 18/3/2022 Accepted: 3/6/2022 Published: 30/1/2023

Abstract
The Syriac language is one of the ancient Semitic languages that appeared in the first century AD. It is currently used in a number of cities in Iraq, Turkey, and others. In this research paper, we tried to apply the work of Ali and Mahmood 2020 on the letters and words in the Syriac language to find a new encoding for them and increase the possibility of reading the message by other people.

Keywords: Partition, e-abacus diagram, Adjacent Matrix, Directed Graphs.

حول بيان تجزئة الاحرف السريانية

هديل حازم سامي*[1] ، محمد قاسم احمد[2] ، عمار صديق محمود[3]
[1]قسم الرياضيات, كلية التربية, جامعة الحمدانية, العراق
[2]قسم الحاسوب, كلية التربية, جامعة الحمدانية, العراق
[3]قسم الرياضيات, كلية التربية للعلوم الصرفة, العراق

الخلاصه
اللغة السريانية من اللغات السامية القديمة التي ظهرت في القرن الأول الميلادي وتستخدم حاليا في عدد من المدن في العراق وتركيا وغيرها. حاولنا في هذه الورقة البحثية تطبيق ما وجده علي ومحمود 2020 على الحروف والكلمات في اللغة السريانية وإيجاد ترميز جديد لها ولزيادة امكانية قراءة الرسالة من قبل الآخرين.

Introduction

Sami and Mahmoud introduced [1],[2] different types of encoding Syriac letters. Syriac language is an ancient that derived from the Aramaic language, so in this work, we try to employ the method that used by Ahmed and Mahmoud in [3] due to the increasing of the difficulty of cracking the code as we previously found in [1]. In the beginning, we will introduce the important concepts for the work. Let r be a nonnegative integer. The composition Γ of r is a sequence of non-negative integers such that $|\Gamma| = \sum_{i=1}^{n} \Gamma_i = r$. The composition is called a partition of r if $\Gamma_i \geq \Gamma_{i+1}$ for all $i \geq 1$. Let Γ be a fixed partition of r and define $\beta_j = \Gamma_j + b - j,\ 1 \leq j \leq b$. The set $\{\beta_1, \beta_2, \cdots \beta_b\}$ is said to be the set of β -number for Γ, see [4, Ch.3]. Let e be a positive integer number greater than or equal to 2, we

*Email: hadeelsami@uohamdaniya.edu.iq

can represent numbers by a diagram called e-abacus diagram, see [5, pp.1-10] as it is shown in Table 1:

Table 1: e-Abacus Diagram

runner – 1	runner -2	…	runner -e
0	1	…	e – 1
e	e + 1	…	2e -1
2e	2e + 1	…	3e -1
⋮	⋮	⋮	⋮

Where every β – number will be represented by (▪) which takes its location in diagram (A) and in the case of the nonexistence of β - numbers, then it will be represented by (-). For more details about the e-abacus diagram see [5],[6]. In the Syriac letters, the value of e = 7 has been specified, as it is the most suitable value for drawing all letters, for example, Figure 1 is the abacus diagram for the letters ܒ **(b)** and ܠ **(L)** where the partition Γ for each of them ,respectively $(30^8, 24^4), (32^7, 31, 24, 17)$ and the set of β – numbers {24,25,26,27,34,35,36,37,38,39,40,41}, { 17,25,33,35,36,37,38,39,40,41}.

