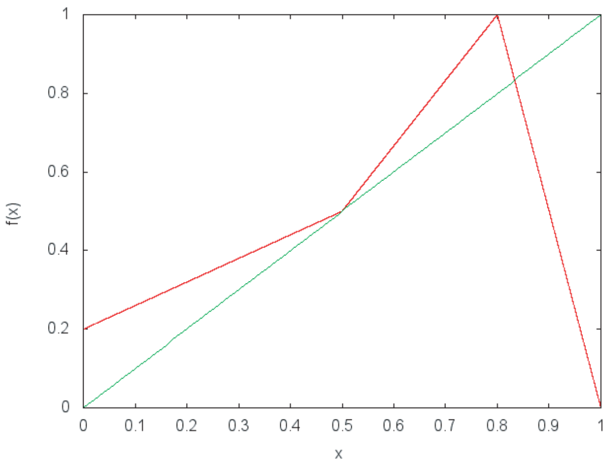

Fig. 1. SOM map ($\alpha = 0.60001$).

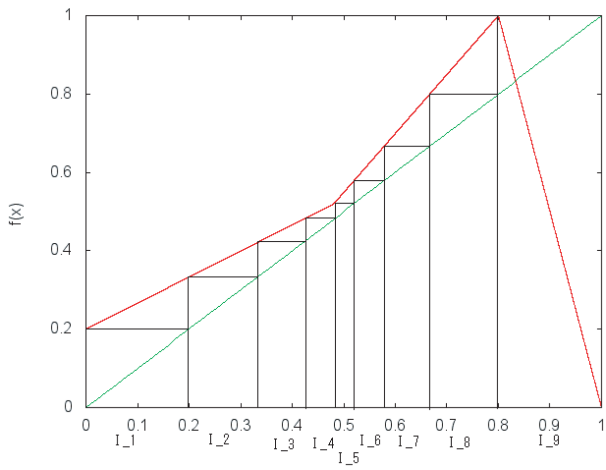

Fig. 3. Markov partition at $\alpha = \alpha_4 \simeq 0.665$.

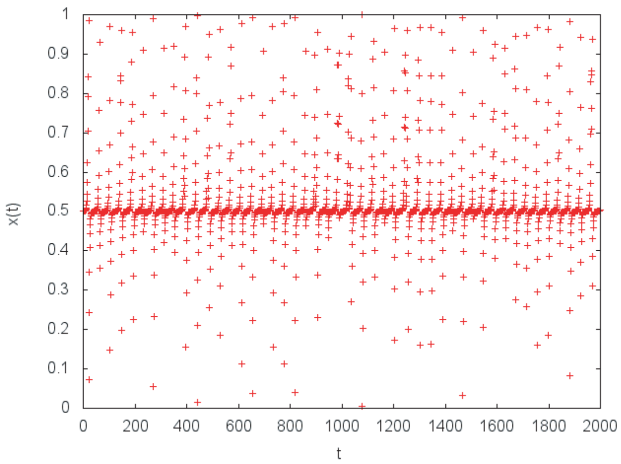

Fig. 2. Time series of the SOM map ($\alpha = 0.60001$).

For $q = 1$, we have

$$(H_1)_{i,j} = \begin{cases} 1 \ (i + 1 = j \text{ or } i = 2m + 1) \\ 0 \ (\text{otherwise}) \end{cases} \tag{16}$$

Regarding H_1 as an adjacency matrix, we can draw a directed graph. The burst part I_{2m+1} mapped to the whole $2m + 1$ subintervals yields output degree $2m + 1$, and the laminar part I_i mapped to the right neighbor subinterval I_{i+1} yields output degree 1, and the number of such subintervals is equal to $2m$, so that output degree distribution $P(d)$ is given by

$$P(d) = \frac{2m}{2m+1}\delta_{d,1} + \frac{1}{2m+1}\delta_{d,2m+1}, \tag{17}$$

where $\delta_{i,j}$ denotes Kronecker delta. The directed graph corresponding to Type-I intermittency is thought to consist of many small-output-degree nodes and a few large-output-degree nodes, which will be confirmed for the logistic map in the subsequent section.

The burst part I_{2m+1} has a unstable fixed point as the shortest UPO in this subinterval. In the laminar part, one of the unstable period-2 periodic points visits I_{2m} and I_{2m+1}, which is the shortest UPO in I_{2m}. In the same way, one of the unstable period-3 periodic points visits I_{2m-1}, I_{2m} and I_{2m+1}, which is the shortest UPO in I_{2m-1}. The shortest UPO in I_k corresponds recursively to UPO with period-$(2m + 2 - k)$. Type-I intermittency of the SOM map can be described by a switching motion only between period-1, period-2, $\cdots$, period-$(2m + 1)$ UPOs among countable infinite number of UPOs. It should be noted that the period-1 to period-$2m+1$ UPOs appear as delta-function-like lines in the power spectrum as shown in the preceding study (Shobu, Ose and Mori 1984).

5. Type-I Intermittency of the Logistic Map

We consider the logistic map in this section, which is explicitly given by

$$g(x) = ax(1 - x) \ (x \in [0, 1]). \tag{18}$$

where real parameter a satisfy $0 \le a \le 4$. In the chaotic regions for $a \ge 3.5699456\cdots$, a period-3 window in the vicinity of $a = 3.84$ is remarkable in the bifurcation diagram. This window locates between the tangent bifurcation point $a = a^{(3)}$ and the band crisis point. Every third iteration $g^3(x) = g \circ g \circ g(x)$ has three *channels* just before the tangent bifurcation point, at which period-3 points are generated.

In order to construct Markov partitions approximately, if an initial point x_0 is mapped into $[x_0 - \epsilon, x_0 + \epsilon]$ after n steps of the mapping function $g^3(x)$, we replace x_0 and x_n by $\frac{x_0+x_n}{2}$, and approximated periodic points $\frac{x_0+x_n}{2}$, x_1, x_2, $\cdots$, x_{n-1} with period-n are used as both endpoints of the subintervals $I_1, I_2, \cdots, I_n$ constructing Markov partition. We set $\epsilon = 0.001$ in the following, and the recurrence time n is assumed to be much longer than the average laminar duration. Around $a = 3.828$, the average laminar duration is nearly equal to 50 steps, we will consider 100 or more iterations of $g^3(x)$ as n.

In order to obtain a matrix representation of the generalized Frobenius-Perron operator, the mapping function is replaced to a piecewise-linear function between the above-mentioned endpoints, so that H_q is equal to $|\frac{dg^3(I_j)}{dx}|^{q-1}$, if I_j is mapped to I_i, $H_q = 0$ otherwise. Although the original local expansion rate $\log|\frac{dg^3(x)}{dx}|$ varies continuously, the