A Chaos-Based Encryption Algorithm for Database System

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Abstract

This paper introduces a new Database Transposition, Substitution and XORing Algorithm (DTSXA) based on using chaotic maps. It is based primarily on two well-known security properties: confusion and diffusion. A random number generator was depended on to produce the keys for the algorithm of encryption and decryption. The encryption of the Arabic language in addition to the English language was done, besides it can encrypt a table, individual row and individual column. The suggested algorithm was obeyed and analyzed by different tests involving brute force attack analyses, statistical attack analyses (security analysis histogram, correlation coefficient analysis and information entropy analysis), key sensitivity analysis, differential attack analyses well-deservedly, which indicates that the

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presented encryption algorithm has a high security level due to its large key space and high sensitivity to the change in the cipher keys.

Keywords: Database, encryption, security, chaos maps, Kaplan–Yorke map, Arnold Cat Map.

1 Introduction

In present time, database contains dynamic data for all life fields such as marketing, learning, and medicine. Security is at the beginning of the list of the biggest dangerous issues encountering the database system. Database information is usually utilized and exchanged by different operators, users and beneficiaries. The valuable data that stored in some database are considered to be as an object of attacks and parasitical interfering from internal and external the establishment. Database ciphering provides safer and more secure for the significant information to be in a high level of trust. Therefore, database protection is one of the most in demand challenges in computer science research [1]. Encryption techniques are based on a theoretical or algebraic concepts. Chaos is an exploratory model that points to some complex and unpredictable dynamic phenomena. There are some common features of chaos and encryption. The most notable feature is the sensitivity to the changing in variables and parameters. The remarkable difference between cryptography and chaos is actuality that the chaotic systems are defined only in real numbers [2], while integer numbers are the input of cryptography systems. Anyway, it is believed that these disciplines can benefit from each other. There are many database studies within the safety subject involved functional applications. Despite a number of having a good potential but they still need more developments. W. Xing-hui et al. 2010 [3] suggested a database cipher system depends on the integration of IDEA & RSA hybrid. The role of IDEA is to execute data encryption and decryption operations. The execution is accomplished via 8 iterations of the whole program involving sub-key production. The role of the RSA algorithm is to encrypt the key of IDEA via the public key of the RSA cryptosystem that is passed to the other end. Manivannan et al. 2010 [4], focused especially on protecting the databases having sensitive data by TSFS algorithm containing alteration, replacement, folding and shifting. It's the symmetric-key block encipherment algorithm, with three keys. The generated keys were widened to 12 subkeys through utilizing the key expansion. S.M. Darwish et al. 2014 [5] define a new fuzzy chaos algorithm and cellular automata technique for database encryption. It generates a set of random passwords and uses a fuzzy logic approach to choose the best password from a set of produced passwords. Then, it generates a key using Cellular Automata. After that, the encrypted of sensitive database fields is chosen by Pseudo-Random Number Generators (PRNGs). The algorithm contains a new fuzzy chaos theory by Takagi-Sugeno fuzzy models to transform discrete-time chaotic systems to separate linear systems. The encryption intends to hide the message signal by making the chaotic carrier hide the encrypted password. V. Galushka et al. 2018 [6] proposed end-to-end data encryption. It was performed in the final nodes of an interaction of the information system using symmetric encryption algorithms. Its key arrangement was intended to be used in multiuser systems. The encryption process is based on username and password, where the password is transformed into an altered password of 128 bits in length by the md5 algorithm. Depending on the distributed key representation model, the first fraction of the key is kept in the database, while the second fraction is gotten by transforming the user's password. After that, it performs the bitwise exclusive-OR operation for the encryption process.

In the present study, a new chaotic DTSXA algorithm for database encryption/decryption is suggested. The suggested algorithm consists of three methods (transposition, substitution, and XORing) which are implemented based on the chaotic system and can encrypt/decrypt English & Arabic database systems.

The rest sections of the paper are arranged as follows: the contribution and feasibility of the proposed system, the basic theory of the chaotic functions, key generation method, the proposed database encryption and decryption algorithm, implementation, and results.

2 Contributions and Feasibility

- 1. A new, chaotic DTSXA algorithm for database encryption/decryption is proposed.
- 2. The proposed algorithm consists of novel three methods (Transpose, Substitute, and XORing) implemented based on the chaotic system.
- 3. The proposed system is capable of encrypting/decrypting the English and Arabic database systems.
- 4. In addition, the proposed system can encrypt specific tables with N rows and M columns, encrypt only one row in a table, encrypt only one column in a table, encrypt a sequence of rows and columns, and lastly encrypt the query. Therefore can be very useful for handling single records, which can lead to higher accuracy in times.

Feasibility: the proposed DTSXA takes into consideration the feasibility of the practical situations by allowing the secure performance of the three main security properties (confidentiality, integrity, and availability). In general, confidentiality property imposes predefined restrictions on access to protected data and prevents disclosure to unauthorized persons. The integrity property ensures that data cannot be invisibly corrupted. Finally, the property of availability ensures reliable access at an appropriate time to the database. All these properties are provided in the proposed system. Database encryption satisfies the first property via that the encryption process is done only for the users who have the right to do that. As for the second property, it is implicitly verified where only the authorized user can decrypt the data, which ensures the integrity of the data. The last requirement is that all data are available for authorized users, and this feature is provided by the system because the processes of encryption and decryption are carried out only by authenticated users.

3 Chaotic Maps

Chaotic behavior represents a complex dynamic behavior with certain properties, which are possible to be linked to the substitution and permutation attributes in a perfect cipher. Chaotic systems have the following features [7, 8]:

- The system is very critical to initial conditions (Aperiodicity).
- The chaotic system is complex and unpredictable (Nonlinearity).
- System's manner will be altered for any small change in the input (Sensitivity).
- Chaotic system generates identical output if it receives identical input.

In this paper, we used two chaotic maps: 2D Kaplan–Yorke Map and 2D Arnold Cat Map.

3.1 2D Kaplan–Yorke Map

The Kaplan–Yorke map can be defined as a discrete-time dynamical system that shows chaotic behavior. 2D Kaplan–Yorke system maps a point (x_{n+1}, y_{n+1}) depending on another known point (x_n, y_n) through the following equation [9]:

$$\frac{x_{n+1} = 2x_n \;(mod\;1)}{y_{n+1} = \alpha y_n + \cos(4\pi x_n)}\tag{1}$$

Where (mod) is modulo operator. This system relies on just one parameter (α). To prevent the operator to be zero after a relatively few number of iterations, mod 0.99995 is taken instead of mod 1.

3.2 2D Arnold Cat Map

It's a chaotic and reversible map with two-dimensional, which was presented by Vladimir Arnold. The word "cat" was given because of utilizing an image of a cat to show its chaotic behavior. Its equation is given by [10]:

$$\begin{bmatrix} x_{i+1} \\ y_{i+1} \end{bmatrix} = \begin{bmatrix} 1 & a \\ b & ba+1 \end{bmatrix} \begin{bmatrix} x_i \\ y_i \end{bmatrix} \mod(n)$$
(2)

Where, (x_{i+1}, y_{i+1}) is the new value of (x_i, y_i) , a and b represent the control parameters and n is the number that is used for mod. The control parameters additionally work as secret keys. The inverse of Equation (2) is [11]:

$$\begin{bmatrix} x_i \\ y_i \end{bmatrix} = \begin{bmatrix} 1 & a \\ b & ba+1 \end{bmatrix}^{-1} \begin{bmatrix} x_{i+1} \\ y_{i+1} \end{bmatrix} \mod(n)$$
(3)

4 Key Generation Method

The key generation algorithm that generates the key for the proposed database encryption/decryption algorithm is called Chaotic Key Stream Generator (CKNG), which is previously designed based on a method given in [12]. The core of the CKNG is a 2D Henon map and a 2D Rational map. The products of the 2D Hénon and 2D Relational chaotic maps, which are double point digits, are linked by CKNG. These products are transformed into binary sequences of 64-bit. XOR process is used to link the sequences to yield only one binary sequence. The reason behind selecting Hénon chaotic map that has a large key space with the Relational chaotic map was to broaden the complexity of the system and reduplication the difficulty for an attacker to obtain important data.

5 The Proposed Database Encryption and Decryption Algorithm

A new database encrypting and decrypting algorithm called DTSXA (Transposition, Substitution and XORing Algorithm) was proposed based on using

AALBORG	DENMARK	8694	10	1/2/2018	5706N 0951E	Enter Key of Encrption and Decr
ABBEVILLE	FRANCE	5249	220	2/2/2018	5009N 0150E	X
ABBOTSFORD	CANADA	8000	190	3/2/2018	4901N 12222W	Y
ABERDEEN	UNITED KINGDOM	6001	215	4/2/2018	5712N 0212W	7
ABHA	SAUDI ARABIA	10991	6858	5/2/2018	1814N 4239E	
ABIDJAN	IVORY COAST	8858	20	6/2/2018	0515N 0356W	W
ABU DHABI	UNITED ARAB EMI	13451	88	7/2/2018	2426N 5439E	CTR 0
ABU DHABI	UNITED ARAB EMI	10500	15	8/2/2018	2426N 5427E	Select table name
ACAPULCO	MEXICO	10824	16	9/2/2018	1645N 9945W	Conned "TMPCLP404131
ACCRA	GHANA	9800	203	10/2/2018	0536N 0010W	ai smail table
ADANA	TURKEY	9022	66	11/2/2018	3659N 3517E	All Execution table
ADDIS ABABA	ETHIOPIA	12139	7625	12/2/2018	0859N 3848E	table larabic
ADELAIDE	AUSTRALIA	8294	20	1/2/2019	3457S 13832E	table2 tablearabi1
ADEN	YEMEN ARAB REP	10168	12	2/2/2019	1250N 4502E	Scloct tablearabic2
ADRAR	ALGERIA	9843	915	3/2/2019	2750N 0011W	Encryption
AGADES	NIGER	7546	1656	4/2/2019	1658N 0759E	
AGADIR	MOROCCO	10499	230	5/2/2019	3020N 0925W	Part Table Encryption and Dec
AGLEN	FRANCE	7103	203	6/2/2019	4411N 0035E	From Row
AHMEDABAD	INDIA	8999	180	7/2/2019	2304N 7238E	To Bow
AJACCIO	FRANCE	7933	15	8/2/2019	4155N 0848E	From Columna
AKUREYI	ICELAND	6496	6	9/2/2019	6539N 1805W	
AL HOCEIMA	MOROCCO	7087	89	10/2/2019	3511N 0350W	To Columna
AL JOUF	SAUDI ARABIA	10827	2261	11/2/2019	2947N 4006E	Part
ALBUQUERQUE	UNITED STATES	13375	5352	12/2/2019	3503N 10636W	Part Enception Decryption
ALDERNEY	UNITED KINGDOM	2887	291	1/2/2020	4942N 0213W	
ALESUND	NORWAY	5249	71	2/2/2020	6234N 0607E	New Qyery of Encryption or Dec
ALEXANDRIA	EGYPT	7218	4	3/2/2020	3111N 2957E	Name table/Query
		aran .	-			N N

Figure 1 Selecting a table that needs to be encrypted from the database.

chaotic maps. The DTSXA algorithm has two main algorithms: database encryption and database decryption.

- A. *Database Encryption Algorithm:* The suggested DTSXA encryption algorithm consists of the following steps:
 - 1. **Preprocessing step:** open the specified database file and select a table that needs to be encrypted. For example, for a hospital database, the table that needed to be encrypted is a medicine table as shown in Figure 1. The selected table is auto-saved in memory by the Data Table. Data Table (denoted by DT) represents one table of in-memory relational data and temporary storage in RAM and it was treated as a 2D array. Each cell value in DT is converted to its ASCII value and saved into 2D Database Array denoted by (DA[m x n]) as shown in figure.
 - 2. **Key generation step:** in this step, the keys that are needed for the encryption algorithm in all operations are generated and scheduled based on CKNG algorithm. This step involves:
 - First, using the CKNG algorithm with four initial parameters (x1, x2, x3, x4) to generate the key array1 (KA1) with size equal to the size of DA. These initial parameters are double

Denny, Mark-McFadzean, Alan	2/4/2016	4170988946037	71123512\$	40.GH5U02.5R / pharmacies
ASCII		$\overline{\mathbf{v}}$	-	
68 101 110 110 121 44 32 77 97 114 107 45 77 99 70 97 100 122	50 47 52 47 50 48	52 49 55 48 57 56 56 57 52 54 48 51 55	55 49 49 50 51 53 49 50 36	52 48 46 71 72 53 85 48 50 46 53 82 32 47 32 112 104 97 114 109 97 99 105 101 115

Figure 2 The ASCII values of a row in a certain table.

numbers with accuracy of 10^{-16} and they are treated as the algorithm keys.

- Second, the CKNG algorithm is applied to generate the key array2 (KA2) with size equal to DA size. This is done through using the same initial parameters (x1, x2, x3, x4) after adding any number to them. KA1 and KA2 elements are used to perform the Xoring operation in encryption step.
- Third, the CKNG algorithm is applied with new parameters (newx1, newx2, newx3, newx4) to generate the keys that needed for transposition and substitution operation in encryption step. The parameters (newx1, newx2, newx3, newx4) are created based on the initial parameters (x1,x2,x3,x4) using the Equation (4):

$$new_{x1} = x_1 \oplus x_3$$

$$new_{x2} = x_2 \oplus x_4$$

$$new_{x3} = (x_1 + x_1) \oplus (x_3 * 0.7)$$

$$new_{x4} = (x_2 * 0.2) \oplus (x_4 * 0.5)$$
(4)

- 3. Encryption step: For each row in DA array, do the following operation:
 - *Transposition method*: the transposition method permuted the input row values according to Kaplan–Yorke map values. Here, the algorithm iterates the 2D Kaplan–Yorke map in Equation (1) for a number of cycles by as same as the size of the input row. In each iteration, two double numbers are generated and converted to two integer numbers in the range [1 Input row length]. The repeated number will be ignored. These numbers represent the new indexes that will be used to

permute the input row, in which every two numbers (as two indexes), exchange their values. This operation needs that the input row length must be an even number. The reason behind that can be explained in the following example. Let the input row is [34, 78, 89, 102, 205, 88, 155, 65, 90]. While the input length is odd, so the value 32d which is the ASCII code of the space bar will be added to the input row as shown [34, 78, 89, 102, 205, 88, 155, 65, 90, 32]. The generated indexes are [4, 7, 2, 6, 9, 1, 3, 10, 8, 5], where the first pair of indexes, 4 and 7, are swapped so the resulted row will become [,,, 155, , , 102, ,]. The second pair of indexes, 2 and 6, are also swapped so the resulted row will become [, 88, 155, 78, 102,] and so on. The resulted permuted row will be [90, 88, 32, 155, 65, 78, 102, 205, 34, 89]. This process can provide diffusion property. The Pseudo-Code algorithm 1 shows the transposition method.

