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Evaluation of Art Style Using AI and Psychological Experiments

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Abstract

GANs (Generative adversarial networks) is a new AI technology that has the capability of achieving transformation between two image sets. Using GANs we have carried out a comparison among several art sets with different art styles. We have prepared four image sets; a flower image set with Impressionism art style, one with the Western abstract art style, one with Chinese figurative art style, and one with the art style of Naoko Tosa, one of the authors. Using these four sets we have carried out a psychological experiment to evaluate the difference between these four sets. We have found that abstract drawings and figurative drawings are judged to be different, figurative drawings in West and East were judged to be similar, and Naoko Tosa's artworks are similar to the Western abstract artworks.

Keywords: Cycle GAN, art style, psychological evaluation

1 Introduction

Recently a new technology of deep learning in AI called GANs (Generative Adversarial Networks) has been proposed [1], and various attempts to create artworks by AI have been carried out. However, many of these methods merely let AI learn the style of a particular painter and output images with the learned style. Is there a different approach to the relationship between AI and art? For example, can AI approach basic questions such as what beauty is that exists at the basis of art, and what the difference between Oriental and Western perceptions of beauty is?

In this paper, a new methodology for approaching the relationship between AI and art will be proposed, and the results of verification through psychological experiments will be shown.

2 Related Works

Recently a new learning method called GANs (Generative Adversarial Networks), that can perform deep learning with a relatively small number of training data, has been proposed [1]. GANs are composed of two networks; a generator network and a discriminator network. By performing learning as a zero-sum game between these two networks, deep learning can converge even with a relatively small number of learning data. By modifying this basic configuration, various GANs have been proposed and interesting results have been obtained. □

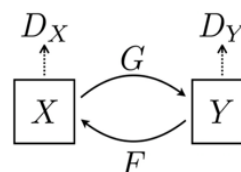


Fig. 1 Basic concept of Cycle GAN.

Among them, Cycle GAN is a new method that enables mutual conversion between two image sets. Figure 1 shows the basic concept of Cycle GAN [2]. In Cycle GAN, when two image sets (X, Y) are given, a transformation function G and an inverse transformation function F between them are considered. Also, two types of errors, D_x and D_y are considered; D_x is the difference between X and X' where X' is the transformation of X by applying G then F and D_y is the difference between Y and Y' where Y' is a transformation of Y by applying F and then G. The training is carried out so that the sum of these two types of errors is minimized.



Fig. 2 Conversion from a landscape photo to a Monet painting using Cycle GAN. ([2])

The feature of Cycle GAN is that, even if there is no one to one correspondence between image sets X and Y , the conversion between them is possible. By using this feature, for example, by learning a group of landscape photographs and a group of paintings of a specific painter, mutual conversion between these image groups becomes possible. Figure 2 shows how a Monet-style landscape painting is created from a landscape photograph [2].

3 Fluid Art “Sound of Ikebana”

The behavior of fluid is an important research subject in physics, and has been studied as "fluid dynamics." It is known that fluid creates extremely beautiful shapes under various conditions. As beauty is a fundamental element of art, it is natural to consider fluid dynamics as a basic methodology of art creation. Naoko Tosa, one of the authors, has been leading a project of creating “fluid art.”

One of the techniques for creating fluid art is the creation of Ikebana-like shapes when sound vibration is applied to paint or other fluids and the phenomenon is shot with a high-speed camera. Based on this method Naoko Tosa created a video art called "Sound of Ikebana [3]," which was exhibited in April 2017 using more than 60 digital billboards at Times Square in New York (Fig. 3).

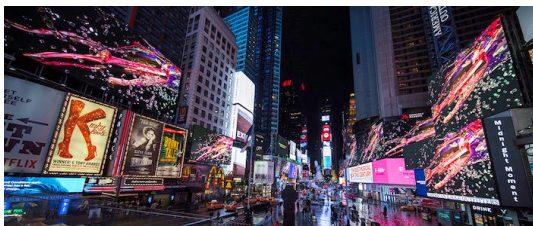


Fig. 3 "Sound of Ikebana" at Times Square in New York.

