

Baudelaire's Ideas of Vagueness and Uniqueness in Art: Algorithm-Based Explanations

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1. Baudelaire's Ideas About Art

- Jean-Paul Sartre wrote a book about the famous 19 century French poet and essayist Charles Baudelaire.
- In this book, he emphasized the following two somewhat unusual aspects of Baudelaire's attitude to art.
- The first aspect is explicit in Baudelaire's essays: vagueness.
- In a well-studied passage of his book *Fusées*, Baudelaire defines beautiful as

“Something a little vague, which leaves room for conjecture”.
- This may sound almost trivial now, after the Impressionists changed our understanding of Beauty.

2. Baudelaire's Ideas About Art (cont-d)

- However, in Baudelaire's time:
 - beauty was still mostly measured by the Renaissance giants such as Leonardo da Vinci or Rafael,
 - with their highly realistic details.
- At that time, this was definitely an almost heretical thought.
- The second aspect is not so explicit, but can also be traced to many of his essays and letters: uniqueness.
- In order to create someone beautiful, one needs to create something truly unique.
- Repetition is an antithesis of beauty.
- This also sounds somewhat heretical.
- Indeed, there seems to be often a lot of similarity between several beautiful paintings.

3. Baudelaire's Ideas About Art (cont-d)

- How can we explain these ideas?
- In this talk, we show that both seemingly counterintuitive ideas can be explained.
- We explain them within a proper algorithm-based formalization of:
 - what is beautiful and
 - how can we design a beautiful object.

4. Birkhoff's Approach

- In the 1930s, Garrett D. Birkhoff – a founding father of lattice theory – develop a theory of beauty.
- Beauty B can be described as the ratio $B = \frac{O}{C}$ between properly defined order O and complexity C .
- In the simplest cases, he formalized these notions – and showed that his formula is indeed working.
- In his examples:
 - complexity C was the number of construction steps needed to construct the given object, and
 - he defined order as a simplicity of the description:
 - if we can describe an object by using a shorter text, then its order is higher.

5. Birkhoff's Approach Reformulated in General Algorithmic Terms

- Birkhoff's theory appeared before the general development of algorithm theory.
- Now we are accustomed to the notion of algorithms.
- So, it is natural to reformulate his theory in precise algorithmic terms.
- In these terms:
 - the number of construction steps simply becomes
 - the number of computational steps,
 - i.e., the computation time $t(p)$ of the algorithm p that generates the given object.

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6. Birkhoff's Approach Reformulated (cont-d)

- The notion of order is a little more difficult to formalize.
- In his examples, by a description of the objects, Birkhoff meant:
 - a complete description,
 - i.e., a description which is detailed enough so that, given this description, we can uniquely reconstruct the object.
- In other words, the description can serve as a program for a computational device which:
 - given this description,
 - reconstructs the object.
- In these terms, the length of the description is equal to the length $\ell(p)$ of this program p .

7. Birkhoff's Approach Reformulated (cont-d)

- In these terms, the beauty B of an object should be a function of:
 - the time $t(p)$ and
 - the length $\ell(p)$ of a program p that generates this object: $B = B(t(p), \ell(p))$.
- In computer science, there is a trade-off between the program time and the program length.
- A short program usually uses only a few ideas of speeding up computations.
- Thus, it takes a reasonable amount of time to run.
- If we want to speed up the computations, we must add some complicated ideas and modify the algorithm.
- As a result, to make the program faster, we must usually make it longer.

8. Birkhoff's Approach Reformulated (cont-d)

- Vice versa, we can often shorten the program:
 - by eliminating some of the time-saving parts and
 - thus, by making its running time longer.
- In general:
 - if we cut a bit from the program that generates the object x ,
 - we get a new program p' which is exactly one bit shorter: $\ell(p') = \ell(p) - 1$.
- To generate the desired object x :
 - since we do not know whether the deleted bit was 0 or 1,
 - we can try both possible values of this bit,
 - i.e., run two programs $p'0$ and $p'1$ and find out which of the two objects is better.

9. Birkhoff's Approach Reformulated (cont-d)

- Thus, if we delete a bit, then:
 - instead of running the original program p once,
 - we run two programs $p'0$ and $p'1$.
- Hence, crudely speaking:
 - when we decrease the length of the program by 1,
 - we thus get a double increase in the running time:

$$t(p') = 2t(p).$$

- The new situation is, in effect, the same, the resulting object is the same.
- The only difference is that we now have $\ell(p') = \ell(p) - 1$ and $t(p') = 2t(p)$.

