Selections by the computer from the five years' stock of Daily Evolved Animations
(Installation)

Topic: (Evolutionary Art, Evolutionary Critic)

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Abstract
As a challenge to make the machine that makes art, a machine in the author's laboratory has been working to create ten art pieces everyday since October 2011 under the project named Daily Evolutionary Animations [1]. Each of the pieces is a type of animation of 20 seconds composed with abstract drawings as the frame images, evolutionarily selected based on a computational aesthetic measures through 300 steps of generational changes. More than 18,000 pieces in total have already been stocked in the server machine so far. Though the author carefully designed the evaluation criterion for the genetic algorithm implemented in the system, the results still do not always satisfy the human's aesthetics.
It would be a reasonable strategy to improve the fitness criteria as to fit more with human's aesthetic measure, but it is also nice to collect the better pieces from the stock according to evaluation by a type of Artificial Critic in order to save the five years of efforts by the system.
To design an appropriate evaluation function, the author choose a number of pieces from 920 pieces produced from January 1st to April 1st of this year, as both positive and negative examples for training a machine-learning system. The target function is to calculate the grade point for each piece based on the values of the twelve elemental features used for evolutionary system of daily production. We already have several types of methods to solve such type of optimization problem such as Statistical Cluster Analysis, Artificial Neural Networks, Support Vector Machine, and so on. Here the author employed a technique of Genetic Programming as the first trial. Through thousands of steps for each of a number of different settings of the algorithm, it found a function that can grade all of 920 samples not perfectly but in acceptable level.
This installation is to display the selections from all of the pieces in the stock from October 14, 2011 to September 2, 2016. The selections contain 3,560 pieces that got higher grade by the evaluation function found though the above algorithm. Because the total duration for all of these pieces is almost 20 hours, the installation will show the pieces in turn within the allowed hours in the exhibition. The data for these animations are not in a form of movie file but program fragments in a shading language of OpenGL. This feature is useful not only to reduce the size of data storage but also to realize lossless images for each frame in high resolution even in 4K. It will be displayed using a 4K monitor or a Full HD projector depending on the availability of the equipment and the environmental situation of the exhibition site.

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Key words: evolutionary art, machine that makes art, artificial critic.

Main References:
[1] Tatsuo Unemi, "*Automated Daily Production of Evolutionary Audio Visual Art - An Experimental Practice*", in Proc. of the Fifth Int. Conf. on Computational Creativity, Session 2-2, Ljubljana, Slovenia, 2014.

Selections by the computer from the five years' stock of Daily Evolved Animations

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Premise

The author has been conducting a project named Daily Evolved Animations since 2011 in which the computer automatically produces ten short animations everyday using a technique of evolutionary computing. Though the author carefully designed the fitness criterion based on computational aesthetic measures, it does still not always fit with the human's aesthetic recognition. To save those more than 19,000 pieces stocked in the server machine, he organized a genetic programming to find a function to select the better ones giving a collection of evaluations by himself as training examples. The installation shows a consecutive playback of those pieces of top 20%.

1. Automated evolutionary production of art pieces

Challenges to design a machine that can produce art have been conducted since 1980s, as a famous pioneering work named AARON by H. Cohen [1]. Its successor, Shizuka by K. Mukaiyama [2], is also driven by a set of rules that indicates how a human painter draws an art piece. On the other hand, borrowing a power of computer that can calculate massive computation much faster than human without any mistakes, evolutionary computation has been employed as a technique for automated massive production combined with computational aesthetic measures [3,4]. The author has also been conducting such a project named Daily Evolved Animations [5] since 2011 in which the computer automatically produces ten short animations everyday. Though the author carefully designed the evaluation criterion referring the previous works, it does still not always fit with the human's aesthetic recognition.

2. Artificial Critic

There are a lot of philosophical literatures concerning *aesthetics* in the human history. As similar to finding what the nature is, we can find different ways of thinking of aesthetics. The following part of this section describes short summaries of rationalism and empiricism from a viewpoint of machine aesthetics.

2.1 Mathematical rationalism

When we recognize something beautiful or ugly, we interpret the look as a type of information. Beauty is a positive interest and ugliness is a negative interest. This means that one of necessary condition of beauty is how the stimulus from the object is informative. A mathematician D. G. Birkhoff [6] proposed an equation that calculates the ratio between signal and noise as an aesthetic measure that has been supported by researchers of machine aesthetics for many decades. We feel no interest if the stimuli is too simple or too complex. M. Bense [7] also wrote literatures on his philosophical consideration about aesthetics from similar point of view. A number of his successors tried to produce art works following this idea, such as H. Kawano [8]. J. Schmidhuber [9] is a notable computer scientist and artist pursuing both theoretical and productive aspects along this direction.

Such type of thought is to seek the universal law valid in general even without human. This idea must be important to consider the possibility of art by the machine for the machine, even if there is no aesthetic criterion sharable with human.

