# A Preference Search System Using an Interactive Genetic Algorithm

Takuma Katanosaka, Haruhiko Sato, Satoshi Oyama, Masahito Kurihara

***Abstract*—This paper describes the development of a preference search system using an interactive genetic algorithm (iGA). An iGA is an functionalize user preferences. Using the mouse and the keyboard to input large data for prolonged periods induces stress and causes mental fatigue. An aim of this research is the reduction of user mental fatigue by using iGA systems and multi-touch interfaces, which are investigated in this study.**

***Index Terms*—interactive design, genetic algorithm, clustering, neural network.**

## I. Introduction

HUMAN-BASED computation solves problems that arise between users and machines and, in recent years, it has become a popular area of study. It can solve problems that cannot be solved by machines alone. The Interactive Genetic Algorithm(iGA) is a method for dealing with problems about preferences or feelings that are difficult to treat algorithmically. On basis of the relationships between mental space and feature parameter space, an iGA searches solutions between users and systems in an accommodating manner. The iGA is primarily studied for application in creation support, information recommendation, multi-objective optimization problems and consensus building systems[1].

Because of interaction, when we use an iGA, a system architect must consider user mental fatigue. A method reducing mental fatigue is the amelioration of user interfaces. A technique to improve search speed reported by Kitamoto et al. involves the velocity differential of computers and queuing type genetic algorithm[2]. However with the advent of advanced computing and current improvements in computer-based search methods cause less user fatigue. Search accuracy has also been improved. As proposed by Ito et al[3][4], and Okada et al, information about an individual selection is made available to a user and the choice made by the user is evaluated, and these results are reflected in successive iterations. In order to reduce burden on the user and to acquire information effectively, which can improve search accuracy, improvement of user interfaces is imperative. The consideration of user burden will restrict the amount of information system may give a user at given a time. Since the demands of complicated operations become a burden to a user, interfaces must avoid presenting such operations. Therefore, to improve user interfaces, appropriate presentation methods and suitable amounts of information must effectively mitigate cognitive load.

Recently, input interfaces have changed dramatically. Input by mouse or keyboard has been the most common; however, finger-based multi-touch interfaces have begun to spread with the adoption of smart phones and tablet computer technology. Compared with the input by a number pad, or the mouse and keyboard, multi-touch systems are possible to use numerous intuitive operations. Such multi-touch interfaces have made it easier to acquire large amounts of information without using complicated input operations.

In our study, we developed an information recommendation system using an interactive evolutionary computation system equipped with a multi-touch interface. An iGA was used the base technology for our interactive evolutionary computation scheme. Implementation and examination of our method was performed using a system with a multi-touch interface. Our system was evaluated experimentally and was verified as an effective and useful method for information presentation.

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## II. Interactive Genetic Algorithm

### A. Outline

An iGA is a genetic algorithm that determines a fitness value from a users subjective evaluation value of the output of a system iGAs are recommended for computerized searches. Specifically, a user selection is evaluated and assigned a subjective value. This subjective value enables formulization of a valuation function for a users preferences and sensitivities.

### B. Considering Multimodal Preference

An iGA, a form of genetic algorithm, is a search algorithm for determining the single semi-optimal solution from a users mental state. However, user preference and sensitivity are not necessarily singular. Since an iGA will yield only a single optimal solution, such systems cannot produce results that truly reflect multimodal user preferences. Ito et al. proposed a preference generation method that can deal with multimodal user preferences. In this method, a user evaluates individual selections generated at random from the domain determined by design variables. Each evaluation is assigned a specific number, and these numerically evaluated selections are saved and clustered. Subsequent selections are determined by this clustering of numerical evaluated preferences. Thus, by this evaluation of individual selections, it becomes possible to generate selections that are better suited to the users preference without relying on unimodal or multimodal preferences. We employed this technique in our study to accommodate and correspond with multimodal preferences.

