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A Programmable New Algorithm to Represent e-Abacus Diagram vertically and Its Application in Industrial Products

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Abstract:

The question often revolves around the extent to which the fields of mathematics can be applied, and is it possible to benefit from them in our lives? We try to provide direct answers to some of them, while we are unable to provide answers to other areas. However, in this work we will present a new vision different from everything that was presented on the subject of the e-abacus diagram; by using a vertical reading which is not previously used for any partition instead of the horizontal, where the works of each Hann and Thomas, Mukai and recently Kirani; each separately, in finding mathematical relationships with cotton and industrial products inspired us to find a link more than Wonderful, it will be useful in increasing production or the possibility of presenting one or more models for design through this diagram.

Keywords: *e*-abacus diagram, horizontal and vertical *e*-abacus, partition theory, Satin and Sateen weaves.

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Introduction

Any industrial product needs many things from us before it is acquired by us. The quality of the design, the good quality of the material, the chosen colors, and other things make us choose one material over another. Mukai [13] presented in his Ph. D. Thesis a more than wonderful presentation on a method in which mathematics and its arts were merged to benefit from it in his field of specialization in chemistry, after which the idea of presenting Kirani [9] research on Satin and Sateen Weaves made us think completely about taking these ideas Which basically applies to the e-abacus diagram, and instead of reading this diagram in the usual way (horizontal), we will try to read the diagram (vertically) and see if it is possible to find a new industrial line for the basic design through the vertical proposal? For this, we have to explain the mathematical construction steps of the proposed design as follows:

Abacus is the first aid device used for mathematical computation and calculation and it's a graphical representation on the theory of numbers for any positive integer partition by James [6]. Abacus is a diagram with *e* column and *r* rows used for this representation is called *e*-abacus. Now, let $\mu = (\mu_1, \mu_2, \ldots, \mu_n)$ be a partition of a given *r* (non-negative integer). It is a sequence of non-negative integers as well, such that: $|\mu| = \sum_{j=1}^{n} \mu_j = r, \forall j \geq 1$ & $\mu_j \geq \mu_{j+1}$. For any μ, choosing an integer *b* greater than or equal to the number of parts of μ and defining $\beta_j = \mu_j + b - j$, $1 \leq j \leq b$. The set $\{\beta_1, \beta_2, \ldots, \beta_b\}$ is said to be the set of β-numbers for μ; see Fayers [3] and [4]. For any given positive integer *e* greater than or equal to 2, β-number represents a place of each μ_j in a layout called "***e*-abacus diagram**"; so that the first row of the diagram contains the numbers from 0 to e-1, while the second row contains the numbers from e to 2e-1, and so on for the rest of the rows, as 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 calculated β will be represented by a bead (■) in exact location in *e*-abacus diagram; by Chari et al. [2]. Each partition μ_j is stands for the number of spaces precede it, row by row in the diagram. For example, let μ = (8, 6, 6, 5, 2), e = 4 & b = 5, then the abacus will be as shown in Table 2:

Table 2. *e*-abacus for μ = (8, 6, 6, 5, 2) & e = 4

e-abacus layout				*e*-abacus diagram			
0	1	2	3	–	–	■	–
4	5	6	7	–	–	■	–
8	9	10	11	■	■	–	–
12	13	14	15	■	–	–	–

The position of each value of β_j can be denoted by P(β_j) and it represents the spaces precede each bead. The above figure shows the horizontal representation of an *e*-abacus, such that the partitions were presented row after row. The proposed method is to present it vertically by columns.

■ Representing *e*-Abacus Diagram Vertically Using New Methods

The vertical *e*-abacus representation is called "*e*-abacus vertically diagram". The usual representation of *e*-abacus diagram is horizontally (row by row). While the representation of the diagram vertically is done by columns. The output form of the vertical partition is totally different than the horizontal form. According to the above example and if the spaces counted column by column, the partition (8,6,6,5,2) will become (5,5,4,2,2).

