

Lai, Shih-Kung

Article

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Journal of Urban Management

Provided in Cooperation with:

Chinese Association of Urban Management (CAUM), Taipei

Suggested Citation: Lai, Shih-Kung (2022) : A rule-based interpretation of the I Ching: Editorial, Journal of Urban Management, ISSN 2226-5856, Elsevier, Amsterdam, Vol. 11, Iss. 4, pp. 407-411,
<https://doi.org/10.1016/j.jum.2022.11.001>

This Version is available at:

<https://hdl.handle.net/10419/271476>

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Editorial

A rule-based interpretation of the I Ching



1. Introduction

The I Ching is one of the earliest sources of Chinese philosophy and has been extensively studied for a long time. However, its relationship to science is still unknown and, thus, the I Ching is regarded as mysterious. There is a need to reinterpret the I Ching in a modern way. Thus, I argue that the 64 hexagrams in the I Ching are a binary system and can be related to the elementary cellular automata (Lai, 2019). In this formulation, a hexagram, or *gua*, corresponds to four of the 256 rules in the elementary cellular automata, and I call this hybrid binary relationship *Complex I*. However, no regularity was found in this formulation as the space-time plots of the four transition rules for each *gua* were not consistent. In this paper, I will demonstrate that these four rules show regularity when each of the 64 *guas* in the I Ching are transformed algorithmically into four of the 256 transition rules in the elementary cellular automata using the cyclic number 142857 (Goldstein, 2013). In other words, the I Ching can be interpreted by classifying the 256 transition rules in the elementary cellular automata into 64 groups, with each group corresponding to a *gua* in the I Ching. The usefulness of this transformation is demonstrated using a linear city model as an example. However, much remains to be explored. Section 2 introduces the binary systems of the I Ching and the elementary cellular automata, Section 3 demonstrates how these two binary systems are related to each other, Section 4 discusses the application of Complex I in a linear city model, and Section 5 concludes the paper.

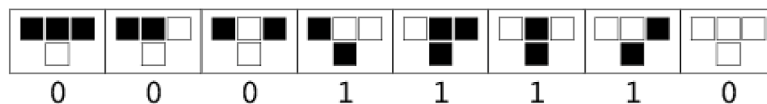
2. Two binary systems

2.1. Binary system 1: the I Ching

There are 64 *guas* in Binary System 1, the I Ching, each of which comprises six *yao*s. Each *yao* can be either *yin* or *yang*, or zero or one in binary terms. For example, the Qian (乾) *gua* has six yangs (111111), whereas the Kun (坤) *gua* has six yins (000000). Thus, the 64 *guas* can be represented as a binary system (see Table 1).

2.2. Binary system 2: the elementary cellular automata

In the elementary cellular automata, there are 256 transition rules, each of which is composed of eight triplets (Wolfram, 2002). For example, Rule 30 is represented as follows:



The black cells have a value of one, while the white cells indicate a value of zero. Thus, Rule 30 can be coded as 00011110, and all other transition rules can be constructed in a similar way.

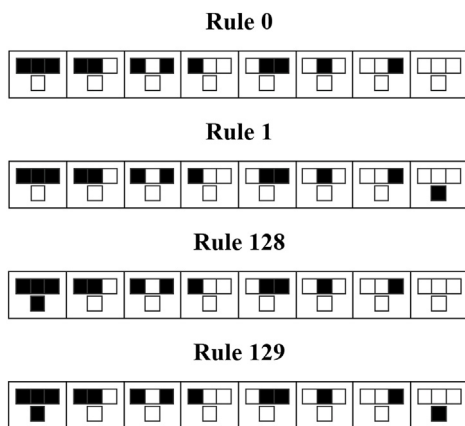
<https://doi.org/10.1016/j.jum.2022.11.001>

Table 1
The classification of the 256 rules in 1-D CA in relation to the 64 hexagrams.