## III. Clustering Method

### A. Self-Organizing Map

A SOM is capable of mapping phase information held in multi-dimensional space to lower order space. A SOM

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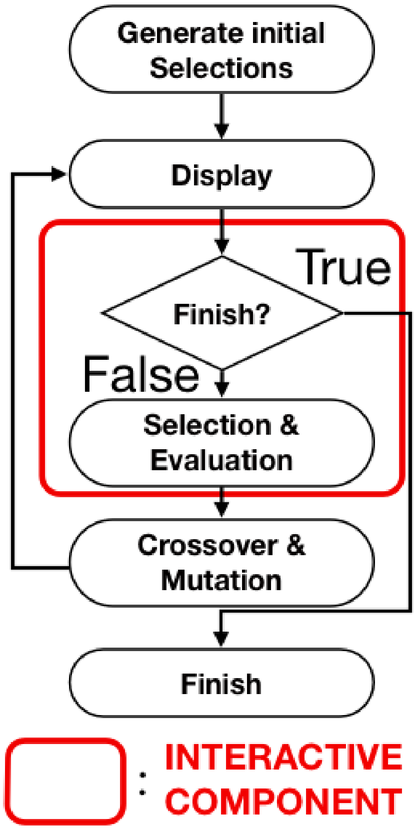


Fig. 1. Interactive Genetic Algorithm

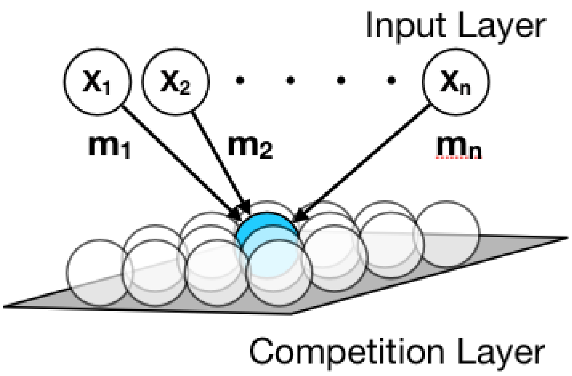


Fig. 2. Self-Organization Map

is formed by two layers, the input and competition layers. One of the formal neurons of the input layer is connected to all the formal neurons in the competition layer. Generally, the formal neurons of a competition layer are arranged from one to three dimensions. The aspect of a SOM feature map changes with the number of dimensions of the competition layer. Figure 2 shows that formal neurons used in our study are arranged as a two-dimensional lattice model. This research uses a SOM to perform clustering in the case of correspondence to multimodal preference. The individual selection, which is the multi-dimension data saved by the SOM, is mapped to a lower order space and has k-means++ applied to it.

### B. K-Means++

The k-means++ method, based on the k-means method[5], is a technique used to improve the selection of the initial


Fig. 3. System interface

value. The algorithm is shown below.

1) Select center of cluster $C_1$ uniformly at random from data $X$.
2) Select center of cluster $C_i(C_i = x' \in X)$ at random with the probability $\frac{D(x\prime)^2}{\sum_{x \in X} D(x)^2}$.
3) Repeat 2 until $k-$th center of the cluster is selected.
4) Standard k-means algorithm processing is performed.

Here $D(x)$ expresses the distance between x and the nearest cluster center already determined. It has been reported that, compared to the k-means method, it is easy to realize good clustering with the k-means++ method.

## IV. About The System

### A. Outline

In this study, a tablet computer with a multi-touch interface system was used as the system environment. The experiment was based on the t-shirt information recommendation system developed by Ito et al. When the experiment was performed, it was assumed that a multi-touch environment would be used. Evaluation and examination of the perceived ease of use of the multi-touch system were performed at implementation. Moreover, the value of k specified by the k-means++ method was two.

### B. Design Variable

Design variable data from previous work was used in our study. The design variable data used was t-shirt color, form, and pattern. The color of a t-shirt was expressed using the way people perceive a color and a similar hue saturation value (HSV) color model. In a HSV color model, the values of the elements hue and saturation determine a color. Sleeve length and collar form determined the t-shirt form two sleeve lengths were available, short and long. There were 15 kinds of collars; boat, V, and crew neck collars were used to change the basic form. Seven t-shirts patterns were available; rainbow, star, flower, dots, line, bubble, and border. The colors of each pattern were white, yellowish-green, light blue, blue, purple, pink, red, and yellow and black.