This research represents this diagram vertically by applying a new algorithm to locate the beads by their indices and calculates the preceding spaces of each bead column by column using a new formula for these calculations to state the vertical partition. Since $P(\beta_j) = \mu_j + b - j$, $1 \le j \le b$, it's exactly equal to the following proposed equation:

$$P(\beta_j) = (k-1)\,e + (l-1) \qquad \ldots \quad (1)$$

where k is the number of the row and l is the number of the column and $1 \le l \le e$. So, each $P(\beta_j)$ is converted to a corresponding k and l according to equation (1). The extracted values of k and l are exactly the indices of the beads' positions. The position of β_1 from the original *e*-abacus diagram is needed to be calculated as it will play a pivotal role to determine the last row in the diagram and there is no need for further rows to be presented. The rest of β_j will take positions in the diagram into the last and preceding rows within different columns according to its value of k and l. Meaning, the maximum value of k which is obtained from β_1 will determine the number of rows in the diagram. Thus, the diagram is considered as a two dimensional array and the values of the calculated k and l will be considered as indices of the beads. Suppose trying to find the k and l values for β_j in the above example according to equation (1), and e=4, the positions of the beads into the diagram will be concluded as shown in Table (3).

Table 3. Calculating k and l for β_j according to equation (1)

μ_i	β_j	(k-1) e + (l-1)	(k-1)	(l-1)	Beads' positions
8	β_1=12	3(4)+0	3	0	(4 , 1)
6	β_2=9	2(4)+1	2	1	(3 , 2)
6	β_3=8	2(4)+0	2	0	(3 , 1)
5	β_4=6	1(4)+2	1	2	(2 , 3)
2	β_5=2	0(4)+2	0	2	(1 , 3)

The diagram dimensions will be determined by the largest value of k=4 and e=4 as e is the number of runners (columns). The vertical representation of this diagram is done by counting the spaces precede each bead column by column. Therefore, (8, 6, 6, 5, 2) will become (2, 2, 4, 5, 5). According to the partition constraint $\mu_j \geq \mu_{j+1}$, it should be reversed as (5, 5, 4, 2, 2), see Table (4). It is obvious that the vertical representation is totally different than the horizontal one.

Table 4. The vertical representation of (8,6,6,5,2) by the k_{rows} and l_{columns} according to equation (1)

***e*-abacus layout**				***e*-abacus diagram**			
(1,1)	(1,2)	**(1,3)**	(1,4)	–	–	■	–
(2,1)	(2,2)	**(2,3)**	(2,4)	–	–	■	–
(3,1)	**(3,2)**	(3,3)	(3,4)	■	■	–	–
(4,1)	(4,2)	(4,3)	(4,4)	■	–	–	–

The previous method for presenting the beads by their indices still have to count the spaces precede each bead manually. The proposed method is started by finding each of P(β_j) and its corresponding k and l as described previously. Then the positions of all k and l are listed in vectors. These vectors should be re-arranged ascending according to the values of l primarily then to the values of k. The following proposed formula is used to calculate the spaces precede each bead column by column depending on their indices to form a new presentation of μ.

$$\mu_j = (k_j - 1) + [(l_j - 1).(max(k)) - (j - 1)] \qquad \ldots \quad (2)$$

According to the previous example, table 2. shows the new algorithm to calculate and present the vertical diagram depending on the values of k and l by applying the proposed equations (1) and (2).

Table 5. Representing (8,6,6,5,2) vertically using proposed equations (1) and (2)

j	**Ascending *k***	**Ascending *l***	**(k_j–1)+[(l_j–1).(*max*(k))–(j–1)]**	***μ***	***μ***
1	3	1	(3-1)+[(1-1).(4)-(1-1)]=2	**2**	
2	4	1	(4-1)+[(1-1).(4)-(2-1)]=2	**2**	**(5,5,**
3	3	2	(3-1)+[(2-1).(4)-(3-1)]=4	**4**	**4,**
4	1	3	(1-1)+[(3-1).(4)-(4-1)]=5	**5**	**2,2)**
5	2	3	(2-1)+[(3-1).(4)-(5-1)]=5	**5**	

■ Implementing The Proposed Method Programmatically

The manual enumerated spaces in e-abacus are suitable with simple numbers' partitions. While the big partitioned numbers need a prolonged counting process. Therefore, the researchers tend to implement the proposed algorithm programmatically. Thus, a program is used to solve this algorithm and results were obtained for different partitions μ and multiple runner e. Algorithm 1 shows the pseudo code for the proposed algorithm. Taking under consideration that the algebraic index of k and l starts from 1, but the programmed algorithm using C++ language, the index starts from 0. Therefore, the equations in the following pseudo code were adjusted to adequate this issue.

