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# Aesthetic Cognition: An Attempt for Implementation in Computer Systems[1]

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**Abstract**

We try to use some views of philosophy of science to advance in solving intellectual obscurity (lacunas) in human mentality that redound aesthetic foe. Our aim is trying to transfer aesthetic as knowledge to computer systems using fuzzy sets. An example is given to clarify our ideas.

**AMS Subject Classification:**
**Keywords:** Aesthetic, cognition, knowledge, fuzzy set.

## 1. Introduction

We are going to try to make clear the following questions:

1. What is aesthetic?
2. What are the aesthetic scales? Are there any specified scales?
3. Can human specify all of aesthetics and aesthetic foes?
4. If "Yes", how can we transfer these to computer systems?
5. If "No", what can we do to empower computer systems to get this knowledge?

[1]This paper is a revised version of [1].

Throughout the centuries human is trying to know aesthetic and its rules, and so the philosophers have pondered over the questions related to it. Actually human does trying everything to be on this aesthetic rules. Despite of the human awareness, wanted or unwanted, his or her doing is on this way and it is scaled by these rules.

As everything (s)he is doing is to get a goal, and reaching to this goal has a satisfaction that can be a kind of aesthetic itself. However, esthetic is consequently a reminder to a beauty which is always coherence with joy, but in fact, it has caused many obscurities and problems in human life. In another meaning it has made aesthetic foe itself [2]. Supposing the world is made on this pivot, it is wise to proceed directly on this main aesthetic cognition disillusion. In this case we can solve at least many obscurities, if not all of them.

In the next sections we try to use some views of philosophy of science to advance in solving intellectual obscurity (lacunas) in human mentality that redound aesthetic foe. An example is given to clarify our ideas in transferring this aesthetic as knowledge to computer systems.

## 2. Some Views on Aesthetic Cognition

Up to now no one could produce exact description of the meaning of aesthetic and maybe it will be never happen. Aesthetic includes a very expanded area. Aesthetic of morality, aesthetic of art such as music, painting, calligraphy, plastic arts, aesthetic in science, and even aesthetic in thought, etc. To elucidate, one can see that all voices in the world, all painted tableaus and all poets styles, all of thinking styles, all of religions, all of philosophical theories or opinions can be beautiful and at the same time can not be beautiful, of course depending on a person's view. Because they are relative and the scales are not implicit, everyone can define his descriptions, depending on his or her own sensibility of mind, which is effected by many parameters such as race, ethos, nationality, history and so on, all which can make philosophy of thinking. That is why from a black human view, a black face will be pretty whereas from a white one view may be something else. Surly, many people tried to define these aesthetics in their own thinking style and wanted to stereotype them, but its brittle is a sign to discordance of human mettle. Actually, these thinking styles have tried to bring the individualized relative opinion to an absolute one, such as ultra-nationalism and ultra-religion. It seems that, implicitly, they have based their style on the Aristotle logic with only two valuations, *yes* or *no*, the most specified aesthetic scale of the past art, which one can recognize and alloy easier. But the first question for clarifying is this; can we scale and recognize nowadays world, which is full of anarchy with this yes-or-no logic? If not, why? And so by which logic? At least we can mention the following logics: Aristotle, Dialectic and Fuzzy logic [3, 4, 5, 6, 7, 8, 9, 10, 11, 12].

The first logic is the Aristotle logic, where anything is own self and not else, and anything except itself is not it. In mathematical way anything is X and except X there is no X. In this logic, a human can have white color of skin and no more and except it there is no human. But, many attempts have tried to oppose with this yes-or-no logic and have

asked to have degrees between these two poles. These attempts, at first, may seem to be an anarchy and a chaos, but in fact it is not so. Even if it is anarchy, it would makes the regular system organized [13]. Of course, we shouldn't make least alloy for this yes-or-no logic, but even if it would be possible to recognize the nowadays world by this logic, which is full of anarchy, then according to high quality of solicitude (precision) needed in this logic, it takes much time that may be we can never get our goal.

