http://dx.doi.org/10.5392/IJoC.2013.9.3.015

Development of an Application for Mobile Devices to Analyze Data Set by a Self-Organizing Map : A Case Study on Saga Prefectural Sightseeing Information

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ABSTRACT

In the preceding studies, an analysis of Saga Prefectural sightseeing information by a Self-Organizing Map (SOM) has been tried. And recent development on Information and Communication Technology (ICT) will help us to access any results via the mobile devices easily. This is why the mobile devices, e.g., smartphones and tablet computers, have an operating system installed, and we can improve their functions by downloading any applications on the Web. Then, in order to realize this basic idea, development of an application for the mobile devices is investigated through some computer simulations on the standard desktop PC in this paper. As a result, it is found that i) a developed feature map is useful to identify some candidate topics, ii) a touchscreen is suitable to show the feature map, and iii) arrangement of the feature map can be modified based on our interests. Then, it is concluded that the proposed idea seems to be applicable, even though further consideration is required to brush it up.

***Key words**: Self-Organizing Map (SOM), Sightseeing Information Analysis, Mobile Device, Feature Map, Touchscreen.*

1. INTRODUCTION

Recent development on the mobile devices, e.g., smartphones and tablet computers, is remarkable, and it might be equivalent to the past PCs released several years ago. In fact, they have an operating system installed, and we can improve their functions by downloading any applications on the Web. Its style how we can use them is completely the same as the past PCs. It is noticeable here that such infrastructure is developed rapidly for these a few years.

On the other hand, it is true that we can develop some applications by ourselves easier than before. This is why there are a lot of articles, books, and manuals from the technical point of view. Also, there are various kinds of tools to develop applications for the mobile devices free of charge.

By the way, an analysis of Saga Prefectural sightseeing information by a Self-Organizing Map (SOM) [1] has been tried in our research group so far. According to the preliminary results, all topics are divided into several regions whose attributes are different from each other [2]. This fact reminds us that we can find out some candidate topics fit for our interests with the help of this developed feature map.

As a next step, the primal objective of this study is determined to develop a sort of applications for mobile devices by means of integrating them together. In order to realize this basic idea, a possibility of installation is investigated through some computer simulations on the standard desktop PC in this paper [3].

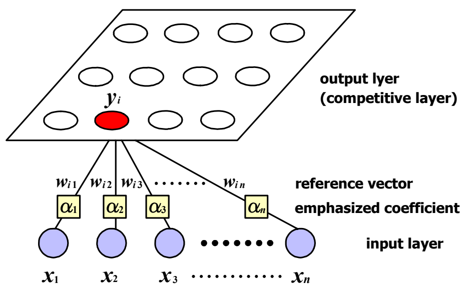

Fig. 1. A revised version of the standard SOM for emphasizing particular items. Each circle depicts a single neuron.

2. BASIC IDEA

2.1 Data analysis by Self-Organizing Map (SOM)

Originally, a Self-Organizing Map (SOM) [1] is proposed as one of the neural network models for the biological visual information processing system. But, in these days, it can be seen as a good tool for signal conversion preserving neighboring arrangement contained in the applied data set. Its

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This is an excellent paper selected from the papers presented at 2013 Korea Contens Association Spring Academic Conference.
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Manuscript received Jul 05, 2013; revised Sep 05, 2013; accepted Sep 11, 2013

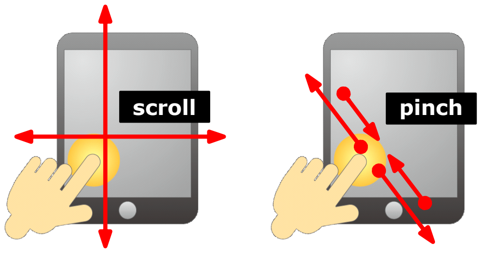

Fig. 2. Some popular gestures on the touchscreen suitable for controlling the developed feature map's appearance.

Table 1. Sightseeing information consisting of three major categories, ten items in total, used for training.

category	item
purpose	i) see, ii) eat, iii) play, iv) buy
location	v) latitude, vi) longitude
contents	vii) nature, viii) history, ix) architecture, x) leisure

Table 2. A part of data set adopted in this study. Originally, it consists of 39 topics, and it is provided by the Saga Tourist Federation Information Center, Japan.