• Substitution method: Arnold's cat map substitutes the pair values of permuted row and generates the substituted row. Each pair values of the permuted row are mapped into a new pair. The substitution method receives permuted row to produce substituted row. Continuing with previous example, one can find the first pair values in the permuted row are v1 = 90 and v2 = 88 and the control parameters for the Arnold cat map are a = 3 and b = 2. The values v1 and v2 are the inputs of Arnold cat map Equation (2) where each value will be inputted to one equation as shown:

$$nv_1 = (v_1 + v_2 * a) \mod 256$$

= (90 + 88 * 3) mod 256 = 98
$$nv_2 = (v_1 * b + v_2 * (a * b + 1)) \mod 256$$

= (90 * 2 + 88 * (3 * 2 + 1)) mod 256 = 28

And so on for the rest values in the permuted row. These steps are repeated for all values in the permuted rows to result in the substituted row. To apply the steps to the Arabic language, the range of Arnold cat map $[0 \dots 255]$ the English language is exchanged in by a new range $[0 \dots 1792]$ for Arabic language. The pseudo-code is shown in the algorithm 2.

- *XORing method*: The XORing process is done with twice phases as follows:-
 - (a) XORing1: Each value of the substitution row is XORed with the value of the KA1, which is generated using the CKNG algorithm and producing cipher row1 (CR1).
 - (b) XORing2: Each value of CR1 is XORed with the value of the KA2 which is generated using the CKNG algorithm and producing cipher row2 (CR2) that will be saved in a cipher table.

Algorithm 1 Transposition method

Input: x_0 , y	v ₀ , a, b // initial and control parameters of Ka	plan–Yorke map
Μ	// input vector of dimension (1 n)	
Output: P /	/ output permuted vector of dimension (1 n)	
Begin		
Process	ing:	
Step 1:	i = 0	
Step 2:	n = length(M)	
Step 3:	if mod $(n, 2) \neq 0$	⊳ // if row length is odd
	n=n+1	
	M[n]=32	▷ // add ASCII value of space bar
	End if	
Step 4:	Iterate n times	
	$x_{i+1} = mod (2^*x_i, 0.99995)$	
	$y_{i+1} = mod (a^*y_i + cos(4^*\pi^*x_0))$	
	$V[i] = integer(x_{i+1}*n)$	▷ // convert to integer in rang[1n]
	$V[i+1] = integer(y_{i+1}*n)$	▷ // convert to integer in rang[1n]
	i = i + 2	
	$\mathbf{x}_{\mathrm{i}} = \mathbf{x}_{\mathrm{i}+1}$	
	$y_{\rm i}=y_{\rm i+1}$	
End Iter	ration	
Step 5:	i = 0	
I	Iterate n times	
	$t_1 = V[i]$	
	$t_2 = V[i+1]$	
	$P[t1] \leftarrow M[t_2]$	
	$P[t2] \leftarrow M[t_1]$	
	i = i+2	
End Iter	ration	
End		

Algorithm 2 Substitution method

Input: a,b // control parameters of Arnold's cat map m // the modularity where in English lang. is 256 and in Arabic is 1793. P // permuted vector of dimension (1.. n) Output: S // output substituted vector of dimension (1.. n) Begin Processing: Step 1: i = 0Step 2: Iterate n times S[i] = mod (P[i] + P[i + 1]*a, m) S[i + 1] = mod (P[i]*b + P[i + 1](a*b + 1), m) i = i + 2End Iteration

B. Database Decryption Algorithm

The decryption algorithm of the proposed DTSXA is an inverse of the encryption algorithm where each operation is reversible. First, for the XORing method, the inverse is achieved by XORing the same key with the cipher data table. Second, for the substitution, the method, inverse Arnold cat map is used in the decryption algorithm. The inverse of the permutation method is archived by returning every value in AD to its real position. The basic steps of the decryption algorithm are:

- 1. **Preprocessing Step:** Connecting to the database and selecting the cipher table that needs to be decrypted. The selected table is auto-saved in memory by DT and treated as a 2D array. Each value in DT is converted to its ASCII value and saved into 2D array referred as Database Array (DA[m x n]).
- 2. Generation of key step: In this step, the keys that needed in all decryption operations of the algorithm are generated and scheduled based on CKNG algorithm in the same way as the encryption algorithm.
- 3. **Decryption step**: For each row in DA array, do the following operation:
 - *XORing method*: The XORing process is performed in the same way as in the encryption except that the ASCII values of each cipher row are XORed first with KA2 and then the result is XORed with KA1. The values of KA1 and KA2 are generated using CKNG in the same way as in the encryption algorithm.

- *Inverse Substitution Method:* Each pair value in the resulted XORed array is substituted using the inverse 2D Arnold cat map Equation (3). Inverse substitution method is shown in algorithm 3.
- *Inverse transposition method*:- Each pair value in the substituted array returns to its original position. The inverse transposition method is same as the transposition method.

Algorithm 3 Invers substitution method

```
Input: a,b // control parameters of inverse Arnold's cat map

m // the modularity where in English lang. is 256 and in Arabic is 1793.

P // Xoring vector of dimension (1.. n)

Output: S // output inverse substituted vector of dimension (1.. n)

Begin

Processing:

Step 1: i = 0

Step 2: Iterate n times

S[i] = mod (P[i]*(a*b + 1) - a*P[i + 1]), m)

S[i + 1] = mod (P[i + 1] - b*P[i], m)

i = i + 2

End Iteration

End
```

C. Implementation with Examples

The proposed algorithm was designed to encrypt any English or Arabic database. All the examples of English database are given from Northwind Plus Database through the link https://docs.y ugabyte.com/preview/sample-data/northwind/. While we built the Arabic database for the purpose of implementing the encryption process. The proposed DTSXA encrypts the database in five options as shown:

- Table Encryption: The encryption algorithm in this option encrypts a whole table, Figures 3 and 4 shows an example of table encryption that has English and Arabic data. To encrypt the whole table, first the initial values and control parameters of the key must be entered to the DTSXA and secondly, the specified table must be selected and then click the Encryption button.
- 2. One Row Encryption: After entering the initial values and control parameter of the key, the specified table must be

9781441109422	Myrsinaceae	Real Estate Investment	SENEGAL	10/27/2014	4704	Enter KEY Value
9781441117571	Compositae	Construction & Materials	BENIN	10/25/2016	2300	0.6138587619820631 x1
9781441124395	Umbellferae	Equity Investment Instru	UNITED STATES	10/29/1992	11315	0.4065864859020624 X2
9781441128157	Leguminosae	General Financial	UNITED STATES	10/29/2004	11916	0.7542975564320686 X3 0.1213985296420658 X4
9781441132482	Compositae	Construction & Materials	UNITED STATES	10/28/1994	5906	Control Value
9781441145512	Acanthaceae	OI & Gas Producers	UNITED KINGDOM	10/27/2014	4103	2.4 a
9781441149763	Myrsinaceae	Construction & Materials	TURKEY	10/27/2015	5305	1.3 b
9781441155733	Acanthaceae	Support Services	MEXICO	10/27/2006	3502	0.4 d
9781441163073	Poaceae	Equity Investment Instru	UNITED KINGDOM	10/27/1950	2901	0.8 e
9781441183859	Annonaceae	OI & Gas Producers	UNITED STATES	10/28/1996	6507	Select table name
9781441185044	Euphorbiaceae	Equity investment instru	UNITED STATES	10/29/2004	12517	76061 V
9781441220233	Cucurbitaceae	Expansion	UNITED KINGDOM	10/19/2015	31776	Decrotion Encrotion
9781441616890	Connaraceae	New facility	SOUTH AFRICA	10/12/1966	2327	
9781444303001	Windows x64	Expansion	ETHIOPIA	1/13/2017	5640C	
9781444303223	Linux x86-64	Expansion	DENMARK	1/10/1994	23400	
			Encryp	tion		
I≠,60=q20Ý158	6.feuJÞe* "	@W#ap+16681-Set	Encryp ArR/Tvēo	tion Copal say	RáĂP	Enter KEY Value
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eé>eláic(5 10+S F 9Háš sIL/E/8o<\$ PigX'sÐUÁX®	e0b(g3453 351,F¥+x7> 1G e-3+67©R Ni~Él	g valme - Z0TI • ?c+2:4b TĐ h Từ To TH "Oayê 5i ac Tit Něc+), ść ryčin- si Ç FéáÔý µJ"_é JJ WmRá	A/N/Tvéo junk 7cçta=OéU 7Dótpf<51%25 Ayj1ASN12aU	e0bQA.8QI .786E`vPy e1D+ZI=7. X>=1-714 J+8.yE+e,	μ2KC PrüςE 10g+K KΩA41	0.6138587619820631 x1 0.4065864859020624 x2 0.7542975564320666 x3 0.1213985296420658 X4 Control Value
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eé>e331e(5 10+S F0+P88 sILUE/80 <s PgX'sDUAX® <8/m×b AFizwPLITA18</s 	e0b[g14[3 15][F¥×7> IG«-3+EF©R Nú~ÉI Mödð+SÆ +veD100à-A	9'32%-2011-?2-5'45TD h u ho3H OayE5' ae3t Nec+).deixekx- si(Cfe8OjsU1_6JJ WmR8 1a'Aze8 B1Y8mg8-6Om 8)Y8iu7-H_UFA).U314	A/N/Tvěo jupik 7cçi&©čeU 7Dočpř(d1245 Aý]1ASN%aU dÉDIU&68°q# Bp1	Фрол Вол . Убб Гуру 610+22-л Хогия 7214 јеб у Ене, Клабер 4 101:85 ж,	μ2KC ΗύςΕ Юд+4 ΚΩA4 Γ1E-a υ/Α	0.6138587619820631 x1 0.4065364859020624 x2 0.7542975564320686 x3 0.1213985296420658 x4 Control Value 2.4 a 1.3 b
eé>eláic(5 10+S F 9H48 stiluE/8ocS PgX'sDUAX* c8jm+t6 AFE:wf%LTA18 üÉáðR0E_YUm	e0bj3403 33JF¥+7> IG+3+6F@R NTEI III060+5AE +veD1008-A AbgKn®6uA	9'327-6-2011+?2-524970 h "0'1037'0392'52 acit Nee+)sénéky- si(FeäO)ju]_6JJ?WmR3 a%Aeis B1Yanjö-5Om a)róiu7-H:ÚFA;) Ú32+ mµ**SDQSI	A/N/Tvéo jack 7004264U 7006449/6 Ay1145872aU 0E01066876* 301 02-73	ФфQA 8QI . Уб65" v Руј 410 • 22 л. X5*18-714 ј • 8 уЕ+с, k*1650 4 101 Вбае, Вћ4µ7]	μ280 PrüςE NOg+4 KGA4 PE-a V/A f±141	0.6138587619820631 x1 0.4065864859020624 x2 0.7542375564320665 X3 0.1213985296420658 X4 Control Value 2.4 1.3 b 0.4 d
eéxelále(5 10 + S I 9 Háš stáluE/ Bock Pap X = BUÁX= Cláin + Tá A Filter Hurnius účála NOE _ YÚm A Di Tá YpSC Z	e00/g4/3 33/f4+7> IS=3+IS@R NU~E1 III000+SA 40gKn7060A NRA6803	9'38"#-2011;?;;?:49'10 h 'û '10:4' '0ayê'5' aelt !%c+) 66:q:83x- si(CFe8O'3);J]'_6JJ'WmR3 'a/Aeâ B1Yâng6-sôm â)?63;7-H:(DFA) (D2+ mp:*sDQ51 >65:9E('5'; YLB(Cç69	A/N/Tvéo jack 7004/2640 7006/r41/26 Ayj1A5N°260 0600468°q# 3p1 10-73 12-73 12-73	ФОрОА ВОЛ Убб6Г vPyj 410-21-Л X>-16-714 јеб уЕ-е, k-1650 4 101.85æ, Вл4µЛ 3418/46	μ28C PrúcE Ng+4 KúA4 PIE-a VA Istal SX5	0.6133587619820631 x1 0.4065864859020624 x2 0.7542375564320685 X3 0.1213985296420658 X4 Control Value a 1.3 b 0.4 d 0.8 e
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eézelász(5 10+S 79468 szüleZ/8e<5 Pgg/sgDUAX# csjin+% AFIzwit2/11/11/8 0E684N0E_VOm A DTBYpSC Z TrFCæein]Jull Illf2e8-50	e0b(g)4/5 bit/F4-7> G3+E1#R Pit-E1 mbit/0-5.4 +vcD100-A ÅogKn®64A 1#Å68/05 Titlejq 033833/154<	9'32"-6-2011-?;-2'44"DD h 'û '10-11' 0xyê5's anit fêc+) 6ê nêsw- si(FeâO'j4J]_6JJ'WmRâ 'a 'Arak B1Yânjiō-sôm â) râin7-H, ÛFA) ÛIse mju*-sDQ5I >E65E('5', YLIS(Colan âê I'n'5wKG_0?2' +58'4JS=Nyg8+4YeALE	A/fl/Tvéo juck 7ççis=ökU 7ççis=ökU 7ççis=ökU 7ççis=ökU 8 Xotis 12 X Xotis 12 X Xotis 12 X Xotis 12 X Xotis X Xotis X X X	ФОрОА ВОШ .У566 ГУРуј 430 + 21 = 11 УХ - 11 - 121 = 11 Јеб УЕ+е, К*-653 4 101 Вбае, Вћ-4µЛ У18% 5еојс80WN укђе,	и 280 7645E 109+4 17E-9 17E-9 17E-9 17E-9 15-141 16254 15574 15574 15574 15574 15574 15574 15574 15574 15574 15574 15574 15574 15575	06135587619820631 x1 04065864859020624 x2 0.7542975564320685 x3 0.1213985296420688 x4 Control Value 24 a 1.3 b 0.4 d 0.8 e Select table name table1 v
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Figure 3 Example of encryption of English whole table.

selected, then one must choose the row and click on the Encryption button. Figure 5 shows the encryption process of a certain selected row in a table.