The proposed algorithm can be best beneficial to an appropriate field in computer science called "Cryptography". Cryptography is a way in which the sending letter is encoded to be sent to an authorized receiver and avoiding to be exposed by an unauthorized persons see Sharmi [14]. In this paper a 5×5-pixel letter is taken under consideration to encode a word consists of two letters or more; Mahmood and Mahmood [10] and [11]. The highlighted pixels in the word is considered as beads (values of the word's μ partition) and have been read vertically. Then, applying the proposed algorithm to this partition leads to a totally different representation of the word. Therefore, it leads to a different partition value. These values are symbolized in a new abacus diagram and give a new representation differ from the original word.

Algorithm 1. Pseudo code for the proposed algorithm

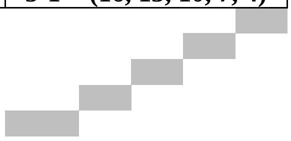
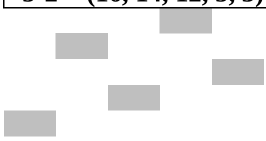
Input number of partitions *b*
Input number of runner *e*
Input the partitions μ_j
for j = 0 to b do
Calculate β_j

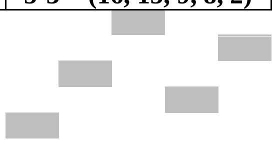
$k_j = \beta_j / e + 1$
$l_j = \beta_j \% e + 1$
find max(k_j)
end do
Initiate the array abacus[max][*e*] by setting all elements to "."
for *j* = 0 to *b* do
Set abacus[*k*[*j*] - 1][*l*[*j*] - 1] to "*"
end do
Rearrange vectors *l*[*b*] and *k*[*b*] ascending depending on the values of *l* then *k*
for *j* = 0 to *b* do
calculate the spaces precede each bead using its indices
newμ_j = (*k*[*j*] - 1) + ((*l*[*j*] - 1) * max - *j*)
end do
Reset a vector of length (max*e) to "."
for *j* = 0 to *b* do
set vector[new μ_j] to "*"
end do
Convert the vector to a new abacus diagram of *e* columns
Print the new representation of abacus
Print the calculated partitions newμ_j in reverse order

Application in Industrial Products

The question now is that all that was presented is in mathematics, where is the industrial aspect of it, specifically that we said we will apply it to cotton or industrial products? We will say that any product depends on choosing a specific design for marketing, so if we take the basic design and through the *e*-abacas diagram, but vertically, to see what gives us a new design and thus marketing “a product from the same company and with the same specifications that the customer trusts, but the design differs!”. Following with interest the work of Hann and Thomas [5], Kempkes et al. [7], which mainly revolves in the direction of chemistry. The idea is based on choosing a matrix called circular, which is essentially square (meaning the number of rows is equal to the number of columns) and is formed from a specific row or column by shifting it towards the left or right. The method used for displacement is usually the first row is the specified row vector, while the second row is obtained by shifting the first row circularly by one element, then the third row by shifting the first row by two elements, and so on to the rest of the rows. This displacement exactly corresponds to a very important topic in mathematics, which is Mobius ladder, who has many interests and studies in graph theory that are not mentioned in this research. Kirani [9] gave a good example of what was mentioned above by defining Satin and Sateen Weaves, so he chose a specific shape in the simplest case and then performed the displacement to show us the possible cases. For example, if we choose the number of rows is equal to 5 then we have the following cases in Satin weaves:

Table 6. Satin weaves graphs

type	5-1 = (16, 13, 10, 7, 4)	5-2 = (16, 14, 12, 5, 3)
		

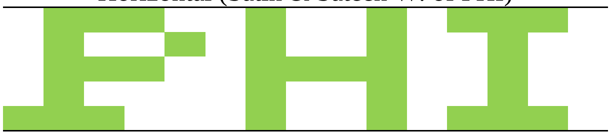
type	5-3 = (16, 15, 9, 8, 2)	5-4 = (16, 16, 11, 6, 1)
		

type	5-5 = (16, 12, 8, 4)
	

