

The Effects of Button Arrangement on Evaluations In interactive Genetic Algorithms

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Abstract—We discussed the effects of button arrangement on evaluations in interactive Genetic Algorithms (iGAs). It was reported that the visual interface effects human's subjective. The visual interface systems of iGAs may affect the solutions as humans evaluate the candidate solutions, evaluation of these candidates may be affected by the interface. In this paper, we conduct the two experiments. One of them is the experiment to verify the association between gazing and evaluation. The experiment showed that visual interface systems effects to the evaluation of human subjective. This means that evaluation value is changed according to visual interface or locations of systems. The other is the experiment to discuss the effect to iGA search. Since visual interface affects evaluation values, derived solution by iGA is different with along to the different visual interface. From these results, visual interface of iGA should be designed carefully to use the positive or negative effect of interface design and location.

I. INTRODUCTION

iGAs (interactive Genetic Algorithms) are optimization methods using human subjective sensibility. In iGA, human evaluates each solution candidate through visual interfaces. However, it has been reported that subjective sensibility, such as human interest and preferences, are influenced by visual information on advertisements and web pages [1]–[5]. This influence may apply to iGAs and the solution search. This paper is described the effects of visual interface, particularly the arrangement of screen transit button. Here, the following two points are discussed. Discussing the association between the human subjective and gazing at iGA interface is the first point. Previous studies of the web and in the field of advertising have shown that screen composition influences subjects' gaze. The gazed position The statistics of gazed position among evaluation are derived. The second point is the effects to solution search of iGA. In iGA, optimization is performed based on user selection of each generation. Therefore, it is necessary to examine the influence of button arrangement on the results of the solution search. The result of the solution search is examined by the examinee questionnaire regarding satisfaction and diversity of the final solution.

II. INTERACTIVE GENETIC ALGORITHMS

Genetic Algorithms (GAs) are optimization methods that mimic the process of biological evolution on the computer [6]. In GA, there are plural searching points and they are called individuals. The solution is optimized by repeating genetic operations, evaluation, selection, crossing-over, and mutation of individuals. Substituting computer evaluation to

human evaluation, iGA can search for the solution using human subjective. iGAs have been applied to the creation of difficult music and design, etc., for quantitative evaluation of the objects of human evaluation that could not be estimated quantitatively using previous methods [7]–[13]. As the user's evaluation is the only standard in iGA optimization, small differences in the evaluation influence the search for the solution [14], [15]. Therefore, there have been studies of factors that may influence evaluation in iGA, e.g., fatigue and the diversity of the solutions.

III. BUTTON ARRANGEMENT AFFECTS HUMAN EVALUATION

A. Experimental Overview

This experiment used three iGA interfaces with different screen transition button arrangements. The interfaces had buttons at the top, bottom of the screen, or no button. Figure 1 shows the experimental interfaces. In this interface, the transition button is a bar but it is called button in this paper. Each subject used these three interfaces sequentially, and selected three images from among 16 presented on the screen. We confirmed the positions at which the selected images were presented. In addition, we considered whether the position of the image selected was related to the button arrangement. The images presented were the same data set for all subjects to exclude the effects of the images themselves. In this experiment, images were shown randomly and the presented images have not been optimized by iGA. The optimization results by iGA are shown in the next experiment in the next chapter.

B. Experimental Procedure

In this experiment, the subjects were instructed to select three images according to their preference. The experimental procedure was as follows.

- 1) The subject practiced using each interface for 3 generations to confirm the procedure.
- 2) The subject searched for images according to their preference within 6 [s] over 12 generations.
- 3) The subject performed a similar operation with each interface.

For intuitive operation, a selection time of 6 [s] was set. This time limit was the average time for all subjects to evaluate the images. While experimenting, the eye movement of subjects is

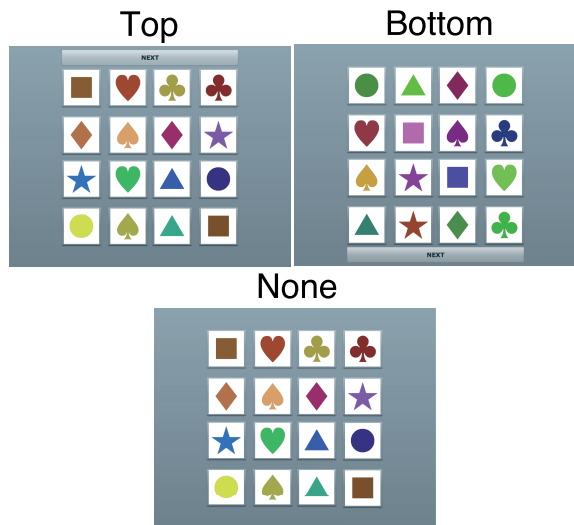


Fig. 1. Experimental Interfaces

measured. The order of interface use was set such as to avoid overlap.

