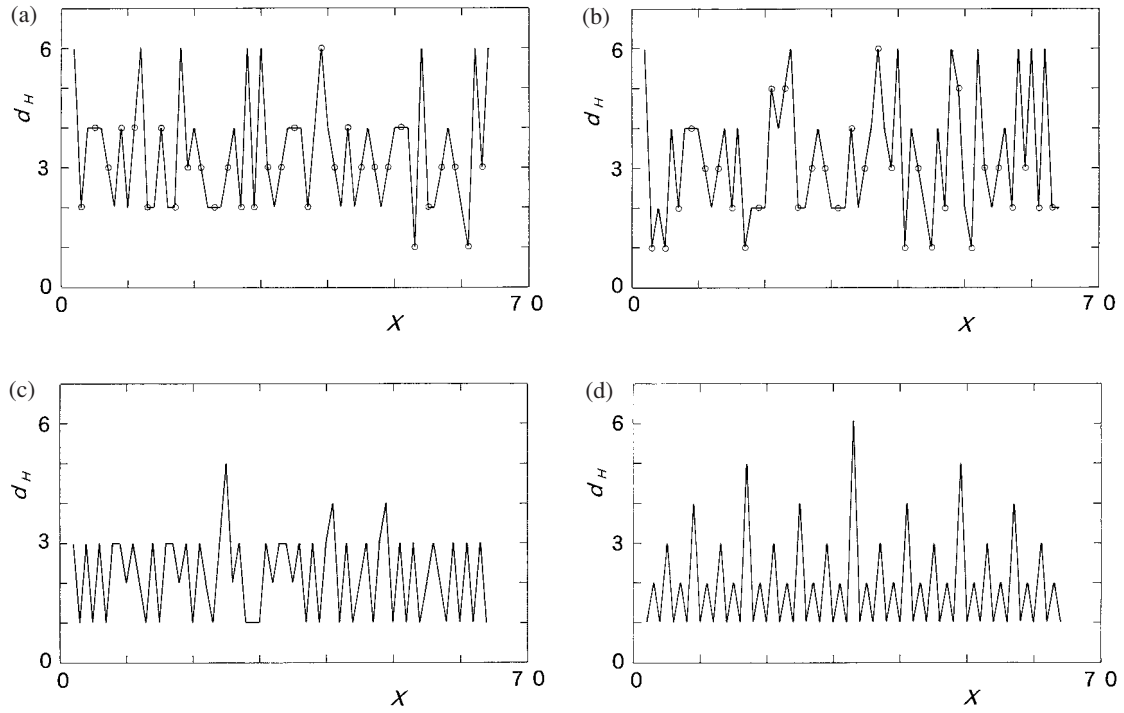

Fig. 6. Variation of Hamming distance, d_H, along the hexagrammatic sequence, x. (a) Received (Type I) order. (b) *Miscellaneous* (Type II) order. (c) *Mawangdui* (Type III) order. (d) *Fuxi* (Type IV) order. In (a) and (b) the hollow circles indicate the distances at the boundaries between adjacent pairs of hexagrams.

to the entire path length between the two position vectors $\boldsymbol{u} = (u_1, u_2, \ldots, u_n)$ and $\boldsymbol{v} = (v_1, v_2, \ldots, v_n)$, provided that the path is restricted solely on the sides of the n-dimensional unit hypercube. In this paper we define the divergence as the Hamming distance between two nodes on the hypercube.

3.3 The city-block (the Manhattan) distance

The concept of the Hamming distance defined for the binary counting system can be extended to the arbitrary n-dimensional Cartesian coordinate as

$$D_1(\boldsymbol{u}, \boldsymbol{v}) = \sum_{i=1}^{n} |u_i - v_i|, \tag{5}$$

where u_i and v_i $(i = 1, 2, \ldots, n)$ are arbitrary real numbers, and the suffix 1 indicates the Minkowski's parameter. In analogy with typical two-dimensional urban systems the distance defined with Eq. (5) is identified frequently with the city-block or, more specifically, the Manhattan distance between the two points in the n-dimensional Euclidean space (Takeuchi, 1989; Jurafsky and Martin, 2009). With the path being restricted along the sides of the n-dimensional hyper rectangular solid, the geometrical interpretation of the present distance is basically identical to the one given for the Hamming system.

4. Results and Discussion

4.1 Comparison between Hamming patterns

The sequential patterns of the Hamming distances between adjacent hexagrams are plotted in Fig. 6 (Hayata, 2005). In comparison among the four patterns for Type I–IV, one can see a variation of its own, which depends sensitively upon the permutation of hexagrams. Among the pat-

Table 1. Comparison among frequency distributions of Hamming distances in Fig. 6.

Distance	Frequency			
	Type I	Type II	Type III	Type IV
1	2	6	22	32
2	20	21	10	16
3	13	10	28	8
4	19	14	2	4
5	0	3	1	2
6	9	9	0	1
Sum	63	63	63	63

Table 2. Comparison among characteristic values of Hamming data in Table 1, where *SD*, *CV*, and μ_3, respectively, stand for the standard deviation, the coefficient of variation, and the third-order moment around the mean.

	Type I		Type II		Type III		Type IV
$\sum d_H$	211	>	203	>	139	>	120
Mean	3.35	>	3.22	>	2.21	>	1.90
Mode	2		2		3		1
Range	5		5		4		5
SD	1.38		1.54		1.01		1.19
CV	0.41		0.48		0.46		0.63
μ_3	1.54		1.78		0.14		2.41