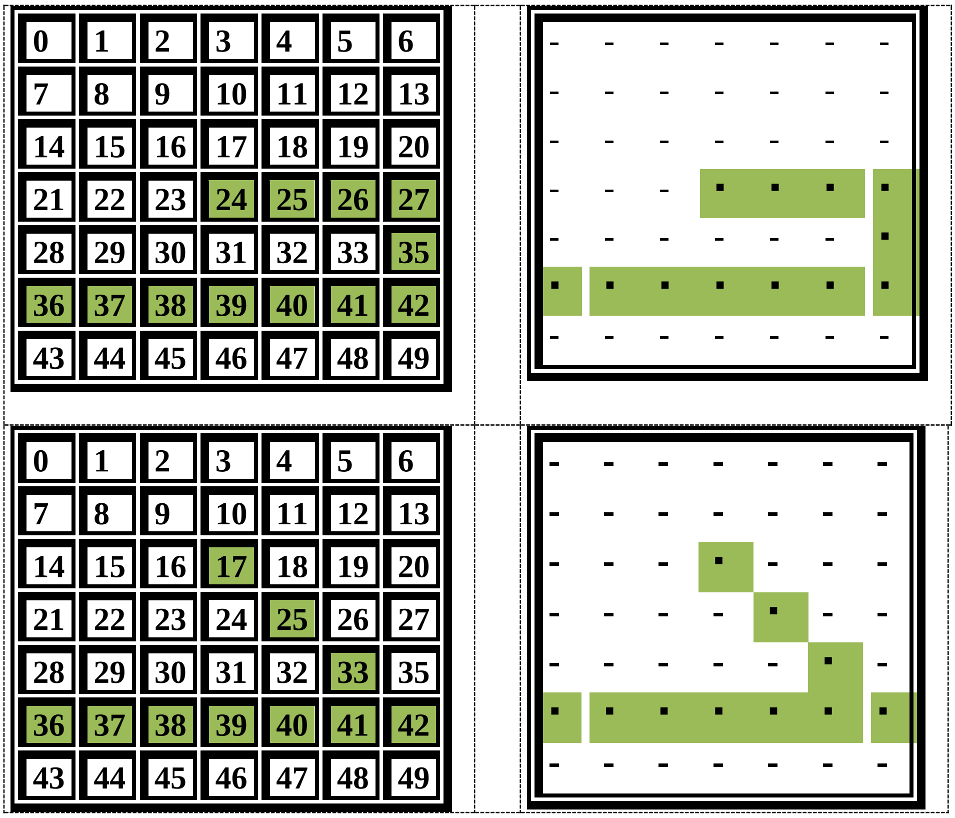


Figure 1: Abacus diagram for the letters ܒ and ܠ

Graph theory is one of the wonderful primary topics in modern mathematics. This theory is used in most branches of knowledge. It is a simplified mathematical model for any system involving a binary operation. Graph theory was first studied as a concept in mathematics by Euler in 1736. It has been witnessed in the current century as a great development. Its applications and use have shown that it is of great interest in topics of scientific and economic importance [7, Ch.1]. The graph, which is denoted by G, is defined as a non-empty set of elements called the graph vertices (G) V with a family (G) E of unordered pairs of graph vertices. Each of its elements is called an edge or a side. We express statement (G) in ordered pair (V,E). This type that was mentioned is called the undirected graph, and there is another type that we will deal with is called the directed graph, which is symbolized by D. It consists of a non-empty set of elements called vertices and symbolized by V(D) with a family of A(D) pairs Arranged by vertices. An ordered pair (g,h) where $g, h \in V(D)$ is called the edge of a vector or arc, g is called the starting vertex and h is the ending vertex, and (g,g) represents a directed loop [7],[8].

Graph directed to the Syriac letters

To make a special directed graph for the e-Abacus Diagram for Syriac letters, we will benefit from the idea that was found by [3], which is at the beginning of the representation of each number of beta numbers represented by (▪) expressed by 1and (-) expressed by 0 and thus The Abacus diagram will be transformed into a matrix whose elements are zero and one, as it is shown in Figure 2:

The text of your paper should be formatted as follows:

-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	▪
-	-	-	▪	-	▪	▪
-	-	▪	-	▪	-	▪
▪	▪	▪	▪	▪	▪	▪
-	-	-	-	-	-	-

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	1
0	0	0	1	0	1	1
0	0	1	0	1	0	1
1	1	1	1	1	1	1
0	0	0	0	0	0	0

Figure 2: Adjacency matrix for the letter ܦ

In order to calculate the degree of each vertex in the directed graph, we calculate the sum of the number of edges inside into vertex (σ^-) and the number of outside edges of vertex (σ^+)that is:

$$\deg(g) = \sigma^- + \sigma^+$$

The adjacency matrix is used to represent any directed graph. It is a square matrix of measure p*p defined by A(G)=[c_{nk}] where c_{nk} is the number of edges joining the two vertices g_n and g_k such that:

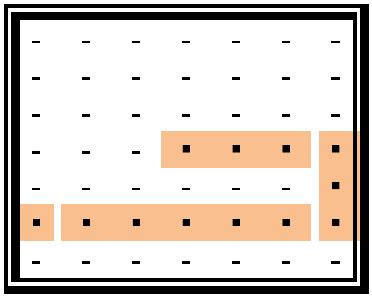
$$c_{nk} = \begin{cases} 1\,; & if\ (g_n\ , g_k\,)\ is\ an\ arc\ of\ D \\ 0 & ;\ \text{otherwise} \end{cases}$$

where $c_{nn} = 1$ is equal to the number of loops at the vertex g_n, if the two vertices are not adjacent, then $c_{nk} = 0$. The elements of the adjacency matrix of the directed graph consist of 0 and 1. The sum of the elements of each row represents the degree of the vertex in that row, and the sum of the elements of each column represents the degree of the vertex in that column. To apply this method to an Abacus diagram of Syriac letters, it is clear that the Abacus diagram for each letter is an array 7*7 which means it is a square matrix [1]. To encoding of each letter by applying the directed graph will generate a special code for each letter, and this code consists of 14 values, which represent the degree of the outside edges, that starts from the vertex g_1 up to g_7 and then the degree of the inside edges to g_1 up to g_7 that is:

Code any letter ($\sigma^+(g_1),\ldots,\sigma^+(g_7);\ \sigma^-(g_1),\ldots,\sigma^-(g_7)$) , where $0 \le \sigma^+(g_z) \le 7\ and 0 \le \sigma^-(g_z) \le 7\ \ \forall\ 0 \le z \le 7$. For an example in the Table 2, we will take the Syriac letters, ܒ, ܠ , ܩ

Table 2: Represents the Adjacency Matrix and Directed Graphs For the Letters ܒ, ܠ , ܡ

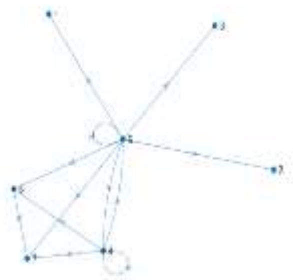
e- Abacus diagram	Adjacent Matrix of Digraphs	Directed Graphs

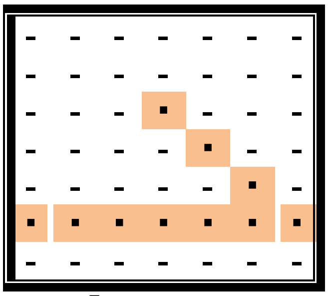


$(30^8, 24^4)$

	1	2	3	4	5	6	7
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	1	1	1	1
5	0	0	0	0	0	0	1
6	1	1	1	1	1	1	1
7	0	0	0	0	0	0	0

code (ܒ)
= (0,0,0,4,1,7,0; 1,1,1,2,2,2,3)

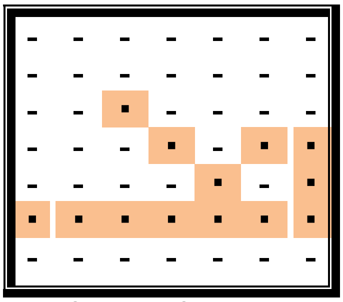




$(32^7, 31, 24, 17)$

	1	2	3	4	5	6	7
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	1	0	0	0
4	0	0	0	0	1	0	0
5	0	0	0	0	0	**1**	0
6	1	1	1	1	1	1	1
7	0	0	0	0	0	0	0

code(ܠ)
= (0,0,1,1,1,7,0; 1,1,1,2,2,2,1)



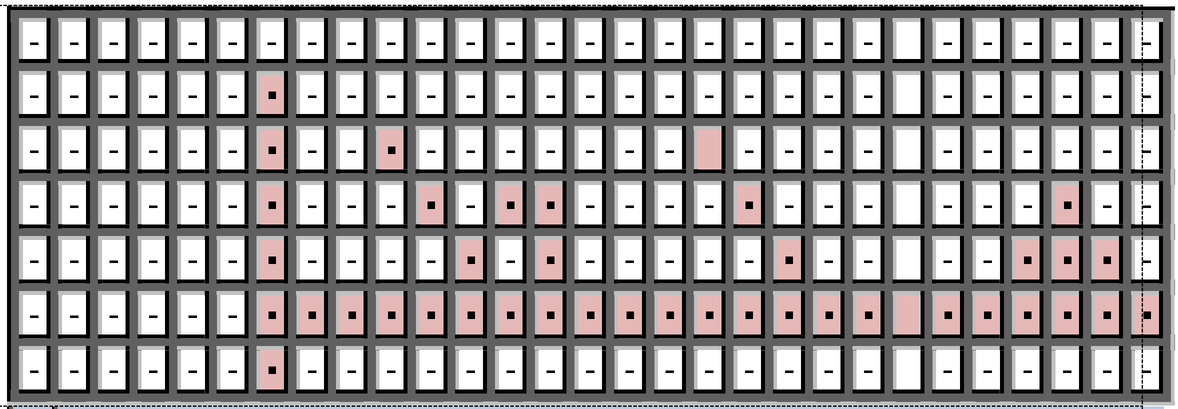
$(29^8, 28, 24^2, 23, 16)$

	1	2	3	4	5	6	7
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	1	0	0	0	0
4	0	0	0	1	0	1	1
5	0	0	0	0	1	**0**	1
6	1	1	1	1	1	1	1
7	0	0	0	0	0	0	0

code (ܡ)
= (0,0,1,3,2,7,0; 1,1,2,2,2,2,3)