- 3. One Column Encryption: First of all, the initial values and the control parameter of the key are entered then the specified table must be selected. Later the column number must be entered finally click on the Encryption button. Figure 6 shows an example of the column encryption process.
- 4. Encryption of Rows and Column Sequences: This option allows to encrypt a number of rows or columns. If one wants to encrypt a sequence of rows, he must select the specified table after entering the initial values and the control parameter

549325	معاون مدير حسابات	الرابعة	100	دبل	فداد	4	نهاد	على عبيد خالد جاسم
429427	امين مخزن افنم	الخامسة	دية	اعداد	-ان	- <u></u> -•	, على	فاطمة عباس هادي
459690	رليس ملاحظين	الخامسة	دية	اعداد	غداد	ų	، سعد	مر فاخر محمد جناتی
723864	رليس مبرمجين اقنم	الثانية	رس	بكالوربو	مرة	البه	لمان	مهدي كومان څالب س
443547	مترس ثالث	الخامسة	-	بكالوريو	وى	لين	ضافر	زهراء فالح عبدالله
7405676	رليس مهننسين اقتم	الثانية		بكالوريو	لیں	ديا	صالح	سری نجم قاسم ثامر
362989	ملاحظ فندى	السادسة	دية	اعداد	تبار	21	کریم	اهیم انتیم طارق جبر
296234	معاون رليس سواق	السابعة	لية	ابتداا		ų	ذياب	د يونس براهيم قاسم
329432	مهلنس اقتم	, الخامسة		بكالوربوس		ذي	, ابراهيم تحسين مجيد اكرم	
808764	رليس كيميا ويبن اقنم	الثانية	-	بكالوربو	فداد	ų	ياسر	ابراهيم لامى حسين
654632	معاون مدير	الرابعة		بكالوربو	باوة	النسو	رسن	نورا سالم شاکر
757765	منير	الثالثة		بكالوريو	انية	الذيو	, ظمد	باة مهدي مالك عريبه
774345	رليس مهنئسين اقتم	الثانية		بكالوربو	كوك	کرۂ	سهر	د محمد ابراطیم منحت
740987	منرس اقتم ثائنى	الثانية	نير	ماجست	جف	3	-	نام مصطفی <mark>محمود س</mark>
459678	مبرمج اقنم	الخامسة	-	بكالوريو	بلاء	کر	صغاء	كرار كاظم حسين
565876	معاون مدير فئى	الرابعة	نية	اعداد	بابل		وسی	بان جمعة عامر فجر م
435234	ملاحظ	السادسة	دية	اعداد	فداد	ų	حطية	حسان راضی عیسی
441543	رئيس ملاحظين فنيين	الخامسة	10	دبا		ų	هادي	سان علی سعد حسن ہ
320346	معاون رليس حرفيين	النسابعة	دية	اعداد		ų	. اكرم	سان محمود غيث محمد
45987	رليس حرفين اقنم	الخامسة	10	دېل	بغداد		الاء غازي محي سغير بحر	
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		-	E	.Tb?3ē				ùŪÿ`+₩\$Э\$0*E,
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×2,7Pp mj0G10ū	ذ0بزو فهوی XuB ² ۲. برمان XuB ² ۲. برمان Xup	مےی توسیع	ی۔۔۔ و ا	۳۵?35 ±¢حدامــَّ نا0ئرۇ.بل		ڏN¢0≎ډ آت≂او∶ويا		بیع: ۵۵۵ وک۲ تر0 ن بریند کرریز الق ق منتض لاید زمین ۱۹۰۹ مر
×2,7Pp mj1G10 Bhiþ	ذ0برو فعنی ۲۵۵۶ ۲۹۹۵ ۲۰۸۹ مرمو ۲۹۹۵ ۲۰۸۹ ۲۰۱۵ ۲۰۰۶ ۲۰۰۵ ۲۰۰۶	مرک ک ۲۰۰۳ ۲۰۰۰ ۲۰۰۶ ۲۰۰۰ ۲۰۰۰ ۲۹۹۰ (ک	۰	.7Ъ?3ē ~ ඇვ.2θύ βέν۶Й3аς		ڏNdOْ≎ آنتينونويا ≲ <u>دا</u> ا		ڹڔٵ؆٥ڴۉۅٛ؆ڮ؆ ۑٮڝڹڂ؆ڔؠڕؽڷۊؾۊ ڹڹڞڕڶٳ؉ؽ؋ڛڰڹؠڔ ڐڔؿٷؖڗڿؿػٷڿڗڰڸ
×2JPp mjDGDJ Bhijb +š%ēDD	ذن بنوز به متن ۲ متن ۲ می ۲ می ۲ می ۲ می ۲ می ۲ می ۲ می ۲ می	مرک ک ۲۰۰۳ ۲۰۰۰ ۲۰۰۶ ۲۰۰۰ ۲۰۰۰ ۲۹۹۰ (ک	۰	۲۵?36 ۲۵۵۵ ۲۵۵۵ ۲۵۵۵ ۲۵۵۶ ۲۵۵۵ ۲۵۵۵ ۲۵۵۵ ۲۵۵		¢0þИ≚ آتتندون ویا ⊡ <u>⊻</u> ≭GIAbla		ڹؚؾڮ؆٥ۮۅٛ؇ڹٷڽ ؠڝڹڂؿ؇ڔؠۯڷؾؾػ ڣڹڞڸ؉ؽؠؠ؈ڰؠؠڗ ڲٳڴڔ؇ػؠػؿؿڰ ^ۅ ؠڲۯ ۅٲڴڔ؇ػٳؿۿٵػڎۼ؊ڮۯؿ
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×2,7Pp mjtCati Bhip +š%ētD Aōet A¥ā dž∃pB	Χωσζου φ. μ. Ο. Χωσζου φ. μ. Ο. χόφω Κ. Α. Ιμαι Χ. Δ. Χωσχω Κ. Α. Ιμαι Χ. Δ. Ιμαι Χ. Ιμαι Χ. Ιμαι Χ. Ιμαι Χ. Ιμαι Δ. Ιμαι Δ. <td>م_کې ۲۹۹۵ ۲۹۹۵ ۲۰۰۹ ۲۹۹۹ ۲۹۹۹ ۲۹۹۹ ۲۹۹۹ ۲۹۹۹ ۱۹۹۹ ۲۹۹۹ ۲۹۹</td> <td></td> <td>. ۲۵۶3۵ ۲۰۵۵ کی کی کی ۲۰۵۶ ۲۰۱۵ کی ۲۰۵۶ ۲۰۱۵ کی ۲۰۵۰ کی کی ۲۰۵۵ کی ۲۰۵۵ ۲۰۵۵ کی ۲۰۵۵ کی</td> <td></td> <td>÷ОрИ≚ ۱۳۹۰ е е י≦≍ жGIAЫо иА⊊т иА⊊т</td> <td>-</td> <td>۵۵۶ میکوکی بیر تفضل یا جزیمی میر بیرینی بر بیری بیر بیری بیری بیری بیر میکو بیری میکو که بیری بیری بیری بیری بیری بیری بیری بیری</td>	م_کې ۲۹۹۵ ۲۹۹۵ ۲۰۰۹ ۲۹۹۹ ۲۹۹۹ ۲۹۹۹ ۲۹۹۹ ۲۹۹۹ ۱۹۹۹ ۲۹۹۹ ۲۹۹		. ۲۵۶3۵ ۲۰۵۵ کی کی کی ۲۰۵۶ ۲۰۱۵ کی ۲۰۵۶ ۲۰۱۵ کی ۲۰۵۰ کی کی ۲۰۵۵ کی ۲۰۵۵ ۲۰۵۵ کی ۲۰۵۵ کی		÷ОрИ≚ ۱۳۹۰ е е י≦≍ жGIAЫо иА⊊т иА⊊т	-	۵۵۶ میکوکی بیر تفضل یا جزیمی میر بیرینی بر بیری بیر بیری بیری بیری بیر میکو بیری میکو که بیری بیری بیری بیری بیری بیری بیری بیری
×2,7Pp mitClui Briip •š½ētĐ AōerA¥ā dž∃pB iLJ1B.U	Χισζιοφ.,Δ.,Ο. Χισζιοφ.,ΚΛή, μ. Χίσφ.,ΚΛή, μ. Ικίλλωδ Χ.Α.Η. μ. ·	م_ک۹ ۲۰۳۰ می ۲۰۹۰ می ۲۹۹۰ می ۱۹۹۰ می ۱۹۹۰ می ۱۹۹۰ می ۱۹۹۰ می	ی و: با الل	. 15738 స్. 238 స్. 3260 స్. 260 స్. 260 స . 260 · 260 · 260 · 260 · 260 · 27 · 260 · 27 · 260 · 27 · 260 · 27 · 260 · 27 · · 27 · 27 · 27 · 27 · 27 · 27 ·		بَ ⁵ OþИ ⁵ التبدو.ول <u>التي</u> د KGIAbla ن <u>ا</u> ب المريك المريك		۵Uy ۱-W 220 кЕң 353,Дуу 1- (2007) ۱- (2007) 1- (2007) 2- (2007) 5- (2007)
×2,7Pp mj1G30 Brhip *5%20 Ao er A%3 dz 3b B iLJ1B.U 1jL1B.U 1jL1B.U	Χισζοπφ, Δ., Ο. Χισζοπφ, Δ., Ο. Χιφωκκ.κ. Ε. JkuXJb-XÅHJ, J. ·ΩΩ)*ber -Jyέξ0"ξάCNμe? Eác/KöYběfg b ⁿ /He-Xgk.kXJ, e. Θ.j.88.kG/JK"	م_ى ى م_ى م م م م م م م م م م م م م م م م م	ـــــــــــــــــــــــــــــــــــــ			بن ObN2 محسو، وی بنی بنی بنی بر بر بر بر بر بر بر بر بر بر بر بر بر	-	۲۵۵٬۵۰۵ ۲۵۵ ۲۵٬۵۰۵ ۲۵ ۵۵۶ ۲۰۰۰ ۲۵۵ ۲۵۵ ۵۰۰۰ ۲۵۵ ۲۵۵ ۲۰۰۰ ۲۵۹ ۲۵۵ ۲۵۶ ۲۵۹ ۲۵۹ ۲۵۶ ۲۵۹ ۲۵۹ ۲۵۶ ۲۵۹ ۲۵۶ ۲۵۹ ۲۵۶ ۲۵۹ ۲۵۶ ۲۵۹ ۲۵۶ ۲۵۹ ۲۵۶ ۲۵۹ ۲۵۶ ۲۵۹ ۲۵۶ ۲۵۹ ۲۵۹ ۲۵ ۲۵۹ ۲۵ ۲۹ ۲۹ ۲۹ ۲۹ ۲۹ ۲۹ ۲۹ ۲۹ ۲۹ ۲۹
×2,JPp mjGjū Bňip *š%čiĐ Åöcī Aך džĐpB jLJIB.U jūNčaģ úŠXLĒdž	Χισξιπφ, Δ., Ο. Χισζιπφ, Δ., Ο. Χιφωκκικ, Ε. JkuXJbXAHJJJ ·ΔΩΣbCR ·ΔμέξΘ"ξάCNμος Eác\KöYběfg b [*] /bu-X ₀ K, AXJ, Θ Θ±84.κΩK [*] nFubK6Yhě/NQO2	م_ک ب ۲۹۳۳ می ۲۹۹۳ ۲۹۹۰ می ۱۹۹۳ می ۱۹۹۵ می ۲۹۹۰ می ۲۹۹۰ می ۲۹۹۰ می ۱۹۹۰ می				نگنگن محمد و به به بازی بازی بازی بازی بازی بازی بازی بازی		۵۵۶ میگوی با ۲۵ ۵۵ میلی ۲۵ میل ۲۰۱۹ میلی ۲۵ میلی ۲۰۱۹ میلی ۲۵ میلی ۲۰۱۹ میلی ۲۰۱۹ می

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Figure 4 Example of encryption of Arabic whole table.

of key, the range of rows required for encryption will be highlighted. Furthermore, one also needs to press the Encryption button. Figure 7 shows an example for encryption of Row Sequences. Encryption a sequence of columns is conducted in the same way, i.e. the number of columns to be encrypted must be specified and press the encryption button as shown in Figure 8. To encrypt a specific set of columns and rows,