C. Experimental System

1) *Images*: In this experiment, a simple image was used with various combinations of color and shape. Figure 2 shows the components of the image. The color is expressed by HSV color model. The HSV color model according to three elements expresses color: hue, saturation, and value (i.e., brightness). Figure 3 shows the shapes. These shapes are arranged in the sequence, which has a high degree of similarity. This similarity was checked in the exploratory experiment [16]. Two images were presented per type. For vivid and clear presentation, numerical values for saturation and value were generated at random between 50 and 100. 16 images were presented at one step through the interface.

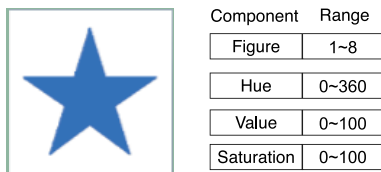


Fig. 2. Image Components

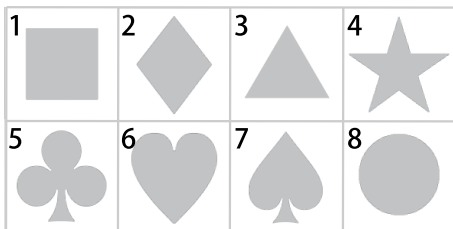


Fig. 3. Image shapes

2) *Image evaluation*: In the conventional iGAs, each solution is scored at evaluation operation. In this system, user just made their selection by clicking the presented image with the mouse. Here, we defined the selected solutions got higher scores. Therefore, selecting images is the same as evaluating solution. To derive selection rate, we can find the solutions which have higher scores and the area where many high score solutions exist.

3) *Screen Transit*: The screen transit method differed among the interfaces. There were three button arrangements (top, bottom and buttonless). The space key was used to transit the screen in the buttonless interface, while the button was clicked on the screen in the other interfaces.

4) *Experimental environmental*: 19-inch LCD (resolution: 1280*1024) monitor is used for display the interfaces. Non-contact eye mark recorder EMR-AT VOXER (NAC) is used for the pursuit of glance. The subjects are 13 of men and women in twenties. 4 of them are monitored their gaze. Figure 4 is one example of experiment landscape. Figure 5 is the measurement result of eye mark recorder. Lines are the track of glance. Squares are the point of gaze.

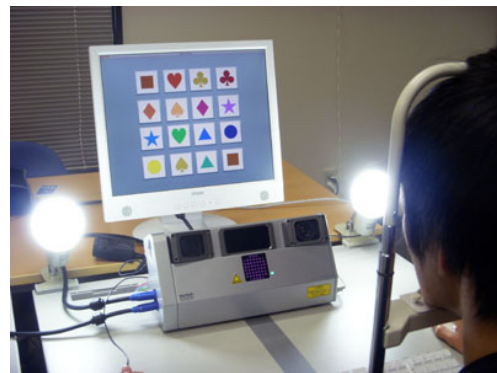


Fig. 4. Experiment landscape

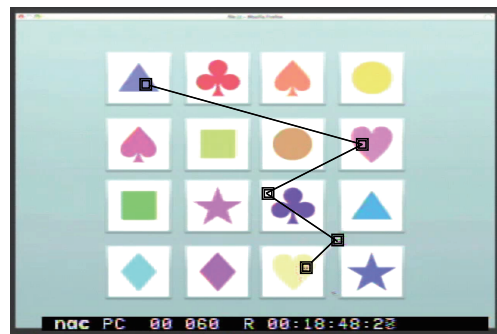


Fig. 5. The measurement result of eye mark recorder

D. Results

We verified the vertical positions of gaze the images selected by the subjects. We labeled the name of positions, such as upper, lower, center and edge shown in Figure 6. The differences of the trend in the result between subjects were examined.

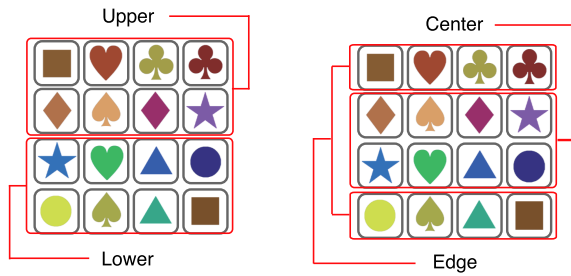


Fig. 6. Positions

1) *Eye gaze*: Figure 7 shows the ratio of gazing time in the experiment using the interface with the transit button on the top and bottom of the screen and buttonless interface. In case of top button interface, the mean ratios of gazing time in the upper and lower parts of the screen were 56% and 44%, respectively. In case of bottom button interface, the mean ratios of gazing time in the upper and lower parts of the screen were 39% and 61%. In case of buttonless interface, the mean ratios of gazing time in the center and edge parts of the screen were 68% and 32%. The differences in the results between subjects were examined. All subjects have the same tendency.