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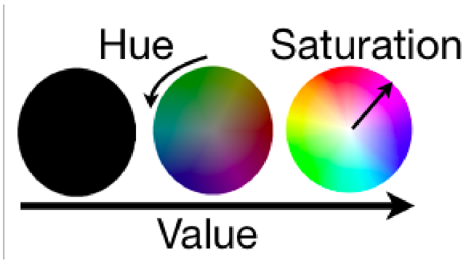
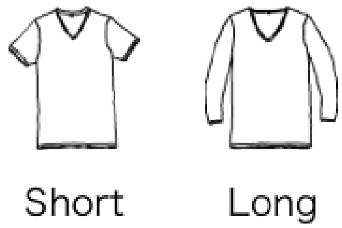
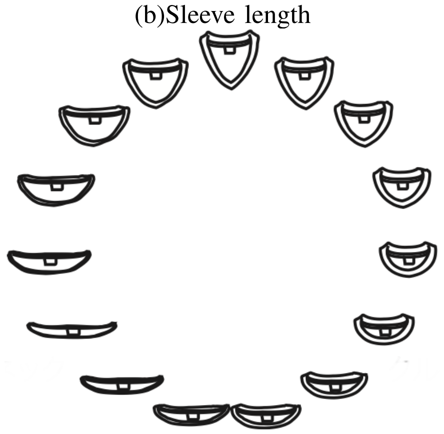


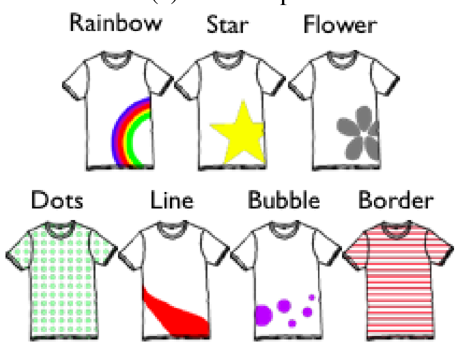

(a)HSV color model




(b)Sleeve length



(c)Neck shapes




(d)Patterns

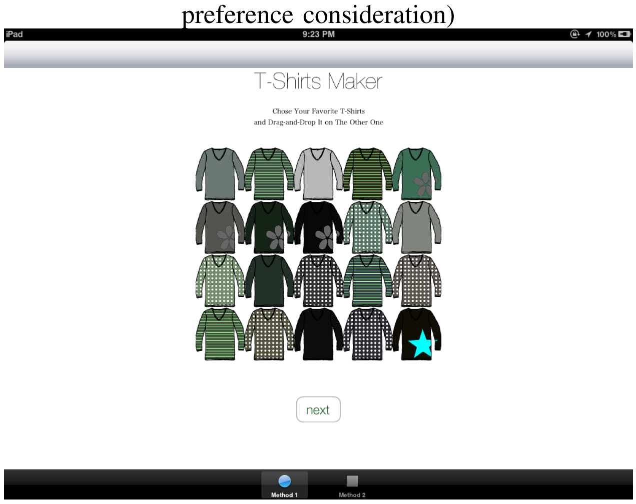
Fig. 4. About design variables

### C. Presentation Method

*1) Determination of the pair of the parent individual by a user:* Pair determination of parent selection by a user: In the iGA, selection and evaluation of selections is performed using a method generally called an imitation breeding scheme. An imitation breeding scheme is a method for repeating selection operations that progresses these selections and their intersecting selections to the next iteration. A pair of items can be selected by the user. These pairs can generate intersections that are evaluated by the system and may be used in the decision mechanism. It becomes possible to provide a combination of various selections according to these pairs and the selections a user chooses to progress to the next iteration.


Fig. 5. Determination of the pair of a parent individual


(a)Results at the 5th iteration (before multimodal preference consideration)




(b)Results at the 6th iteration (after multimodal preference consideration)

Fig. 6. Results for the 5th and 6th iterations

Figure 5 is a screenshot of a user choosing pairs of parent selections. Using the multi-touch interface, the user moves a selection on top of another selection to make a pair.

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## V. Results and Conclusion

Figure 6 shows the results of selections at the fifth iteration. Figure 6 also shows that correspondence to multimodal preference by clustering using the SOM and the k-means++ method is attainable. However, under the present circumstances, there is no basis for the determined number of clusters specified by the k-means++ method; therefore, we cannot determine it this cluster division is appropriate. Therefore, use of clustering methods like the x-means method to determine the number of clusters automatically will be considered in the future. Moreover, mapping the multi-dimensional data to lower order space using the SOM requires excessive time on a tablet computer with low computational performance. In future, techniques other than the SOM will be examined to improve the speed of the system.

In addition, experiments to assess the overall usefulness of the proposed technique will be conducted. A test subject will use an experimental system and respond to a questionnaire. Statistical analysis of the questionnaire results will be performed to evaluate the usefulness of the system.

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