9780511993053	Poaceae	Support Services	MEXICO	11/21/1960	33525 S	Enter KEY Value
9780511993145	Sapindaceae	Equity Investmen	UNITED KINGD	11/20/2000	30520 S	×1 0.6138587619820631
9780745673677	Linux x86-64	New facility	UNITED ARAB E.	1/11/1954	564003\$	x2 0.4065864859020624
9780754684206	Amarylidaceae	New facility	EGYPT	10/18/2000	26367 S	X3 0.7542975564320686
9780754689072	Bignoniaceae	New facility	AUSTRALIA	10/18/2000	25766 S	X4 0.1213985296420658
9780754694229	Rubiaceae	New facility	ITALY	10/18/1993	24564 S	Control Value a 24
9780754696988	Capparaceae	New facility	FRANCE	10/18/1994	25165 \$	b 1.3
9780754699033	Capparaceae	Expansion	BULGARIA	10/17/2006	22761 S	d 0.4
9780759112506	Rubiaceae	New facility	ITALY	10/12/2016	7135 \$	e 0.8
9780759112513	Sterculiaceae	New facility	FRANCE	10/13/2005	8337 S	Select table nam
9780759112520	Sterculiaceae	Expansion	SWEDEN	10/13/2005	8938 \$	table1
9780759112544	Sterculiaceae	Expansion	UNITED STATES	10/14/1955	10140 S	From Row .1
9780759112551	Sterculiaceae	Expansion	UNITED KINGD	10/14/1971	10741 S	to Row 120
9780759113602	Palmae	Expansion	BURKINA	10/12/2010	5933 S	120
9780759113640	Poaceae	New facility	INDIA	10/13/1993	7736 \$	Encrpti Decrpti
9780759113749	Cochlospermaceae		SOUTH AFRICA	10/12/2005	5332 S	
9780759118645 9780784471807	Cochlospermaceae Compositae	Expansion New facility	MALAWI MALAYSIA & BR	10/12/2005	4731 \$ 17352 \$	
-		-		ation		
720511993053	Poaceae	Support Services	_	_	13525 s	Enter KEY Value
	Poaceae	Support Services	MEXICO	11/21/1960	33525 \$ 30520 \$	Enter KEY Value X1 0.6138587619820631
780511993145	Poaceae Sapindaceae Linux x86-64	Equity Investmen	_	11/21/1960		
780511993145 780745673677	Sapindaceae		MEXICO UNITED KINGD	11/21/1960 11/20/2000	30520 \$	×1 0.6138587619820631
0780511993145 0780745673677 0780754684206	Sapindaceae Linux x86-64	Equity Investmen New facility	MEXICO UNITED KINGD UNITED ARAB E	11/21/1960 11/20/2000 1/11/1954	30520 \$ 564003\$	X1 0.6138587619820631 X2 0.4065864859020624
0780511993145 0780745673677 0780754684206 0780754689072	Sapindaceae Linux x86-64 Amarylidaceae	Equity Investmen New facility New facility	MEXICO UNITED KINGD UNITED ARAB E EGYPT	11/21/1960 11/20/2000 1/11/1954 10/18/2000	30520 \$ 564003\$ 26367 \$	X1 0.6138587619820631 x2 0.4065864859020624 X3 0.7542975564320686 x4 0.1213985296420658 Control Value
7780511993053 7780511993145 7780745673677 7780754684206 7780754689072 7780754694229 7780754696888	Sapindaceae Linux x86-64 Amarylidaceae Bignoniaceae	Equity Investmen New facility New facility New facility	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000	30520 \$ 564003\$ 26367 \$ 25766 \$	X1 0.6138587619820631 X2 0.4065064859020624 X3 0.7542975564320686 X4 0.1213985296420658 Control Value a 2.4
1780511993145 1780745673677 1780754684206 1780754689072 1780754694229 1780754696988	Sapindaceae Linux x86-64 Amaryllidaceae Bignoniaceae Rubiaceae	Equity Investmen New facility New facility New facility New facility	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993	30520 \$ 5640038 26367 \$ 25766 \$ 24564 \$	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.7542975564320686 X4 0.1213985296420658 Control Value a 2.4 b 1.3
780511993145 780745673677 780754684206 780754689072 780754694229 9780754696988 9780754696988	Sapindaceae Linux x86-64 Amaylidaceae Bignoniaceae Rubiaceae Capparaceae	Equity Investmen New facility New facility New facility New facility New facility	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1994	30520 s 564003s 26367 s 25766 s 24564 s 25165 s	X1 0.6138587619820631 X2 0.4065064859020624 X3 0.7542975564320686 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4
780511993145 780745673677 780754684206 780754689072 780754694229 780754699033 780754699033 780759112506	Sapindaceae Linux x85-64 Amayliidaceae Bignoniaceae Rubiaceae Capparaceae Capparaceae	Equity Investmen New facility New facility New facility New facility Expansion	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1994 10/17/2006	30520 s 564003s 26367 s 25766 s 24564 s 25165 s 225165 s 22761 s	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.7542975564320686 X4 0.1213985296420658 Control Value a 2.4 b 1.3
780511993145 7780754673677 7780754684206 7780754689072 7780754696988 7780754699033 7780759112506 7780759112513	Sapindaceae Linux x86-64 Amaylidaceae Bignoniaceae Rubiaceae Capparaceae Rubiaceae Rubiaceae	Equity Investmen New facility New facility New facility New facility Expansion New facility	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY FRANCE	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1994 10/17/2006 10/12/2016	30520 S 564003S 26367 S 25766 S 24564 S 25165 S 22761 S 7135 S	X1 0.6136587619820631 X2 0.405564859020624 X3 0.7542975564320666 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name
7780511993145 1780745673677 1780754684206 1780754689072 1780754694229 1780754699033 1780754699033 1780759112506 1780759112513 AVAEsu66Xnh	Sapindaceae Linux x86-64 Amaylidaceae Bignoniaceae Rubiaceae Capparaceae Capparaceae Rubiaceae Sterculiaceae	Equity Investmen New facility New facility New facility New facility Expansion New facility New facility New facility	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY FRANCE POSisé	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1994 10/17/2006 10/12/2016 10/13/2005	30520 s 564003s 26367 s 25766 s 24564 s 25165 s 22761 s 7135 s 8337 s	X1 0.6136587619820631 X2 0.405564859020624 X3 0.7542975564320666 X4 0.1213985296420688 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table 1
7780511993145 1780745673677 1780754684206 1780754689072 1780754694229 1780754696888 1780754699033 1780759112506 1780759112513 AVAEsubeexhh 178075911254	Sapindaceae Linux x86-64 Amarylidaceae Bignoniaceae Rubiaceae Capparaceae Capparaceae Capparaceae Rubiaceae Sterculiaceae artiti:AdiliwTA	Equity Investmen New facility New facility New facility New facility Expansion New facility New facility Qu'ac0 <nit< td=""><td>MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY FRANCE POSisé</td><td>11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1994 10/17/2006 10/12/2016 10/13/2005 6500-00</td><td>30520 s 564003s 26367 s 25766 s 24564 s 25165 s 22761 s 7135 s 8337 s 8037 v</td><td>X1 0.6136587619820631 X2 0.4065964859020624 X3 0.7542975564320665 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ↓ From Row 1</td></nit<>	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY FRANCE POSisé	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1994 10/17/2006 10/12/2016 10/13/2005 6500-00	30520 s 564003s 26367 s 25766 s 24564 s 25165 s 22761 s 7135 s 8337 s 8037 v	X1 0.6136587619820631 X2 0.4065964859020624 X3 0.7542975564320665 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ↓ From Row 1
7780511993145 7780745673677 7780754684206 7780754689072 7780754694229 7780754699033 7780759112506 7780759112513 AVAEsu56cXnh 7780759112551	Sapindaceae Linux x85-64 Amarylidaceae Bignoniaceae Rubiaceae Capparaceae Capparaceae Rubiaceae Seculiaceae Seculiaceae Seculiaceae	Equity Investmen New faolity New faolity New faolity New faolity Expansion New faolity Qu'ac0 <nit Expansion</nit 	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY FRANCE POSAÉ UNITED STATES	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1994 10/17/2006 10/12/2016 10/13/2005 63t0-tu 10/14/1955	30520 s 564003s 26367 s 25766 s 24564 s 25165 s 22761 s 7135 s 8337 s 30RVE 10140 s	X1 0.6136587619820631 X2 0.4065964859020624 X3 0.7542975564220686 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table 1
7780511993145 7780745673677 7780754684206 7780754689072 7780754694229 7780754699033 7780759112506 7780759112513 AVJ.Eu.5ex.vh 7780759112551 7780759112551	Sapindaceae Linux x85-64 Amarylidaceae Bignoniaceae Rubiaceae Capparaceae Capparaceae Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae	Equity Investmen New facility New facility New facility New facility Expansion New facility Qu'ac0 dVIII Expansion Expansion	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY FRANCE POSAÉ UNITED STATES UNITED KINGD	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1994 10/17/2006 10/12/2016 10/13/2005 58005mu 10/14/1955 10/14/1971	30520 S 564003S 26367 S 25766 S 24564 S 25165 S 22761 S 7135 S 8337 S 807V2C 10140 S 10741 S	X1 0.6136587619820631 X2 0.4065564859020624 X3 0.7542975564320666 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ↓ From Row 1 to Row 1 20
7780511993145 7780754684206 7780754689072 7780754699072 7780754699033 7780754699033 7780759112506 7780759112513 7780759112514 7780759112551 7780759112551 7780759112551	Sapindaceae Linux x85-64 Amarylidaceae Bignoniaceae Rubiaceae Capparaceae Capparaceae Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Palmae	Equity Investmen New facility New facility New facility New facility Expansion New facility Expansion Expansion Expansion Expansion	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY FRANCE POSAÉ UNITED STATES UNITED KINGD BURKINA	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/1993 10/18/1993 10/18/1994 10/17/2006 10/12/2016 10/12/2016 10/14/1955 10/14/1971 10/12/2010	30520 S 564003S 26367 S 25766 S 24564 S 25165 S 22761 S 7135 S 8337 S 30520 S 10140 S 10741 S 5933 S	X1 0.6136587619820631 X2 0.4065964859020624 X3 0.7542975564220686 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table 1 ↓ From Row _1
780511993145 7780745673677 7780756684206 7780754689072 7780754699032 7780754699033 7780754699033 7780759112506 7780759112513 7780759112551 7780759112551 7780759113602 7780759113640 7780759113640	Sapindaceae Linux x85-64 Amaylidaceae Bignoniaceae Rubiaceae Capparaceae Capparaceae Capparaceae Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Palmae Poaceae	Equity Investmen New facility New facility New facility New facility Expansion New facility Currad «NIT Expansion Expansion Expansion New facility	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY FRANCE POSAÉ UNITED STATES UNITED STATES UNITED KINGD BURKINA INDIA	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1993 10/18/1993 10/12/2016 10/12/2016 10/14/1955 10/14/1971 10/12/2010 10/13/1993	30520 S 564003S 26367 S 25766 S 24564 S 25165 S 22761 S 7135 S 8337 S 8377 S 8377 S 8377 S 10140 S 10741 S 5933 S 7736 S	X1 0.6136587619820631 X2 0.4065564859020624 X3 0.7542975564320666 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ↓ From Row 1 to Row 1 20
0780511993145 0780745673677 0780754684206 0780754689072 0780754694229	Sapindaceae Linux x86-64 Amaylidaceae Bignoniaceae Rubiaceae Capparaceae Capparaceae Rubiaceae Sterculiaceae Sterculiaceae Palmae Poaceae Cochiospernaceae	Equity Investmen New faolity New faolity New faolity New faolity Expansion New faolity Expansion Expansion Expansion New faolity Expansion	MEXICO UNITED KINGD UNITED ARAB E EGYPT AUSTRALIA ITALY FRANCE BULGARIA ITALY FRANCE PASAÉ UNITED STATES UNITED KINGD BURKINA INDIA SOUTH AFRICA MALAWI	11/21/1960 11/20/2000 1/11/1954 10/18/2000 10/18/2000 10/18/1993 10/18/1993 10/18/1994 10/17/2006 10/12/2016 10/12/2016 10/14/1955 10/14/1955 10/14/1971 10/12/2010 10/13/1993 10/12/2006	30520 S 564003S 26367 S 25766 S 24564 S 25165 S 22761 S 7135 S 8337 S 8337 S 807V/IE 10140 S 10741 S 5933 S 7736 S 5332 S	X1 0.6136587619820631 X2 0.4065564859020624 X3 0.7542975564320666 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ↓ From Row 1 to Row 1 20

Figure 5 Example of encryption of one row.

the bundle of columns and rows is selected for encryption followed by pressing the Encryption button.

5. Query Encryption: – A query is a request for data or information from a database table or combination of tables. This data