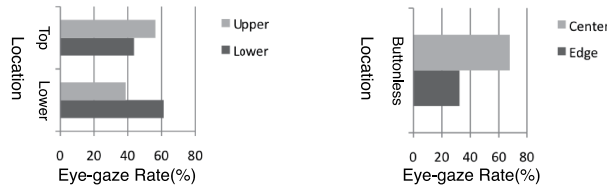


Fig. 7. The deference of Eye-gaze Rate by button arrangements

2) *Evaluation*: Figure 8 shows the ratio of selected individuals in the experiment using the interface with the transit button on the top and bottom of the screen and buttonless interface. In case of top button interface, the mean ratios of image selection in the upper and lower parts of the screen were 55% and 45%, respectively. In case of bottom button interface, the mean ratios of image selection in the upper and lower parts of the screen were 40% and 60%. In case of buttonless interface, the mean ratios of image selection in the center and edge parts of the screen were 60% and 40%. The differences in the results between subjects were examined by Wilcoxon-test. There were significant differences in selection among subjects using the interface with the button at the top ($T = 16, P < 0.05$), the interface with the button at the bottom ($T = 3, P < 0.01$) and the buttonless interface ($T = 0, P < 0.01$).

E. Discussions

We discuss the association between the gaze and evaluation. As explained in the previous section, selecting images is the same as evaluating solution. The selected images have higher evaluations. We compared the areas where subjects gaze to the areas of high evaluation. These areas are accordant. Moreover, Almost subject have this tendency. This result

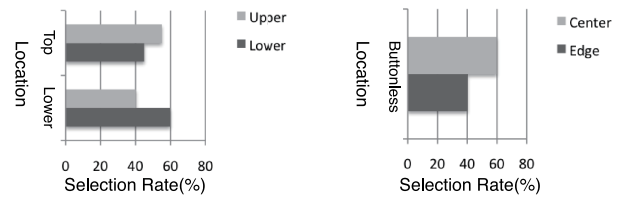


Fig. 8. The deference of selection rate

shows the association between the human subjective and gaze. Previously, iGA is not considered that the gaze effects to evaluations. We make the visual interface system of iGA that do not effects to gaze.

IV. BUTTON ARRANGEMENT AFFECTS iGA SOLUTION SEARCH

A. Experimental Overview

An experiment was performed to examine the results of the iGA solution search according to the positions at which individuals are presented. As described in section 3, the button arrangement in the interface affected selection by the users. The results indicated that it is possible that the evaluation cannot be performed correctly when the individual that the user prefers are presented in the space where individuals are hardly got good points. This prevents the smooth convergence into optimal solution. In this section, the arrangement where the images are placed in the users' focused area is called "focused arrangement". On the other hand, the opposite arrangement is called "defocused arrangement". We prepared the three types of the interfaces; in the top, in the bottom, and without button. For these interfaces, the images are illustrated in the focused arrangement and the defocused arrangement. The result of the solution search was examined by the examinee questionnaire. The subjects were seven of men and women in twenties. The questionnaire included the following two items regarding the order at the interface and the presentation position used.

1) Satisfaction

The satisfaction rate of the examinee to the final solution is discussed. To perform this discussion, in the simulations, the individuals which examinee prefers are changed its position and derived the final solutions. As a result, whether the solution of iGA was appropriately searched is considered.

2) Diversity

The diversity of the final solution is discussed. In this simulation, the selected individuals were also changed its position. In the final solution, when the optimum solution is converged, there is small diversity. This check was also performed thorough the questionnaire.

B. Experimental Procedure

Subjects were given instructions similar to those in the experiment described in section 3. The experimental procedure was as follows.

- 1) The subjects practiced using each interface for three generations to confirm the procedure.
- 2) The subject searched for images according to their preference within 6 s using one of the interfaces and performed 12 generations. The both focused arrangement and defocused arrangement were used.
- 3) The subject performed a similar search with a different interface (if focused arrangement is performed, next is defocused arrangement).
- 4) Systems were compared based on the results of the questionnaire.
- 5) The above-mentioned procedure was performed with each interface.

To press an intuitive operation, this selection time of six seconds was set. The time limit of 6 s was the average time for all subjects to evaluate the images. The order of interface use was set such as to avoid overlap.

C. Experimental System

The images, evaluation method, and screen transition were the same as those described in section 3. The examinee selects the image and this selected image is scored high point. The best image for the examinee was chosen by iGA.

D. Results

A questionnaire survey was performed regarding the diversity of the solutions and the users' preferences. There are two patterns; one of them is the pattern where the preference image was located in the focused arrangement and the other is the pattern where the preference image was located in the defocused arrangement.