The second logic is dialectic logic that invented by G.W.F. Hegel the German philosopher in nineteen century, who developed a dialectical scheme that emphasized the progress of history and of ideas from *thesis to antithesis* and thence to a *synthesis*. In this philosophy every variation was accounted. Here, it was believed, as time increases, X is changing to non-X, opposed to Aristotle philosophy. The process of this variation are thesis , antithesis and synthesis. Everything has it's own foe thing (foe material) inside itself, and variation is being starting from itself to its foe, in every specified case. From this view everything is relative, except dialectic itself which is implicit. But can we solve all our problems by these two above mentioned logics? Khwarizmi an Iranian mathematician and philosopher [14, 15], invented a method to solve problems, that is similar to what the computers do today's. In this method, that is named on his honor as Al-Khwarizmi, or Algorithm. The problem will be divided into some steps and after solving these steps we can reach to the answer. We can offer various algorithms, each for different problem, but we can not give an algorithm for all problems. To be algorithmic, a problem must have a specified statement and must be composed of specified parameters. So, the problems that are based on inexact, superstition and vagary which are generally cultural, social and humanities problems and specially aesthetic can not be solved by this algorithmic method. But it is interesting when we observe that human mind is doing all its jobs algorithmic with its own self method which it seems to be a fuzzy algorithm.

The third logic is fuzzy logic, invented in 1965, at Berkeley by Lotfi A. Zadeh [3], a famous Iranian originated scientist. The meaning of fuzzy is unvocal, vague, giddy and inexact. Fuzzy logic is retreating from the exact logic of Aristotle. In Cantor's mathematical set theory, each element of the universal set either belongs to a set A or not. That is each element satisfies an exact statement and a proposition is either true or it is wrong. But in fuzzy logic an element can belongs to A with some degrees and it does not belong to A with some degrees too. These degrees are relative in the sense that it is person, social, political, case dependent and so on. This inexactness helps us to understand more of the harmonies in aesthetics, which is depended on its each single member's harmony. Actually some details without any meaning, which even may not be pretty or ugly, when coming together can produce excellent composition and make a great harmony. As an example in the poet that it's beauty is in the composition of gathered words that inducts the whole of sentence meaning, where each of its composed words do not have our needed meaning alone or even it has a bad meaning. We use lens instead of microscope and long shot instead of close up in this logic to be able to find similarities and variations and then analyze them. We must look at the collection of things instead of looking at each its individual ones. When we look at twins we can see many similarities but when we look at them from near and closer side we only see differences.

As we mentioned earlier, it is the same as human thinking logic. If it was not so and human had two values of one and zero logic then his movement could not be so smooth. If human's view was not general and he had not selective mind, one could not find any favorite in a market shop, since in this case one must record all of scenes and pictures like a video camera [13] and then he must process a large quantity of information, which is impossible to get the goal with this quantified information. But what algorithm human is used to select and how reduces this large quantity of information? Human brain has two parts for two types of processing functioning, the brain left and right hemispheres. This is shown in Table 1 [16, 4].

Table 1: Processing in the mind.

| Left hemisphere | Right hemisphereModel |
|---|---|
| Exactness | Inexactness |
| Calculation and so on | Feeling and so on |
| Categorical | Approximation |
| Binary systems | dispositional |
| Two valued logic | fuzzy valued logic |
| | etc |

This diagram could be converted for modeling in the real situations such as applications in artificial intelligent as in Table 2 [16, 4].

Table 2: Modeling in the real situations.

| Hard computing | Soft computing |
|---|---|
| Exactness | Inexactness |
| Two valued logic | Fuzzy valued logic |
| Two valued softwars | Fuzzy valued software |
| Binary systems | Fuzzy systems |
| etc | Probabilistic systems |
| | Genetic algorithms |
| | Artificial neural networks |
| | Ant colony |
| | Rough sets |
| | etc |