9780754699033	Capparaceae	Expansion	BULGARIA	10/17/2006	22761 \$	Enter KEY Value
780759112506	Rubiaceae	New facility	ITALY	10/12/2016	7135 S	×1 0.6138587619820631
780759112513	Sterculiaceae	New facility	FRANCE	10/13/2005	8337 s	x2 0.4065864859020624
780759112520	Sterculaceae	Expansion	SWEDEN	10/13/2005	8938 s	×3 0.7542975564320686
780759112544	Sterculiaceae	Expansion	UNITED STATES	10/14/1955	10140 S	X4 0.1213985296420658
780759112551	Sterculiaceae	Expansion	UNITED KINGD	10/14/1971	10741 \$	a 2.4
780759113602	Palmae	Expansion	BURKINA	10/12/2010	5933 s	b 1.3
780759113640	Poaceae	New facility	INDIA	10/13/1993	7736 \$	
780759113749	Cochiospermaceae	Expansion	SOUTH AFRICA	10/12/2006	5332 \$	d 0.4
780759118645	Cochlospermaceae	Expansion	MALAWI	10/12/2005	4731 \$	e 0.8
780784471807	Compositae	New facility	MALAYSIA & BR	10/16/1998	17352 \$	Select table name
780784472682	Compositae	Expansion	UNITED KINGD	10/16/1985	16751 \$	table1 ~
780786722181	Leguminosae	Personal Goods	THAILAND	10/22/2014	49205 s	From Column 6
780786724635	Leguminosae	Equity Investmen	UNITED STATES	10/23/1968	49806 s	to Column 7
780786727049	Leguminosae	Mining	UNITED STATES	10/22/2004	48604 s	
780786727506	Annonaceae	Pharmaceuticals	FRANCE	10/21/2015	47402 \$	Encrpti Decrpti
780786743681	Leguminosae		CHINA	10/21/2013	46801 \$	The second s
780786744428	Leguminosae	General Retailers	MEXICO	10/22/1996	48003 \$	
780814415146	Combretaceae	New facility	CONGO	10/14/2008	13145 \$	
780814416303	Combretaceae	New facility	GERMANY	10/14/2011	13746 S	
780814427583	Burseraceae	New facility	ITALY	10/15/2013	15549 s	
		En	cryption			
		En	cryption			
9780754699033	Capparaceae	Expansion	BULGARIA	10/17/2006	22761 \$	Enter KEY Volue
9780754699033 9780759112506	Capparaceae Rubiaceae			10/17/2006	22761 \$ £0-bR	×1 0.6138587619820631
		Expansion	BULGARIA			×1 0.6138587619820631 ×2 0.4065864859020624
9780759112506	Rubiaceae	Expansion New facility	BULGARIA ITALY	10/12/2016	£0.¢R	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.7542975564320686
9780759112506 9780759112513 9780759112520 9780759112544	Rubiaceae Sterculiaceae	Expansion New facility New facility	BULGARIA ITALY FRANCE	10/12/2016 10/13/2005	ED+bR 6P8:E ×übix ×10-1A	x1 0.6138587619820631 x2 0.4065864859020624 x3 0.7542975564320686 x4 0.1213985296420658
9780759112506 9780759112513 9780759112520	Rubiaceae Sterculiaceae Sterculiaceae	Expansion New facility New facility Expansion	BULGARIA ITALY FRANCE SWEDEN	10/12/2016 10/13/2005 10/13/2005	£0xbR eP8:E xúbix xl0- iA Þ*séFiU	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.7542975564320686
9780759112506 9780759112513 9780759112520 9780759112544	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae	Expansion New facility New facility Expansion Expansion	BULGARIA ITALY FRANCE SWEDEN UNITED STATES	10/12/2016 10/13/2005 10/13/2005 10/14/1955	ED+bR 6P8:E ×übix ×10-1A	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.7542975564320686 X4 0.1213985296420558 Control Value
9780759112506 9780759112513 9780759112520 9780759112544 9780759112551 9780759113602 9780759113640	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae	Expansion New facility New facility Expansion Expansion Expansion	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1971 10/12/2010 10/13/1993	£0xbR eP8:E xúbix xl0- iA Þ*séFiU	X1 0.6138587619620631 X2 0.4065864859020624 X3 0.754295564320686 X4 0.1213985296420658 Control Value 8 2.4
9780759112506 9780759112513 9780759112520 9780759112544 9780759112551 9780759113602 9780759113640 9780759113749	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Palmae	Expansion New facility New facility Expansion Expansion Expansion New facility	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1971 10/12/2010	E0+bR 6P8:E #0ble #10-1A P*#6F10 84	X1 0.6138567619620631 X2 0.4065864859020624 X3 0.754295564320686 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4
9780759112506 9780759112513 9780759112520 9780759112544 9780759112551 9780759113602 9780759113640	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Palmae Poaceae	Espansion New facility Espansion Espansion Espansion Espansion New facility Espansion	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1971 10/12/2010 10/13/1993	E0 +bR 698:E sùbie sùbie sùbie bhef50 8 %	X1 0.6138587619620631 X2 0.4065864859020624 X3 0.754295564320686 X4 0.1213985296420658 Control Value 0 2.4 b 1.3 d 0.4 c 0.8
9780759112506 9780759112513 9780759112520 9780759112544 9780759112551 9780759113640 9780759113640 9780759113645 9780759118645	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Palmae Poaceae Cochlospermaceae	Espansion New facility Espansion Espansion Espansion Espansion New facility Espansion	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA SOUTH AFRICA MALAWI MALAYSIA & BR	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1951 10/12/2010 10/12/2006 10/12/2005 10/16/1998	E0-6PR 698:2 NGD14 NGD14 NGC-14 P3-6F30 8 @r<35 i 611 %)phA Y342sg	X1 0.6138567619620631 X2 0.4065864859020624 X3 0.754295564320686 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 c 0.8 Select table name
9780759112506 9780759112513 9780759112520 9780759112524 9780759112551 9780759113540 9780759113640 9780759113749 9780759118645	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Palmae Poaceae Cochlospermaceae Cochlospermaceae	Epansion New facility Epansion Espansion Espansion Espansion New facility Espansion Espansion	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA SOUTH AFRICA MALAVI MALAVISIA & BR UNITED KINGD	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1951 10/12/2010 10/12/2006 10/12/2005 10/16/1998 10/16/1985	50-bR eP8:£ 	X1 0.6138587619620631 X2 0.405586435020624 X3 0.75429755643202658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1
9780759112506 9780759112513 9780759112520 9780759112544 9780759112551 9780759113640 9780759113640 9780759113645 9780759118645	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Palmae Poaceae Cochiospermaceae Compostae	Espansion New facility Hew facility Espansion Espansion Espansion Espansion Espansion Espansion Espansion	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA SOUTH AFRICA MALAWI MALAYSIA & BR	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1951 10/12/2010 10/12/2006 10/12/2005 10/16/1998	E0-6PR 698:2 NGD14 NGD14 NGC-14 P3-6F30 8 @r<35 i 611 %)phA Y342sg	X1 0.6138587619620631 X2 0.4055864359020624 X3 0.7542975564320685 X4 0.21398529642058 Control Value a 2.4 b 1.3 d 0.4 c 0.8 Select table name table1
9780759112506 9780759112513 9780759112520 9780759112544 9780759112551 9780759113640 9780759113640 9780759113645 9780784471807 9780784472682	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Paimae Poaceae Cochiospemaceae Cochiospemaceae Compostae	Espansion New facility Espansion Espansion Espansion New facility Espansion New facility Espansion	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA SOUTH AFRICA MALAVI MALAVISIA & BR UNITED KINGD	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1951 10/12/2010 10/12/2006 10/12/2005 10/16/1998 10/16/1985	50-bR eP8:£ 	X1 0.6138587619620631 X2 0.405586435020624 X3 0.75429755643202658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1
9780759112506 9780759112513 9780759112520 9780759112524 9780759113630 9780759113640 9780759113645 9780759113645 9780784471807 9780784472682 9780786722181	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Patmae Poaceae Cochospemaceae Cochospemaceae Cochospemaceae Cochospemaceae Compostae Compostae	Espansion New facility Espansion Espansion Espansion New facility Espansion New facility Espansion New facility Espansion Personal Goods	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA SOUTH AFRICA MALAYSIA & BR UNITED KINGD THAILAND	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1957 10/12/2010 10/12/2006 10/12/2005 10/16/1998 10/16/1985 10/22/2014	50-6-R eP8:E #dbis #31-54 b=4F10 # # # # * 5-jbh4 Y2#'sg RubR.ý & #K38D~;	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.754297564320686 X4 0.1213985296420580 Control Value 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ~ From Column 6 to Column 7
9780759112506 9780759112513 9780759112520 9780759112521 9780759112551 9780759113602 9780759113640 9780759113645 978078471807 978078472822 978078472822	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Paimae Poaceae Cochiospemaceae Cochiospemaceae Compostae Compostae Leguninosae Leguninosae	Espansion New facility Espansion Espansion Espansion Espansion New facility Espansion New facility Espansion New facility Espansion Personal Goods Equity Investmen.	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINDD. BURKINA INDIA SOUTH AFRICA MALAYSIA & BR. UNITED KINDD. THAILAND UNITED STATES	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1951 10/12/2006 10/12/2005 10/12/2005 10/16/1983 10/16/1985 10/22/2014 10/22/1968	20-bR 408:2 wdbis sit)- sk b%45/0 si 40°-c5 ia13 ia13 ia13 ia15 ia13 ia15 ia	X1 0.6138597619020631 X2 0.4055864359020624 X3 0.7542975564320685 X4 0.213985296420658 Control Value a 2.4 b 1.3 d 0.4 c 0.8 Select table name table1
9780759112506 9780759112513 9780759112520 9780759112544 9780759112545 9780759113502 9780759113602 9780759113640 9780759113645 9780784471807 9780784471807 9780784272811 9780786724635 9780786724049	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Painae Painae Poaceae Cochlospemaceae Cochlospemaceae Compositae Leguninosae Leguninosae	Espansion New facility Espansion Espansion Espansion Espansion New facility Espansion New facility Espansion Personal Goods Equity Investmen. Mining	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA SOUTH AFRICA MALAYSIA & BR UNITED KINGD THAILAND UNITED STATES UNITED STATES	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1971 10/12/2010 10/12/2010 10/12/2005 10/16/1985 10/16/1985 10/22/2014 10/22/2014	50-6R 40-68 40-82 40-54 40-54 54 54 54 54 54 54 54 54 54	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.754297564320686 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ~ From Column 6 to Column 7
9780759112506 9780759112513 9780759112520 9780759112524 9780759112521 9780759113502 9780759113640 9780759113640 9780759113640 978078672118 9780786722181 9780786722181 9780786722163 97807867221649	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Sterculiaceae Painae Painae Poaceae Cochlospemaceae Compostae Compostae Leguninosae Leguninosae Leguninosae	Espansion New facility Espansion Espansion Espansion Espansion New facility Espansion New facility Espansion Personal Goods Equity Investmen. Mining	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD. BURKINA INDIA SOUTH ARICA MALAWI MALAYSIA & BR. UNITED KINGD. THAILAND UNITED STATES UNITED STATES FRANCE	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1971 10/12/2010 10/12/2010 10/12/2005 10/12/2005 10/12/2005 10/12/2014 10/23/1968 10/22/2014 10/22/2014	50-bR 698:2 wbbs xl3-sA 94-650 8 6*-c5 1a17 4-jbhA 194-159 RubRý AubRý AubRý 1957	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.754297564320686 X4 0.1213985296420580 Control Value 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ~ From Column 6 to Column 7
9780759112506 9780759112513 9780759112520 9780759112524 9780759112551 9780759113600 9780759113640 9780759113640 9780759113645 978078672181 9780786722181 9780786724635 9780786724635 9780786727049 9780786727049	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Palmae Palmae Poaceae Cochlospermaceae Conpositae Compositae Leguninosae Leguninosae Leguninosae Leguninosae	Espansion New facility Espansion Espansion Espansion Espansion Espansion Espansion Espansion New facility Espansion New facility Espansion Personal Goods Equity Investmen. Mining Pharmaceuticals	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA SOUTH AFRICA MALAYSIA & BR UNITED KINGD THAILAND UNITED STATES UNITED STATES FRANCE CHINA	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1951 10/12/2010 10/12/2010 10/12/2005 10/12/2005 10/12/2005 10/12/2014 10/22/2014 10/22/2014 10/22/2014 10/22/2014 10/22/2014	50-6-R e90:£ wbbix x10- x4 91- x4 91- x4 91- x4 91- x5 10- x5	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.754297564320686 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ~ From Column 6 to Column 7
9780759112506 9780759112513 9780759112520 9780759112551 9780759112551 9780759113640 9780759113640 9780759113640 9780759113645 978078471807 978078471807 978078472822 978078672445 9780786724049 97807867243881 9780786744428	Rubiaceae Sterculiaceae Sterculiaceae Sterculiaceae Paimae Poaceae Cochospemaceae Cochospemaceae Cochospemaceae Cochospemaceae Cochospemaceae Cochospemaceae Compostae Leguninosae Leguninosae Leguninosae Leguninosae Leguninosae	Espansion New facility Espansion Espansion Espansion Espansion New facility Espansion New facility Espansion New facility Espansion New facility Espansion Mening Pharmaceuticals General Retailers	BULGARIA ITALY FRANCE SWEDEN UNITED STATES UNITED KINGD BURKINA INDIA SOUTH AFRICA MALAYI MALAYIA & BR UNITED KINGD THAILAND UNITED STATES CHINA MEXICO	10/12/2016 10/13/2005 10/13/2005 10/14/1955 10/14/1951 10/12/2010 10/12/2005 10/12/2005 10/12/2005 10/16/1988 10/22/2014 10/22/1968 10/22/2004 10/22/2004 10/21/2015 10/21/2013 10/22/1996	ED-6-R eP0:E wdbis	X1 0.6138587619820631 X2 0.4065864859020624 X3 0.754297564320686 X4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table name table1 ~ From Column 6 to Column 7

Figure 6 Example encryption one column.

may be generated as results returned by Structured Query Language (SQL), pictorials, graphs or complex results. Figure 9 illustrates the encryption method of query yield. The process begin from the blue field of "New Query" followed by typing query SQL instruction.