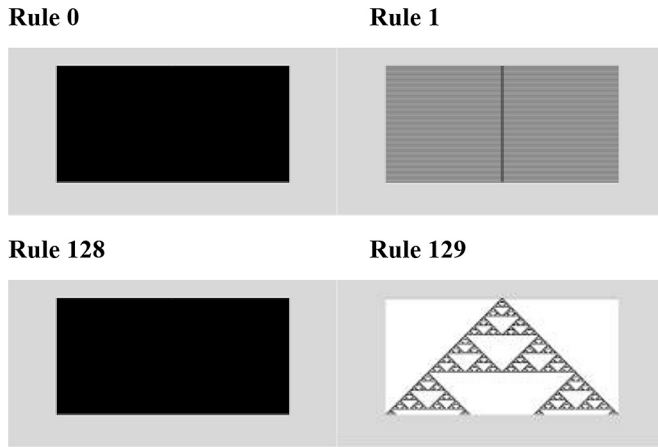
Qian	乾	111111	255, 223, 251, 219	Dun	遯	001111	111, 79, 107, 75
Kun	坤	000000	36, 4, 32, 0	Dazhuang	大壯	111100	245, 213, 241, 209
Tun	屯	100010	172, 140,168,136	Jin	晉	000101	39, 7, 35, 3
Meng	蒙	010001	54, 22, 50, 18	Mingyi	明夷	101000	228, 196, 224, 192
Xu	需	111010	252, 220, 248, 216	Jiaren	家人	101011	238, 206, 234, 202
Song	訟	010111	63, 31, 59, 27	Kui	睽	110101	183, 151, 179, 147
Shi	師	010000	52, 20, 48, 16	Jian	蹇	001010	108, 76, 104, 72
Bi	比	000010	44, 12, 40, 8	Jie	解	010100	53, 21, 49, 17
Xiaoxu	小畜	111011	254, 222, 250, 218	Sun	損	110001	182, 150, 178, 146
Lu	履	110111	191, 159, 187, 155	Yi	益	100011	174, 142, 170, 138
Tai	泰	111000	244, 212, 240, 208	Guai	夬	111110	253, 221, 249, 217
Pi	否	000111	47, 15, 43, 11	Gou	姤	011111	127, 95, 123, 91
Tonghrehn	同人	101111	239, 207, 235, 203	Cui	萃	000110	45, 13, 41, 9
Dayou	大有	111101	247, 215, 243, 211	Sheng	升	011000	116, 84, 112, 80
Qian	謙	001000	100, 68, 96, 64	Kun	困	010110	61, 29, 57, 25
Yu	豫	000100	37, 5, 33, 1	Jing	井	011010	124, 92, 120, 88
Sui	隨	100110	173, 141, 169, 137	Ge	革	101110	237, 205, 233, 201
Gu	蠱	011001	118, 86, 114, 82	Ding	鼎	011101	119, 87, 115, 83
Lin	臨	110000	180, 148, 176, 144	Zhen	震	100100	165, 133, 161, 129
Guan	觀	000011	46, 14, 42, 10	Gen	艮	001001	102, 70, 98, 66
Shihe	噬嗑	100101	167, 135, 163, 131	Jian	漸	001011	110, 78, 106, 74
Bi	賁	101001	230, 198, 226, 194	Guimei	歸妹	110100	181, 149, 177, 145
Bo	剝	000001	38, 6, 34, 2	Feng	豐	101100	229, 197, 225, 193
Fu	復	100000	164, 132, 160, 128	Lu	旅	001101	103, 71, 99, 67
Wuwang	無妄	100111	175, 143, 171, 139	Xun	巽	011011	126, 94, 122, 90
Daxu	大畜	111001	246,214, 242, 210	Dui	兌	110110	189, 157, 185,153
Yi	頤	100001	166, 134, 162, 130	Huan	渙	010011	62, 30, 58, 26
Daguo	大過	011110	125, 93, 121, 89	Jie	節	110010	188, 156, 184, 152
Kan	坎	010010	60, 28, 56, 24	Zhongfu	中孚	110011	190, 158, 186, 154
Li	離	101101	231, 199, 227, 195	Xiaoguo	小過	001100	101, 69, 97, 65
Xian	咸	001110	109, 77, 105, 73	Jiji	既濟	101010	236, 204, 232, 200
Heng	恆	011100	117, 85, 113, 81	Weiji	未濟	010101	55, 23, 51, 19