2.2 Cognitive empiricism

It is obvious that the phenomenal evidence of aesthetics is the cognitive function of human. The approaches of *soft computing* to produce an optimized design fitting with human mind and emotion should be useful to develop a machine that makes art. Fuzzy logic provides a formal framework to express informal intuition by human, artificial neural networks, typically in deep learning, extracts hidden relationship between data, and genetic algorithm constructs complex structure adapting to a complicated situation.

There are a number of challenges to estimate the human's criteria of subjective preference by the methods described above, such as Yang Li [10]. It looks useful to design an individual piece for the customer, but is not always helpful from a viewpoint of fine art because the criteria should be a combination of a number of aspects strongly dependent each other.

3. Genetic optimization of evaluation function

By the author's observation on more than 19,000 pieces produced through the project of Daily Evolved Animations, it is a mixture of wheat and chaff. Because this type of evolutionary art makes care about only on the visuals in perception level but never on recognition level nor interpretation level, what we need to consider is whether the image is interesting or not as a visual stimuli.

The author organized a type of machine learning that predict if a given piece is good or bad, based on the statistical features of resulted frame images. The training data is a collection of examples on which the author judged it is good, bad or neutral. He observed 920 pieces produced from January 1st of 2016 to April 1st, then marked 158 *good* pieces, 113 *bad* pieces and 649 *neutral* pieces. He tried to organize a discrimination filter into two categories, good and bad, by *support vector machine*. It worked well for the training example, but it looks not so good when he checked it by cross validation to measure how the learned boundary by the subset of training examples discriminates well the rest set of the examples.

Instead of discrimination filter, the author examined genetic programing, a type of evolutionary computing that finds an optimal function expression. The target function is to calculate the grade point for each piece. The fitness criterion is how well the grade point is useful to distinguish good and bad pieces by assigning higher points to good pieces and lower points to bad pieces. The fitness $F(f)$ is calculated based on the ranks $r(f,p)$ of pieces p in the list sorted following the grade points calculated by the candidate function f, as shown in the following equations.

$$F(f) = \sum_{p \in P} g(r(f,p), m(p))$$

$$g(k,l) = \begin{cases} \alpha^{k-1} & \text{if } l = \text{good} \\ \alpha^{|P|-k} & \text{if } l = \text{bad} \\ 0 & \text{otherwise} \end{cases}$$

where P is a set of pieces of training example, $m(p)$ is a label indexing human's evaluation, good, bad, or neutral, and α is a constant in the range (0,1). Each piece p is described by a vector of 12 scalar values of features that are used in automated evolution in SBArt [11].

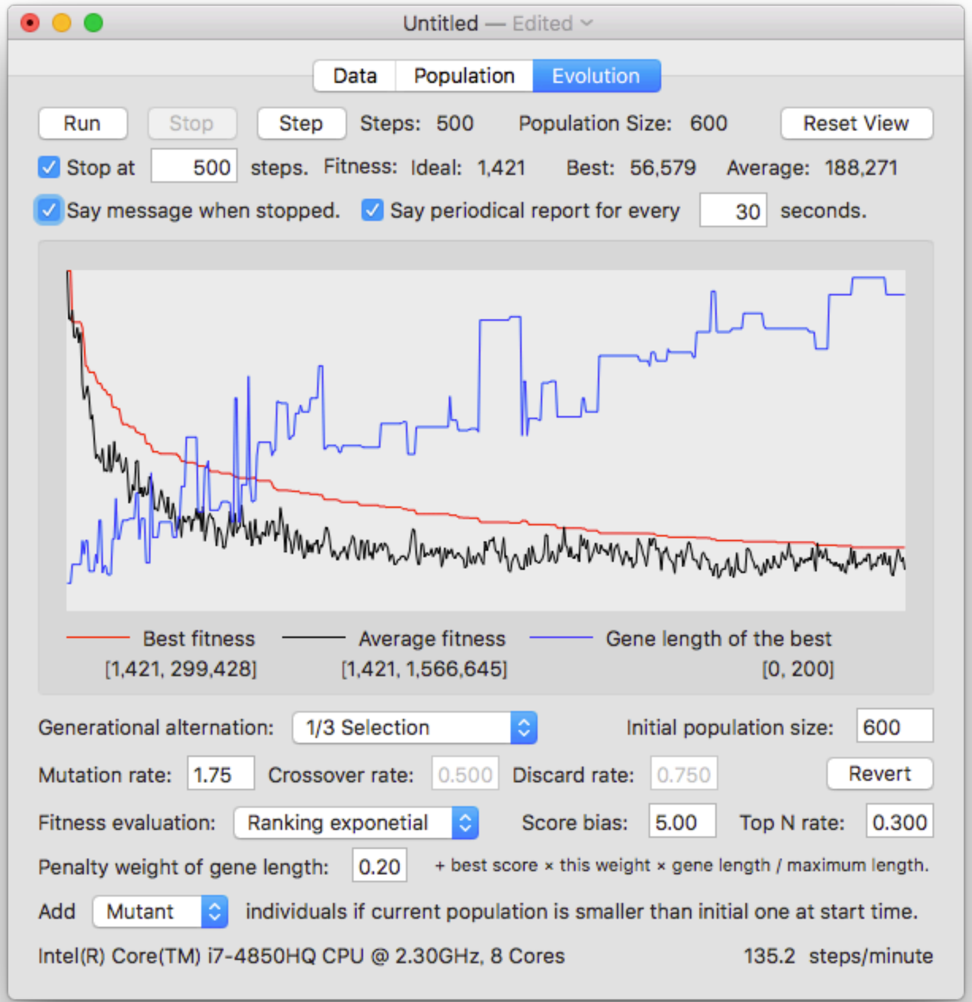

Figure 1. A sample monitoring view of evolutionary process to optimize a function that calculates the grade point for each piece in the training example.