80275998974	Celastraceae	Expansion	INDIA	1/30/2001	42020 \$	Enter KEY Value
80275999391	Celastraceae	Expansion	THAILAND	1/30/2001	42621 S	×1 0.6138587619820631
80313012136	Leguminosae	Expansion	UNITED STATES	10/11/2013	1726 \$	x2 0.4065864859020624
80313014055	Euphorbiaceae	New facility	UNITED KINGD	1/6/2014	51636 \$	×3 0.7542975564320686
80313014086	Compositae	New facility	UNITED KINGD	1/6/2015	52237 S	×4 0.1213985296420658
80313014482	Bombacaceae	Expansion	CENTRAL AFRI	1/3/1979	41419 \$	Control Value
80313017292	Rutaceae	Expansion	SOUTH AFRICA	10/10/2007	61853 s	b 1.3
30313017391	Verbenaceae	Expansion	UNITED KINGD	10/11/2012	1125 \$	d 0.4
30313021893	Cannabinaceae	Expansion	UNITED KINGD	1/25/2017	31202 S	e 0.8
30313038334	Rutaceae	Expansion	GERMANY	10/1/2004	58247 S	
30313038570	Polygalaceae	New facility	BAHRAIN	1/29/1985	38414 S	Select table name
30313038662	Cyperaceae	Expansion	IRAQ	1/29/1962	37212 5	
30313038853	Amaranthaceae	New facility	SPAIN	1/31/2006	45025 S	From Row 7 to Row 16
30313039119	Verbenaceae	New facility		10/11/2006	524 S	to How 16
30313043109	Amaranthaceae	New facility	BARBADOS	1/31/2002	44424 S	Encrpti Decrpti
30313049477	Sapindaceae	Expansion		1/28/2015	35409 s	
80313052286	Menispermaceae	Expansion	LIBYA	1/9/2012	55843 s	
80313052989	Rubiaceae	Expansion		1/8/2007	54641 S	
80313053337	Cucurbitaceae	Expansion		10/1/1998	57646 S	
			Encryption	L		
070075000074			Encryption			Fotor KEY Value
9780275998974	Celastraceae	Expansion	Encryption	1/30/2001	42020 S	Enter KEY Volue
9780275999391	Celastraceae	Expansion	INDIA THAILAND	1/30/2001 1/30/2001	42020 S 42621 S	Enter KEY Value X1 0.6138597619820631 x2 0.4065564859020624
9780275999391 9780313012136	Celastraceae Leguminosae	Expansion Expansion	INDIA THAILAND UNITED STATES	1/30/2001 1/30/2001 10/11/2013	42020 S 42621 S 1726 S	×1 0.6138587619820631
9780275999391 9780313012136 9780313014055	Celastraceae Leguminosae Euphorbiaceae	Expansion Expansion New facility	Encryption INDIA THAILAND UNITED STATES UNITED KINGD	1/30/2001 1/30/2001 10/11/2013 1/6/2014	42020 5 42621 s 1726 5 51636 s	×1 0.6138587619820631 ×2 0.4065864859020624
9780275999391 9780313012136 9780313014055 9780313014086	Celastraceae Leguminosae Euphorbiaceae Compositae	Expansion Expansion New facility New facility	INDIA THAILAND UNITED STATES UNITED KINGD UNITED KINGD	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015	42020 S 42621 S 1726 S 51636 S 52237 S	X1 0.6133587619820631 x2 0.4065864859020624 X3 0.7542978564320686 X4 0.1213935296420658 Control Value
9780275999391 9780313012136 9780313014055 9780313014086 9780313014482	Celastraceae Leguminosae Euphorbiaceae Compositae Bombacaceae	Expansion Expansion New facility New facility Expansion	INDIA THAILAND UNITED STATES UNITED KINGD UNITED KINGD CENTRAL AFRI	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979	42020 5 42621 5 1726 5 51636 5 52237 5 41419 5	X1 0.6138597619820631 x2 0.4065864859020624 X3 0.7542975564320666 X4 0.1213985296420558 Control Value a 2.4
9780275999391 9780313012136 9780313014055 9780313014086 9780313014482 9780313017292	Celastraceae Leguminosae Euphorbiaceae Compostae Bombacaceae Rutaceae	Expansion Expansion New facility New facility Expansion Expansion	Encryption INDIA THAILAND UNITED STATES UNITED KINGD. UNITED KINGD. CENTRAL AFRI. SOUTH AFRICA	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007	42020 \$ 42621 \$ 1726 \$ 51636 \$ 52237 \$ 41419 \$ 61853 \$	X1 0.6133587619820631 x2 0.4065864859020624 X3 0.7542978564320686 X4 0.1213935296420658 Control Value
9780275999391 9780313012136 9780313014055 9780313014086 9780313014482 9780313017292 'A1:ru?0/+aEft	Celastraceae Leguminosae Euphorbiaceae Compostae Bombacaceae Rutaceae PoxO+h1UQó	Expansion Expansion New facility New facility Expansion Expansion O.O.(T)pa	Encryption INDIA THALAND UNITED STATES UNITED KINGO CENTRAL AFRI SOUTH AFRICA @~III'0107-ESD	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 dpå*0	42020 s 42621 s 1726 s 51636 s 5227 s 41419 s 61853 s Ý Êr	X1 0.6138597619820631 x2 0.4065864859020624 X3 0.7542975564320666 X4 0.1213985296420558 Control Value a 2.4
9780275999391 9780313012136 9780313014055 9780313014086 9780313014482 9780313014482 9780313017292 'A1:ru?0/+aEM ô/2+D-"enr	Celastraceae Leguminosae Euphorbiaceae Compostae Bombacaceae Rutaceae PbxO+AEUqó A-3,13[O_córg	Expansion Expansion New facility Expansion Expansion OJO(T)aa u°q#sIIgUØ	Encryption INDIA THALAND UNITED STATES UNITED KINGD. UNITED KINGD. CENTRAL AFRI. SOUTH AFRICA @-III'010'-ÆSD 18bqt\aN-	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 dpá*0 EÉITHÚJ#Ó	42020 5 42621 5 51636 5 52237 5 41419 5 61853 5 Ý Ê ÆEA*E:1	X1 0.6138597619820631 x2 0.4065864859020624 X3 0.7542975564320686 X4 0.12192526420650 Control Value a 2.4 b 1.3
9780275999391 9780313012136 9780313014055 9780313014086 9780313014482 9780313017492 'Å1:"u?0/+aE*fl ô/3+Đ-" anr flÅ->773#'UEIN	Celastraceae Leguminosae Euphorbiaceae Compostae Bombacaceae Rutaceae PbxO=A1EUqó A-5,13[O_cóng JG15E	Expansion Expansion New facility Expansion Expansion O.O, T Dáã U°C#allgUØ á*Ss°n/.	Encryption INDIA THAILAND UNITED STATES UNITED KINGD. UNITED KINGD. CENTRAL AFRI. SOUTH AFRICA @~III"0.10%ESD 188bqt:&N~ V=b00/gh	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 de&T0 EÉ:ITH0]@O IG762E#P	42020 S 42621 S 51636 S 52237 S 41419 S 61833 S Ý Ê ÆΕΑΝΣΞΙ ΣύδυΨο,	X1 0.6138597619820631 x2 0.4065864859020624 X3 0.7542975564320666 X4 0.121395526420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8
9780275999391 9780313012136 9780313014055 9780313014056 9780313014482 9780313017292 "A11"u"?0/+aE" 0/7+D-" anr #A+::?73#'UEIN u-e6@ElüÜÜF	Celastraceae Leguminosse Euphorbiaceae Compostae Bombacaceae Rutaceae Phyto-ntil/cpt A-3; 30, drg JGtbE É14,6,£Q.®@16	Expansion Expansion New facility New facility Expansion Expansion OxO,T() Dia Urc#atgU0 ArSx*n/. AQI*bCIV	Encryption INDIA THAILAND UNITED STATES UNITED KINGD. UNITED KINGD. CENTRAL AFRI. SOUTH AFRICA @-mr010%ESD 138bqt3N- Veb2r/dh Ses(@~8	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 dpáľ0 EÉITHÚJ#O K3/02EP doj M>60	42020 5 42621 5 1726 5 51636 5 52237 5 41419 5 51853 5 Y Ê #E4521 £úšolúa, 00%TA	X1 0.6138597619820631 x2 0.4065864859020624 X3 0.7542975564320666 X4 0.121395526420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8
9780275999391 9780313012136 9780313014055 9780313014086 9780313014482 9780313014282 *Å1;"u?0/+aE*[] 0;%=D:"-arr t[Å-::??3#"UEIN u-&0;0E1;UUT E1;4A01Åy02;bE	Celastracceae Leguminosae Euphorbiacceae Compostae Bombacceae Putacceae Φ ₂ x0-h1Uq0 A-3/3D/córg JS1FE E14 6-60®0/6 UhtEDyUD:	Expansion Expansion New facility Expansion Expansion O/O/TJaa O/O/TJaa O/O/TJaa O/O/TJaa O/O/TJaa O/O/TJaa O/O/TJaa O/O/TJaa	Encryption INDIA THALAND UNITED STATES UNITED KINGD. CENTRAL AFRI. SOUTH AFRICA @~III'010%ESD 188bqt:AN + V=b01/ph Sas{@~3 III)S	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 dp4*0 EÉITH0J900 G?62E#P d6JMx60 f0vie@UO	42020 S 42621 S 1726 S 51636 S 52237 S 5141419 S 61853 S Ý Ê ÆEA* <u>E23</u> ÉÚBÓU 60°*7AJ 0080Y	X1 0.6138597619820631 X2 0.405556859020624 X3 0.7542975564320656 X4 0.121398529424058 Control Value 0.24 b 1.3 d 0.4 e 0.8 Select table name
9780275999391 9780313012136 9780313014055 9780313014086 9780313014482 9780313017292 'A1::	Celastraceae Leguminosae Euphotbiaceae Compositae Bombaceae Putaceae Putaceae	Expansion Expansion New facility New facility Expansion Expansion Expansion C/O,T[bå 0'C;#5:IgU0 a'Ss"n/. A;(I"bCIN OGåJISF: OR?oT)=ö <w< td=""><td>Encryption INDIA THAILAND UNITED STATES UNITED KINGD UNITED KINGD CENTRAL AFRI SOUTH AFRICA @~III'01/07-KESD 1880ct/8N V-b607/ch Sest(@~2) 105 ~00o1</td><td>1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 dpå*0 EEITH()#0 dj%*60 Adj%*60 Adj%*60 Adj%*60 dj% dj% dj% dj% dj% dj% dj% dj% dj% dj%</td><td>42020 S 42621 S 51636 S 52237 S 41419 S 61553 S Ý Ê ÆEA*E:: Eúőuüa, OU*T;AJ OOSOY «-riz®y</td><td>X1 0.6138597619820631 X2 0.4065584559020624 X3 0.7542975564320686 X4 0.1213385259420658 Control Value a 2.4 b 1.3 d 0.4 0.8 Select table name table 1</td></w<>	Encryption INDIA THAILAND UNITED STATES UNITED KINGD UNITED KINGD CENTRAL AFRI SOUTH AFRICA @~III'01/07-KESD 1880ct/8N V-b607/ch Sest(@~2) 105 ~00o1	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 dpå*0 EEITH()#0 dj%*60 Adj%*60 Adj%*60 Adj%*60 dj% dj% dj% dj% dj% dj% dj% dj% dj% dj%	42020 S 42621 S 51636 S 52237 S 41419 S 61553 S Ý Ê ÆEA*E:: Eúőuüa, OU*T;AJ OOSOY «-riz®y	X1 0.6138597619820631 X2 0.4065584559020624 X3 0.7542975564320686 X4 0.1213385259420658 Control Value a 2.4 b 1.3 d 0.4 0.8 Select table name table 1
9780275999391 9780313012136 9780313014055 9780313014055 9780313014482 9780313014482 7415°u?0/+aE*I o/%+D- ⁻ anr EÅ-×773#UEIN u=606EU007 WE1460F4025E WE1460F4025E WE1460F4025E	Celastraceae Leguminosae Euphotkaceae Compositae Bombacaceae Pax0-h3Uq0 A-5,13D46 SthE E14 6-6Q#0/0 UtateSy00 céch00Up-w.EP C#4L03	Expansion Expansion New facility New facility Expansion Expansion Expansion Ch0,Tb83 u°c#stg00 a*5 = "n". AQ1*bCN OGa185: OR?aTb>300	Encryption INDIA THAILAND UNITED STATES UNITED KINGD. CENTRAL AFRIL SOUTH AFRICA @-III'010'#ESD 138bq:2AN+ V-b60/ch 505 ~00o1 T#W00/CE	1/30/2001 1/30/2001 10/11/2013 1/6/2015 1/3/1979 10/10/2007 dp&*0 EEITH0}e0 16/362EP doj M>60 fo/xe2000 \$*0186bo0 36NA;	42020 5 42521 5 51535 5 52237 5 41419 5 51533 5 ¥ Ê ÆEA*523 50500, 00%TA 0080Y «-712®v 008a-G	X1 0.6138597619820631 X2 0.4055864859020624 X3 0.754297564320666 X. 0.131952594420558 Cortrol Value a 2.4 b 1.3 d 0.4 c 0.8 Select table name table1
9780275999391 9780313012136 9780313014055 9780313014086 9780313014086 978031301482 7401720/+6E ^{II} 0/J+D anr EÅ-3<773#UEIN a-600EL0U0T E1440LÅy0236E E1440LÅy0236 E1440LÅy0236 JUEINGE2 p_ JÚEINE ALS	Celastraceae Leguminosae Euphorbiaceae Compostae Bombacaeae Putaceae Pax0-h1Uq0 A-8,12026ng J31FE E14.660%/00 UtacE0y001 Lé±0000/b-w:EP CR6±03 é±0300 é±0300	Expansion Expansion New facility New facility Expansion Expansion O/O/(T)ää dirc#s1gU0 ä*5="n/. AQII-bct# OGäuISE OG3uISE OG3uISE OG3uISE OG3uISE AAd=y2ZA®	Encryption INDIA THAILAND UNITED STATES UNITED KINGD CENTRAL AFRI SOUTH AFRICA CENTRAL AFRI SOUTH AFRICA SOUTH AFRICA.	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 dp&'0 EEITH()#0 K3/02EP doj M>69 K3/02EP doj M>69 S'01B6boO S'01B6boO S'01B6boO	42020 S 42621 S 51636 S 52237 S 41419 S 51833 S Ý Ê ÆEA*E::1 Eù6uÜ4, OU*E:A1 OO800 0 c800 0 c8000 0 c8000 0 c8000 0 c8000 0 c8000 0 c8000 0 0 c8000 0 0 c800	X1 0.6138597619820631 X2 0.4055864859020624 X3 0.754297564320666 X. 0.131952594420558 Cortrol Value a 2.4 b 1.3 d 0.4 c 0.8 Select table name table1
9780275999391 9780313012136 9780313014055 9780313014085 9780313014082 9780313014282 9780313017292 'ATL'02'0-48 ⁻¹ 6/3-0 ⁻ arr 6/3-0 ⁻ arr 6/3-0 ⁻ arr 6/3-0 ⁻ arr 6/3-2 ⁻ arr 6/3- ⁻ ar	Celastraceae Leguminosae Exphorbiaceae Compositae Bombacaceae Putaceae Pax0-h3Ugó Ad, 1302,drg Sta1PE E14 6AC#016 UttE5y001 cle-L000,m.EP Qm4ic03 é-L000,m.ED Qm4ic03 é-L000, Qm4	Expansion Expansion New facility New facility Expansion Expansion COUT[bit drops]QU	Encryption INDIA INDIA IHAILAND UNITED STATES UNITED KINGD. UNITED KINGD. UNITED KINGD. CENTRAL AFRI SOUTH AFRICA @-III'010%ED 138bqt3AV- V=b50/ch 5x5(@^3 II) F#wi0i/cE LI6A// a68xp.465j:@?a2Av	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 ds4'0 EEITH0J#00 K3/55EP 86j/M>60 K3/55EP 86j/M>60 S'0186boO S'0186	42020 S 42621 S 51536 S 52237 S 41419 S 61853 S Ý Ê ÆEA*ELI EÚGUÍA, OD*EAL ODSOY «~FLE®v ODSA-G 4®****	X1 0.6130507619820631 X2 0.4055544359020624 X3 0.7542975564320658 Control Value a [24] b].3 d 0.4 e [0.8 Select table name table 1 ~ From Row 7 to Row 16
9780275999391 9780313012136 9780313014055 9780313014086 9780313014086 978031301482 7401720/+6E ^{II} 0/J+D anr EÅ-3<773#UEIN a-600EL0U0T E1440LÅy0236E E1440LÅy0236 E1440LÅy0236 JUEINGE2 p_ JÚEINE ALS	Celastraceae Leguminosae Euphorbiaceae Compostae Bombacaeae Putaceae Pax0-h1Uq0 A-8,12026ng J31FE E14.660%/00 UtacE0y001 Lé±0000/b-w:EP CR6±03 é±0300 é±0300	Expansion Expansion New facility New facility Expansion Expansion COUT[bit drops]QU	Encryption INDIA THAILAND UNITED STATES UNITED KINGD. CENTRAL AFRI SOUTH AFRICA. @~III'010'#ED 135b0:3N+ V+b50'ch Se\${@~8 II05 ^00e3 T#woid <e <="" el64µ="" td=""><td>1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 dp4/0 EÉITH0J900 G3/62E#P d6JMx60 AGM26200 5/0186be0 38NA/ UDA/454M4 V É Y1888 1/9/2012</td><td>42020 S 42621 S 51636 S 52237 S 41419 S 51833 S Ý Ê ÆEA*E::1 Eù6uÜ4, OU*E:A1 OO800 0 c800 0 c8000 0 c8000 0 c8000 0 c8000 0 c8000 0 c8000 0 0 c8000 0 0 c800</td><td>X1 0.6130507619820631 X2 0.4055544359020624 X3 0.7542975564320658 Control Value a [24] b].3 d 0.4 e [0.8 Select table name table 1 ~ From Row 7 to Row 16</td></e>	1/30/2001 1/30/2001 10/11/2013 1/6/2014 1/6/2015 1/3/1979 10/10/2007 dp4/0 EÉITH0J900 G3/62E#P d6JMx60 AGM26200 5/0186be0 38NA/ UDA/454M4 V É Y1888 1/9/2012	42020 S 42621 S 51636 S 52237 S 41419 S 51833 S Ý Ê ÆEA*E::1 Eù6uÜ4, OU*E:A1 OO800 0 c800 0 c8000 0 c8000 0 c8000 0 c8000 0 c8000 0 c8000 0 0 c8000 0 0 c800	X1 0.6130507619820631 X2 0.4055544359020624 X3 0.7542975564320658 Control Value a [24] b].3 d 0.4 e [0.8 Select table name table 1 ~ From Row 7 to Row 16

Figure 7 Example encryption of row sequences.

6 Performance Analysis of the Proposed DTSXA

The results of the proposed DTSXA were analyzed through a number of statistical and security tests to sure its performance.