3. The relationship between the two binary systems

One way to relate guas to transition rules is to use the six central binary digits in a transition rule that correspond to a particular gua so that each gua corresponds to four transition rules (Lai, 2019). For example, the Kun (坤) gua corresponds to transition rules 0, 1, 128, and 129 as follows:



However, as shown below, the space-time plots of the four transition rules show no relationship to each other. In this example, a black cell represents zero, while a white cell indicates one.



A different relationship exists between the 64 guas and the 256 transition rules when the cyclic number 142857 is used. The order of the primordial eight trigrams, or *xian tian ba gua*, in the I Ching is 111 (乾), 110 (兌), 101 (離), 100 (震), 011 (巽), 010 (坎), 001 (艮), and 000 (坤), which is consistent with the eight triplets of the elementary cellular automata shown in Section 2.2. Herein, the cyclic number 142857 is assumed to represent the positions of the six yaos of a gua in relation to the primordial eight trigrams. The hexagram Kun (坤) is 000000 in binary form, as shown in the first two rows below. Thus, rearranging the six yaos' sequence according to the cyclic number 142857 results in the possible transition rules in the elementary cellular automata demonstrated in the bottom two rows below:

```

0 0 0 0 0 0
1 4 2 8 5 7
↓
0 0 x 0 0 x 0 0
1 2 3 4 5 6 7 8
    
```

The numbers greater than zero denote the positions of the yaos or rules, and the two x's in the third row stand for the unknown values for positions 3 and 6, which are absent in the cyclic number 142857. Thus, there are four possible combinations of transition rules for the hexagram Kun (坤):

```

0 0 1 0 0 1 0 0 (36)
0 0 0 0 0 1 0 0 (4)
0 0 1 0 0 0 0 0 (32)
0 0 0 0 0 0 0 0 (0)
    
```

Therefore, the Kun (坤) gua corresponds to the four transition rules that are specified in the parentheses based on the cyclic number transformation. The space-time plots of these four transition rules are shown below. It is immediately clear that the patterns for the four space-time plots are similar. Table 1 shows the relationship between the 64 guas and the 256 transition rules according to the transformational algorithm provided above. A closer examination of the space-time plots demonstrates that the four space-time plots included in each gua bear some similarity, which is evidence of the regularity derived from the provided transformational algorithm.

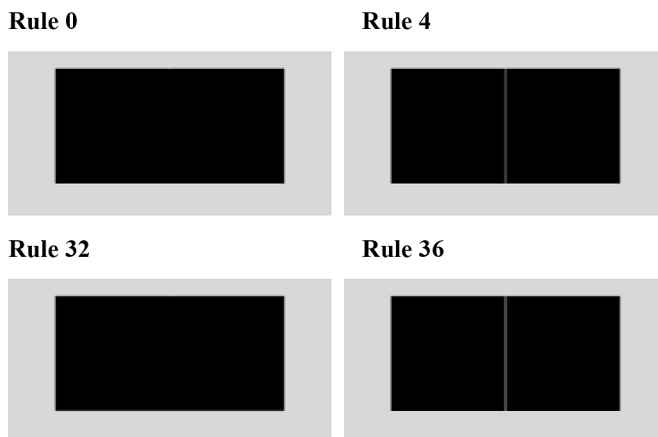


Table 2
The eight transition rules that are semi-lattices and result in Class 4 structures.