Figure 1 shows a sample of monitoring view of evolutionary optimization process in which the population size is 600, generational alternation is by 1/3 selection [12], and mutation rate is 1.75 divided by the gene length. After a number of trials of a variety of parameter settings for the process including local mating [12], an alternative model of generational change, a promising function was obtained as sown below.

exp(max(max(cos(-SE),min(max(0.370446+ME,max(max(sin(sin(log(ME))-(sin(log(-log(HH)))-0.366921)),max(MT^cos(max(HH/max(GC,0.454969),ME/FT)),CP*cos(sin(-0.776241/SA)))^0.761739),CP*log(MT*CE/EA))^CP),sin(0.7865+max(sin(GC+HI/GC),SS^cos(exp(ME)))))),max(sin(log(EA*(EA-sin(exp(CP))))),max(ME,max(ME,max(sin(EA*(log(MT)*(EA/sin(GC)))),min(ME*MT,CE*(sin(sin(log(ME))-(0.125628-HH*HI))*(min(SA,SS)*exp(exp(EA)+0.261546))))*(-GC*sin(sin(SS))^max(cos(GC-cos(exp(CP))),EA)))^0.135918)^sin(sin(sin(CP))))))^min(CP,log(ME^cos(EA))^cos(EA)))+0.71765/(cos(CP)+(0.135918-HH)^((sin(min(0.377795,SS))-min(HH*CP/sin(EA),EA/GC))^((min(ME,CE)+(0.764454-CE))^CP/max(ME,0.341475))))

The symbols of two capital letters in the above expression are an element of the vector that describes the target piece. The summary is as follows.

HH = hue histogram, HI = intensity histogram, EA = edge angle distribution, GC = global contrast factor, CE = evaluation value of complexity, CP = estimated complexity, SE = evaluation value on saturation distribution, SA = average saturation, SS = standard deviation of saturation, ME = evaluation value on motion factor, MT = motion factor, FT = original fitness value used in Daily Evolved Animation, where *evaluation value* means the fitness with the ideal value given by the author as the preset of Daily Evolved Animation.

4. Exhibiting the selections

It would be natural to embed the obtained function into evolutionary system for the project of Daily Evolved Animation. Instead, the author used the function to organize selections from 18,000 pieces that have been produced for these five years. These are stocked in the server machine of the author's laboratory. This means that the function took a role of an *artificial critic* who recommends pieces to be exhibited. This is also good to save five years of the effort by the computer system. Sorting a collection of all pieces produced in the period from October 14, 2011 to September 2, 2016 by the grading function, the author picked up the top 20%, that is 3,560 pieces, to be exhibited in turn. As each piece is 20 seconds animation, the total duration of playback is 20 hours.

The data for these animations are not in a form of movie file but program fragments in a shading language GLSL of OpenGL. This feature is useful not only to reduce the size of data storage but also to realize lossless images for each frame in high resolution even in 4K. It will be displayed using a 4K monitor or a Full HD projector depending on the availability of the equipment and the environmental situation of the exhibition site.

Figure 2 shows the frame image examples of top 10 pieces.

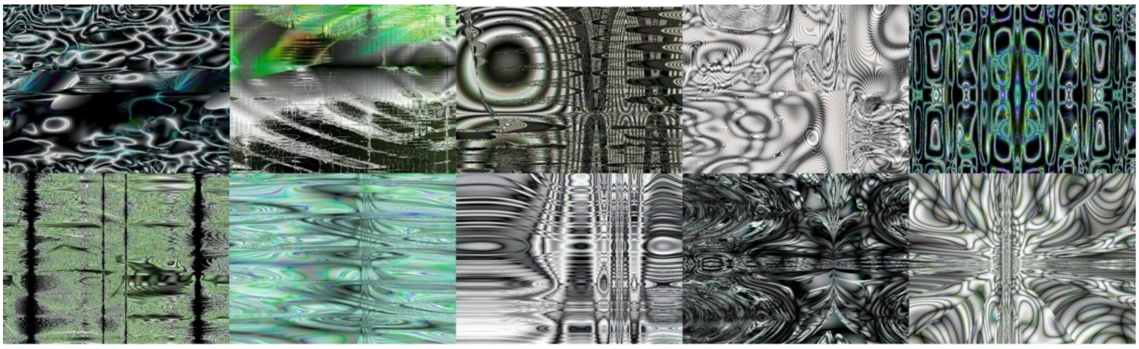

Figure 2. Frame image examples of top 10 pieces.

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