In fact, once we pay attention a little, we see that the idea of choosing a square matrix is in itself completely identical to the idea presented by Mahmood and Mahmood [10-11], which put each letter of the English language in a design according to the 5-abacus diagram.
It is quite natural that in the case of industry, the model is chosen according to a specific template, perhaps by (pasting) this model with other models (similar or complementary to the original model) and then printed. This will be our idea that we seek to apply here by choosing a letter, a word or even a sentence and then reading it horizontally (according to the proposed method to present unfamiliar industrial models as if they were encrypted for the chosen model). We will take into account the example below; table 8, of a well-known sign, and then we enter into it what we have done in this research to see the following figure; *Unreal brands were selected solely to demonstrate our aspirations; they were not actually used to avoid any legal issues with any trademark by using the notes in Kirani* [9]:

Table 7. Horizontal and Vertical (Satin & Sateen W. of PHI)

Horizontal (Satin & Sateen W. of PHI)



Vertical (Satin & Sateen W. of PHI)

This study led us to the possibility that this is the beginning of the topic of fractal geometry Kempkes et al. [7].

Results and Discussions

The program was executed on different values of partitions and different runner *e*. The results of the proposed algorithm showed perfect representation for *e*-abacus diagram in vertical form. Meaning, the enumerated spaces that precede each bead were perfect and the positions of these beads were right. Re-representing *e*-abacus vertically is totally different from its horizontal one. Thus, this method can be suitable to be used in the field of words encryption by considering each word as an *e*-abacus and re-representing it vertically using the proposed algorithm.

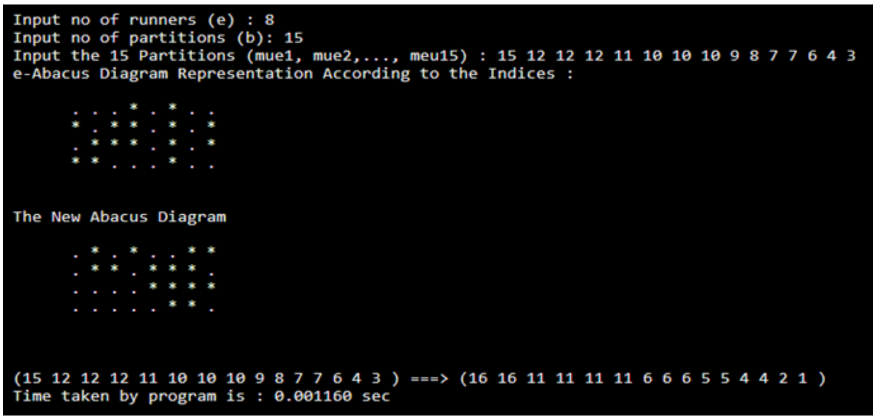
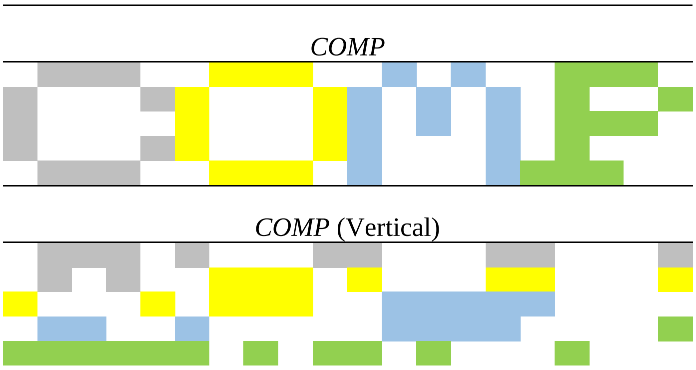


Figure 1. Vertical representation for $e = 8$, $\mu = (15\ 12\ 12\ 12\ 11\ 10\ 10\ 10\ 9\ 8\ 7\ 7\ 6\ 4\ 3)$

The result of representing any word's diagram in vertical way shows different representation from the origin. For example, as the presentation diagrams' dimensions of each letter in the word to be processed is 5×5. Then, the representation of the word *COMP* in horizontal form will be $\mu = (51^4, 48, 47^3, 45^3, 41, 40, 37^2, 34^2, 31, 30^3, 29, 28, 27^2, 24, 20^2, 18, 17, 16, 15^2, 12^2, 9, 8^3, 6, 5, 3^3, 1^3)$. The vertical representation of it will give a different partition. So, if this vertical partition representation is read horizontally again it will give different representation of the word *COMP*; See table 6.