Rule Number	111	110	101	100	011	010	001	000
9	0	0	0	0	1	0	0	1
41	0	0	1	0	1	0	0	1
65	0	1	0	0	0	0	0	1
97	0	1	1	0	0	0	0	1
107	0	1	1	0	1	0	1	1
111	0	1	1	0	1	1	1	1
121	0	1	1	1	1	0	0	1
125	0	1	1	1	1	1	0	1

Table 3
The characteristic transition rule for semi-lattices with complex structures.

States of Surrounding Cells	State of Cell under Consideration	
	Live Cell (1)	Dead Cell (0)
Two Live Cells	Dead	¼ Chances of Being Dead
One Live and One Dead Cells	¼ Chances of Being Live	¼ Chances of Being Dead
Two Dead Cells	¼ Chances of Being Live	Live

4. Application

I have demonstrated that the elementary cellular automata can be used to model the linear city in my arguments for spontaneous order within cities (Lai, 2021). In particular, each of the 256 transition rules represents a space-time plot of the linear city in which each cell denotes a parcel of land that can be used in one of two ways: residential (0) or commercial (1). Based on the automata theory, each rule corresponds to a unique deterministic finite automaton (DFA) derived from a non-deterministic finite automaton, and the graph of a DFA can be classified into tree, semi-lattice, or other structures. Thus, the 256 transition rules can be divided into 12 groups according to the three structural DFA types and the four classes of the elementary cellular automata proposed by (Wolfram, 2002). These four classes are:

- Class 1: A fixed, homogeneous state is eventually reached;
- Class 2: A pattern consisting of separated periodic regions is produced;
- Class 3: A chaotic, aperiodic pattern is produced; and
- Class 4: Complex, localized structures are generated.

The eight transition rules that result in semi-lattice DFA structures and complex space-time structures are shown in Table 2. The general characteristics of the eight rules are discussed below and are summarized in Table 3:

- If the central cell (block) has the same value (type of land use) as that of two neighbors at time (t ; 000 and 111), its value will change at $t + 1$.
- If the central cell has a value of zero at t while its two neighbors have different values of 001 and 100, there is a probability that three quarters of the value of that cell will remain the same, while one quarter of the value will change at $t + 1$.
- If the central cell has the value of zero at t while its two neighbors have the value of one (101), there is a probability that three quarters of the value of that cell will change, while one quarter of the value will remain the same at $t + 1$.
- If the central cell has the value of one at t while its two neighbors have the value of zero (010), there is a probability that three quarters of the value of that cell will change, while one quarter of the value will remain the same at $t + 1$.
- If the central cell has the value of one at t while its two neighbors have different values (110 and 011), there is a probability that one quarter of the value of that cell will change, while three quarters of the value will remain the same at $t + 1$.

Table 3 shows some degree of symmetry or order in the characteristic transition rule, which would be worth exploring further.

According to the classification in Table 1, Rules 9 and 41 fall into the Cui gua group, Rules 65 and 97 fall into the Xiaoguo gua group, Rules 107 and 111 fall into the Dun gua group, and Rules 121 and 125 fall into the Daguo gua group. Thus, the pairs have a relationship with the eight transition rules in Table 2 in terms of urban evolution in the linear city and the four guas in Table 1 based on the transformational algorithm discussed above.

5. Conclusion

This editorial has demonstrated that the two binary systems of the I Ching and the elementary cellular automata are closely related through the use of a transformational algorithm derived from the cyclic number 142857. More specifically, each of the 64 guas in the I

Ching correspond to four of the 256 transition rules in the elementary cellular automata, and their space-time plots yield similar patterns. Therefore, the 64 guas in the I Ching can be scientifically interpreted as four transition rules in the elementary cellular automata. The mystery that needs to be solved is why and how the cyclic number 142857 works in the present formulation. Thus, much remains to be explored.

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Shih-Kung Lai
School of Public Affairs, Zhejiang University, Hangzhou, China
E-mail address: sklai@zju.edu.cn.