In Table 2, by hard computing we mean what we have had in the traditional mathematics based on Cantor set theory which are actually based on the two valued logic. Therefore, for example all the softwares that we had based on two valued logic belong to this category, which are all exact and no place for imprecision on them. On the other hand, by soft computing, we mean the new generation of mathematics or engineering,

which tolerate the inexactness of the world and try to use it in modeling rather than rejecting it. As we see here, the questions appeared in 1-3 in section 1 come to the existence and we see that in the fashion that we process the information in our brain we have the counterparts in mathematics, engineering, art and so on, under the name of soft computing. This is what we need for machine intelligent quotient (MIQ) to be implemented in robots. Note that our technology has already achieved to simulate the right hemisphere of the brain functioning through centuries efforts, by creating lastly the high speed digital computers which are an emerging in all high technologies. But, the simulation of the right hemisphere of the brain is started increasingly to bring into machines the MIQ needed to communicate with human. This simulation is going on by developing theories like fuzzy sets [3], rough sets [17, 18] for reasoning process, neural networks [19] for learning process, ant colony [20] and genetic algorithms for optimization process and so on. In order to elaborate more on the hard and soft computing, we give more explanation. Assume we have an input-process-output system.By taking into account the two kind of exactness and inexactness for each component of the system, we can realize eight situations for this diagram as shown in Table 3 [21, 16].

Table 3: Eight realizations for input-process-output systems.

| | Input | | Process | Output | Real World Example |
|---|---|---|---|---|---|
| 1 | Exact | | Exact | Exact | Classical Mathematics |
| 2 | Exact | | Exact | Inexact | |
| 3 | Exact | | Inexact | Inexact | |
| 4 | Exact | | Inexact | Inexact | |
| 5-1 / 5-2 | Inexact | Fuzzy / Probabilistic | Exact | Exact / Probabilistic | Fuzzy controller |
| 6 | Inexact | Fuzzy / Probabilistic | Exact | Inexact \| Fuzzy | Fuzzy mathematics |
| 7 | Inexact | | Inexact | Exact | |
| 8 | Inexact | | Inexact | Inexact | Human, Animals |

In Table 3, we see that the last line is the simulation of the human mind and it is needed for any artificial intelligent implementation. This is actually in the direction of answering the questions 4-5 in Section 1. How one can observes the real world situations, makes them into the models and then predicts from these models the required aesthetic is explained in the next section as a fuzzy expert system.

## 3. Fuzzy Expert System

The goal of the expert system [22] is to employ human knowledge and experience in the field where conventional technologies do not apply. The process of uncertainty is, therefore, a crucial step to the expert system. From this observation we see that the expert system needs fuzzy theory and fuzzy theory needs the expert system for its most

important applications, fuzzy inference is absolutely appropriate for the framework of the fuzzy expert system [10]. In a fuzzy expert system, first, ask human experts. Have them write their know-how in a natural language, i.e., the sentences in which they usually speak. Convert the language into a bunch rules such that "if ... then it becomes ..." or " if ... then do ..." by setting the words in the rules as fuzzy sets, the experts give subjectively the corresponding fuzzy sets to the words. The rules used in the fuzzy expert system consists of some fuzzy sets, and so called fuzzy rules. The attempt to have computers make inference using uncertain human knowledge in conjunction with fuzzy sets open up a new field. A fuzzy rule is in the form:

*If X is low and Y is high then Z in medium,*

where, X and Y are input values and Z is output value. Low, high, and medium are fuzzy sets. Rule base is called to the collections of rules that is used on fuzzy expert system. In the Antecedent part it would be specified that how much degrees are believable with rules and in Conclusion part for each output values it would specified how much degrees are believable for the conclusion as an output. An overview of a fuzzy expert system is shown in Figure 1 [12].