10. Birkhoff's Approach Reformulated (cont-d)

- It is therefore reasonable to require:
 - that the beauty value $B(t, \ell)$ does not change under this transformation, i.e.,
 - that for all possible values of t and ℓ , we have

$$B(t, \ell) = B(2t, \ell - 1).$$

- It can be shown that every function satisfying this property can be described as a function of the ratio:

$$r(p) \stackrel{\text{def}}{=} \frac{2^{-\ell(p)}}{t(p)}.$$

- Thus, the beauty of the object can be described as:
 - the largest possible value of the ratio $r(p)$
 - over all the programs p that generate this object.

11. Is This an Adequate Formalization?

- The ratio $r(p)$ is in perfect accordance with Birkhoff's formula:

$$r(p) = \frac{2^{-\ell(p)}}{t(p)}.$$

- Indeed, the time $t(p)$ is exactly what Birkhoff meant by complexity.
- The numerator $2^{-\ell(p)}$ is a decreasing function of the program's (thus description's) length.
- This is in perfect accordance with Birkhoff's idea of order.

12. Relation to Kolmogorov Complexity

- Maximizing the ratio is equivalent to minimizing its inverse $t(p) \cdot 2^{\ell(p)}$ and to minimizing the binary logarithm

$$\ell(p) + \log_2(t(p)).$$

- From this viewpoint, the beauty of an object is related: to the notion of *Kolmogorov complexity* $K(x)$.
- $K(x)$ is defined as the length of the shortest possible program that generates the given object.
- It is also related to:
 - resource-bounded versions of Kolmogorov complexity
 - that minimize a combination of the program's length and time.
- So, Birkhoff's beauty can be viewed as a variant of resource-bounded Kolmogorov complexity.

13. What Is Vagueness

- Birkhoff's definition is usually applied to abstract objects.
- However, many objects of art describe real-life objects and/or events; for example:
 - a painting can reflect a person or a landscape,
 - a poem can describe some events and/or feelings, etc.
- Real-life objects can be reproduced with different number of details; for example:
 - we can have a photograph that captures all the details of an object,
 - or we can have a blurred image or even a silhouette, where many details are missing.
- This is exactly what is meant by vagueness – that some details are missing.

14. Why Is Vagueness Important for Beauty

- For each object of art a , we define its beauty $B(a)$ as:
 - the largest possible value of the ratio $r(p)$
 - over all programs that generate this object.
- For the same original real-life object x :
 - for reproductions x_v corresponding to different levels of vagueness v ,
 - we have, in general different value of beauty $B(x_v)$.
- Our goal is to make the most beautiful object of art.
- So, we should select the level v for which the corresponding beauty $B(x_v)$ is the largest possible.
- There are many possible levels; let us denote this number by $L \gg 1$.

15. Why Is Vagueness Important (cont-d)

- A priori, we have no reason to assume that one of these levels is more susceptible to beauty:
 - we can enjoy Leonardo’s madonnas with lots of detail, and
 - we can enjoy impressionistic painting where most details are missing.
- So, it is reasonable to conclude that each of these levels is equally probable to be the most beautiful one.
- This reasoning goes back to Pierre-Simon Laplace – one of the founders of probability theory.
- It is therefore known as Laplace’s Indeterminacy Principle.
- So, each of the L levels has the same probability $1/L$ to be the most beautiful.

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16. Why Is Vagueness Important (cont-d)

- In particular, this means that:
 - only with probability $1/L \ll 1$,
 - the most beautiful level is the level of all the details.
- In all other cases, the most beautiful level corresponds to some vagueness.
- This explains Baudelaire's observation that:
 - in the overwhelming majority of cases,
 - vagueness is an important attribute of beauty.

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17. Why Uniqueness

- As we have mentioned earlier, there are many possible representations of an object.
- Our goal is to select the most beautiful representation.
- In abstract terms, our goal is to select a representation a that maximizes the corresponding beauty $B(a)$.
- In contrast to science – that studies objects that already exist – art is about creating new objects.
- So, it makes sense to think of algorithms that can help in this creation.
- Art can reflect everything, so the corresponding optimization problems are very generic.

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18. Why Uniqueness (cont-d)

- In general:
 - the problem of finding the object that maximizes a given computable function
 - is not algorithmically solvable.
- However, there is an important case when:
 - under some reasonable condition, the corresponding algorithm *is* possible:
 - the case when there is exactly *one* optimizing object.
- Interestingly:
 - if we consider all the cases when there are *two* equally good optimizing objects,
 - such an algorithm is no longer possible.

19. Why Uniqueness (cont-d)

- So, the case of uniqueness is the most general case if we want our problems to be algorithmically solvable.
- We want to actually *create* a beautiful artistic reflection of a given real-life object or situation.
- So, a natural idea is:
 - to impose additional restrictions
 - that would make the optimal reflection unique.
- This is exactly what Sartre described as one of the main Baudelaire's ideas.
- Thus, this idea is indeed explained.

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