Table 8. Re-representing the word *COMP* using vertical *e*-abacus representation



The results that we obtained through Figure 2 will make us, while applying the idea of Ali and Mahmood [1], that there is a graph for each case that completely reflects the size of the difference in form and content, so that it makes us safe to send any information as follows:

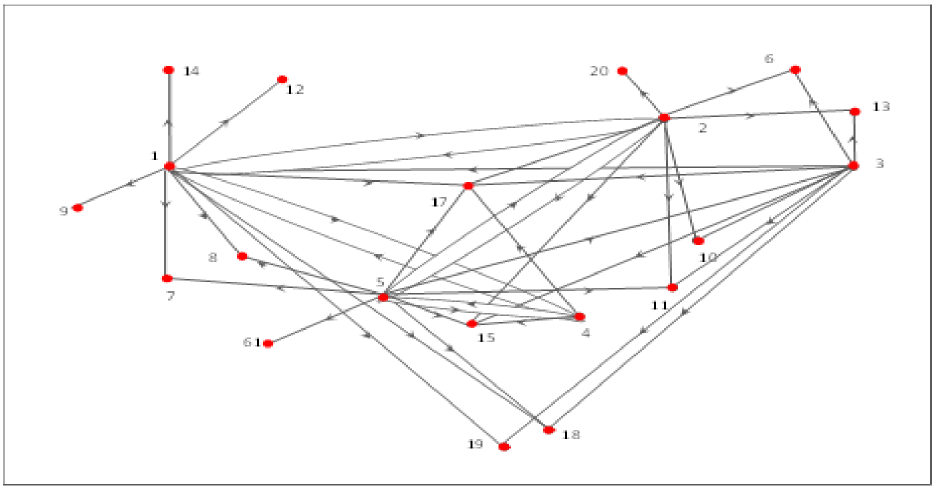


Figure 2. The Graph of the word *COMP*

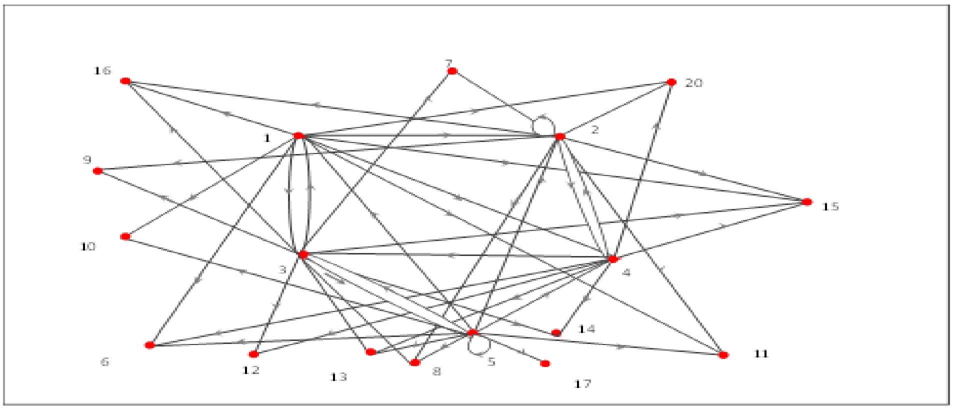


Figure 3. The Vertical Graph of the word *COMP*

■ Conclusions

The vertical representation of the *e*-abacus diagram of any given partition is different from its horizontal representation. The two new equations that have been used in this algorithm showed effective and useful different representation. This new representation can be used into many mathematical and computer fields such as cryptography As well as the possibility in the practical use of modern trends as it is in Hann and Thomas [5], Kempkes et al. [7], Kirani [9] and Mukai [13].

We believe that the use of this technique will be wonderful with the ideas that were discussed in Mahmood and Khaleel [8 - 12] through which it is possible to add one or more new rows according to special rules to the origin of the diagram resulting from the selected Partition. We must mention that it will be possible to apply everything that is mentioned with the Mobius Ladder, and all of this will have a great and mathematic impact in the foundation, but the industrial application will provide additional profits through the outputs of one form to several forms.

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