6.1 Brute Force Attack Analyses

Any system can get good resistance to the brute-force attack by making its key space sufficient big (i.e. as a rule, the main space has a key space lower than 2^{128} is not reasonable to be secure enough), otherwise in a limited period

9780275999391	Celastraceae	Expansion	THAILAND	1/30/2001	42621 \$	×1 0.6138587619820631
9780313012136	Leguminosae	Expansion	UNITED STATES	10/11/2013	1726 \$	X2 0.4065864859020624
9780313014055	Euphorbiaceae	New facility	UNITED KINGD	1/6/2014	51636 S	X3 0.7542975564320686
9780313014086	Compositae	New facility	UNITED KINGD	1/6/2015	52237 S	X4 0.1213985296420658
9780313014482	Bombacaceae	Expansion	CENTRAL AFRI	1/3/1979	41419 \$	Control Value
9780313017292	Rutaceae	Expansion	SOUTH AFRICA	10/10/2007	61853 S	a 24
9780313017391	Verbenaceae	Expansion	UNITED KINGD	10/11/2012	1125 \$	b 1.3
9780313021893	Cannabinaceae	Expansion	UNITED KINGD	1/25/2017	31202 S	d 0.4
9780313038334	Rutaceae	Expansion	GERMANY	10/1/2004	58247 \$	e 0.8
9780313038570	Polygalaceae	New facility	BAHRAIN	1/29/1985	38414 \$	Select table na
9780313038662	Cyperaceae	Expansion	IRAQ	1/29/1962	37212 \$	table1 v
9780313038853	Amaranthaceae	New facility	SPAIN	1/31/2006	45025 \$	From Column 2
9780313038855	Verbenaceae	New facility	DENMARK	10/11/2006	40020 S	to Column 6
9780313039119	Amaranthaceae	New facility	BARBADOS	1/31/2002	44424 5	-
9780313043103			UNITED STATES	1/28/2015	35409 \$	Encrpti Decrpt
9780313049477	Sapindaceae	Expansion	LIBYA	1/28/2015	35409 S	
	Menispermaceae	Expansion	LIBYA	1/9/2012	55843 5	
		Lansac.200	A DE LONGER DE LONGER DE	10.000	F 10 10 1	
9780313052989	Rubiaceae Cucurbitaceae	Expansion Expansion	UNITED KINGD FRANCE	1/8/2007 10/1/1998 yption	54641 S 57646 S	
9780313052989		1000000000	FRANCE	10/1/1998		
9780313052989 9780313053337		1000000000	FRANCE	10/1/1998		X1 0.6138587619820631
9780313052989 9780313053337 9780275999391	Cucurbitaceae	Expansion	FRANCE	10/1/1998 vption	57646 S	X1 0.6138587619820631 x2 0.4055864859020624
9780313052989 9780313053337	Cucurbitaceae ÝlAs)71i)Wi	Expansion	FRANCE Encry sëA8ZA	10/1/1998 yption ÆEelidi	57646 S 42621 S	x2 0.4065864859020624 x3 0.7542975564320686
9780313052989 9780313053337 9780275999391 9780275999391 9780213012136	Cucurbitaceae ÝlAa)71i)Wi IIIIé čá b°w	Expansion TýDÝ(rÉÉ Tý@É?Æ1)	FRANCE Encry sëA8ZA (te=1E01A]=*	10/1/1998 yption ÆEelidi Úl5y2?8K	57646 S 42621 S 1726 S	x2 0.4065864859020624 x3 0.7542975564320686 x4 0.1213985296420658
9780313052989 9780313053337 9780275999391 9780313012136 9780313014055 9780313014055	Cucurbitaceae ÝľAa)711JWI IIIIeřőä b 'w iüolgi 10 EHIII	Expansion TyDY#EE Ty@E?#1 TetyVazeMO,	FRANCE Encr 98Å8ZA (E=1E0)Å]=* 00258D3EEZg1	10/1/1998 yption ÆE&Idi ÚI5iy278K Ê¿OŬîli -6jûl	57646 5 42621 5 1726 5 51636 5	x2 0.4065864859020624 x3 0.7542975564320686
9780313052989 9780313053337 9780275999391 9780275999391 9780313012136 9780313014055	Cucurbitaceae YTAa)711[W] IIIIe čā b 'w iüalqi 10 EHIII RA1ú@#YaL	Expansion 	FRANCE ##A82A @#A82A @#_B82A @#	10/1/1998 yption /EE&Idi UI5\y2?8K E¿OUi1i +8jill	57646 \$ 42621 \$ 1726 \$ 51636 \$ 52237 \$	x2 0.4055864859020624 x3 0.7542975564320686 x4 0.1213885296420658 Control Value a 2.4
9780313052989 9780313053337 9780373053337 9780275999391 9780313012136 9780313014055 9780313014086 9780313014482	Cucurbtaceae Yi/Aa)711/W/ IIIIei õä b.'w Iüolq/10EHIII NA1ü@FYaL VSPNvr4S1	Epansion "yDY%EE "y@E?/E"; Tey/AzeIMO; as60z0.qbB/E- ú-as";2?M~1	FRANCE Energy séÁ8ZA (É=:E0)Á =* O0)I5AD&E22g1 IIq0IP40)E0 Éh8@.dÉJNuT'L.	10/1/1998 xption x Ecellol UISy278K E¿OUili +őjül 4//SJBL	57646 S 42621 S 1726 S 51636 S 52237 S 41413 S	x2 0.4055864859020624 x3 0.7542975564320686 x4 0.1213985296420658 Control Value a 2.4 b 1.3
9780313052989 9780313053337 4780275999391 4780313012136 4780313014055 4780313014065 4780313014482 4780313014482	Cucurbtaceae Y(Aa)711(W) IIII:63.b1% Wolq110EHIII NA1W@8YaL YsSNW4651 (kE14ig	Epansion "yDY6/EE "y@E?/E1 16/y/Aze3MO, ae8/02/0pB/E- 0-ae*/22M~1 En**~<0+*	FRANCE Encr: séÁSZA (É= ±E0/Å =* O0154D&ɱZg] In61940.E8 Èh8Ф.dENva1*1. mÁ921:u=*Å.	10/1/1998 xption <i>k</i> E64(d) UI5/y278K <i>E</i> 2/UI10 -6yill 4/sjBl, -3/sjBl, -3/sjBl, -3/sjBl,	57645 \$ 42621 \$ 1726 \$ 51636 \$ 52237 \$ 41419 \$ 61853 \$	x2 0.4055864859020624 x3 0.7542975564320686 x4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4
9780313052989 9780313053337 9780275999391 9780313012136 9780313014055 9780313014086 9780313014482 9780313014292 9780313017292	Cucurbitaceae Y(Aa)711(W) IIIIei öä b.*w iiuoloj 10EHIII RA10@9YaL %EN4jo Ja*~eA<®ld(II	Eppansion "yDY6EE "y@E?/E"] Iéy/AzéIMO, æ60/20(pB.Æ- ùcat"27M") Enf*~c0+* NNO'3+O	FRANCE Encr séASZA (É=:E004]=* O015508EE2g1 Ing03940E6i EhsΦ.dENva1*1. mAS21:u='A. .s.*_P05*sR	10/1/1998 xption <i>k</i> E641d1 UI55/278K <i>E</i> 2/0111 -6jil 4//5]81, -3/6 ⁺ «P4 [Daym]:	57646 S 42621 S 1726 S 51636 S 52237 S 41419 S 61853 S 1125 S	x2 0.4065864859020624 x3 0.7542975564320686 x4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8
9780313052989 9780313053337 9780313053337 9780275999391 9780313012136 9780313012136 9780313014065 9780313014065 9780313014065 9780313014065 9780313017891 9780313017891	Cucurbitaceae YIAa)7110W IIIIe 63.b1w iiuelg10EHIII RA10@9YaL VS9NvRe51 kE14ig µ=~A<®Id(I) c*CIIA51x8;wov	Epansion "yDY6EE "y@E?/E"] Tey/AzelMO, ae80/20(pBJE- 0:e8*27M*1 En**e:0+* NNO'3+O e8Chimh8	FRANCE Encr séASZA (É=:E004]=* O015508E:E2g1 IIq03540)E60 EhsΦ.dENva1*1. mA92%u=*A .*_P05%B 78s1=D0g40	10/1/1998 xption xEE41d1 UI51y278K Ê¿OŬi11 +ôjál 4X/SJB1, -sôjál 4X/SJB1, -sôjál Qagm1: xEÇR/P(ú	57645 \$ 42621 \$ 1726 \$ 51636 \$ 52237 \$ 41419 \$ 61853 \$ 1125 \$ 31202 \$	x2 0.4065864859020624 x3 0.7542975564320686 x4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table nor
9780313052889 9780313053337 9780313053337 9780275999391 9780313012136 9780313012136 9780313014065 9780313014065 9780313014065 9780313014065 9780313017391 9780313017391	Cucurbitaceae Y(Aa)71()W/ IIIIe čá b tv iüelg(10EHIII RA10@97aL tv591vr451 k/E14ig µ*~A<®(d()) c*C(2A97x8;wcv 7)Eep '{	Epansion "yOY6EE "y@E?/E"] Tey/AzelMO, ae80/20(pBJE- 0:e8*27M*3 En**e:0+* NNO'3+O e8Chimhă Ç@8 wEE	FRANCE Encr seAS2A (E=:E004]=* O015508EE2g1 IIq03540/E60 EhsΦ.dENva1*1. mA92%u=*A .*_P05*sR 78sI=J0gµO n/#1546	10/1/1998 #E6/(d) UISy278K E2/D'III -6jil 3//3[B], -7,0,6° «R4 [Dami: E(C)?(t) 5/1/22 d)	57646 \$ 42621 \$ 1726 \$ 51636 \$ 52237 \$ 41419 \$ 61853 \$ 1125 \$ 31202 \$ 58247 \$	x2 0.4065864859020624 x3 0.7542975564320686 x4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table non table1
9780313052989 9780313053337 9780275999391 9780275999391 9780313012136 978031301245 978031301482 978031301292 978031301292 978031302893 978031303834 978031303834	Cucurbitaceae Y(Aa)71()W(IIIIe 63.b 1w iiiiafa10EHIII RA10@974L 1%976v4651 &E14ig µ~~A<®Id(II c*CILA91%9;wov 7/Eep 1 Y34@w%Ea	Epansion "yOY6EE "y@E2/E1 16/vAz63MO, es60/20(pB/E- 0-es62/20/m1 Enf*-e0-* NNO'a-O es6Chimhá C@6 IsEE où -oVfY	FRANCE Ener; seA82A (fc=:E004]=* O015508EE2g1 IIq53F40)E64 Eh8Φ.qE3N43T1. mA92%u=*A .s_b051zR ?dsII=l0gu0 n#1516 3dfy8;	10/1/1998 #E6/(d) UISy278K E2/0010 6jil 10/278K E2/0710 6jil 10/278K E2/0710 6jil 10/278K E2/0710 6jil 10/278K E2/0710 6jil 10/278K E2/0710 6 78K 	57646 \$ 42621 \$ 1726 \$ 51636 \$ 52237 \$ 41419 \$ 61853 \$ 1125 \$ 31202 \$ 58247 \$ 38414 \$	x2 0.4055864859020624 x3 0.7542975564320686 x4 0.1213985296420658 Control Value a a 2.4 b 1.3 d 0.4 e 0.8 Select table non table1 ~ From Column 2
9780313052989 9780313052387 9780313053337 9780275999391 9780275999391 9780313012186 9780313012186 9780313014065 9780313014065 9780313014065 978031301405 978031301289 978031302893	Cucurbitaceae Yifa)71()W IIIIé ö3 b.'w iüolg/10EHIII ÑA1ú@97vaL 'v@9%@97vaL i%E4ig III'~aA<@Id(II c?CIIA9%@xwcv 7Eep?{ Y33@m%Ea \$706#%Cx	Epansion "yDY6EE "y@E7.E; T6Y-Va48MO, ex8/12/0408.F: 0xe8"27M"3 Enf*c0+* NNO'3+O e8Ch3mh3 C@8 teEE e0 -eVffY J6A6cIII	FRANCE Encry séASZA (E=.E0JA]+* OOIISSUBÉEZgJ IIQSIH/0.E6) EhS%_dÉINHIT*L mA921:u=*A ;s_PDS*R 768II-109µO n/*1516 3dly%;]&*A	10/1/1998 #Eelidi UIS9278K EgOUiti -óyil 34/3(8), -oyil 34/3(8), -oyil 200ml: #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #GR #G	57646 5 42621 5 1726 5 51636 5 52237 5 41419 5 61853 5 1125 5 31202 5 58247 5 38414 5 37212 5	x2 0.4065864859020624 x3 0.7542975564320686 x4 0.1213985296420658 Control Value a 2.4 b 1.3 d 0.4 e 0.8 Select table non table1

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Figure 8 Example encryption of columns sequences.

of time, it will be discovered by somewhat long inspection to obtain the secret key [13, 14]. In this encryption system, the key space is constructed from the initial and control values that are needed for generating the key (CKNG). These parameters are double point number (x_1, x_2, x_3, x_4) and have precision of 10^{-16} . Therefore, the present work has a final key space of 2^{213} . A well prepared database encryption program must have a powerful resistance to different kinds of attacks like brute-force attack and statistical attack. So the security of the proposed DTSXA is analyzed through a number of tests include brute force attack analysis, key sensitivity, statistical attack

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Figure 9 Example of query encryption.

analysis, differential attack analysis, information entropy analysis and mean square error.

6.2 Statistical Attack Analyses

1. Histogram Analysis: – For optimal database encryption, no characteristic distribution mode must be shown on the cipher text histogram. In other words, the cipher text letters must be distributed in an equal way for the total span of the ASCII codes. The cipher crypto-analysis uses the

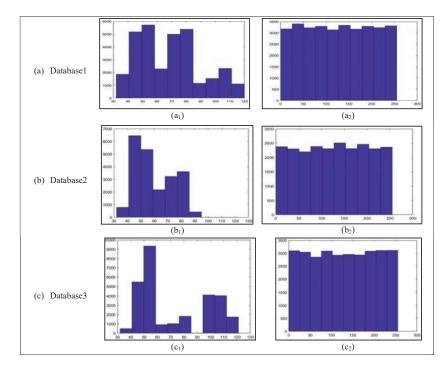


Figure 10 Histogram analysis of the English language. (a_1) , (b_1) and (c_1) histograms of plain table that were chosen randomly. (a_2) , (b_2) and (c_2) corresponding histograms of cipher table.

histograms gauges to look at the distribution of letters and/or symbols of cipher text and plain-text. We have used various databases in Arabic and English language. Each database contains several types of data like (text, Number, Date) with different sizes of data.

Figure 10 shows the histogram of separate databases in English language that were chosen randomly. Figure 11 shows the histogram of several databases in Arabic language that were also chosen randomly. For example, in Figures 10.a₁ and 11.a₁, one can see that high peaks start at (40 - 60, 70 - 85). While at the lower peaks, differences are also observed. On other the hand, the cipher texts have nearly uniform character distributions.

2. Correlation Coefficient Analysis: – Correlation test is useful to know how to specify the strength of the linear relationship between two sequences. The ways for investigating the correlation of the strings are given below [13, 15]:

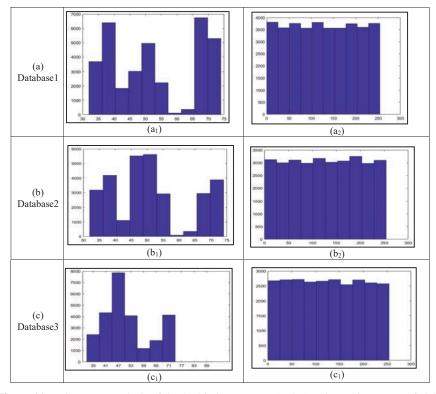


Figure 11 Histogram analysis of the Arabic language. (a_1) , (b_1) and (c_1) histograms of plain table that were chosen randomly. (a_2) , (b_2) and (c_2) corresponding histograms of cipher table.