ID	topic	abbrev.	purpose				location		contents			
			see	eat	play	buy	latitude	longitude	nature	history	architect.	leisure
01	Niji-no-Matsubara	虹松原	レ		レ		33.44	130.01	レ			
02	Kunenan	九年庵	レ				33.35	130.36	レ		レ	
03	Nanatsugama Caves	七ツ釜	レ				33.54	130.93	レ			
04	Saga Castle	佐賀城	レ				33.24	130.30		レ	レ	
05	Chikugo River Lift Bridge	昇開橋	レ				33.21	130.35		レ	レ	
06	Yoshinogari Historical Park	吉野里	レ		レ		33.28	130.34		レ		
07	Kiyomizu Falls	清水滝	レ	レ			33.32	130.21	レ			
08	Daikouzenji Temple	大興善	レ				33.42	130.49		レ	レ	
09	Yutoku Inari Shrine	祐徳社	レ				33.07	130.10			レ	
10	Taku Seibyou	多久廟	レ				33.25	130.09		レ	レ	

major feature is visualization as a result of projection from the multi-dimensional space (the input layer) $\boldsymbol{x}$ to the two-dimensional plane (the output layer[†]) $\boldsymbol{y}$. Fig. 1 is a revised version of the standard SOM for analyzing the sightseeing information in this study. Then, signal transmission equations are defined as follows:

$$\boldsymbol{x} = (x_1, x_2, \cdots, x_n) \ , \quad (1)$$

$$\boldsymbol{w}_i = (w_{i1}, w_{i2}, \cdots, w_{in}) \ , \quad (2)$$

$$d_i = \sqrt{\sum_{k=1}^{n} (w_{ik} - \alpha_k x_k)^2} \ , \quad (3)$$

$$i^* = \arg\min_{1 \le i \le N} d_i \ , \quad (4)$$

$$y_i = \begin{cases} 1, & i = i^* \\ 0, & i \ne i^* \end{cases} \ , \quad (5)$$

where n is the number of neurons in the input layer, and N is the number of neurons in the output layer, respectively. A parameter

$$\boldsymbol{\alpha} = (\alpha_1, \alpha_2, \cdots, \alpha_n) \ , \quad (6)$$

in Eq.(3) is a coefficient vector to emphasize the particular items depending on our interests. A neuron i^* is a winner, and it will appear depending on attributes which the corresponding input possesses.

As a collection of such projections from the input to the output, a sort of feature map is developed in the output layer. During the training period, weight updates are carried out based on the repetition of two modes: One is a competitive mode, and the other is a cooperative mode. And finally, a feature map is developed automatically, and visualization of applied data structure is also achieved. Based on the features mentioned above, Saga Prefectural sightseeing information analysis has been tried in our research group so far [2].

2.2 Development of applications for mobile devices

From the viewpoint of tourists, for example, it must be convenient that we can access any results of sightseeing information analysis not only via the PCs inside a room but also via the mobile devices wherever we are. It might be just a fantastic story until several years ago, but recent development on Information and Communication Technology (ICT) enables us to become realistic.

Under the circumstance mentioned above, a developed feature map will be displayed on the touchscreen, so we can easily change both its placement and magnification depending on our interests. As can be seen in Fig. 2, some popular touch gestures, e.g., scroll in the four directions (upward, downward, leftward, and rightward) with one finger, and pinch in two ways (open and close) with two fingers, must be useful for controlling the feature map's appearance.

Then, presenting a developed feature map on the touchscreen is a suitable means to show the results easily from the viewpoint of practical use [3].

[†] Among the SOM researchers, it is usually called "*a competitive layer*". This is why a feature map described later is developed through training in the competitive manner.

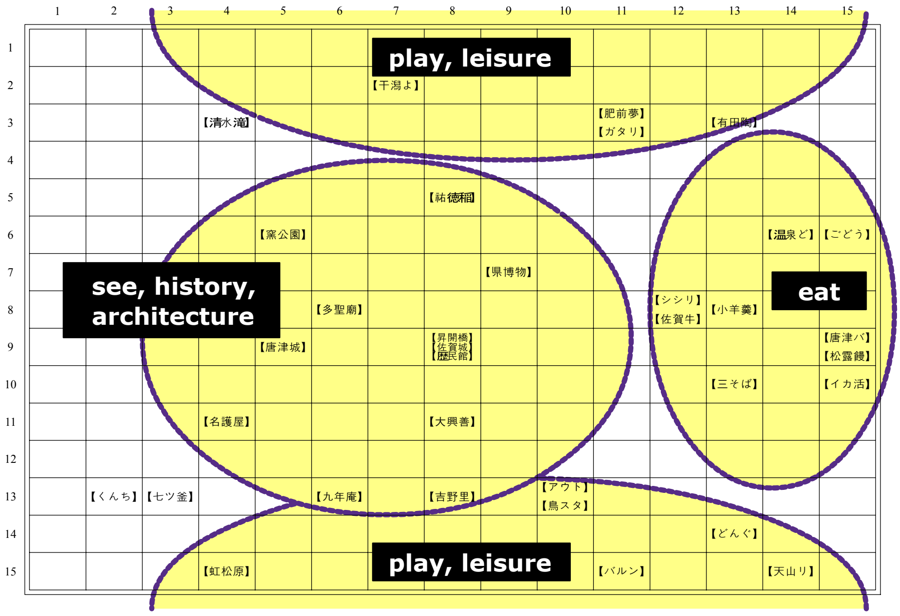

Fig. 3. An example of the developed feature maps based on the Saga Prefectural sightseeing information.