1) *Questionnaire regarding user preference of the final solutions:* The effects of changes in image position were verified by the questionnaire survey. The examinee was asked which system presented a more favorite image. In the questionnaire, there are four choices; focused or defocused arrangements displayed a lot, both arrangements displayed a lot, and none of them displayed. The results were summarized as the rate to all answers. The Left part of Figure 9 is the Questionnaire regarding user preference of the final solutions. Figure 9 A1 shows the results for the interface with the transit button at the top of the screen. Figure 9 A2 shows the results for the interface with the transit button at the bottom of the screen. Figure 9 A3 shows the results for the buttonless interface. These results described that subjects have high satisfaction when images were displayed in the focused area for the interfaces.

2) *Questionnaire results regarding diversity of the final solutions:* A questionnaire survey was performed to determine the influence of changes in image presentation position on the diversity of iGA solutions. The examinee was asked in the questionnaire which system prepared more various images. There were also four choices; focused or defocused arrangements, both arrangements, and neither arrangement. The Right part of Figure 9 is the Questionnaire results regarding diversity of the final solutions. Figure 9 B1 shows the results for the

interface with the transit button at the top of the screen. Figure 9 B2 shows the results for the interface with the transit button in the bottom of the screen and Figure 9 B3 is the result of buttonless interface. These results described that there is high diversity when images were displayed in the defocused order for the interfaces whose button was in the bottom and there was no button.

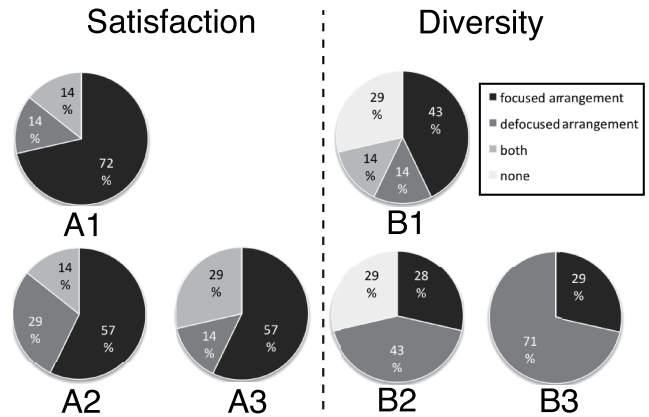


Fig. 9. Questionnaire of the final solution

E. Discussions

This study was performed to examine the influence of transit button arrangement in a visual interface on the solution search in iGA. The differences of evaluation caused by gazing at a certain point of interface were examined. The results indicated that the button arrangement influenced eye gaze and it influenced the evaluations. We have examined the three interfaces; button on the top, on the bottom, and without button. Differences in evaluation were seen between the upper and the lower of the screen using the top and bottom button interface. Moreover, Differences in evaluation were seen between the center and the edges of the screen using the buttonless interface. The subjects which are located in the area where user tend to gaze have high evaluation. The next experiment derived solutions by iGA using these interfaces. The results confirmed that there were differences in diversity and preferred aspect in the final solution. Thus, the visual interface was shown to influence the solution search in iGA. Further studies are currently underway to examine the influence on evaluation when selection is performed without a time limit in comparison to that with a time limit of 6 s as in the present study. Moreover, it is possible that the color of the button, its shape, size, etc., and the background color may also affect selection. It is reported only to differ the design of the background, and to have changed the thing bought on EC site, and is necessary to examine the influence that the design that becomes a background in the interface gives in detail in iGA.

V. SUMMARY

This study was performed to examine the influence of transit button arrangement in a visual interface on the solution search

in iGA. The differences in subject gaze and evaluation were examined according to the different interface arrangements. The results indicated that the button arrangement influenced eye gaze and it influenced the evaluations. We have examined the three interfaces; button on the top, on the bottom and without button. Differences in evaluation were seen between the upper and the lower of the screen using the top and bottom button interface. Moreover, differences in evaluation were seen between the center and the edges of the screen using the buttonless interface. The areas where subjects gaze correspond with the areas of high evaluation. These interfaces were applied to perform iGA in the next experiment. The results confirmed that there were differences in diversity and preferred aspect in the final solution. Thus, the visual interface was shown to influence the solution search in iGA. Several further studies are currently underway. Firstly, examination of the influence on evaluation should be performed when selection is operated without a time limit in comparison to that with a time limit of 6 s as in the present study. Secondly, several other factors such as button color, shape, size, background color, etc may also affect selection. Actually, it was reported that purchasing operation was influenced by the design of background on E-commerce Sites [17]. Thus, it is necessary to examine the other factors that the visual interface affects human solution and solution search of iGA.

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