• **Pearson's Correlation Coefficient**: The test aims to examine the presence of a relevance that links the sequences in the generated pseudo-random numbers by measuring the Pearson correlation coefficients of every string sequences of the pair. If the chosen pair are: str1 = [x1...,xn] and str2 = [y1...,yn] then:

$$(str1, str2) = \frac{\sum_{i=1}^{n} (x_i - x)(y_i - y)}{\sqrt{\left[\sum_{i=1}^{n} (x_i - \overline{x})^2\right]\left[\sum_{i=1}^{n} (y_i - \overline{y})^2\right]}}$$
(5)
Where $\overline{x} = \sum_{i=1}^{n} \frac{x_i}{n}$ and $\overline{y} = \sum_{i=1}^{n} \frac{y_i}{n}$

• Hamming Distance: the test aims to find the difference between two binary strings having same size. Here, hamming distance calculates

Database	Pearson's correlation Value	Hamming Distance Value
English database1	-0.0113	0.9961
English database2	-0.0079	0.9958
English database3	0.0150	0.9964
Arabic database1	0.0118	0.9961
Arabic database2	-0.0016	0.9960
Arabic database3	-0.0012	0.9960
	English database1 English database2 English database3 Arabic database1 Arabic database2	English database1-0.0113English database2-0.0079English database30.0150Arabic database10.0118Arabic database2-0.0016

 Table 1
 Results of correlation analysis between plain table and cipher table

the numbers of sites that the string bits are different, for example, the number of places containing (0) and that containing (1). It is given by Equation (6) where the series involves the strings (String S1) and (String S2):

$$d(S_1, S_2) = \sum_{j=0}^{m-1} (X_j y_j)$$
(6)

The correlation coefficients between the original table and encrypted table, for different tables of different data types, were taken and the results are shown in Table 1. The original tables use databases in English and Arabic. The encrypted database shows that the correlation coefficients approach zero and so the correlation is nearly trivial. These correlation analyses prove that all algorithms correspond to zero correlation and so the attacker could never get any significant information by employing a statistical contravention.

6.3 Information Entropy Analysis

Entropy is the rate at which information is produced by a stochastic source of data. To build a perfect encryption system, the entropy of enciphered data of a table approaches the optimal state is required, and can be calculated according to the equation [13, 15, 16]: –

$$H(m) = \sum_{i=1}^{2^{n-1}} \left(p \log \frac{1}{p(m_i)} \right)$$
(7)

Here, n is the count of bits that given by (m_i) where $m_i \in m$. p (mi) is the probability of m_i and log () is a logarithm of base 2, therefore the equation outcome will be in bits. For an actual random source producing 2n symbols, the entropy will equal to (n). Table 2 shows the entropy of diverse Arabic and English databases where all values having an entropy close to the ideal value.

Table 2	Inf	ormation entropy ana	lysis result of cipher table	e
		Data Base	Entropy Value	
	1	English database1	8	
	2	English database2	8	
	3	English database3	8	
	4	Arabic database1	7.9	
	5	Arabic database2	7.9	
	6	Arabic database3	7.9	

6.4 Key Sensitivity Analyses

A simple change in the key will be selected to evaluate the system sensitivity of the proposed encryption system. The procedure will be done for ten different databases that were first encrypted using the encryption key based on the following initial values:

$$\begin{split} X_1 &= 0.613858761982063\textbf{1}, \ X_2 &= 0.406586485902062\textbf{4}, \\ X_3 &= 0.754297556432068\textbf{6}, \ X_4 &= 0.121398529642065\textbf{8}. \end{split}$$

After that, the database will be encrypted using the encryption key with a minimal change. The change is only for the number of rank of 16 and the other fifteen numbers remain unchanged, i.e.:

$$\begin{split} \mathbf{X}_1 &= 0.6138587619820632, \ \mathbf{X}_2 &= 0.4065864859020625, \\ \mathbf{X}_3 &= 0.7542975564320687, \ \mathbf{X}_4 &= 0.1213985296420659 \end{split}$$

Pearson's correlation coefficient and Hamming distance are calculated between two encrypted databases where they are encrypted using two slightly different key values. Table 3 illustrates the results of the Pearson's correlation coefficient and hamming distance which indicate that the correlation is very small despite the slight change in the basis of key values. This means that the proposed algorithm is sensitive to the secret key and it has the ability to resist mass attack.

6.5 Differential Attack Analysis

It exhibits the effect of variation in the input on the variation in the output. It is a try to get the decryption key using a simple variation in the input. Here, the large enough output variation, the more difficult for an attacker to find the decryption key [13–15]. A reliable cipher system must distribute the effect of

 Table 3
 Results of the sensitivity of the key between the cipher tables (Cipher1 table and Cipher2 table) which encrypted with slightly different keys

	/ JI	6 1	
	Database	Pearson's Correlation Value	Hamming Distance Value
1	English database1	0.0230	0.9851
2	English database2	0.0089	0.9882
3	English database3	-0.0071	0.9936
4	Arabic database1	0.0302	0.9574
5	Arabic database2	0.0129	0.9960
6	Arabic database3	0.0139	0.9959

 Table 4
 Results of differential attack analysis (SAD test) between the Cipher1 table and Cipher2 table

	Data Base	SAD Value
1	English database1	0.329829817
2	English database2	0.331284375
3	English database3	0.274028125
4	Arabic database1	0.2745255208
5	Arabic database2	0.324802734
6	Arabic database3	0.330626171

a single plaintext character on the maximum possible portion of the cipher text. This property makes the statistical entity of the plaintext does not be observed easily and in turn avoids the known-plaintext attack and the chosenplaintext attack. That implies, if a little chance in the plaintext table can bring about a huge change in the cipher-table, regarding diffusion and confusion, so the differential attack really no longer has its effectiveness and becomes reasonably pointless.

The differential attack is analyzed by calculating the sum of the absolute difference (SAD) between each pair of encrypted databases. The SAD is determined using the following equation [14–16]:

$$SAD(F, F') = \frac{1}{N} \sum_{j=1}^{N} \left(\frac{|F - F'|}{2^8} \right)$$
 (8)

Where F and F' are two encrypted databases with the same length N. Through the change of one character in the data of the table, the SAD test is calculated. The result of SAD is shown in Table 4. Since the sum of absolute difference is so approaching the ideal value of 1/3. So, the results on various databases in Arabic and English demonstrate that the proposed system has a high efficiency of resistance to differential attack.

	Data Base	MSE Value in dB
1	English database1	46.96
2	English database2	47.15
3	English database3	48.24
4	Arabic database1	47.09
5	Arabic database2	45.65
6	Arabic database3	47.18

 Table 5
 Results of MSE for six different databases between plain table and Cipher table

One can observe that SAD value is different for each used database. This variation relates to the initial values that have an important effect on the chaotic map, control parameters, and content of the database where their correlation is another reason for such variation.

6.6 Mean Square Error (MSE)

(MSE) is a statistical method to evaluate a hidden quantity. It calculates the mean of the errors upped to power 2. The error here is the difference between the observed and predicted values. MSE is a risk function, compatible with the expected value of the squared error loss [17, 18]. The encrypted text should have a significant difference with the plain text. This difference is measured by the mean square error function as in Equation (8):

$$MSE = \frac{1}{mn} \sum_{i=0}^{n-1} \sum_{j=0}^{m-1} \|f(i-j) - g(i-j)\|^2$$
(9)

Where f is the original database table of length m and g the encrypted table of length n. if the MSE value ≥ 30 dB, quality variation between the plain and cipher databases is clear. Table 5 shows the MSE for six encrypted databases where all values are close to the ideal value so we can conclude that the difference between cipher and plain data table is evident.

6.7 The Time Complexity for Encryption and Decryption Algorithms

A very important metric for the measurement of encryption algorithms where the Time complexity is the number of operations an algorithm performs to accomplish its task (taking into account that each operation takes the same amount of time). The most efficient algorithm is the one that performs tasks within the smallest number of operations. However, the complexity of time is also influenced by factors such as the operating system and hardware, but we will not include them in this discussion.

Let us consider a table of N rows and M columns, then the complexity of the encryption algorithm will be considered based on the complexity of the three steps which are Preprocessing step, the Key generation step, and the Encryption step. The complexity of Preprocessing step is O(1). The complexity of the Key generation step can be calculated first for one iteration which is O(64) and for N rows will be O(64N). The complexity of the Encryption step consists of the complexity of the transposition method and substitution method. The transposition method complexity for a row data of size N is O(N), but the complexity for M rows in a table will be O(N³). A table's substitution method will also be O(N³). The whole encryption complexity of a table of N rows and M columns is O(1) + O(64N) + O(N³) + O(N³) = O(1) + O(N) + O(N³).

7 Conclusion

In this study paper, a database encryption method was designed depending on a chaotic two-dimensional functions. The chaotic encryption operations lead to enhance two properties (diffusion and confusion) which produce highly secure algorithm. The whole test results proved that high security through its resistance to the different attacks. The proposed database encryption can be applied to any type of database administration language such as SQL Server or Microsoft Access and any size of data. The proposed work treats Arabic language, which suffers from large lacks in cryptographic techniques, as well as dealing with English language. Besides that, DTSXA algorithm can treat individual rows or columns that make it more applicable for diverse users and diverse organizations. Hence the proposed algorithm has high strength and efficiency in database encryption.

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References

- P. Singh and K. Kaur, "Database security using encryption," 2015 International Conference on Futuristic Trends on Computational Analysis and Knowledge Management (ABLAZE), 2015, pp. 353–358, DOI: 10.1109/ABLAZE.2015.7155019.
- [2] J J. S. Teh, M. Alawida, and Y. C. Sii, "Implementation and practical problems of chaos-based cryptography revisited," Journal of Information Security and Applications, 2020, vol. 50, no. 102421, pp. 102421, DOI: 10.1016/j.jisa.2019.102421.
- [3] X.-H. Wu and X.-J. Ming, "Research of the Database Encryption Technique Based on Hybrid Cryptography," 2010 International Symposium on Computational Intelligence and Design, 2010, pp. 68–71, DOI: 10.1109/ISCID.2010.105.
- [4] Manivannan and R. Sujarani, "Light weight and secure database encryption using TSFS algorithm," 2010 Second International conference on Computing, Communication and Networking Technologies, 2010, pp. 1–7, DOI: 10.1109/ICCCNT.2010.5591778.
- [5] S. M. Darwish, A. A. El-Zoghabi, and M. A. Abdewi, "Database encryption using fuzzy chaotic," International Journal of Future Computer and Communication, 2014, vol. 3, no. 6, pp. 436–443, DOI: 10.7763/IJFC C.2014.V3.343.
- [6] V. V. Galushka, A. R. Aydinyan, O. L. Tsvetkova, V. A. Fathi, and D. V. Fathi, "System of end-to-end symmetric database encryption," Journal of Physics: Conference Series, 2018, vol. 1015, p. 042003, DOI: 10.108 8/1742-6596/1015/4/042003.
- [7] R. N. AL-Zubaidy and E. Al-Bahrani, "New Key Generation Algorithm based on Dynamical Chaotic Substitution Box," 2018 Al-Mansour International Conference on New Trends in Computing, Communication, and Information Technology (NTCCIT), 2018, pp. 93–98, DOI: 10.1109/NTCCIT.2018.8681187.
- [8] A. A. Maryoosh, "A new block cipher algorithm for image encryption based on chaotic system and S-Box", International Journal of Civil Engineering and Technology, 2018, vol. 9, no. 13, pp. 318–327.
- [9] M. H. P. Ranmuthugala and C. Gamage, "Chaos theory based cryptography in digital image distribution," in 2010 International Conference on Advances in ICT for Emerging Regions (ICTer), 2010, pp. 32–39, DOI: 10.1109/ICTER.2010.5643275.
- [10] F. Chen, K.-W. Wong, X. Liao, and T. Xiang, "Period distribution of generalized discrete Arnold cat map," Theoretical Computer Science,

vol. 552, pp. 13–25, 2014, DOI: https://doi.org/10.1016/j.tcs.2014.08. 002.

- [11] X. Jin, Y. Chen, S. Ge, K. Zhang, X. Li, Y. Li, Y. Liu, K. Guo, Y. Tian, G. Zhao, X. Zhang, and Z. Wang, Color Image Encryption in CIE L*a*b* Space, International Conference on Applications and Techniques in Information Security (ATIS), 2015, vol. 557, pp. 74–85, DOI: https://doi.org/10.1007/978-3-662-48683-2_8.
- [12] N. H. Ghayad and E. A. Albahrani, "A combination of two-dimensional hénon map and two-dimensional rational map as key number generator," in 2019 First International Conference of Computer and Applied Sciences (CAS), 2019 pp. 107–112, DOI: 10.1109/CAS47993.2019.90 75731.
- [13] Albahrani, A. A. Maryoosh, and S. H. Lafta, "Block image encryption based on modified playfair and chaotic system," Journal of Information Security and Applications, 2020, vol. 51, no. 102445, pp. 1–9, DOI: https://doi.org/10.1016/j.jisa.2019.102445.
- [14] K. A. Hussein, S. A. Mahmood, and M. A. Abbass, "A new permutationsubstitution scheme based on Henon chaotic map for image encryption," in 2019 2nd Scientific Conference of Computer Sciences (SCCS), 2019, pp. 63–68, DOI: 10.1109/SCCS.2019.8852590.
- [15] S. Mahmood and M. S. M. Rahim, "Novel method for image security system based on improved SCAN method and pixel rotation technique," Journal of Information Security and Applications, 2018, vol. 42, pp. 57–70, DOI: https://doi.org/10.1016/j.jisa.2018.08.001.
- [16] Albahrani and R. N. Kadhum, "A New Cipher Based on Feistel Structure and Chaotic Maps", Baghdad Science Journal, 2019, vol. 16, no. 1, pp. 270–280, DOI: https://doi.org/10.21123/bsj.2019.16.1(Suppl.). 0270.
- [17] B. Norouzi, S. M. Seyedzadeh, S. Mirzakuchaki, and M. R. Mosavi, "A novel image encryption based on hash function with only two-round diffusion process," Multimedia Systems, 2014, vol. 20, no. 1, pp. 45–64, DOI: https://doi.org/10.1007/s00530-013-0314-4.
- [18] B. D. Parameshachari, Kiran, P. Rashmi, M. C. Supriya, Rajashekarappa, H. T. Panduranga, "Controlled partial image encryption based on LSIC and chaotic map," in Proceedings of the 3rd International Conference on Cryptography, Security and Privacy – ICCSP '19, 2019, pp. 60–63, DOI: https://doi.org/10.1145/3309074.3309107.
- [19] J. Xu, B. Zhao, and Z. Wu, "Research on color image encryption algorithm based on bit-plane and Chen chaotic system," Entropy (Basel), 2022, vol. 24, no. 2, p. 186, DOI: 10.3390/e24020186.

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