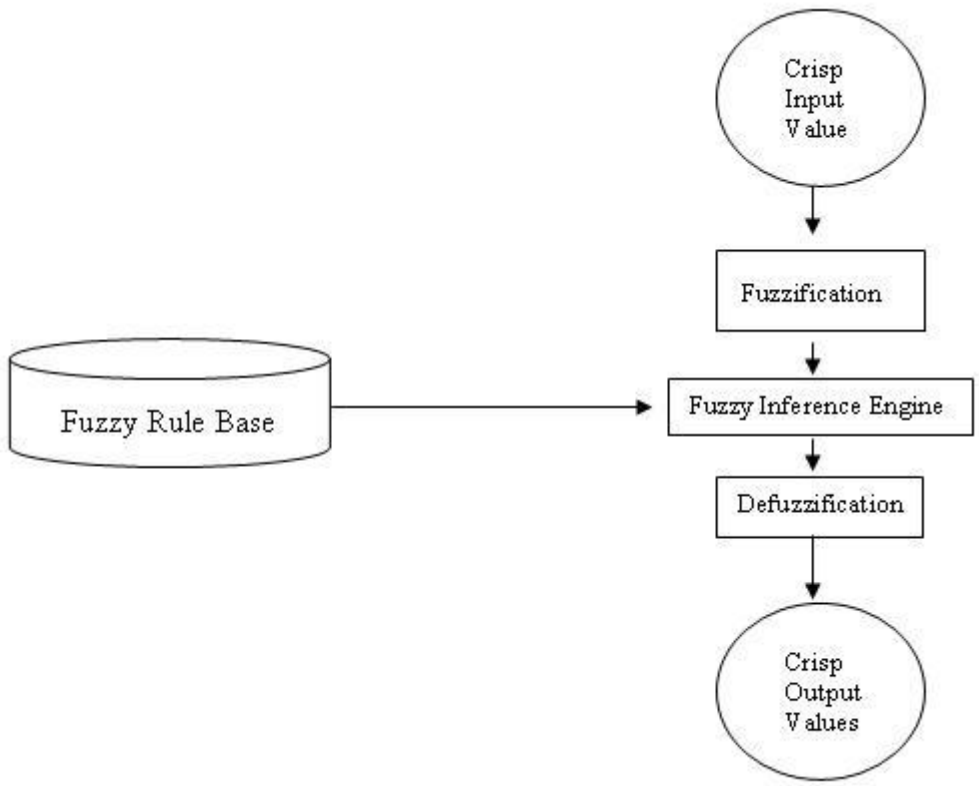


Figure 1: Overview of fuzzy expert system model.

### 3.1. Understanding an Aesthetic

Let's give an example to see how one can observes the real world in different domains and how aesthetic would be extracted.

**Example 4.1.** Suppose a music composer wants to show a scene of a war. First (s)he studies in depth the real situation of that scene which we call The *Real World (RW)*. Actually RW is very complex, has no aesthetic at the first glance contact and has many unbelievable ambiguous aspects unknown to the composer. Then the composer makes his imagination into a very simple world, which we call it *Abstracted World (AW)*. The composer does trust on AW even it may be wrong in reflecting RW. Based on this AW the music product - notes, are created which is aesthetic which we call it *Guessed Aesthetic (GA)* or *Guessed Knowledge (GK)*. This GA should be a prediction of the RW. If the notes are played and the listeners had the feeling of a war, then whole process is evaluated to be correct. Otherwise the composer should revise the process. This revision process is called *Evaluation*. We call this whole process, *Aesthetic Modeling Process (AMP)* as shown below in Figure 2, see [23, 24].