It was interesting that the video art mentioned above let the authors consider what beauty is and also what Japanese beauty is. When Tosa exhibited her media art around the world, many foreign art-related people indicated, "Tosa's media art expresses a beauty hidden in physical phenomena, which might be the core of Japanese beauty." Inspired by this, the authors would like to compare Western and Oriental artworks using AI.

4 Framework of This Research

Although Cycle GAN can carry out the transformation between two image sets, so far, reference [3] merely states that landscape photographs could be converted into Monet-style paintings and vice versa. But the authors consider that Cycle GAN could be applied to research investigating the relationship between art and beauty. Considering that art is an essential feature extracted from real or natural objects, it is possible to use Cycle GAN to convert between real objects or natural phenomena and art that extracts their essence. In the long history of art, the painting originally tried to imitate nature. As the times go down, however, the impressionism was born

that tries to paint the light and its transitions perceived by human eyes. Later, however, the history of Western painting was followed by Cubism and Surrealism, and recent abstract paintings. Nevertheless, artists extract essential things they felt in their hearts from the surrounding nature and made them into abstract paintings.

On the other hand, the history of Oriental painting is characterized by the fact that the painted objects have been clear since ancient times. Rather, it is characterized by the direction of minimalism that removes color like ink painting and by the way of drawing emphasizing the characteristics of the object like Ukiyo-e and remains at the level of figurative painting compared to the West. In such a situation, how is “Sound of Ikebana” described earlier positioned in the history of Oriental painting? It does not depict landscapes and looks like abstract images/videos. Nevertheless, as mentioned earlier, many people said "The artwork has the feeling of Japanese beauty." Is it possible to use AI style conversion functions to find out how the Sound of Ikebana is positioned compared to Western and Oriental figurative and abstract paintings?

In this study, this important and interesting issue is approached using Cycle GAN as follows.

(1) Two types of image sets (image set A, and multiple image sets B1, B2, ...) are prepared. The image set A consists of photos of natural phenomenon. And each of B1, B2, ... consists of art images.

(2) Using Cycle GAN, mutual conversion of an image set A and multiple image sets B1, B2, .. are achieved to obtain conversion functions (G1, F1), (G2, F2), ... (Fig. 4).

(3) A psychological experiment is performed using the image sets G1(A), G2(A), ... that are obtained by performing the conversion G1, G2, ... to the image set A. In the psychological experiment, questionnaires such as "Can you evaluate it as art?" "Do you feel beauty?" are filled by the subjects.

By doing this, it is possible to verify depending on different art styles what kind of information is extracted as essential information from real objects and made into artworks.

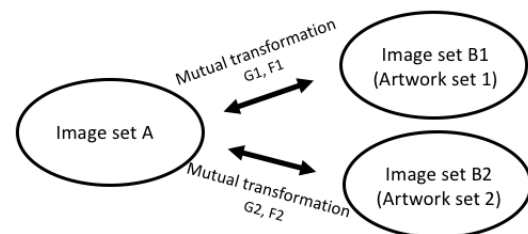


Fig. 4 Mutual conversion between two types of image sets.

5 Learning of Various Art Style and Transformation of Art Style

The following image sets were prepared. (Resolution of all images are 256x256)

Image set A: 8069 flower images

Image set B1: 1072 images of Monet paintings of flowers.

Image set B2: 123 images of Kandinsky paintings.

Image set B3: 238 images of Chinese hand-painted flower painting called “Gongbi.” (Stanford University project "Chinese Painting Generation Using Generative Adversarial Networks")

Image set B4: 569 images selected from "Sound of Ikebana."

The image set B1 includes paintings drawn by the Impressionist Monet as a representative example of the Western figurative paintings. As a representative example of Western abstract paintings, Kandinsky paintings were prepared as image set B2. Image set B3 includes flower paintings of Chinese hand-painted painting, called “Gongbi [5],” as a representative example of Oriental figurative paintings. Image Set B4 is a set of still images taken from the media art "Sound of Ikebana." As the Sound of Ikebana is made from a physical phenomenon, it should not be said that it originally contains "Japanese beauty." In this experiment, the art style of the Sound of Ikebana was compared with Western and Oriental representative painting styles.