3. COMPUTER SIMULATIONS

3.1 Methods

In this paper, sightseeing information provided by the Saga Tourist Federation Information Center, Japan [4] is adopted, and a feature map is developed by the SOM to confirm a possibility of installation. The data set consists of 39 topics, and each of them are represented by a binary code (0/1) based on the three major categories, ten items in total, as summarized in Table 1. A part of data set is also shown in Table 2.

A configuration of the output layer (the competitive layer) is a torus, as adjoining both the top to the bottom and the left to the right, in order to eliminate the edges. The number of neurons n in the input layer is fixed at 10, while the number of neurons N in the output layer is fixed at 225 (=15x15), respectively. Under the above-mentioned condition, some computer simulations are carried out on a standard desktop PC.

3.2 Results

During the training period for 100 epochs, 34 topics are applied to the torus SOM. Fig. 3 shows an example of the developed feature maps. It is clear that each topic is assigned in the output layer based on similarity of the attributes of neighboring topics. Roughly speaking, there are three major groups, i.e., a) eat, b) see, history, architecture, and c) play, leisure.

3.2.1 Appearance of developed feature map: As can be seen in Fig. 3, any groups are sometimes divided into two separate regions in appearance. But since the output layer is a torus, i.e., the uppermost/leftmost line adjoins to the lowermost/rightmost line, respectively, they share the same single region in fact. Then, paying attention to the region entitled "play, leisure", for example, the line #1 (top) of the feature map is adjoined to the line #15 (bottom), so scrolling upward on the touchscreen allows us to move continuously without any breaks, and vice versa. In the same manner, scrolling leftward/rightward is expected to have the same effect in the horizontal direction.

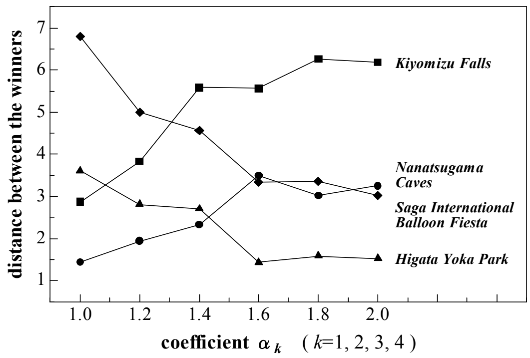

Fig. 4. An example of distance between the winners when a part of emphasized coefficients are changed from 1.0 to 2.0.

By the way, the region entitled "eat" contains most topics related to foods, and it is limited to a small area even though each topic is distributed all over the prefecture. Then, pinching open on the touchscreen allows us to magnify it continuously, and vice versa. This kind of operation must be useful when we want to find out any local specialties nearby.

3.2.2 Effect of emphasized coefficient: An example of developed feature map shown in Fig. 3 is the case which is the same as the conventional standard SOM, i.e., the emphasized coefficient α is set to 1.0. In contrast, Fig. 4 shows another case when the emphasized coefficient is modified. It is clear that the distance between the winners corresponding to two topics changes gradually depending on the emphasized coefficient α. Although not shown here for brevity, this fact suggests that the feature map developed through training might be possible to adjust the arrangement of each topic with the help of the emphasized coefficient α [3].

4. DISCUSSION

As mentioned above, some elemental technologies have been confirmed through the computer simulations. Even though each of them seems to be immature, it might be possible to realize the proposed basic idea near future. One of the problems in front of us is the gap between the theoretical world (the virtual space) and the practical world (the real space). For example, only some computer simulations are carried out on the standard desktop PC in this study, but in fact installing source code of the objective application on the mobile devices is essential to confirm its possibility. Taking into account of recent development on ICT, the threshold of startup is becoming lower and lower. Therefore, it must be possible, but how to construct the human-friendly interface is a key issue as a next upcoming stage of this study.

5. CONCLUSIONS

In this paper, a possibility of installing an application for mobile devices is investigated. Though its original objective is to analyze Saga Prefectural sightseeing information by the SOM, utilizing its result via mobile devices is also interesting according to the recent development on ICT. As a result of some computer simulations on a standard desktop PC, it is found that the proposed basic idea seems to be applicable, and presenting the developed feature map on the touchscreen is a suitable means to show the results from the viewpoint of practical use. It is true that there are some problems to be solved, and hence further investigations will be required to realize this idea.

ACKNOWLEDGEMENT

This work was partially supported by a Grant-in-Aid for Scientific Research (C) No.20500208 from the Japan Society for the Promotion of Science. It was also supported by the Saga Tourist Federation Information Center, Saga, Japan.

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