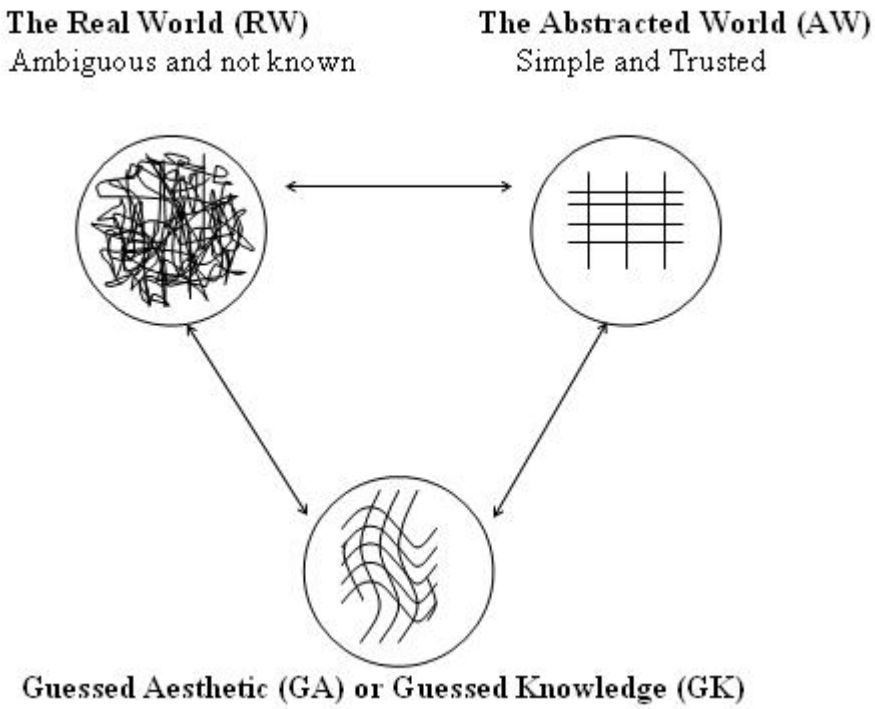


Figure 2. Aesthetic Modeling Process (AMP).

**Remark 4.2.** One can follow Example 4.1 to explain AMP for a painter, a mathematician, a theologian, a poet and so on. This means that this modeling process is a dynamic process which is person dependent, time dependent, context dependent, political dependent and so on. Therefore, the aesthetic cognition is dynamic and care should be done for its implementation on a computer to be applied in MIQ as explained in Section 1.

### 3.2. An idea of implementation of the AMP into a computer system

Let us try to show how one can simulate AMP by computers. To keep the consistency let's explain the idea of Example 1. The music composer first will translate his aesthetic cognition of the abstracted world into a set of rules to make its fuzzy expert system. These rules are, of course, fuzzy rules [11], reflecting the aesthetic cognition of the problem which is designed by the composer. They are surly dynamic and depend on the composer as well, as explained in Remark 4.2. Suppose the composer has come up with the following six fuzzy rules:

Rule 1: if the sword sound is *High*, then play *Upper* themes.
Rule 2: if the whine sound is *High*, then play *Upper* themes.
Rule 3: if the sword sound is *Medium*, then play *Medium* themes.
Rule 4: if the whine sound is *Medium*, then play *Upper Medium* themes.
Rule 5: if the sword sound is *Low*, then play *Low* themes.
Rule 6: if the whine sound is *Low*, then play *Lower* themes.

These rules are the emotional cognition of the aesthetic of a scene of a war that is also called a *fuzzy rule base*. To explain how these fuzzy rules could be applied, suppose that composer would like to play a scene of a heavy war according to the following rules:

Rule 7: if whine sound is high and sword sound is High, then war is Heavy
Rule 8: if whine sound is high and sword sound is Very high, then war is Heavy

Now suppose that the compose come up with the following:
Belief degree of "high" for whine sound would be 0.2,
Belief degree of "high" for sword sound would be 0.1,
Belief degree of "very high" for sword sound would be 0.4.
Then using the computation of fuzzy rules [11], we have:
*Min (0.2 , 0.1 ) = 0.1 and Min( 0.2 , 0.4 ) = 0.2,*
and hence *max (0.1 , 0.2 ) = 0.2.*
This means that the belief for playing the *Upper* themes in Rules 1 and 2, is 0.2.

The next step is to code these rules into a computer. The following is the pseudo code of the above fuzzy knowledge base.

#### 3.2.1 Pseudo code for the aesthetic cognition of a composer function

```
Found_emotion (the perceived sound)
        {
        sword_membership = find_sword_membership (the perceived sound)
        whine_membership = find_whine_membership (the perceived sound)
        return (FRBM (sword_memberhip, whine_membership))
        }
```

where FRBM means the *Fuzzy Rule Base Matching*, sword_membership and whine_ membership are the belief degrees of the composer as a number between zero and one for the sword and whine sounds, respectively.

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