But if we want to be a word in the Syriac language by using the graph and the neighborhood matrix, then we know that each letter will consist of 7 rows and 7 columns. As it is done in [3], we add rows by $7(\theta - 1)$ all elements are zeros, and thus a square matrix will be formed consisting of a new capacity, which is $7\theta * 7\theta$, and the code of a word consisting of f letters is:

Code any word ($\sigma^+(g_1), \dots, \sigma^+(g_7), 0, \sigma^+(g_8), \dots, \sigma^+(g_{14}), 0, \dots, 0, \sigma^+(g_{f-6}), \dots, \sigma^+(g_f)$;
$\sigma^-(g_1), \dots, \sigma^-(g_7), 0, \sigma^-(g_8), \dots, \sigma^-(g_{14}), 0, \dots, 0, \sigma^-(g_{f-6}), \dots, \sigma^-(g_f)$).
As shown in the Figures 3and 4 the Syriac word (ܫܠܡܐ) (Hello).



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0
5	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1	1	1	0
6	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

28	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Figure 3: Adjacent Matrix of Digraphs for the word (ܥܠܡܐ)

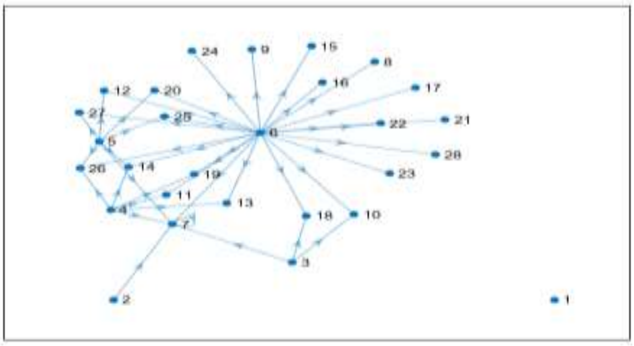


Figure 4: Directed graphs for the word (ܥܠܡܐ) and code =(0,1,3,6,7,22,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;0,0,0,0,0,0,6,0,1,1,2,2,2,2,2,3,0,1, 1,1,2,2,2,1,1,1,1,2,3,2,1)

Discussions and Conclusions

The choice of the directed graph is the most appropriate for converting the e- Abacus diagram to any letter. In the case of a word, the adjacency matrix is created before the graph. To make the matrix square we add rows of zeroes. Each letter has its own graph and a code that can also be used to draw the graph.

A technique, called GCYD, is existed in [9] which can be applied to our research. It will be our focus in future work.

Acknowledgments

All appreciation and respect to the universities of Al-Hamdaniya and Mosul universities for their support to complete this paper.

Reference

[1] H. H. Sami and A. S., Mahmood "Syriac letters and James diagram (A)," *Int. J. of Enhanced Research in Science, Technology Engineering*, vol. 6, Issue 12, PP. 53-62, 2017.

[2] H. H. Sami and A. S.,Mahmood "Encoding Syriac letters in partition theory using extended Vigenere cipher," *Eastern-European J. of Enterprise Technologies*, vol. 1/2, no. 103, pp. 37-46, 2020.

[3] A. M. Ali and A. S. Mahmood " The Graph of e-Abacus Diagram," *Wseas Tran. on Math*., Vol. 19, Issue 52, pp. 486-497, 2020.

[4] A. Mathas "Iwahori-Hecke algebras and Schur Algebras of the Symmetric Group," *Amer. Math. Soc*., vol.15, 1999.

[5] G. D James "Some combinatorial results involving Young diagrams," *Math. Proc. of the Cambridge Phil. Soc*., vol. 83, pp.. 1-10, 1978.

[6] W. Fulton "*Young Tableaux, with Applications to Representation Theory and Geometry," Cambridge University Press*, 1997.

[7] J. W. Robin "*Introduction to Graph Theory," 4th ed., Library of Congress Cataloguing in Publication Data*, 1996.

[8] G. Chartrand and L. Lesniak "*Graphs and Digraphs," 6th ed., Wadsworth and Brooks / Cole. California*, 2016.

[9] A. S. Mahmood " On GCYD-method in e-abacus diagram," to appear in *Iraqi J. of Science*, 2023.