Fig. 5 Examples of conversion from flower photos to Sound of Ikebana style images.

The image set A was converted to the four types of different image set B1, B2, B3, B4 using the Cycle GAN. Figure 5 shows examples of the result of the conversion from the flower photos to the Sound of Ikebana like images.

The question here is why Monet art, Kandinsky art, Chinese Gongbi art, and Sound of Ikebana images were not directly compared and evaluated using psychological experiments. There have been some studies that evaluated artworks through psychological experiments [4]. However, by using a copy of the original artwork, it can be relatively easy to identify the artist for each art. For example, knowing that a painting is Monet's art suggests that a subject has a prejudice of the work of Monet and that this will have a significant effect on evaluation experiments.

On the other hand, using GAN allows for AI to learn an art style and to apply the art style on the input images. Therefore, bias can be avoided in the evaluation experiment and this is the benefit of using AI to evaluate artworks.

6 Evaluation of Obtained Results Based on

Psychological Experiment

By having people evaluate the results of applying various style transformations to various flower images, it might be possible to know what art is, what is the beauty behind it, and the culture of beauty. There may be suggestion on how people perceive Japanese beauty and the corresponding Western beauty. That is the goal of this research. Since this is a subjective evaluation, a method used in psychological experiments, which is to present a target image to a subject, to conduct a questionnaire survey, and to statistically analyze the results, was used.

6.1 Psychological experiment

Image groups, Goup1, Group2, Group3, and Group4, are prepared by selecting two images from each of image sets G1(A), G2(A), G3(A), and G4(A) obtained by converting image set A into image sets B1, B2, B3, and B4. The resolution of each image is 256x256.

Twenty three Kyoto University students (12 male and 11 female, all are Japanese) were used as subjects. The gender ratio is almost half. Each of 8 images was printed out on A4 high-quality paper, and the eight images were presented to the subjects. The order of the presented images was set randomly for each subject. The subjects were asked to perform a seven-step subjective evaluation of the 6 items shown in Table 1. These items were selected to identify the difference between the Oriental and Western art styles.

Table 1 Adjective pairs used for evaluation

Individual - Ordinary	Bold - Careful
Dynamic - Static	Artistic - Non-artistic
Stable - Unstable	Oriental - Western

6.2 Analysis

The results of the subjective evaluations by the 23 subjects for six items, were averaged for each evaluation item, graphed, and t-tested. Figures 6 – 8 show the results of the averaged value and the standard error for each evaluation item. Also, the results of t-analysis (**:1%, *:5%) are shown on these figures.

6.3 Discussion

(1) Group 2 vs Group 4

Group 2 and Group 4 received similar evaluations. This indicates that there is a small significant difference between the style of Kandinsky and that of Sound of Ikebana. Conversely, Group 4 is evaluated as having a significant difference from Group 1 and Group 3 for all items except “Oriental-Western”. This indicates that the Sound of Ikebana is considered to be abstract rather than figurative. The Sound of Ikebana can be positioned in the history of the transition from figurative painting to abstract painting in the Orient.

(2) Group 1 vs Group 3

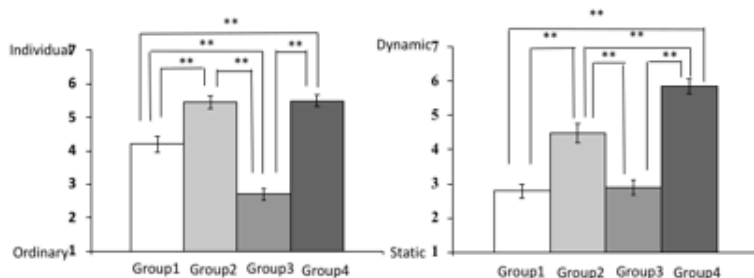


Fig. 6 Subjective evaluation results for "individual-ordinary" (left) and "Dynamic-Static" (right). (Group1: Monet-style flower images, Group2: Kandinsky-style flower images, Group3: Chinese figurative art-style flower images, Group4: Naoko Tosa art-style flower images.)

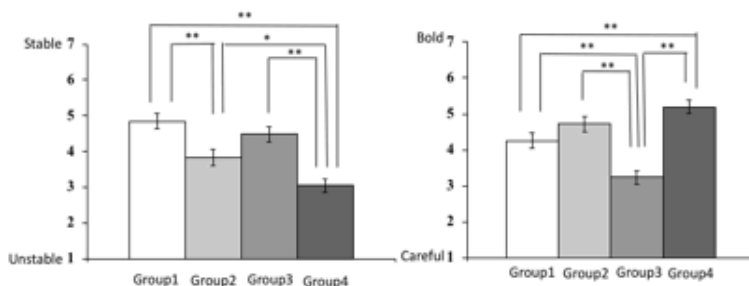


Fig. 7 Subjective evaluation results for "Stable-Unstable" (left) and "Bold-Careful" (right).

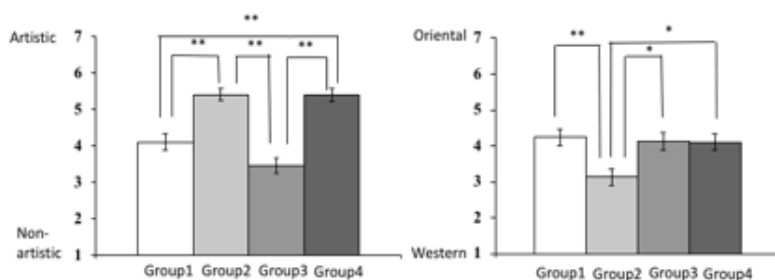


Fig. 8 Subjective evaluation results for "Artistic-Non-artistic" (left) and "Oriental-Western" (right).

Similarly, Group 1 and Group 3 received similar evaluations. In particular, the hypothesis that there is a significant difference of 5% level between Group 1 and Group 3 for the "Dynamic-Static" and "Artistic-Non-artistic" items have been rejected. Group 1 is an image set with the Western Impressionism style, and Group 3 is an image set with the Oriental figurative painting style. These styles may have something in common in an essential part.

(3) Artistic or not

It is interesting to note that Group 1 and Group 3 are around or below the median value of 4 for "Artistic-Non-artistic." Few people will rate Monet's original image as unartistic. Chinese hand-painted paintings have also been highly evaluated as elaborately depicting nature. However, Groups 2 and 4 are evaluated as being higher artistic than Groups 1 and 2. This is thought to be due to the young age of the subject. They may have an aesthetic sense appreciating abstract paintings. Also, this means that our principle of using the converted photos with a specific art style instead of the original artworks worked well. By using the original art image for evaluation,

it was relatively easy to identify who the artist is and this had a significant effect on the evaluation.

(4) Oriental or Western

As shown in Fig. 8, the answers to the question of Oriental or Western are all around the median of 4 except for Group 2. This indicates that the subject did not identify whether Oriental or Western for the artworks in these groups, and gave a response near the middle. This seems to indicate that at this stage, the art style extracted by AI has not yet reached a level to identify Western or Oriental impression.

7 Conclusion

In this paper, a new method of handling art with AI was described by using GANs to investigate where is the difference in art style, and what is the essence of the difference in aesthetic sense between Oriental and Western beauty.

By using the method proposed in this paper, subjects evaluated the styles of Western and Oriental figurative and abstract paintings without bias created by identifying specific artists and/or artworks. As a result, it was shown that the figurative drawings of the Orient and the West are not very different. Also, it was shown that one of the authors' work, "Sound of Ikebana," has no significant difference from the Western abstract drawings.

However, it is not enough to clarify why the Sound of Ikebana is evaluated by Westerners as Oriental in the scope of this research. It is our future work to clarify this.

Also, it is necessary to use Western subjects to know the difference of sensitivity between Oriental and Western people.

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